COVID-19's Impact on Physical Activity and Mental Health:

A Mixed-methods Longitudinal Study.

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Overview

The COVID-19 pandemic has negatively impacted people's physical and psychosocial wellbeing. While quantitative studies have examined the relationships between physical activity (PA) and mental health, a mixed method study is scarce. Further, the feasibility of 'socially prescribing' community activities as a pandemic recovery 'solution' remains unclear.

Part 1 comprises a Conceptual Introduction, an overview of the evidence and literature on the relationship between PA, depression, anxiety and loneliness prior to and during COVID-19. It considers the feasibility of social prescribing as a COVID-19 recovery solution and reviews methodology used in the literature to inform the empirical paper.

Part 2 is a prospective mixed method study of *how* and *why* PA, anxiety, depression, and self-perceived loneliness are related to inform the feasibility of social prescribing. Data from the Global COVID-19 Study wave 1 (April 17– July 17 2020, *N* = 1,037) were used to conduct follow-up interviews at wave 4 (March 18 – August 1, 2022). Twenty-one UK adults who self-identified as low or high-PA at wave 1 were recruited. Wave 1 findings highlighted depression and loneliness predicted low-PA levels relative to higher PA levels and depression were associated with higher odds of being in low-PA. Low-PA group described the threat of contracting COVID-19 affected their PA. Both PA groups cited the impacts of COVID-19 policies and heightened awareness of the mind-body connection. Participants endorsed social prescribing as a way to improve psychosocial wellbeing, but also identified the practical and emotional challenges affecting engagement.

Part 3 includes a discussion of assumptions, dilemmas and learnings from the research process, and ideas for future research.

Impact Statement

The findings of this thesis have implications for 'socially prescribing' community-based activity as a potential COVID-19 recovery solution to alleviate psychosocial distress and narrow the research-practice gap. It has extended previous quantitative research focusing on the earlier phases of COVID-19 outbreaks by investigating sustained patterns of behaviour. This mixed-method research has developed knowledge into *how* and *why* people's physical activity and mental health, namely self-perceived loneliness, depression and anxiety, were related over time. Specifically, data from the Global COVID-19 Study wave 1 (April 17 – July 17, 2020) were used to conduct follow-up one-on-one semi-structured interviews at wave 4 (March 18 – August 1, 2022). Twenty-one UK adults who self-identified as having high or low levels of physical activity at wave 1 were recruited and interviewed, which highlighted the similarities and/or differences in how people have fared during the pandemic. This research built on the literature that shows different patterns in how people's physical activity level and mental health have changed over time, and perceptions towards social prescribing as a COVID-19 recovery solution to meet increasing demand for mental health services.

Psychological distress gradually reduced for some after the easing of lockdown, whilst 23.8% of our UK follow-up sample continued to struggle. This increased knowledge has highlighted more support is still needed to help people recover from the adverse impacts of COVID-19. This has implications for utilising community resources when clinical psychologists and other healthcare professionals are supporting individuals in distress.

The benefits of 'social prescribing' are recognised, but our findings also highlighted several practical and emotional challenges affecting engagement.

Therefore, alongside changes around interpersonal, policy and population, that can be made to increase the feasibility and success of social prescribing, our findings also highlighted how healthcare professionals and link workers can engage with patients. The significance of working collaboratively with patients to listen to concerns and doubts, as well as identify and overcome barriers that hinder them from engaging with social prescribing, is also highlighted. As such, building supportive relationships and increasing their motivation and self-efficacy may increase feasibility and enhance social prescribing. Other changes can be made and advocated for by healthcare professionals. Healthcare professionals should work collaboratively across health, social and voluntary sectors to ensure options in offerings are provided to meet individuals' needs, increasing opportunities to socialise, help people feel heard and destigmatise mental health and/or loneliness among the general population.

Our findings emphasise that staying physically active is an effective means to protect people's mental health and reduce psychological distress caused by COVID-19. Public health policies and governmental responses should encourage people to maintain good levels of physical activity if faced with another pandemic. They should provide opportunities and resources for people who are new to exercising to build their skills, knowledge and self-efficacy on how to stay active. This information should be made widely available and accessible. Although many people feel that the pandemic has ended, longitudinal research examining the longer-term impact of COVID-19 on people's physical activity and mental health are necessary.

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I am grateful and privileged to have heard the moving accounts shared by the 21 UK participants with whom I interviewed. They have dedicated their time to speaking to me and sharing their stories, reflections and insights. I feel humbled as many of them described and spoke candidly about the gifts and struggles that stemmed from this pandemic and shared with me other significant life events that happened during this period. I also feel inspired by their hopes and struck by their

strengths. Our conversations have made me realise what this research project means to them, and they reminded me that there are still people out there who are struggling even after the easing of COVID-19 restrictions. My hope is that this project can make their voices heard, encourage us to take lessons from people's lived experiences and influence how organisations respond to a crisis.

Lastly, a big thank you to my family, friends and colleagues for their support and reassurance. They have reminded me of the bigger picture, encouraged me and believed in me. This project would not have come to fruition without their support.

Part 1: Conceptual Introduction

Understanding the Impacts of COVID-19 Pandemic on Physical Activity, Loneliness, Depression and Anxiety

Abstract

The COVID-19 pandemic has forced countries globally to enforce restrictions and lockdowns to reduce transmission, which has reduced physical activity and increased mental health issues, including loneliness, depressive and anxiety symptoms in the population. Some studies have shown improvement in depressive and anxiety symptoms after the easing of lockdown restrictions. However, other studies have shown that reduced physical activity levels and loneliness remained stable as lockdown measures eased. Little is known about the underlying nature and reasons why some people were highly active during the pandemic, yet others were inactive. This conceptual introduction will review the evidence on the relationship between physical activity and mental health outcomes before and during the COVID-19 pandemic. Based on the behavioural change literature, it is proposed that social factors – social support and social connectedness – could play a significant role in initiating and maintaining physical activity. In particular, 'socially prescribing' community-based activities post-pandemic, may improve exercise levels, reduce loneliness, and alleviate depressive and anxiety symptoms. The feasibility of social prescribing as a potential psychosocial recovery solution is considered, and research questions and hypotheses are proposed.

Introduction

This project intends to expand our knowledge on the roles of physical activity (PA) and loneliness on adults' mental health, namely depression and anxiety, across different countries during the global outbreak of coronavirus disease 2019 (COVID-19) pandemic. Prior to the pandemic, physical inactivity - a modifiable risk factor for non-communicable diseases (NCDs) – accounted for over 5 million deaths (9%), 6-10% of coronary heart disease, type 2 diabetes, breast and colon cancers (Lee et al., 2012) and cost international dollars (INT $) 53.8 billion on healthcare (Ding et al., 2016).

However, in spite of the vast health benefits, more than one in three adults in Europe do not meet recommended PA levels (of ≥150 minutes of moderate intensity PA per week) in 2016 (OECD/WHO, 2023). Globally, over a quarter of the population (27.5%) are insufficiently active (Guthold et al., 2018). Another global study warned that, if no actions were taken to improve physical inactivity, this will result in over 499 million new cases of preventable NCDs and mental health conditions worldwide by 2030, with direct healthcare cost of INT $520billion (Santos et al., 2023). Yet, despite having effective interventions for mental disorders, nearly 30% of individuals are affected by a common mental disorder during their lifetime (Steel et al., 2014), and disability-adjusted life-years for mental disorders have elevated by 55.1% between 1990 and 2019 (Global Burden of Diseases [GBD] 2019 Collaborators, 2022).

Whilst adopting a healthy lifestyle, including regular PA, is key for promoting physical and mental health, when the WHO declared the outbreak of novel coronavirus as a global pandemic on March 11, 2020 (Cucinotta & Vanelli, 2020), it caused negative changes to PA and increased psychological distress. As coronavirus is airborne and invisible to the naked eye, a key method of managing COVID cases has

been to isolate individuals through quarantine and, in more severe cases, local or national lockdowns to avoid person-to-person contact. This of course is not optimal for facilitating good mental health as social ties are being severed. Different countries have implemented varying degrees and lengths of measures to contain the spread of COVID, which is documented by the Oxford COVID-19 Government Response Tracker project (Hale et al., 2021). For example, a full lockdown approach or stay-at-home orders were used by many European countries (e.g., UK, France, Italy), while parts of Asia (e.g., Hong Kong, Taiwan, etc.) had strongly advised their residents to stay home, mask-up, without enforcing a nationwide lockdown (Wong et al., 2020). These measures have limited opportunities for in-person interactions, where researchers have raised concerns about increased feelings of loneliness (Killgore et al., 2020a). Invariably, COVID-19 has drastically changed people's social lives, daily routines and behaviours, which has had a profound implication on our physical and psychosocial wellbeing.

Studies suggest that lockdown caused a reduction in physical activity. A systematic review conducted in June 2020 found that 25 out of 26 studies that examined changes in time spent on PA have reported overall decreases since the onset of the COVID-19 lockdowns (Stockwell et al., 2021). A multi-nations survey conducted across 11 countries (e.g., Brazil, Bulgaria, US, China etc.) found that 40% of adults engaged in none or low PA level and 44.8% reported reduced PA levels between 1 June and 31 August 2020 (Ding et al., 2021). Of more concern is the early negative changes in PA levels from first lockdown which persisted into subsequent lockdowns among UK adults, without signs of recovery as restrictions eased (Mitchell et al., 2022). Global daily step counts were still 10% below pre-pandemic (May-November 2019) levels in May and November 2021 (Tison et al., 2022). While regular

PA can improve mental health (Zhang et al., 2020), reduced PA levels have been associated with higher levels of depression, anxiety and loneliness in lockdown (e.g., Jacob et al., 2020; Meyer et al., 2020; Wolf et al., 2021), and there is good evidence that an important part of the cause effect is from low exercise to poor mental health (Creese et al., 2021). It has been estimated that COVID-19 resulted in a global increase of 27.6% and 25.6% cases of major depressive disorders and anxiety disorders during 2020, respectively (Santomauro et al., 2021). Considering PA and sports are widely accessible to many and have fewer side effects than pharmacological interventions, these are encouraging scopes for preventing and treating common mental disorders (Lange et al., 2023).

In particular, clinical psychologists faced with individuals and patients struggling with mental health issues as we come out of the pandemic are in need of clinical advice. One evidence-based area that has received less attention is the positive benefits of community-based activities and/or social support groups. This engagement, known as 'social prescribing', encourages social connectedness, promotes health and wellbeing, and reduces healthcare use (NHS England and NHS Improvement, 2020). Addressing health disparities and reviewing how psychological services are delivered is imperative considering the increasing needs and demands due to COVID-19 (Gruber et al., 2021). Furthermore, it has been recognised that a significant proportion of people needing psychological services will not seek them due to the stigma of mental health difficulties; in England, an estimated 8 million people with mental health needs were unable to access services in 2021, and 1.2 million were waiting for community-based mental health service in 2022 (National Audit Office, 2023). In the realm of clinical psychology, this thesis intends to inform clinical practice

on how clinicians may utilise valuable community resources to optimise patients' physical and psychosocial wellbeing.

This conceptual review will explore ways of promoting PA participation to alleviate the adverse impacts of COVID-19 on individuals' mental health. To begin with, it will describe PA and measurements. It will then explore pre-/post-pandemic literature on the association between PA and depressive and anxiety symptoms and loneliness that are relevant for this study including the methodology and proposed hypotheses based on behavioural change theories. Lastly, it will describe the social prescribing literature, focusing on what practitioners and services must do to improve people's physical and psychosocial wellbeing and outlining knowledge gaps.

Physical Activity for Physical and Psychological Health

Definition and Measurement of Physical Activity

Physical activity (PA) is defined as "any bodily movement produced by skeletal muscles that require energy expenditure" (World Health Organization [WHO], 2010, p.53). It is distinctive to 'exercise' (a sub-group of PA, which involves planned, structured, and repetitive bodily movements) and 'physical fitness' (entails health-related components and specific skills) (Caspersen et al., 1985). The current WHO guideline recommends adults aged 18-64 years should engage in at least a) 150-300 minutes of moderate-intensity PA (i.e., raised heart rate and faster breathing, e.g. brisk walking, cycling), b) 75-150 minutes of vigorous-intensity PA (i.e., breathing harder and faster, e.g. running, football), or c) an equivalent combination of both moderate-to-vigorous PA (MVPA) during the week (Bull et al., 2020). The health implications of physical inactivity are of significant concern. As the fourth leading risk factor for mortality, it accounts for 6% of global deaths (WHO, 2010). The WHO has warned that physical inactivity is likely to be the primary cause for NCDs, including breast and colon

cancer, diabetes, and ischaemic heart disease. These are responsible for almost half of the global burden of disease and six out of 10 deaths. Physical inactivity is not only detrimental to our physical health but it has been associated with poor mental health, including bipolar disorder, depression, anxiety, loneliness, and stress (Chekroud et al., 2018; Firth et al., 2020; Fluetsch et al., 2019; Pels & Kleinert, 2016; Penedo & Dahn, 2005; Warburton et al., 2006). More recently, evidence showed that regular PA may reduce COVID-19 infection risk and mortality (Hamer et al., 2020; Sallis et al., 2021). Hence, supporting groups at risk of reduced PA or being inactive during and after the COVID-19 pandemic is of utmost importance for physical and mental health outcomes.

To understand what these global rates of PA represent, one must know how these constructs are being measured and assessed. Two main methods of measuring PA levels are objective measures (e.g., tracking apps, accelerometers and wearable devices) and self-reported measures (e.g., the International Physical Activity Questionnaire [IPAQ]; Craig et al., 2003). Advances in technology may provide more objective 'live' data in tracking PA. However, these methods are costly, require access to equipment, and the monitoring nature could lead to higher than usual PA levels due to social desirability bias (Hills et al., 2014). On the other hand, self-report measures such as the IPAQ-Short Form (IPAQ-SF) are widely used in research of sports and exercise to assess PA patterns. It captures the intensity, frequency and duration of types of activities, including walking, moderate-intensity and vigorous-intensity, over the last seven days. Previous research suggest that PA are more likely to be overestimated when using self-report measures rather than objective measures (Lee et al., 2011), but evidence shows that IPAQ-SF MVPA is moderately correlated with accelerometer measured MVPA (r = 0.31) (Rääsk et al., 2017). Additionally, it is a standardised and validated measure, with evidence of high test-retest reliability among

participants aged 16-69 years across 12 countries (Spearman's ρ = 0.76) (Craig et al., 2003).

PA, Depression, Anxiety, and Loneliness: Before COVID-19

Physical inactivity is associated with poor mental health outcomes, primarily depression, anxiety and loneliness. Evidence from prospective longitudinal studies suggests that regular PA is a protective factor against common mental disorders (i.e., depression and anxiety) (Mammen & Faulkner, 2013; McDowell et al., 2019; Schuch et al., 2019). In 2019, the global prevalence rates of depression and anxiety are 3.8% (2.49% major depressive disorder and 1.35% dysthymia) and 4.1%, respectively (Castaldelli-Maia & Bhugra, 2022). Previous research found that higher depressive and anxiety symptoms predicted higher levels of loneliness, and feeling lonely also increases the risk for depression and loneliness, which are likely to be bi-directional (Beutel et al., 2017; Mushtaq et al., 2014; Santini et al., 2020; Wang et al., 2018). Loneliness itself has been considered an epidemic that could occur across the lifespan (Fried et al., 2020; Luhmann & Hawkley, 2016), with prevalence at 5.3% (18-29 years), 6.9% (30-59 years), and 11.9% (≥60 years) pre-COVID-19 (Surkalim et al., 2022), although self-perceived loneliness levels reported by participants across the lifespan during the first lockdown was relatively stable (Wong et al., 2022). With the increasing rates of depression, anxiety and loneliness, research examining “lifestyle factors”, including PA, as a new method for preventing and treating mental disorders beside or without traditional mental health care is growing (Firth et al., 2020; Wanjau et al., 2023).

Interaction between PA, Depression and Anxiety

To understand the benefits of PA on depression and anxiety, we must first understand their symptoms and how these are being measured. As outlined in the

Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association [APA], 2013) (see text box 1), depression is characterised by persistent sadness and an absence of interest or pleasure from engaging in activities that were previously enjoyable or fulfilling. Generalised anxiety disorder (see text box 2) is characterised by constant anxiety or excessive and uncontrollable worry about many events and problems. The nine-item Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) and the seven-item Generalised Anxiety Disorder Scale (GAD-7; Spitzer et al., 2006) are reliable measures (Shevlin et al., 2022), and are widely used among the primary care (Arroll et al., 2010; Hinz et al., 2017) and general populations (Kocalevent et al., 2013; Löwe et al., 2008). Specifically, a total score of 10 or above are usually used as 'clinical cut-offs', suggesting probable clinically significant depression or anxiety.

Box 1. *DSM-5 (APA, 2013, p. 160-161) Diagnostic Criteria for Major Depression Episode*

"A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure."

1. Depressed mood most of the day, nearly every day
2. Markedly diminished interest or pleasure in all or almost all activities most of the day, nearly every day
3. Significant weight loss when not dieting or weight gain
4. Insomnia or hypersomnia nearly every day
5. Psychomotor agitation or retardation nearly every day
6. Fatigue or loss of energy nearly every day
7. Feelings of worthlessness or excessive or inappropriate guilt nearly every day
8. Diminished ability to think or concentrate or indecisiveness, nearly every day
9. Recurrent thoughts of death, suicidal ideation, plan or attempt

Box 2. *DSM-5 (APA, 2013, p. 222) Diagnostic Criteria for Generalised Anxiety Disorder*

A. Excessive anxiety and worry, occurring more days than not for at least 6 months, about a number of events or activities.
B. The individual finds it difficult to control the worry.
C. The anxiety and worry are associated with three (or more) of the following six symptoms - some of which must be present for more days than not for the last 6 months:

1. Restlessness or feeling 'keyed up' or on edge
2. Easily fatigued
3. Difficulty concentrating or mind going blank
4. Irritability
5. Muscle tension
6. Sleep disturbance (difficulty falling or staying asleep, or restless unsatisfying sleep)

The benefits of PA on mood and anxiety are broadly recognised in both clinical and non-clinical samples (e.g., De Moor et al., 2006; Dunn et al., 2001; Goodwin, 2003; Herring et al., 2010; Molarius et al., 2009; Saxena et al., 2005). Group exercise has been recommended as an intervention for people with mild to moderate depression (National Institute for Health and Care Excellence [NICE], 2022). Early evidence for anxiety disorder is promising, but there is a need for more research on this (NICE, 2020). For the non-clinical adult populations, a meta-analysis of meta-analyses (Rebar et al., 2015) concluded that PA has a moderate anti-depressive (standardised mean difference [SMD] = -0.50) and a small anxiolytic effect (SMD = -0.38). A large UK prospective cohort study (*n* = 60,235) using accelerometer data indicated that engaging in 60 minutes of MVPA instead of sedentary behaviour had the greatest effect on reducing depression symptoms and anxiety symptom scores (13% and 7%, respectively), though smaller and more realistic changes of engaging in any PA (<60 minutes) could still be beneficial for alleviating mental health risks (Kandola et al., 2021).

The social components of PA are associated with an enhanced psychological effect. For example, a cross-sectional study of 1.2 million US adults found that participants who engaged in any type of exercise had fewer days of self-reported poor mental health in the past month than participants who did not exercise. However, team sports were associated with the lowest mental health burden than other types of exercise (Chekroud et al., 2018). A prospective longitudinal study of 2,932 Dutch adults showed that lower sports participation (i.e., out-of-home organised sports activity) was the only predictor of increased anxiety and depression severity and the likelihood of developing a disorder after two years, while more severe anxiety and depressive symptoms or a diagnosis predicted lower general PA and sports participation two years later (Hiles et al., 2017). This suggests that the relationship between PA and mental health is likely to be bi-directional and complex, influenced by other factors (e.g., social engagement, motivation and self-efficacy).

Whilst regular PA participation is associated with better mental health, research has proposed that several complex physiological and psychosocial mechanisms may be responsible for reducing symptoms of depression and anxiety (Mikkelsen et al., 2017; Teychenne et al., 2020). Biologically, PA may produce elevated endorphins, activate the release of serotonin and adrenaline, promote neuroplasticity, and attenuate the hypothalamic-pituitary-adrenal axis reaction to stress (Anderson & Shivakumar, 2013; Dinas et al., 2011). Psychologically, several hypotheses have been proposed on how PA may contribute to better mental health, including distraction, self-efficacy and social interaction (Paluska & Schwenk, 2000; Peluso & De Andrade, 2005). The distraction hypothesis (Morgan, 1985) proposed that exercise could divert individuals from stressful stimuli, akin to a time-out from the challenges of daily life, leading to improved mood post-exercise (Mikkelsen et al., 2017). However, the

evidence for a better mood state after exercise is ascribed to distraction from worry or rumination is mixed (Chan et al., 2019). The self-efficacy hypothesis (North et al., 1990), developed from Bandura's self-efficacy theory (1977), postulates that exercise is challenging. Hence, individuals who successfully transitioned from a sedentary lifestyle to being regular exercisers are likely to experience mood enhancement and increased feelings of competence and confidence in their ability to be physically active (i.e., exercise self-efficacy). Indeed, previous research showed that exercise self-efficacy is an important correlate and determinant of PA participation (Bauman et al., 2012; Trost et al., 2002; Williams & French, 2011). Lastly, the social interaction hypothesis (Ransford, 1982) proposes that the social relationships and mutual support between individuals facilitated through exercise are beneficial to mental health, and this will be discussed in the section below.

Interaction between PA and Loneliness

Self-perceived loneliness is described as the unpleasant and distressing feelings that occur when individuals perceive a discrepancy between their desired and current social ties (de Jong Gierveld, 1998; Perlman & Peplau, 1981). It is therefore distinct from social isolation - the objective absence of meaningful social contact or support (de Jong Gierveld et al., 2006). Thus, individuals who are alone may not experience loneliness and lonely individuals may not be alone (Perlman & Peplau, 1981).

To understand the implications of loneliness on health outcomes, one must first understand how it is evaluated. Epidemiological studies have commonly used single-item questions to directly evaluate loneliness by asking questions that explicitly refer to the terms "lonely" or "loneliness" (Shiovitz-Ezra & Ayalon, 2012). These terms are potentially stigmatising and socially undesirable, which may lead to under-reporting

due to feelings of shame for being alone (Barreto et al., 2022). In addition, the assumption that respondents would have a shared understanding of the terms “loneliness” or “lonely” could also lead to an underestimation (Victor et al., 2000). As such, indirect measures like the Revised UCLA Loneliness Scale (Russell, 1996), a reliable and valid questionnaire assessing loneliness, are recommended (Das et al., 2021; Maes et al., 2022).

Loneliness has been associated with higher mortality and morbidity, higher cholesterol, poorer sleep, more severe mental health symptoms (e.g., anxiety, depression and paranoia), and increased risk for Alzheimer’s disease among older adults (Holt-Lunstad et al., 2015; Lim et al., 2020; Park et al., 2020). A large-scale study of German adults (*n* = 15,010; aged 35-74 years) found that loneliness increases the odds of depression by nearly two-fold and generalised anxiety by 21%, regardless of demographic variables such as age, gender, partnership and socioeconomic status (Beutel et al., 2017). Moreover, not meeting the PA guidelines might play a significant role in the relationship between loneliness and poor physical and mental wellbeing (Diehl et al., 2018; Richard et al., 2017; Vancampfort et al., 2019). Yet, evidence on the bidirectional association between loneliness and PA is inconsistent. Some studies reported no association (Lindsay Smith et al., 2017; Pels & Kleinert, 2016), but other studies found physical inactivity is related to higher levels of loneliness. While intervention studies found that PA can reduce loneliness (Pels & Kleinert, 2016), it has also been proposed that lonely individuals are more likely to be physically inactive because of reduced capacity to regulate their emotions and behaviours (Hawkley et al., 2009). Conversely, literature focusing on older adults or school-aged children suggest that PA participations with social aspects (e.g., having a social partner, group activity or sports) have many benefits, including opportunities for social interaction,

shared experience, common interest, increased social support, forming social ties, mutual enjoyment, fostering a sense of belonging, which can buffer against loneliness (Kahlbaugh et al., 2011; Tubic et al., 2023). PA participation not only fulfils social needs, but can distract individuals from worry or rumination, improve their self-efficacy, and foster positive emotions (Anderson & Shivakumar, 2013; Kim et al., 2017; Peluso & De Andrade, 2005).

COVID-19, Physical Activity and Mental Health

The Relationships Between PA and Depression and Anxiety

COVID-19 restriction measures have directly impacted on PA globally. Numerous reviews conducted between mid-2020 and late-2021 found that most studies reported a significant decline in PA during lockdown (Christensen et al., 2022; Stockwell et al., 2021; Wilke et al., 2022; Wunsch et al., 2022). This is potentially due to a lack of perceived physical opportunity to access desired PA with the closure of sports facilities (e.g., gyms and swimming pools) and a ban on organised team sports, as well as lowered motivation for PA (Forde et al., 2022; Howe et al., 2021). Yet, increased PA indoors during the acute phase of the pandemic seemed to be a protective factor against depression and anxiety (Zhu et al., 2022).

Finding ways to maintain an active lifestyle during the pandemic was not only necessary for physical health but also beneficial for mental health (Bentlage et al., 2020). Specifically, a meta-analysis including 68 studies from 19 countries concluded that one in three adults in the general population had anxiety or depression during COVID-19, but the effects are heterogenous (Wang et al., 2020). Psychological distress was greater among younger people (<35 years), women, those of lower socioeconomic status, those living in rural areas, those living in severely affected

areas, and those having pre-existing physical conditions or mental health problems (Saunders et al., 2022; Wang et al., 2020; Xiong et al., 2020).

During COVID-19, reduced PA level was associated with higher psychological distress (anxiety and depressive symptoms) among the general population across different countries (Cross et al., 2021; Jacob et al., 2020; Meyer et al., 2020; Pieh et al., 2020). While these studies are useful, different measurement instruments were used to assess different aspects of PA (e.g., intensity, duration and frequency) making comparisons between studies challenging, whereas a standardised measure (e.g., IPAQ-SF) would have enhanced the comparability of findings across studies.

Studies that included the IPAQ-SF have consistently shown significantly more depressive and anxiety symptoms among those who reported a negative change in their PA after COVID-19 restrictions were imposed (Faulkner et al., 2021; Gierc et al., 2021). One cross-sectional study of 11,775 adults living in 11 countries (e.g., Brazil, China, Spain etc.) found that more depressive and anxiety symptoms were associated with increased odds of reduced PA during lockdown (Ding et al., 2021). More depressive symptoms were also associated with increased chance of being insufficiently active (no or low PA). Another cross-sectional study conducted among Chinese college students (n = 1,396) found a greater association between PA and depression than the association between PA and anxiety (Xiang et al., 2020). Specifically, those who engaged in moderate and high PA levels reported less depressive symptoms compared to those engaged in low PA, whereas only those who engaged in high PA had less anxiety symptoms compared to those engaged in low PA. Similar findings have been reported in longitudinal research. For example, a four-time-point Spanish quantitative study conducted between 14 March 2020 and 4 May 2020 found that depressive symptoms increased across the home confinement period,

but being sufficiently active (measured by the IPAQ-SF) can avoid more depressive symptoms from developing (Cecchini et al., 2021). Despite this, the majority of studies to date are cross-sectional or have compared PA behaviour between pre- and during the initial lockdown.

Although the importance of maintaining a healthy lifestyle is widely recognised, a few longitudinal studies reported little change in PA levels from lockdown to after the easing of restrictions. A substantial proportion (29%) of the UK general population had reported reduced PA during and after the first lockdown (March-August 2020) and some (12%) were consistently inactive (Bu et al., 2021). A longitudinal study conducted in the UK and New Zealand found that mental health (e.g. total scores of depression, anxiety and stress) improved between containment period and following easing of restrictions, but not PA (Faulkner et al., 2022). However, it is not possible to determine whether change in mental health differed between depression and anxiety. Instead, a UK longitudinal study investigated changes in depressive (measured by PHQ-9) and anxiety symptoms (measured by GAD-7) and health behaviours, including PA (measured by the IPAQ), between the first lockdown (May-June 2020) and 12 months later (Solomon-Moore et al., 2022). There were no significant differences in PA and depressive symptoms across time, but anxiety symptoms did improve. However, the proportion of participants reporting moderate-to-severe levels of anxiety remained the same. The underlying reasons why there was little change in PA levels and depressive symptoms even after lockdown restrictions had been eased remain unknown.

The Relationship Between PA and Loneliness

Quantitative research from different countries have found increased levels of loneliness during the early phases of the pandemic (Killgore et al., 2020b; Kovacs et

al., 2021). For instance, almost a third (35.86%) of the UK general population reported feeling loneliness sometimes or often in April 2020 (Li & Wang, 2020). A cross-sectional survey encompassing a retrospective measure element found that one-fifth (21%) of the respondents from 101 countries (*n* = 20,398) reported severe loneliness between June and November 2020 compared with 6% before the pandemic (O'Sullivan et al., 2021). Loneliness levels were higher among young adults (18-30 years), women, those with lower incomes, those living alone, students, and those experiencing mental health difficulties (Bu et al., 2020; Groarke et al., 2020; Varga et al., 2021). Yet, other studies have found no significant increase in loneliness, which could be partly explained by the greater perceived support (Luchetti et al., 2020). Furthermore, a meta-analysis including studies with longitudinal designs assessing loneliness before and during the pandemic (*N* = 45,734) concluded that the pandemic only had a small effect on increases in feelings of loneliness and prevalence (Ernst et al., 2022). However, some studies have used unvalidated single-item measures or adapted questionnaires.

Findings of cross-sectional research indicate that increased loneliness, assessed by 3-item or 8-item short version of the UCLA, is associated with increased severity of depression and anxiety symptoms (McQuaid et al., 2021; Palgi et al., 2020). Conversely, maintaining regular PA is associated with reduced likelihood for loneliness, psychological distress and increased social relatedness (Antunes et al., 2021; Werneck et al., 2021). Specifically, engaging in daily PA during lockdown is related to feeling less lonely, reduced negative perception about restrictions, and fewer worries about the pandemic (Haucke et al., 2022). This, in turn, may lower stress levels. However, causality cannot be inferred from cross-sectional relationships.

A few longitudinal cohort studies have examined physical and psychosocial wellbeing during lockdown relative to pre-pandemic data. Most of these studies were conducted with specific groups and focus on the first lockdown. For example, a UK longitudinal study conducted between 10 April and 30 June 2020 found worsening moderate and severe depressive symptoms and across all severity of anxiety symptoms (e.g. mild, moderate, and severe) during lockdown compared to pre-pandemic data among 1,860 mothers (Dickerson et al., 2022). Feelings of loneliness and insufficient PA during lockdown were associated with more depressive and anxiety symptoms. Similarly, another longitudinal study found that increased loneliness and reduced PA are related to more depressive and anxiety symptoms among UK participants over the age of 50 during the earlier phases of the pandemic (May-June 2020) (Creese et al., 2021).

Trends in PA, depression, anxiety and loneliness during subsequent waves were examined in other longitudinal studies. For instance, a study of 280 Canadian adults reported less depressive and anxiety symptoms from May 2020 to August 2020, followed by more symptoms between September 2020 and January 2021(Lowe et al., 2022). These changes corresponded to infection rates and subsequent public health responses, but loneliness did not change. Moreover, higher PA levels pre-pandemic and maintenance of PA during the pandemic were both related to fewer depressive symptoms from May 2020 to January 2021. These were also reflected in UK longitudinal qualitative studies conducted with older adults examining the impacts of COVID-19 over six and 12 months, where some participants described feeling less motivated to engage in PA, greater feelings of loneliness, psychological distress (low mood and anxiety), reduced sense of belongingness and resilience (Bloom et al., 2022; Derrer-Merk et al., 2022). Additionally, seasonality, changes to usual ways of

working and worries about the safety in sport facilities or group activities are thought to be some of the reasons for not returning to usual PA routines (Howe et al., 2021; Mitchell et al., 2022; Strain et al., 2022). However, there is limited knowledge about *how* and *why* PA and mental health are related, which can be addressed by qualitative research (Tremblay et al., 2021).

Indeed, qualitative research concerning PA have been conducted with particular groups, including regular gym users (Kaur et al., 2020), older adults (65-91 years) (Adams et al., 2021), and individuals with severe mental health illnesses (Newbronner et al., 2022). One UK qualitative study interviewed 116 participants who were purposively sampled based on the perceived greater impact from COVID-19 on their PA and mental health levels (i.e., 18-24 years, 70+ years, parents of young children, and individuals with long-term physical or mental health conditions) between May 2020 and January 2021 (Roche et al., 2022). Reflexive thematic analysis was used with an inductive approach to identify four broader themes which can be barriers or facilitators: 'importance of the outdoor environment', 'the impact of COVID-19 restrictions', 'fear of contracting COVID-19 and related complications' and 'level of engagement with home exercise'. Similar themes were reported by Canadian adults with mixed levels of PA (n = 12), where 'disruption to daily routines', 'changes in PA', 'balancing health', and 'family life' were identified using thematic analysis. These ascribed both positive and negative implications of COVID-19 on PA. For instance, some participants maintained their PA because they adapted their exercise routines to outdoor activities (e.g., walking or cycling) or home exercise, whilst others became less active as they experienced challenges in finding alternative activities. This is consistent with quantitative research that found going outside more regularly is associated with increased PA (Cross et al., 2021) and better mental health (Cindrich et al., 2021; Stock

et al., 2022), but also related to higher anxiety levels during home confinement periods (Young et al., 2022). The relationship between PA and mental health is complex, and likely to interact with personal, environmental and situational factors. Existing qualitative studies primarily focusing on individuals from particular sociodemographic groups are explanative, but it is still not clear why some people in the UK were highly active and others were not during the pandemic despite receiving the same government lockdown guidelines and suggestions on how to stay active in lockdown. Whilst PA is associated with various mental health outcomes, such as less feelings of loneliness, depressive and anxiety symptoms, and is seen as a protective factor of mental health outcomes – the question that remains is how do we promote PA?

Several theories which have helped identify PA behavioural change mechanisms in this literature are the Theory of Planned Behaviour (TPB; Ajzen, 1991), Social Cognitive Theory (SCT; Bandura, 1989), Self-determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2000), and 'Capability, Opportunity, Motivation and Behaviour' (COM-B) model (Michie et al., 2011). A review of 51 PA intervention studies among adult nonclinical populations conducted in the non-pandemic context concluded that no single theory or construct seems to be a main motivator for mediating behaviour change (Rhodes et al., 2021). Despite this, several theories have stressed the significance of social support and social connectedness in PA behavioural change (McEachan et al., 2011; Ntoumanis et al., 2021; Young et al., 2014). For instance, evidence shows that activity coach characteristics, shared learning opportunities, engaging with others who shared similar experiences, increased meaningful interaction, and responsibility were valued by older adults who participated in PA intervention to reduce loneliness (Franke et al., 2021). These findings are also consistent with the perspectives of mental health practitioners for addressing

loneliness, where they recognised the potential of increasing opportunity for social interactions and helping people build connections with their community (Stefanidou et al., 2021).

In the pandemic context, numerous studies have been conducted to examine PA facilitators and barriers using the COM-B model (Knight et al., 2021). This proposes that the interactions of three components, individuals' capability (physical and psychological), opportunity (physical or social), and motivation (reflective and automatic), influence on the target behaviour (Michie et al., 2011). Research found that improving people's knowledge and stamina and physical opportunity become the primary focus (Hailey et al., 2022; Knight et al., 2021; Roche et al., 2022). For example, one cross-sectional survey encompassing an open-text question on how the 4-week lockdown in New Zealand in 2020 changed PA among young people (16-24 years, *n* = 2,014) was conducted between late May and June 2020 (Trask et al., 2023). The qualitative responses were thematically analysed using a deductive approach that drew on a strengths-based framework and informed by the COM-B model. Findings highlighted that more effort and intentionality are required to find opportunities for alternative PA (i.e. capability) during lockdown, promoting successful adaptations to be physically active. Meanwhile, limited opportunities for PA, loss of usual PA routine and exercise facilities coupled with fewer opportunities for social interactions were likely contributors to lowered motivation during lockdown. Furthermore, psychological distress and fear of contracting COVID-19 also played a role in influencing PA behaviours. Considering that some people had still not returned to their usual PA levels post-lockdown (e.g. Bu et al., 2021), it is imperative that all three components of the COM-B model (i.e. capability, opportunity and motivation) should be targeted during the recovery phase.

Social Prescribing: A Pandemic recovery 'solution'

'Social Prescribing' (SP) focuses on connecting people seen at healthcare services to non-medical community-based activity and assets. These include skills development, group learning, social support, befriending programmes, and community activities, which aim to empower individuals and target social determinants of health (Jani & Gray, 2019; Office for Health Improvement & Disparities, 2022). SP and related methods have been used in the NHS for at least 30 years, though it is gaining greater prominence today (Buck & Ewbank, 2020) and has become a key aspect in the NHS England Long Term Plan (NHS, 2019). This approach can potentially reduce the negative physical and psychosocial impact of COVID-19 (Royal College of Psychiatrists, 2021).

There is growing evidence from quantitative and qualitative research indicating that SP has a positive impact on numerous health and well-being outcomes. A systematic review found that eight out of 10 studies reported a positive effect of SP on physical or psychological wellbeing (Costa et al., 2021). It is associated with increased social connectedness, lowered anxiety, depression and loneliness, which in turn, reduced referrals to secondary care and usage of primary healthcare (Kellezi et al., 2019; Maughan et al., 2016; Woodall et al., 2018), Furthermore, social connectedness might play a more significant role in the context of COVID-19. For example, Quirk et al. (2022) investigated changes in health, well-being and PA levels among UK park runners (n=438) when a weekly community-based PA opportunity (i.e., Parkrun events) was stopped abruptly during the pandemic. They found that this has not only reduced happiness and life satisfaction by 12% and PA levels by 6%, but the greatest impact has been their connections with others, including the socialisation and community of park run. However, the effectiveness of SP for health outcomes is not

supported by enough robust research (Cooper et al., 2022). More research using standardised outcome measurements is needed to understand what aspects of SP are responsible for change considering how the activities and approaches may differ across settings.

Literature on 'social cure' emphasises the role of group memberships and social identities as determinants of psychosocial health (Jetten et al., 2012). Indeed, adopting community models could be more effective than individual models for increasing reach, building social connection and fostering community belonging, resulting in positive health outcomes (Younan et al., 2020). Despite its potential to increase social connectedness and alleviate the physical and psychological impacts of COVID-19, barriers to engagement must be considered when determining the potential of SP. A meta-synthesis of qualitative literature exploring people's experiences of participating in any social prescribing intervention to address loneliness or social isolation identified three themes, including 'increased sense of wellbeing', 'factors that engendered an ongoing desire to connect with others' and 'perceived drawbacks of social prescribing' (Liebmann et al., 2022). They suggested that SP are seen as beneficials for addressing loneliness and social isolation, but lack of appropriate choice of SP activities, incompatibility with approach of their link worker, or being too unwell to participate were identified as well (Liebmann et al., 2022). Stuart et al. (2022) interviewed 11 middle aged and older adults (48-86 years) who are already feeling lonely or isolated about barriers to participating in groups. They identified three main themes: 'when groups do not meet needs', 'accumulative barriers over the lifetime', and 'the challenges of fitting in with others in groups'. These studies are helpful, but little is known about its potential from the perspectives of the wider general population on SP as an intervention for improving mental health impact of COVID-19.

In addition to perceived values and drawbacks of SP, there are concerns about inequitable access to SP. This will worsen rather than lessen existing health inequalities. Data from the Royal College of General Practitioners Research and Surveillance Centre show that SP referral rates are significantly higher than average among people ≥65 years, and less than expected for people ≤40 years (Jani et al., 2020). This indicated that people of other age groups (e.g., children, young people and younger adults) who need support may be overlooked. Moreover, individuals' context and circumstances are likely to influence the way in which they interact with SP during COVID-19 where those who have lower digital skills were affected more (Morris et al., 2022). While other countries (e.g., US, Australia, Canada) have prioritised offering SP to people experiencing food insecurity or social isolation (Morse et al., 2022), how the wider population feels about receiving SP is yet to be explored fully.

Summary and aims of the thesis

Summary

Overall, the impacts of COVID-19 on people's physical activity and mental health, namely depression, anxiety and loneliness, are complex and heterogeneous. Studies have consistently shown an overall decline in time spent engaging in PA during the first lockdown relative to pre-pandemic data (Stockwell et al., 2021), though findings are limited by the use of brief, unstandardised measures for PA, rather than standardised instruments (e.g., the IPAQ-SF; Craig et al., 2003) in the general population. It is evident that negative changes in PA are associated with increased anxiety and depressive symptoms during lockdown (Violant-Holz et al., 2020; Wolf et al., 2021). The health benefits of regular PA are well acknowledged, and this has become even more important during the pandemic as a modifiable health behaviour

that can be used to alleviate distress and in turn, prevent the development of mental health conditions.

Yet, despite the health benefits of PA, little is known about the challenges of engaging in PA during COVID-19 among the general population, what they perceived were the effects on their mental health, and the types of support that are needed (Wong et al., 2022), which can be explored using qualitative approach. However, qualitative studies on this topic are scarce and many have been conducted with specific demographic groups that are considered to be most affected by lockdown restrictions (Roche et al., 2022). These are informative, but none have focused and compared those who engaged in low PA versus high PA levels during the first lockdown. A mixed methods approach can therefore provide both quantitative and qualitative insights (Johnson & Onwuegbuzie, 2004), which can enhance our understanding into the impacts of COVID-19 on PA and mental health to inform potential recovery solutions. Additionally, several behavioural change theories have highlighted the importance of social factors, including social support and social connectedness, for initiating and maintaining PA behaviours (McEachan et al., 2011; Ntoumanis et al., 2021; Young et al., 2014).

In addition to social factors, implementing measures to address individuals' level psychological factors, namely mental health and cognitions, and helping to improve access and physical opportunity to participate in PA is pivotal to reduce the extensive consequences of the COVID-19 pandemic (Knight et al., 2021). As such, SP would appear to be a feasible pandemic recovery solution for addressing the physical and psychosocial impacts of COVID-19 pandemic for some people, but this approach may not be viable for all.

Aims of the thesis

This conceptual introduction examined the current literature on the relationships between PA, depression, anxiety and loneliness in both non-pandemic and pandemic contexts. However, it is still unclear how and why PA and mental health have changed since the onset of the pandemic, what support is needed to help people recover, and whether 'socially prescribing' community-based activities are a potential solution. In turn, this could inform public health strategies and clinical practice for ways to improve and/or preserve people's physical and mental health during the pandemic, including subgroups which are more vulnerable, as well as supporting those who are experiencing the longer-term effects from lockdown.

The overall aim of this mixed-methods thesis was to understand the causes of poor mental health during the COVID-19 pandemic to inform the feasibility of 'socially prescribing' community-based activities as a potential recovery solution. It encompasses secondary analysis of the wave 1 data (April to July 2020) collected as part of the UCL-Penn Global COVID study (Wong & Raine, 2020) and follow-up interviews with UK participants who self-reported high or low PA levels in wave 1 were conducted two years later (March to August 2022). To provide context, wave 1 data collection period began four weeks after the first national lockdown was introduced and ended 13 days after the lifting of restrictions.

The following approaches were taken to examine these research questions:

1. Is there a bivariate association between reduced levels of PA associated with increased levels of loneliness, anxiety and depressive symptoms at wave 1 of COVID-19?

   H1: Individuals with higher levels of PA (high/moderate-PA group) will have lower levels of loneliness, anxiety, and depressive symptoms compared to those in the low-PA group.

   Analysis: Bivariate correlations were conducted to examine whether individuals who were physically active (high/moderate-PA) compared to those who were physically inactive (low-PA) reported higher levels of loneliness (Revised UCLA Loneliness Scale 20-items total scores), anxiety (GAD-7 total scores) and depressive symptoms (PHQ-9 total scores). A multivariate multiple regression analysis was conducted to further investigate the relationship between PA levels (IV; 3 levels) and levels of loneliness, anxiety and depressive symptoms (DVs). Correlated sociodemographic factors (including, age, ethnicity, gender, marriage status, socioeconomic status, education, household size, and existing physical/ mental health conditions) (IVs) were included.

2. Do levels of loneliness, anxiety and depressive symptoms predict the likelihood of low PA at Wave 1 of COVID-19 when controlling for covariates?

   H2: Individuals with higher levels of loneliness, anxiety, and depressive symptoms will be more likely to be in the low-PA group during COVID-19 when controlling for covariates.

Analysis: Two logistic regressions were conducted to examine whether levels of loneliness, anxiety and depressive symptoms (IVs) predicted the likelihood of PA groups (DV: low vs. moderate-PA or high vs. moderate-PA) after adjusting for correlated sociodemographic variables and pre-COVID IPAQ-SF PA levels.

Qualitative phase.

1. What are the challenges to PA participation?
2. What are people's impressions of Social Prescribing?

Semi-structured qualitative interviews were carried out to gain a better understanding of the quantitative relationships observed and explore what motivated or hindered PA during the pandemic. Then, it explored what support might people need during and after COVID-19. In particular, it focused on the feasibility of SP as a potential COVID-19 recovery solution to improve people's physical and mental health. Reflexive thematic analysis (Braun & Clarke, 2006, 2019), a six-phase qualitative analysis process, was applied to identify patterns of meaning and themes that the participants shared or differed concerning their PA and mental health during the pandemic. This provided an insight into the potential solutions of SP to improve people's physical and psychosocial wellbeing when recovering from the pandemic.

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Part 2: Empirical Paper

COVID-19's Impacts on Physical Activity and Mental Health: A Mixed-methods Longitudinal Study

Abstract

Background. The global COVID-19 pandemic has negatively impacted people's physical and mental health, but qualitative studies are scarce.

Aims. To investigate how and why physical activity (PA), loneliness, depression and anxiety are related during the pandemic to inform the feasibility of 'socially prescribing' community-based activity as a pandemic recovery solution.

Method. Prospective mixed method study using data from the Global COVID-19 Study wave 1 (April 17 – July 17, 2020, *N* = 1,037) to conduct follow-up one-on-one semi-structured interviews at wave 4 (March 18 – August 1, 2022). Twenty-one UK adults self-identified as low or high-PA at wave 1 were recruited using purposive sampling. Data were thematically analysed.

Results. Multivariant analyses showed more depressive symptoms and higher levels of loneliness predicted low-PA levels compared to moderate/high-PA levels. Increased depressive symptoms were associated with higher odds of being in low-PA compared to the high-PA group. Participants from the low-PA group described the threats of contracting COVID-19 contributed to reduced PA. Both high/low-PA groups spoke about the impacts of COVID-19 policies – including lack of in-person socialising, and heightened awareness of the mind-body connection. While social prescribing was commonly endorsed by the participants to reduce loneliness and provide purposeful activities, all participants spoke about the practical and emotional challenges affecting engagement.

Conclusions. While keeping an active lifestyle is important for mental wellbeing during the pandemic and social prescribing seems to be a feasible COVID-19 recovery solution, healthcare professionals and link workers play an important role in promoting engagement.

Introduction

Globally, the outbreak of coronavirus disease 2019 (COVID-19) caused sudden and unprecedented disruptions to our day-to-day life. Many countries have enforced disease control policies of varying stringency, such as lockdown and social distancing measures (Hale et al., 2021). These interventions were intended to reduce the rate of infection but have also caused higher prevalence of psychological distress, such as feelings of loneliness (Carollo et al., 2022; Groarke et al., 2020; Wong et al., 2021), more depressive and anxiety symptoms (Pieh et al., 2020), and reduced physical activity (PA) (Ding et al., 2021; Maugeri et al., 2020). Indeed, even before the pandemic, over a quarter (27.5%) of the global population was insufficiently active (Guthold et al., 2018) as defined by not meeting the World Health Organisation (WHO, 2010) PA guidelines for health benefits, that is at least 150 minutes of moderate-intensity, 75 minutes of vigorous-intensity, or any equivalent combination of moderate-to-vigorous PA per week. Researchers have expressed concerns about the increasing risk of reduced PA and social isolation caused by lockdown, resulting in further deterioration of an individual's physical and psychosocial wellbeing (Füzéki et al., 2020; Hall et al., 2021).

Physical inactivity – the fourth leading risk factor for mortality – is a modifiable risk factor for major non-communicable diseases, such as coronary heart disease, Type 2 diabetes, breast and colon cancers (Arem et al., 2015; WHO, 2010). Research has highlighted many health benefits of PA on physical and psychological wellbeing, including lowered stress, anxiety, depression (Molarius et al., 2009; Rebar et al., 2015; Warburton et al., 2006), and even lower COVID-19 infection risk and mortality (Hamer et al., 2020; Sallis et al., 2021). A systematic review found that lockdown has been associated with reduced levels of PA among the non-clinical population (Stockwell et

al., 2021). One survey conducted in 14 countries (e.g., Australia, USA, Italy, Singapore) (*n* = 13,503) between 3 April and 9 May 2020 showed that only 62.5% of the sample met the WHO recommended PA levels – a reduction from 80.9% before restrictions (Wilke et al., 2021). Nevertheless, keeping an active lifestyle during COVID-19 seems to protect against depression, anxiety and loneliness in 2020 (Christoffersen et al., 2023; O'Sullivan et al., 2021; Santomauro et al., 2021; Wang et al., 2020). Indeed, numerous cross-sectional studies have shown that individuals who engaged in lower PA levels reported more depressive, anxiety symptoms, greater feelings of loneliness and lower wellbeing than those individuals who engaged in higher PA levels (Jacob et al., 2020; Meyer et al., 2020; Wolf et al., 2021; Xiang et al., 2020). While longitudinal studies conducted with Spanish adults (Cecchini et al., 2021) and Chinese college students (Zhang et al., 2020) indicated that being physically active may directly mitigate the psychological distress caused by lockdown, limited access to preferred or usual PA, governmental advice to stay home, and reduced motivations are likely barriers for engaging in PA (Forde et al., 2022; Howe et al., 2021). Still, some longitudinal studies show no significant changes in PA level during and after the easing of initial lockdown restrictions (Faulkner et al., 2022) and 12 months later (Solomon-Moore et al., 2022). Moreover, 28.6% of the UK general population reported sustained reduced PA level from the first global lockdown in March 2020 and post-lockdown in August 2020, and an additional 11.6% were consistently inactive (Bu et al., 2021).

A key challenge in capturing how PA fluctuates over time or is stable is in how PA is measured. PA measures have varied considerably (Stockwell et al., 2021), making it difficult to compare both the *intensity* and *duration* of PA across studies. All limitations can be addressed by using a standardised PA measure such as the

International Physical Activity Questionnaire (IPAQ-Short Form) (Craig et al., 2003). Nevertheless, most studies to date examining the impact of COVID-19 on PA and mental health outcomes have been quantitative, and precludes the understanding of *why* and *how* reduced PA is related to higher psychological distress during lockdown, as well as the underlying reasons for some individuals to not resume their usual activity levels despite having more opportunities when restrictions have eased.

Qualitative research can build on quantitative studies to better understand the *why* and *how* of people's experiences during the pandemic and to inform health strategies (Tremblay et al., 2021). Most qualitative studies have explored the impacts of COVID-19 on PA of specific groups, such as regular gym users (Kaur et al., 2020) or participants who are more vulnerable based on their sociodemographic or health factors (Adams et al., 2021; Newbronner et al., 2022; Roche et al., 2022), and only a few studies have focused on the general population (Hailey et al., 2022; Petersen et al., 2021). A study in the UK conducted thematic analysis on free-text survey data from 5,396 adults collected between 14th October and 26th November 2020 (Hailey et al., 2022) – which coincided with the second UK lockdown. Participants spoke about the facilitating factors and barriers for PA during COVID-19, which included seven main themes: 'the importance of outdoor space', 'changes in daily routine', 'COVID-19 restrictions prevented participation', 'perceived risks or threats to participation', 'the importance of physical health', 'the importance of physical activity for mental health', and 'the use of technology'. Although these findings are meaningful and themes were mapped onto the Capability, Opportunity, Motivation, and Behavioural (COM-B) Model of Behaviour (see Chapter 1 Conceptual Introduction for details of the COM-B Model), free-text survey data as a method limits the details and nuances that participants were able to communicate, although similar themes were also found in a separate interview

study of 12 Canadian adults between June and October 2020 (Petersen et al., 2021). However, neither of these studies used a comparison group based on PA levels; thus, the underlying reasons *why* and *how* some people engaged in higher levels of PA, whilst others engaged in low PA during the pandemic, are yet to be explored. This evidence is further limited by a lack of quantitative data to understand the complexity of COVID-19 on people's PA and mental health, which can be addressed by mixed methods research (Johnson & Onwuegbuzie, 2004). It is conceivable that closure of sports facilities and transitioning to online platforms caused the loss of socialising in lockdown (Hailey et al., 2022; Petersen et al., 2021). Previous studies have demonstrated that increasing opportunities for social interactions and building social connectedness with the community can play an important role in improving people's physical and psychological wellbeing (Franke et al., 2021; Stefanidou et al., 2021).

As such, one potential COVID-19 recovery solution is for clinicians to 'socially prescribe' community-based activities (SP) (Royal College of Psychiatrists, 2021). This approach differs from traditional medical healthcare models as it aims to connect people with community activities, groups and social support schemes to improve their physical and mental wellbeing (NHS England and NHS Improvement, 2020). There is increasing evidence that SP can alleviate healthcare usage by increasing social connectedness and reducing anxiety, depression and feelings of loneliness (Costa et al., 2021). Although more high-quality robust research is needed to ascertain the key components that lead to change (Cooper et al., 2022), literature on 'social cure' suggests that increasing opportunities to connect and cultivate community belonging could lead to positive health outcomes (Jetten et al., 2012; Younan et al., 2020). Additionally, community resources and support were highly valuable during COVID-

19, which indicates the potential of SP in addressing public health challenges especially during a global crisis (Hossain et al., 2020; Younan et al., 2020).

While researchers have argued that SP may obscure pre-existing issues of inequalities in social determinants of health (Gibson et al., 2021; Moscrop, 2023), other countries (e.g., US, Canada, Australia) have used standardised screening tools to identify and target specific populations with social risks. For example, individuals experiencing food insecurity or social isolation (Morse et al., 2022). Moreover, individuals who are already feeling lonely or isolated might be unwilling to join groups offered by SP (Stuart et al., 2022). Physical inactivity has been identified as a global pandemic (Kohl et al., 2012) with loneliness considered an epidemic even before the COVID-19 pandemic (Fried et al., 2020; Luhmann & Hawkley, 2016). As more people are in need and waiting longer for support from pressured mental health services in England (National Audit Office, 2023), more creative solutions are urgently needed.

Aims

The current mixed-method prospective study examines the impact of the COVID-19 pandemic on physical activity (PA) and mental health outcomes, namely self-perceived loneliness, depression, and anxiety over an 18-month period. Using the UCL-Penn Global COVID-19 Study dataset (Wong & Raine, 2020), UK participants who self-reported high/low on PA levels during wave 1 (April 17 – July 17, 2020) were followed up with 1-on-1 semi-structured interviews (March 18 – August 1, 2022) to understand: 1) the challenges of PA participation during COVID-19, and 2) their views toward 'socially prescribing' community-based activities as a pandemic recovery solution. An inductive thematic approach was applied to the data with the intention of providing a richer description of the respondents' lived experiences during COVID-19.

The research questions were:

1. Is there a bivariate association between reduced levels of PA and increased levels of self-perceived loneliness, anxiety and depressive symptoms at wave 1 of COVID-19?
2. Do levels of self-perceived loneliness, anxiety and depressive symptoms predict the likelihood of low-PA group membership at wave 1 of COVID-19 when controlling for covariates?
3. What are the challenges to PA participation?
4. What are people's impressions of 'Social Prescribing'?

Method

Design

In this mixed-methods study, data from the UCL-Penn Global COVID Study (Wong & Raine, 2020), a three-time-point longitudinal study (April 17, 2020-July 21, 2021), were first analysed to identify individuals high and low on PA. Further details on the study design can be accessed elsewhere (https://osf.io/fe8q7/). Qualitative data was collected between March 18 and August 1, 2022 through follow-up 1-on-1 Zoom interviews with UK respondents who self-reported high or low-PA levels at wave 1. Specifically, wave 1 data collection began four weeks after the first national lockdown was introduced in 2020 and ended in July 2020. Details can also be found on preregistration on the Open Science Framework (https://osf.io/tqm47).

Procedure and Participants

Screening phase

Data were collected as part of the UCL-Penn Global COVID-19 Study, which aimed to examine the short- and longer-term effects of COVID-19 on people's mental and physical health and social trust in others. The data used in the current study focuses on wave 1 (April 17, 2020-July 17, 2020) (Appendix 1, UK COVID-19 Policies Timeline; Appendix 2, Oxford COVID-19 Government Response Tracker on Stringency index to measure governmental responses on a scale of 0 to 100, 100 = strictest).

The full sample of all those who took part in wave 1 consisted of 2,288 participants (≥ 18 years old) (see Figure 1). A subsample of 1,037 participants (75.4% female, 43.2% of people aged 25 and 34 years) aged 18 and 89 years old (M = 36.54, SD = 13.03) (see Table 1) with data on PA, anxiety and depression, and loneliness were included. Majority of the participants resided in UK (56.8%), 80.0% self-identified as White, and 82.3% were living with one or more other people. As COVID-19 restrictions varied across countries - a potential confounder – participants' country of residence at the time of survey completion was used rather than their permanent residence, and only countries with the highest sample size were included, namely the UK, US, Greece and Italy.

Participants were recruited through social media platforms and personal contacts. The online Qualtrics survey can be accessed by anyone via the study links and was available in seven languages (including English, Greek, Spanish, German, French, Italian and Chinese – traditional or simplified). Questions assessing physical and mental wellbeing (e.g., depression, anxiety, aggression, self-perceived loneliness), social trust towards others, common stressors, lifestyle, worries related to

COVID-19, and sociodemographic factors were presented randomly to account for order effects.

Power analyses conducted using G*Power software (Faul et al., 2007) estimated that to detect a medium effect size of 0.25 with 95% power in a repeated measures within-factors MANOVA (three groups, three measures, alpha = .05), 87 participants were needed in each group**,** namely low, moderate and high PA (*n* = 261).

Qualitative phase

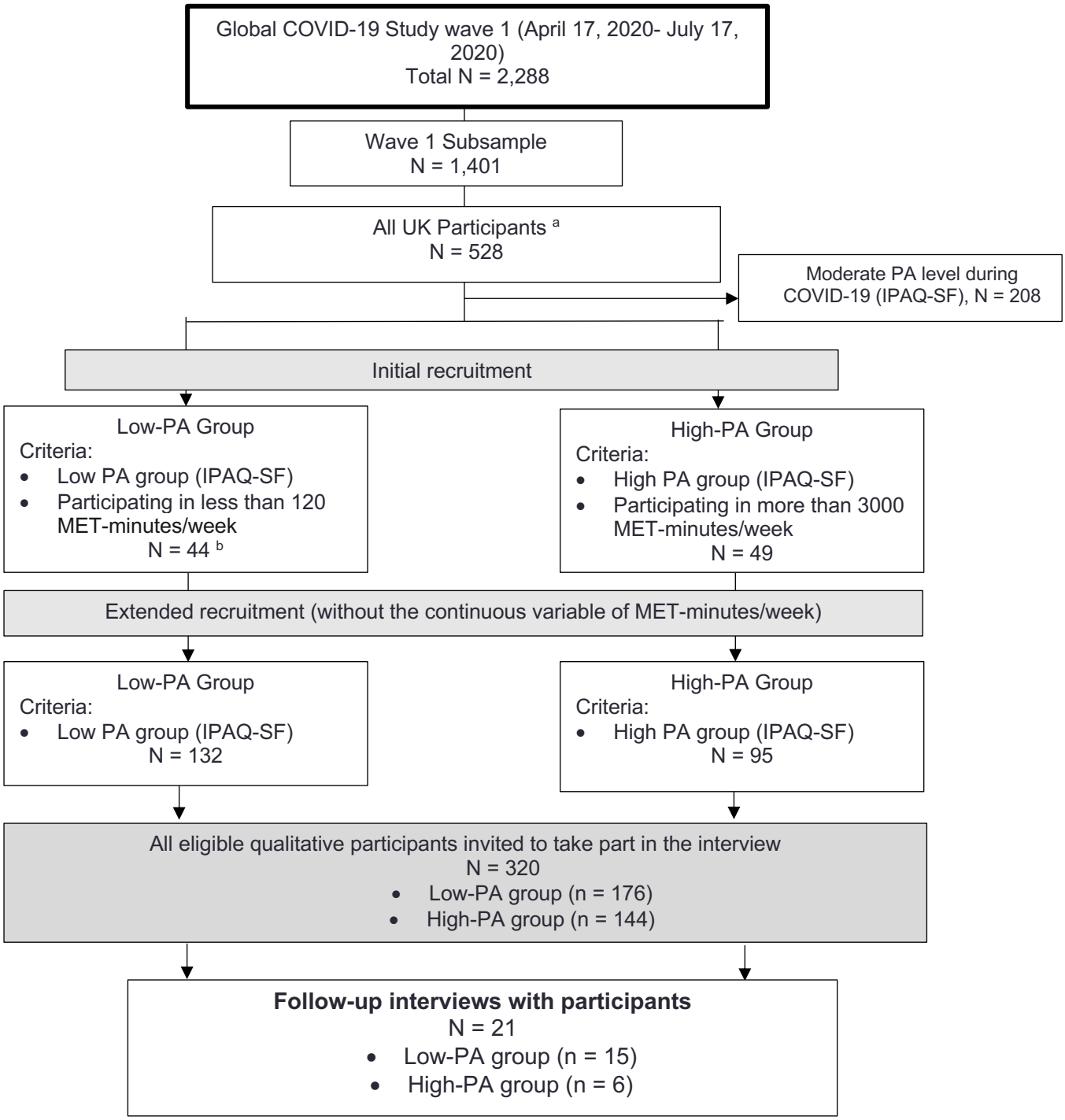
Purposive sampling was used to recruit a subsample of 93 (29.1%) UK respondents who self-reported high or low PA levels as measured by the IPAQ-SF (Craig et al., 2003) in the wave 1 Global COVID-19 Study. Of these, 44 participants engaged in less than 120 MET-minutes/week (low-PA) and 49 participants engaged in more than 3,000 MET-minutes/week (high-PA) (see Figure 1). All eligible participants were invited to take part via emails with the study advert and an online Qualtrics survey link (https://uclpsych.eu.qualtrics.com/jfe/form/SV_3kq11TrnQW2kfpc**)** (Appendix 3, Email Invitation). Individuals had to be able to communicate in conversational English and have access to a computer or phone for the interview.

Thirteen participants responded to the study advert, yielding a response rate of 14.0% (69.2% and 30.8% for low-PA and high-PA groups, respectively). A decision was made to only use PA categories (i.e., low or high PA levels) to improve the low uptake rather than in conjunction with the continuous variable in MET-minutes/week. Subsequently, a total of 320 participants were invited to take part in interview (low-PA, *n* = 176; high-PA, *n* = 144), and 21 participants (81.0% female) were interviewed on a one-to-one basis between March 18 and August 1, 2022 (low-PA, *n* = 15; high-PA, *n* = 6). The majority of the interviewed sample were participants who self-reported as

low-PA at wave 1 (71.4%). While the interviewed sample (*n*= 21) was smaller than the intended target of 25 participants determined in advance, the sample size achieved was sufficient to generate richness and complexity in data to address the research questions from the diverse perspectives of UK participants who self-identified as low or high-PA at wave 1 of the pandemic. This decision was informed by the concept of information power in thematic analysis research rather than data saturation (Braun & Clarke, 2019), as well as influenced by pragmatic considerations. All participants were included in the qualitative analysis though one participant had incomplete data on loneliness at wave 1 when inspected retrospectively.

Figure 1

Flowchart of Participant Recruitment



Note. Decisions and processes for recruiting participants from the Global COVID-19 Study for follow-up interviews conducted between March 2022 and August 2022 are shown.

[a] Reflect the number of participants who completed the wave 1 survey *and* permanently reside in UK.

[b] One participant had incomplete data on loneliness was recruited and interviewed.

All participants completed a 15-minutes online survey before the interview. Participants read the study aims, involvement, and gave consent before completing questions on demographics and measures of self-perceived loneliness, depressive and anxiety symptoms (Appendix 4, Online Survey). One respondent was not presented with questions on feelings of loneliness due to technical issues and had to complete the survey after the interview to avoid any missing data. The researcher contacted participants via email to schedule a Zoom interview (*Range* = 24 to 64 minutes) and reminded them about the study purpose (Appendix 5, Participant Information Sheet). All participants were advised about confidentiality, data protection and their right to pause or withdraw from the interview without providing a reason. Participants confirmed their consents verbally before proceeding with the interview. Two reminder emails were sent to three non-respondents who had completed the survey (Appendix 6, Follow-up Contacts).

The semi-structured interview (Appendix 7, Interview Schedule) included eight open-ended questions to allow participants to speak freely about their experiences and for the interviewer to prompt ideas further. This was piloted with students from University College London (UCL), who suggested slight changes to gather contextual information. At the beginning of each interview, the researcher introduced herself and explained the purpose of the study. All interviewees were debriefed to ensure their wellbeing and received a debrief information sheet listing local services and helplines via email (Appendix 8, Debrief Sheet). Each participant was provided the option to review their transcripts, with eight interviewees expressing interest and these were shared with them for feedback. Participants also had an opportunity to reflect on their interview, and all reported feeling well following the interviews. Participants received a £10 gift voucher for their time, funded by UCL.

Interviews were transcribed verbatim using UCL-approved GDPR-compliant transcription service Scrintal. Researcher T.H. listened to the recordings numerous times and data were carefully checked to ensure accuracy for analysis using a transcription notation system (Braun & Clarke, 2014) in NVivo. Any identifying information were removed, and data were pseudonymised to ensure anonymity.

Ethical Approval

This study was approved by the UCL Institute of Education Research Ethics Committee – REC 1331 (Appendix 9, Approval Letter).

Measures

The following measures were collected at wave 1, prior to the follow-up interview (March-August 2022; 12 months after the wave 1 survey).

Physical Activity

Physical Activity (PA) was assessed using the International Physical Activity Questionnaire - Short Form (IPAQ-SF; Craig et al., 2003). The IPAQ-SF measures the frequency (in days) and time (in minutes per day) spent participating in each of the three specific types of activity (vigorous and moderate-intensity activity and walking) over the last seven days. Participants were asked about their PA pre- and during COVID-19. Outliers were identified and excluded from the analysis if the aggregated times of walking, moderate and vigorous activities exceeded 960 minutes, which is equivalent to 16 hours. Any values below 10 minutes were re-coded to ‘zero’ based on the argument that a minimum of 10 minutes is needed to obtain health benefits.

The overall score of PA was calculated by summing vigorous- and moderate-intensity and walking in MET-minutes/week (MET-minutes/week = activities' metabolic equivalent x the time spent in minutes x the number of days engaged in those activities) (Appendix 10, IPAQ-SF Scoring). Higher MET-minutes/week indicates greater participation. IPAQ-SF responses were classified into high, moderate or low levels of PA (IPAQ Research Committee, 2005): 'High': any combination of walking, moderate- or vigorous-intensity PA across seven or more days achieving ≥3,000 MET-minutes/week; 'Moderate': any combination of walking, moderate- or vigorous-intensity PA across five or more days achieving ≥600 MET-minutes/week; 'Low': not meeting the criteria for the 'High' or 'Moderate' group. Furthermore, PA was dichotomised (0 = insufficiently active, 1 = sufficiently active) based on WHO's PA guidelines (Bull et al., 2020) of ≥150 minutes of moderate-to-vigorous PA (equivalent to ≥600 MET-minutes/week). Total PA measured in MET-minutes/week were positively skewed in the data, which were likely to be related to non-normally distributed energy expenditure in most populations (IPAQ Research Committee, 2005).

Self-Perceived Loneliness

Self-perceived levels of loneliness were measured using the 20-items UCLA-Loneliness Scale (LS; Russell, 1996), which assesses general loneliness and degree of satisfaction with one's social network. Each item is rated on a 1 (*never*) to 4 (*often*) scale, when summed creates a total score ranging 20 and 80. A higher score reflects more lonely feelings. Whilst the LS has no standard threshold to indicate severe loneliness, individuals in the top 15% (i.e., LS score ≥ 56) were classified as 'highest level of loneliness'. LS is a reliable and valid measure to be used in epidemics and pandemics (Das et al., 2021). A recent systematic review found that the reliability

coefficients for the LS ranged between 0.76 and 0.93 in adults (Alsubheen et al., 2021). It has excellent internal reliability (α = .94) for this study.

Anxiety

Anxiety symptoms were measured using the seven-item General Anxiety Disorder scale (GAD-7; Spitzer et al., 2006). Each response is rated on a 4-point Likert scale from 0 (*not at all*) to 3 (*nearly every* day), with scores ranging from 0-21. Higher scores reflecting more severe anxiety symptoms. Scores of ≥10 were used to indicate clinically relevant anxiety (Kroenke et al., 2007). Recent evidence shows that the GAD-7 scale has demonstrated high internal reliability (α = .89 -.92) during COVID-19 (Shevlin et al., 2022), and validated to use in the general population (Löwe et al., 2008). It has excellent internal reliability (α = .91) for this study.

Depression

Depressive symptoms were measured using the nine-item Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001). Each response is rated on a 4-point Likert scale from 0 (*not at all*) to 3 (*nearly every* day), with scores ranging from 0 to 27. Higher scores indicating more severe depressive symptoms. Scores of ≥10 were used to indicate clinically relevant depression (Kroenke & Spitzer, 2002). The PHQ-9 scale has demonstrated high internal reliability (α = .89 -.92) during COVID-19 (Shevlin et al., 2022), and a validated measure in in the general population (Martin et al., 2006). It has very good internal reliability (α = .87) for this study.

Sociodemographic variables

Participants completed questions on sociodemographic, and these were coded as: gender (male vs. female), age (18-24, 25-34, 35-44, 45-54, 55-65, 65+), ethnicity (White vs. people of colour), country (UK, US, Greece, or Italy), employment (student [full/ part time], working [full/ part time], or not working), marital status (single/ separated/ divorced/ widowed vs. married/ civil partnership/ cohabiting), education (highest educational level obtained: high school degree or below/ associate degree, Bachelor's degree, or Graduate degree), annual income (low <£30k, medium £30-60k, or high >£60k), household size (number of people living in their house including themselves: 1 vs. 2+), number of chronic physical health conditions (none vs. one or more including: respiratory conditions, heart conditions, circulatory problems, diabetes, other medical conditions (e.g., cancer, epilepsy, lupus, sleep apnoea, obesity)), number of pre-existing mental health conditions (none vs. one or more including: alcohol or substance use disorder, anxiety disorder, bipolar disorder, depression, disruptive/impulse-control/conduct disorders, feeding/eating disorder, obsessive-compulsive disorder, schizophrenia and psychotic disorders, trauma and stress-related disorder and personality disorder).

Data Analysis

Quantitative phase

Secondary data analysis was conducted using IBM SPSS Statistics (version 27) (IBM Corp, 2020). To test for normality, variables were assessed using histograms, Q-Q plots and the skewness and kurtosis values (Appendix 11, Normality Tests). An absolute value of skewness >2 or kurtosis >7 indicated non-normal distribution in a larger sample size (e.g., $n > 300$) (Kim, 2013). Therefore, PHQ-9, GAD-7 and LS were

normally distributed. The histogram of the continuous indicator of PA measured by the IPAQ-SF suggests that data were positively skewed and platykurtic, but the skewness and kurtosis values were still smaller than the non-normal distribution reference values of 2 and 7, respectively.

Outliers were identified using boxplots and z-scores. Multivariate outliers were identified using the Mahalanobis distance method, and four cases needed to be removed. Multicollinearity was assessed using tolerance value (< 0.1) and the variance inflation factor (VIF > 10) (Field, 2018). Results showed that the data met the assumption of collinearity for analyses (Appendix 11.3, Multicollinearity Test).

Chi-square test was conducted to compare categorical data between PA levels, which included depression and anxiety symptoms (dichotomised: sub-clinical <10 vs clinically relevant ≥10). ANOVA were conducted to compare differences in mental health outcomes as dependent variables (DVs: PHQ-9, GAD-7 and LS scores) between the groups with sociodemographic variables and PA levels as independent variables (IVs). Bonferroni post-hoc tests were conducted to determine significant group differences.

Bivariate correlations (Pearson's and Kendall's tau-b) were conducted to assess the linear associations between all study variables. Specifically, it examined the relationships between low-PA and mental health outcomes (PHQ-9, GAD-7 and LS) compared with high/moderate-PA. Cohen's guidelines were used to interpret the magnitude of Pearson's correlations between study variables as to effect sizes, namely small (r = .10 - .30), medium (r = .30 - .50), and large (r > .50) (Cohen, 1988, 1992). A multivariate multiple regression analysis was conducted to further investigate whether PA levels (IV; 3 levels: low, moderate and high) were significantly associated with levels of self-perceived loneliness, anxiety and depressive symptoms (DVs), after

controlling for covariates (i.e., gender, age, countries, employment status, marital status, education, annual income, household size, self-reported chronic physical health conditions, pre-existing mental health conditions, and IPAQ-SF PA level before COVID-19). Moderate-PA during COVID-19 was the reference category. Two logistic regressions with PA groups (dependent variables: low/moderate-PA or high/moderate-PA) and mental health outcomes (independent variables: PHQ-9, GAD-7 and LS) were entered to predict the likelihood of low-PA group memberships during COVID-19, after adjusting for correlated sociodemographic variables (i.e., ethnicity, countries, employment, education, annual income, self-reported chronic physical health conditions and pre-existing mental health conditions) and pre-COVID IPAQ-SF PA levels.

Qualitative phase

Data analysis was conducted using six-step thematic analysis (Braun & Clarke, 2006, 2022a, 2022b). See Appendix 12 for more detailed information of this process. This method was chosen to capture a complex and rich account of data and identify semantic and latent meanings (Braun & Clarke, 2012). A more inductive approach was used but influences of behavioural change theories on PA are acknowledged. The flexibility of this approach enables the researcher to encompass the emotional impacts of COVID-19 policies on people and recognise how people's contexts play a significant role in their experiences. Analysis was conducted from a critical-realist ontological and epistemological stance. While it assumes that the data does not explicitly reflect reality, interpretations of this reality are influenced by how we understand the underlying structures and mechanisms to explain people's behaviours and experiences (Willig, 2012). As such, the broader social context and systemic factors (e.g., geography, age,

ability, social status, education, economic) were considered throughout data collection and analysis. Research journaling and discussion with other researchers were used to increase reflexivity. When presenting quotes and data excerpts, grammatical corrections were applied and repetitive words in speech were removed to increase readability.

Researcher perspective. The researcher had experienced the severe acute respiratory syndrome (SARS) outbreak in Hong Kong in 2003. She became more aware of the importance of staying active and connected during COVID-19 but understands that such unprecedented changes could have potential long-term consequences. Similar to many of the interviewees, COVID-19 policies and uncertainty have resulted in fluctuations to her PA. Yet, there are differences between her and some of her participants in that she was working, financially secure, not clinically vulnerable, and living in a household with others. Her work with people who are more vulnerable and/or afraid due to numerous reasons, such as physical or mental health issues, living alone, feelings of loneliness, grief, have raised concerns about people's abilities to resume day-to-day life and return to society as the world reopens. These echo the concerns and reflections shared by her research participants, which led her to rethink the role of social injustice and health inequality. Altogether, these experiences prompted the researcher to focus on the disproportionate effects of COVID-19 and how some people may or may not recover from this pandemic. However, she also believes that community spirit was evident as people were coming together, supporting each other, and helping those who were more vulnerable during this time, which should receive more attention. This led her to

consider how clinicians engage people and how services can provide holistic care with community resources being part of the intervention during the recovery phase.

Results

Quantitative Results

Participants characteristics

Table 1 presented the characteristics of 1,037 participants. The majority of the sample (39.6%) reported a moderate level of PA on the IPAQ-SF at wave 1 of COVID-19, followed by 35.7% of low-PA and 19.9% high-PA (Appendix 13, characteristics and chi-square tests for PA levels). Subsequently, 32.2% were identified as insufficiently active by not meeting WHO's PA guidelines of ≥ 150 minutes of moderate PA, ≥75 minutes of vigorous PA or a combination of both (equivalent to ≥600 MET-minutes/week on the IPAQ-SF). The median PA levels reduced from 1639.5 $MET \cdot min^{-1} \cdot week^{-1}$ (interquartile range [IQR] = 1728) before COVID-19 to 1173 $MET \cdot min^{-1} \cdot week^{-1}$ (IQR = 1555) at wave 1 of COVID-19. The average PHQ-9 scores for depression and anxiety at wave 1 were 7.6 (*SD* = 5.7) and 5.8 (*SD* = 5.0), respectively, indicating mild depressive and anxiety symptoms. Using the clinical cut-off scores of ≥10 for PHQ-9 and GAD-7, 30.6% of the sample reported depression and 21.6% reported anxiety (Appendix 14, ANOVAs and post-hoc tests by sociodemographic variables and PA). The average LS scores for loneliness were 42.6 (*SD* = 11.4). Using the top 15% of LS scores (LS ≥56), 15.1% of the participants (*n* = 157) were identified as the highest level of loneliness.

Table 1

Characteristics of Sample at Wave 1 (April 17 - July 17, 2020) of COVID-19 (N = 1,037)

Characteristics	Category	n	%
Gender	Female	782	76.67
	Male	238	23.33
Age group	18-24	145	14.04
	25-34	448	43.37
	35-44	200	19.36
	45-54	110	10.65
	55-64	88	8.52
	65 years or older	42	4.07
Ethnicity	White	830	80.04
	People of Colour	185	17.84
Countries	UK	589	56.80
	US	158	15.24
	Greece	157	15.14
	Italy	133	12.83
Employment status	Employed	555	53.99
	Unemployed	120	11.67
	Student	353	34.34
Marital status	Single/ divorced/ widowed/ separated	501	48.36
	Married/ civil partnership/ cohabiting	535	51.64
Education	High school or below/ Associate Degree	174	16.78
	Bachelor's Degree	265	25.55
	Graduate Degree	598	57.67
Annual income (GBP £)	Low (<30k)	419	42.76
	Medium (30-60k)	230	23.47
	High (>60k)	331	33.78
Household size (including themselves)	1	148	14.79
	2+	853	85.21
Number of self-reported chronic physical health conditions [a]	0	867	83.61
	≥ 1	170	16.39
Number of pre-existing mental health conditions [a]	0	870	83.90
	≥ 1	167	16.10
IPAQ-SF before COVID-19	Low PA	213	20.54
	Moderate PA	508	48.99
	High PA	316	30.47
Met PA guideline before COVID-19[b]	Sufficiently active	831	80.14
	Insufficiently active	206	19.86
Depression (PHQ-9)	Total score (Mean ± SD)	7.61 ± 5.65	
	Sub-clinical (PHQ-9 <10)	720	69.43
	Clinically relevant (PHQ-9 ≥10)	317	30.57
Anxiety (GAD-7)	Total score (Mean ± SD)	5.77 ± 4.96	
	Sub-clinical (GAD-7<10)	813	78.40
	Clinically relevant (GAD-7 ≥10)	224	21.60
Loneliness (LS)[c]	Total score (Mean ± SD)	42.56 ± 11.35	
	Highest level of loneliness (top 15%; total LS score ≥56)	157	15.14

Characteristics	Category	n	%
	Lower loneliness (total LS score <56)	880	84.86

Note. Participants were on average 36.5 years old (*SD* = 13.0). IPAQ-SF, International Physical Activity Questionnaire – Short Form. PHQ-9, Patient Health Questionnaire. GAD-7, General Anxiety Disorder scale. LS, UCLA-Loneliness Scale. PA, Physical activity.

[a] Reflects the number and percentage of participants responding with one or more physical and/or mental health conditions to this question (Appendix 15, details on self-reported physical and mental health conditions).

[b] Sufficiently active: Met WHO's PA guidelines, ≥ 150 minutes of moderate PA, ≥ 75 minutes of vigorous PA or a combination of both (equivalent to ≥ 600 MET-minutes/week) based on IPAQ-SF. Insufficiently active: Did not meet the WHO's PA guidelines based on IPAQ-SF.

[c] Loneliness group was dichotomised: highest level of loneliness identified using top 15% (LS ≥ 56) vs. lower level of loneliness (LS < 56).

Chi-squared tests were conducted to explore differences between participants' characteristics by sociodemographic variables, pre-COVID PA levels, and mental health measures (PHQ-9, GAD-7 and LS) in different PA groups (IPAQ-SF; 3 levels: low, moderate and high) during COVID-19. Being people of colour, being in Italy, being in the low annual income group (<£30k), having chronic physical health conditions and having pre-existing mental health conditions were sociodemographic variables more likely to be associated with low-PA during COVID-19 than being White, being in the UK, being in the high annual income group (>£60k), without chronic physical health conditions and without pre-existing mental health conditions (all *ps* < .05). Participants who scored above the clinical cut-offs for depression (PHQ score ≥10; $X^2(1) = 14.32$, $p < .001$) and had highest levels of loneliness (top 15%; LS scores ≥56; $X^2(1) = 7.34$, $p = .007$) were significantly more likely to be associated with low-PA than participants who scored below the clinical cut-offs for depression and had lower levels of loneliness. The proportion of participants scoring above the clinical cut-offs for anxiety (GAD-7 score ≥10) did not differ by PA levels during COVID-19 (*ps* > .05).

Furthermore, the proportions of participants who scored above the clinical cut-off for depression differed significantly between moderate and high-PA, $X^2(1) = 6.46$, $p = .011$. Participants in the high-PA group were significantly less likely to have depression than participants in the moderate-PA group, but they did not differ by highest level of loneliness (ns $p > .05$).

Associations between PA and mental health

The Kendall's tau-b correlations were conducted to examine PA levels (moderate-PA = reference category) and depression (PHQ-9 total score), anxiety (GAD-7 total score) and loneliness (LS total score). Results showed that low-PA was positively and significantly correlated with depressive symptoms ($\tau_b = .12$, $p < .001$), anxiety symptoms ($\tau_b = .05$, $p = .04$), and loneliness ($\tau_b = .11$, $p < .001$), compared with moderate-PA (Appendix 16, ANOVA tests). Thus, individuals who were physically inactive (low-PA) reported higher levels of depression, anxiety and loneliness. High-PA was negatively and significantly correlated with depressive symptoms ($\tau_b = -.08$, $p = .002$) and loneliness ($\tau_b = -.07$, $p = .01$) compared with moderate-PA. The negative correlation between high-PA and GAD-7 scores was not significant ($\tau_b = -.03$, $p = .29$). Thus, individuals who were most physically active (high-PA) reported lower levels of depression and loneliness than individuals who were moderately active, but not for anxiety. Pearson's correlation analyses were conducted to explore the association between depression (PHQ-9), anxiety (GAD-7) and loneliness (LS). Table 2 shows all mental health outcomes (PHQ-9, GAD-7 and LS) were positively and significantly correlated (*ps* <.01). Specifically, depressive symptoms were significantly and positively correlated with anxiety symptoms, $r = .77$, and loneliness, $r = .55$ (*p*s < .01), with large effect sizes. Loneliness was also correlated with anxiety symptoms with a

medium effect size, r = .48, p < .01. Correlations for all variables can be found in Appendix 17.

Table 2

Descriptive Statistics and Correlations for Key Study Variables

Variable	*n*	*M*	*SD*	1	2	3	4	5
1. IPAQ-SF during COVID-19 – Low PA [a]	1,037	1433.98	1337.41	—				
2. High PA [a]				**-.43****	—			
3. Depression (PHQ-9 total)	1,037	7.61	5.65	**.12****	**-.08****	—		
4. Anxiety (GAD-7 total)	1,037	5.77	4.96	**.05***	-.03	**.77****	—	
5. Loneliness (LS total)	1,037	42.56	11.35	**.11****	**-.07****	**.55****	**.48****	—

Note. Kendall's tau-b correlations were conducted for categorical variables. Person's correlations were conducted for continuous variables (namely, PHQ-9, GAD-7 and LS total scores). PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

[a] IPAQ-SF PA levels: Moderate PA = reference category. IPAQ-SF overall median in MET-mins/week = 1173, interquartile range = 1555.

Bold = significant at the *p < .05; **p < .01 level (2-tailed).

Multivariate multiple regression analysis was conducted to further investigate the relationship between PA levels (IV; 3 levels, moderate-PA = reference category) and depression, anxiety and loneliness (DVs) (see Table 3). After controlling for correlated sociodemographic factors and pre-COVID PA levels, results showed that low-PA during COVID-19 was positively associated with depressive symptoms (estimated coefficient of -0.90, t(983) = -2.28, p = .023), and loneliness (estimated coefficient of -2.10, t(983) = -2.55, p = .011). Thus, individuals with higher levels of PA (high/moderate-PA group) would have lower levels of loneliness and depression compared to those in the low-PA group. However, low-PA was not significantly associated with anxiety symptoms (estimated coefficient of -0.51, t(983) = -1.43, p = .154). Moreover, being in the high-PA group was not significantly associated with

anxiety, depression and loneliness compared to being in the moderate-PA group (all *ps* > .05). Thus, participants engaging in the highest levels of PA (high-PA group) during COVID-19 did not have lower levels of anxiety, depression and loneliness compared with participants in the moderate-PA group.

Predictors of low-PA or high-PA levels during COVID-19

Binary logistic regression was conducted to examine whether levels of depressive symptoms, anxiety symptoms, and loneliness (IVs) predicted the likelihood of low-PA (moderate-PA = reference category) during COVID-19 after adjusting for correlated sociodemographic variables and pre-COVID PA levels (see Table 4). The analysis was also repeated to predict the likelihood of high-PA compared with moderate-PA (reference category). For the low-PA group, results indicated that the overall model was statistically significant, $X^2(17) = 211.25$, $p < .001$. More depressive symptoms were associated with a higher likelihood of low-PA group membership during COVID-19 compared with moderate-PA (odds ratio = 1.05, 95% confidence intervals = 1.01;1.10, $p = .02$). Individuals with higher levels of depression will be more likely to be in the low-PA group during COVID-19. However, anxiety and loneliness were not significantly associated with higher likelihood of low-PA during COVID-19 (*ns* all *ps* > .05). Thus, higher levels of anxiety and loneliness did not increase the likelihood of low-PA group membership during COVID-19. For the high-PA group, the overall model was statistically significant, $X^2(17) = 152.91$, $p < .001$. However, anxiety, depression and loneliness were not significant predictors of high-PA (ns $p > .05$), whereas ethnicity, self-reported chronic physical health conditions and pre-COVID PA levels (IPAQ-SF) were significant predictors of high-PA during COVID-19.

Table 3

Multivariate Regression Model of Levels of Depressive Symptoms, Anxiety Symptoms and Loneliness

Variable	Depression (PHQ-9 total score)						Anxiety (GAD-7 total score)						Loneliness (LS total score)					
	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2
		LL	UL					LL	UL					LL	UL			
Step 1 [a]					.025	**.023*** **					.007	**.005** *					.017	**.015*** **
Intercept	**8.34*** **	7.30	9.38	0.53			**6.19*** **	5.27	7.12	0.47			**44.09*** **	41.99	46.19	1.07		
IPAQ-SF during COVID-19 (moderate-PA = reference)																		
Low-PA	**-1.65*** **	-2.44	-0.87	0.40			**-0.80***	-1.50	-0.11	0.47			**-2.92*** **	-4.50	-1.33	0.81		
High-PA	0.45	-0.43	1.32	0.46			0.13	-0.64	0.90	0.39			0.47	-1.29	2.23	0.90		
Step 2 [b]					.240	**.222*** **					.181	**.162** ***	**52.38*** **	47.72	57.04	2.37	.158	**.138*** **
Intercept	**8.75*** **	6.53	10.98	1.13			**5.14*** **	3.14	7.15	1.02								
IPAQ-SF during COVID-19 (moderate-PA = reference)																		
Low-PA	**-0.90***	-1.67	-0.13	0.39			-0.51	-1.21	0.19	0.36			**-2.10***	-3.72	-0.48	0.83		
High-PA	0.51	-0.33	1.35	0.43			0.26	-0.50	1.02	0.39			-0.53	-2.29	-1.23	0.90		
Gender (male vs. female)	**0.92***	0.16	1.68	0.39			**1.64*** **	0.96	2.33	0.35			-1.71	-3.31	-3.30	-0.12		
Age group (in years) (25-34 years = reference)																		
18-24	-0.30	-1.46	0.86	0.59			-0.14	-1.19	0.91	0.53			-1.97	-4.40	0.47	1.24		
35-44	0.00	-0.91	0.90	0.46			0.18	-0.64	1.00	0.42			0.31	-1.59	2.20	0.97		
45-54	**-1.37***	-2.51	-0.22	0.58			**-1.25***	-2.29	-0.21	0.53			1.67	-0.73	4.08	1.23		
55-64	**-2.16*** **	-3.41	-0.90	0.64			**-2.09*** **	-3.22	-0.95	0.58			-0.88	-3.52	1,75	1.34		

Variable	Depression (PHQ-9 total score)						Anxiety (GAD-7 total score)						Loneliness (LS total score)					
	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2
		LL	UL					LL	UL					LL	UL			
65+	**-4.82*** **	-6.64	-3.00	0.93			**-3.20*** **	-5.16	-1.91	0.84			-3.83	-7.65	-0.01	1.02		
Countries (UK = reference)																		
US	-0.14	-1.09	0.82	0.49			0.48	-0.38	1.35	0.44			-0.57	-2.58	1.43	1.02		
Greece	**-2.66*** **	-3.72	-1.60	0.54			**-1.59*** **	-2.55	-0.63	0.49			**-4.25*** **	-6.46	-2.03	1.13		
Italy	-0.51	-1.61	0.56	0.54			-0.27	-1.25	0.70	0.50			-0.57	-2.84	1.70	1.16		
Employment status (employed = reference)																		
Student	**1.00***	0.16	1.84	0.43			0.59	-0.17	1.35	0.39			-0.04	-1.80	1.72	0.90		
Unemployed	**1.74****	0.59	2.90	0.59			0.93	-0.11	1.98	0.53			**3.84****	1.41	6.27	1.24		
Marital status [c]	**-0.94***	-1.73	-0.15	0.40			-0.50	-1.21	0.22	0.36			**-2.83*** **	-4.48	-1.17	0.84		
Education (graduate degree = reference)																		
High school degree/ below/ associate degree	**2.07*** **	1.04	3.10	0.52			**1.33***	0.40	2.26	0.47			**3.06***	0.90	5.21	1.10		
Bachelor's degree	0.49	-0.28	1.27	0.40			0.40	-0.31	1.10	0.36			1.06	-0.57	2.69	0.83		
Annual income (low income <£30k = reference)																		
Medium (£30-60k)	-0.53	-1.41	0.35	0.45			-0.20	-1.00	0.59	0.41			-0.53	-2.37	1.32	0.94		
High (>£60k)	-0.89	-1.81	0.03	0.47			-0.56	-1.39	0.28	0.42			**-2.44***	-4.51	-0.48	0.98		
Household size (including themselves) (1 vs. 2+)	-0.90	-1.89	0.09	0.50			-0.41	-1.31	0.48	0.46			**-2.95***	-5.02	-0.88	1.06		
Self-reported chronic physical health conditions	**1.24***	0.28	2.19	0.49			0.77	-0.09	1.63	0.46			0.46	-1.54	2.46	1.02		
Pre-existing mental health conditions	**3.13*** **	2.14	4.11	0.50			**2.74*** **	1.84	3.63	0.46			**4.73*** **	2.66	6.80	1.06		
Pre-COVID PA level (IPAQ-SF) (moderate-PA = reference)																		

Variable	Depression (PHQ-9 total score)					Anxiety (GAD-7 total score)					Loneliness (LS total score)				
	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2	B	95% CI for B		SE B	R^2	ΔR^2
		LL	UL					LL	UL					LL	UL			
Low-PA	0.49	-0.39	1.37	0.45			-0.03	-0.83	0.76	0.35			0.35	-1.50	2.19	0.83		
High-PA	0.58	-0.19	1.35	0.39			0.65	-0.05	1.34	0.35			-0.36	-1.94	1.26	0.82		

Note. CI = confidence interval; LL = lower limit; UL = upper limit; SE = standard errors. PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

[a] Step 1: *N* = 1,037.

[b] Step 2: *N* = 984.

[c] Marital status: Single/separated/divorced/ widowed vs. Married/ in a civil partnership/ cohabiting.

Bold = significant at the *$p < .05$; **$p < .01$; ***$p < .001$ level.

Table 4

Logistic Regression Models Predicting Likelihood of Low-PA or High-PA Versus Moderate-PA (reference group) at Wave 1 of COVID-19

Variable	Low-PA vs. Moderate-PA (IPAQ-SF)							High-PA vs. Moderate-PA (IPAQ-SF)						
	B	SE	Wald	p	95% CI for odds ratio			B	SE	Wald	*p*	95% CI for odds ratio		
					Lower	OR	Upper					Lower	OR	Upper
Constant	-1.48	0.37	**16.32**	**< .001*****		0.23		-1.25	0.4	**10.02**	**.002****		0.29	
Depression (PHQ-9 total score)	0.05	0.02	**5.42**	**.020***	1.01	1.05	1.10	-0.05	0.03	3.38	.066	0.91	0.96	1.00
Anxiety (GAD-7 total score)	-0.01	0.02	0.39	.532	0.94	0.99	1.03	0.01	0.03	0.28	.596	0.96	1.01	1.07
Loneliness (LS total score)	0.01	0.01	0.45	.504	0.99	1.01	1.02	0.00	0.01	0.27	.603	0.99	1.00	1.02
Ethnicity (0 = White, 1= people of colour)	0.97	0.19	**25.68**	**< .001*****	1.82	2.65	3.87	-0.54	0.22	5.73	**.017***	0.38	0.59	0.91
Countries (UK = reference)														
US	0.29	0.23	1.61	.205	0.85	1.34	2.10	-0.36	0.24	2.21	.138	0.44	0.70	1.12
Greece	0.35	0.25	1.89	.170	0.86	1.41	2.31	-0.22	0.28	0.63	.427	0.47	0.80	1.38
Italy	0.94	0.24	**15.27**	**< .001*****	1.60	2.57	4.13	-0.25	0.27	0.85	.357	0.45	0.78	1.33
Employment status (Full/part time employment = reference category)														
Full/part time student	-0.11	0.18	0.39	.531	0.64	0.90	1.26	0.10	0.19	0.30	.581	0.77	1.11	1.60
Unemployed	-0.06	0.25	0.06	.800	0.58	0.94	1.53	-0.32	0.31	1.07	.301	0.40	0.73	1.33
Education (Graduate degree = reference category)														
High school or below/associate degree	-0.14	0.22	0.42	.519	0.56	0.87	1.33	0.12	0.25	0.24	.627	0.69	1.13	1.84
Bachelor's Degree	-0.28	0.18	2.46	.117	0.53	0.75	1.07	0.07	0.19	0.12	.729	0.74	1.07	1.54

Variable	Low-PA vs. Moderate-PA (IPAQ-SF)							High-PA vs. Moderate-PA (IPAQ-SF)						
	B	SE	Wald	p	95% CI for odds ratio			B	SE	Wald	*p*	95% CI for odds ratio		
					Lower	OR	Upper					Lower	OR	Upper
Annual income (low income = reference category)														
Medium income (£30-60k)	0.00	0.20	0.00	.997	0.68	1.00	1.47	-0.25	0.23	1.16	.280	0.50	0.78	1.23
High income (>£60k)	-0.45	0.21	**4.45**	**.035***	0.42	0.64	0.97	0.37	0.22	2.87	.090	0.94	1.45	2.24
Self-reported chronic physical health condition (none vs. 1 or more)	0.36	0.21	2.77	.096	0.94	1.43	2.17	-0.57	0.26	4.74	**.029***	0.34	0.57	0.95
Pre-existing mental health conditions (none vs. 1 or more)	0.35	0.23	2.40	.121	0.91	1.42	2.23	-0.26	0.27	0.93	.334	0.46	0.77	1.31
Pre-COVID PA levels (IPAQ-SF; moderate-PA = reference)														
High-PA before COVID-19	-0.91	0.19	**23.92**	**< .001*****	0.28	0.40	0.58	1.38	0.17	**67.62**	**<. .001*****	2.86	3.98	5.53
Low-PA before COVID-19	1.35	0.19	**50.94**	**< .001*****	2.65	3.84	5.56	-0.74	0.28	**7.04**	**.008****	0.27	0.48	0.82
X^2	**211.251*** **							**152.91*** **						
df	17							17						
Cox & Snell R^2	0.188							0.140						
Nagelkerke R^2	0.259							0.207						

Note. N = 1,015. PA group memberships were defined using the IPAQ-SF. Moderate-PA was assigned as a reference category. OR = odds ratio; SE = standard errors; CI = confidence interval. PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

Bold = significant at the *$p < .05$; **$p < .01$; ***$p < .001$ level.

Qualitative results

Participants

Twenty-one UK participants were followed-up with a 1-on-1 interview between March 18 and August 1, 2022 (see Table 5 for characteristics). 15 participants were in the low-PA group (female = 86.7%, mean age = 45.8, *SD* = 15.7). Over half of the low-PA sample scored above the clinical cut-off for depression (PHQ-9 ≥10; 53.5%) at wave 1, and this proportion halved (26.7%) at follow-up. Details on changes in mental health outcomes and PA levels can be found in Appendix 16. Two-thirds of the low-PA sample reported an increase in their PA levels from wave 1 to follow-up, while five participants (33.3%) reported no changes (see Figure 2). Six participants were in the high-PA group (female = 66.7%, mean age = 51.0, *SD* = 14.2). One-sixth (16.7%) of the high-PA sample scored above the clinical cut-offs for depression (PHQ-9 ≥10) and anxiety (GAD-7 ≥10) at wave 1 and follow-up, respectively. One participant also has reduced their PA levels to low-PA at follow-up, while the rest have maintained their PA levels (see Figure 2). Overall, six participants reported having a physical health condition, three reported having pre-existing mental health conditions, and six reported having physical and mental health conditions. Using wave 1 data, 61.9% of the overall sample had a graduate's degree, 47.6% were employed, and 28.6% were students. More than half of the participants were married, in a civil partnership or cohabiting (61.9%), and 26.3% had been living alone.

Table 5

UK Participants' Characteristics at Wave 1 (T1; April 17-July 17, 2020) and Follow-up Interviews (T2; March 18-August 1, 2020) (N=21)

Participant ID	Gender	Age group	Ethnicity	Physical Health Condition	Mental Health Conditions	IPAQ-SF PA levels				Depression [a] (PHQ-9 severity)			Anxiety [a] (GAD-7 severity)			Loneliness (LS scores)		
						Before COVID-19	**T1**	T2	Changes (T2-T1)	T1	T2	Changes (T2-T1)	T1	T2	Changes (T2-T1)	T1	T2	Changes (T2-T1)
P01	F	55-64	White British	Other medical conditions	—	Moderate	**High**	Low	↓	None	None	→	None	None	→	24	22	-2
P02	M	65+	White British	Other medical conditions	—	High	**High**	High	→	None	None	→	None	None	→	39	36	-3
P03	F	25-34	White Irish	—	—	High	**High**	High	→	Moderately severe	None	↓	Moderate	None	↓	31	30	-1
P04	M	55-64	White British	Diabetes, heart conditions	—	High	**High**	High	→	None	Mild	↑	None	None	→	47	49	+2
P05	F	45-54	Any other White background	Other medical conditions	—	High	**High**	High	→	Mild	None	↓	None	None	→	30	24	-6
P06	F	35-44	Any other White background	—	Anxiety	Moderate	**High**	High	→	Mild	Severe	↑	Mild	Severe	↑	68	75	+7
P07	F	25-34	Mixed – White and Asian	—	—	Low	**Low**	Moderate	↑	None	None	→	None	None	→	24	27	+3
P08	F	25-34	Mixed – White and Black Caribbean	—	Anxiety, Depression	Moderate	**Low**	Low	→	Moderate	Mild	↓	None	None	→	42	60	+18

P09	F	35-44	Any other white background	—	—	Low	**Low**	Moderate	↑	None	None	→	Mild	None	↓	41	43	+2
P10	F	18-24	White British	Respiratory conditions, other medical conditions	Anxiety, Depression & other mental health conditions	Moderate	**Low**	Moderate	↑	Moderately severe	Mild	↓	Severe	Mild	↓	59	45	-14
P11	F	55-64	Mixed – White and Black African	Fibromyalgia, osteoarthritis	Depression, Feeding/ Eating Disorder	Low	**Low**	Moderate	↑	Moderate	Moderate	→	None	None	→	40	36	-4
P12	F	65+	White British	Circulatory problems, liver condition & other medical conditions	Anxiety, Bipolar Disorder	Moderate	**Low**	Low	→	None	Mild	↑	None	None	→	24	24	0
P13	F	35-44	Any other White background	Respiratory conditions, other medical conditions	Depression	Moderate	**Low**	Moderate	↑	Moderately severe	Moderate	↓	Mild	Moderate	↑	61	58	-3
P14	M	55-64	White British	Skin condition	Anxiety, Depression	Low	**Low**	Moderate	↑	Moderate	Mild	↓	Mild	Moderate	↑	54	63	+9
P15	M	55-64	White British	—	—	Moderate	**Low**	Low	→	Severe	Severe	→	Severe	Severe	→	77	69	-8
P16	F	25-34	White British	—	Feeding/ Eating Disorder	Low	**Low**	Moderate	↑	None	Mild	↑	None	Mild	↑	52	52	0
P17	F	45-54	White British	Skin condition	Anxiety, Depression, and other mental health conditions	Moderate	**Low**	Low	→	None	None	→	None	None	→	43	33	-10
P18	F	18-24	Pakistani	—	—	Low	**Low**	Moderate	↑	Moderate	None	↓	Mild	None	↓	44	28	-16
P19	F	45-54	Any other White background	Other medical conditions	—	Low	**Low**	High	↑	Moderately severe	Moderate	↓	Severe	Moderate	↓	61	52	-10

P20	F	55-64	White British	—	—	Moderate	**Low**	Moderate	▲	Mild	None	▼	Mild	None	▼	38	47	+9
P21	F	65+	White British	Other medical conditions	—	Low	**Low**	Low	→	None	None	→	None	None	→	/	54	/

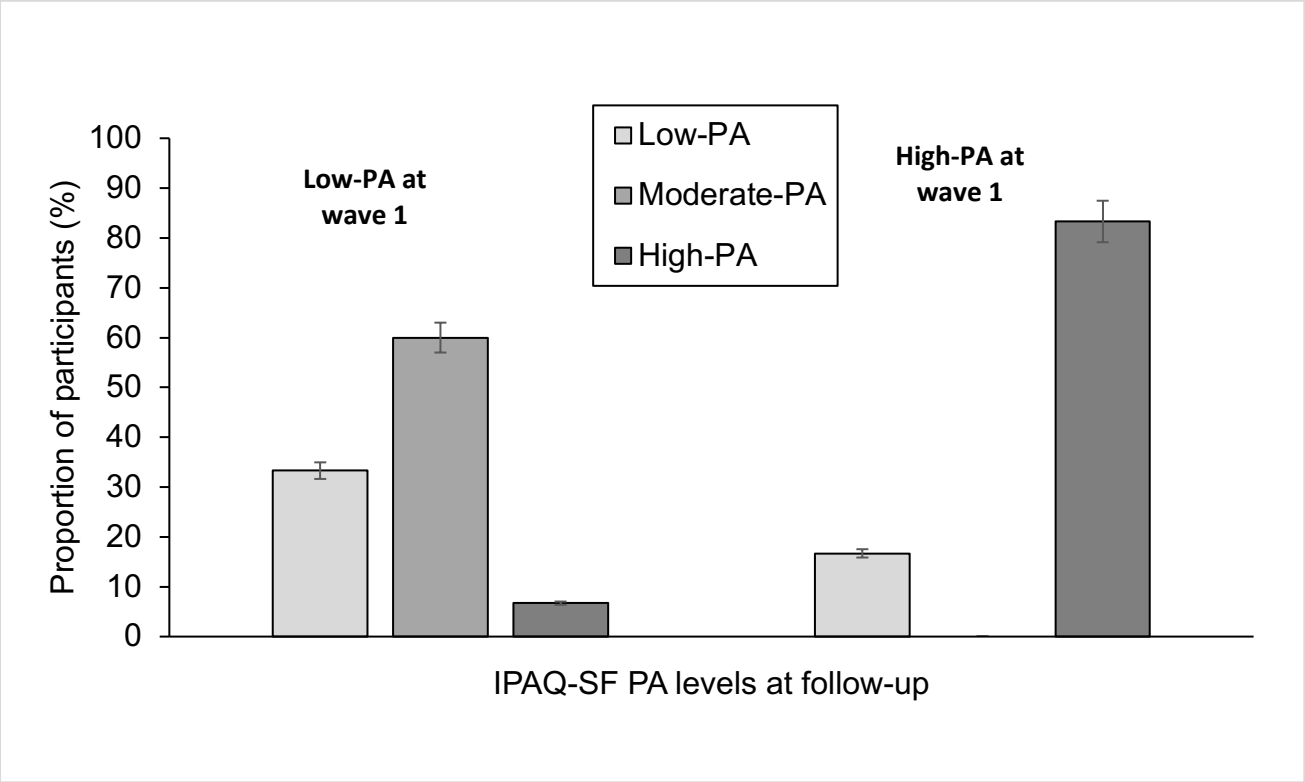
Note. "—", absence of depression, anxiety, physical health conditions or mental health problems. Other medical conditions include cancer, epilepsy, lupus, sleep apnoea, obesity. M, male; F, female. "/", reflects missing data.

[a] "None" reflects on none or minimal depressive or anxiety symptoms (PHQ-9 or GAD-7 total scores ≤4)

PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

Figure 2

Proportion of Participants by IPAQ-SF PA Levels



Note. Proportion of participants are shown for low, moderate and high-PA at follow-up by low-PA and high-PA groups identified at wave 1.

Themes

Eight themes were identified and arranged into two overarching themes in relation to the research questions posed (Table 6). Further details on example quotes can be found in Appendix 18. In the following section, overarching themes and themes are described and discussed with illustrative quotes.

Table 6

Themes Summary Table

Overarching themes	Themes
1. Challenges for PA Participation	1.1 The threat of contracting COVID-19
	1.2 COVID-19 policies – "Groundhog Day"
	1.3 Heightened awareness of the mind-body connection
2. COVID-19 Recovery Solution: Barriers and Recommendations for Social Prescribing	2.1 Listen to individuals' concerns, collaborate and provide interventions to address doubts and needs
	2.2 Provide options to increase personal capital through purposeful activities
	2.3 Support individuals to (re)kindle relationships in the community to enhance wellbeing
	2.4 Offer diverse social prescribing to meet various needs
	2.5 Destigmatise mental health and its treatment

1. Challenges for PA Participation

The participants' accounts illustrated the complexity and varying degrees of impacts on PA participation during COVID-19. While some participants were consistent in their level of physical activity/inactivity, the majority described fluctuations in their PA levels as the pandemic unfolded.

1.1 The Threat of Contracting COVID-19. A majority of high/low-PA participants described an association between increased awareness of the COVID-19 virus and being "terrified" for themselves and/or their social network. In particular, low-PA participants tended to avoid leaving their homes:

> "[…] I felt that if I stepped out of the house like I'd get COVID instantly, and I would feel unwell and stuff. So that worry of getting COVID and getting ill […] I value that more compared to my motivation to go outside and do my walks." (P18, age 23)

As the pandemic unfolded, some low-PA participants described reduced PA when the "excitement" and "novelty wore off'. A few high/low-PA participants expressed gratitude for the unanticipated benefits of the pandemic, namely re-evaluation of lifestyle and more time for PA. Nonetheless, most recognised that the "sense of fear hasn't dissipated" (P21, age 65). This appeared to have contributed to how people engage in PA. Some high/low-PA participants have continued with online classes or outdoor PA instead of returning to indoor settings (e.g., gym, indoor group classes) because these did not "feel safe".

1.2 COVID-19 Policies – "Groundhog Day". Many excerpts described the implications of COVID-19 policies on people's mental health and behaviours. Participants acknowledged that adhering to legalised COVID-19 policies resulted in loss of normal daily activities – including socialising, out-of-home movements, work, and hobbies. Most high/low-PA accounts described wanting and lacking physical contact with people, and some low-PA participants expressed feelings of loneliness

caused by the absence of in-person contact. Though most suggested that the pandemic was more challenging for people who were living alone:

> "[…] I had gotten sixty days without a hug, without touching anyone […] my physical health risk from COVID is much, much less than the mental health risk of not being able to socialise or like have any social touch at all." (P13, age 38, living alone)

While some participants - mostly those who were older (aged 55+ years) - felt gratitude in technology enabling alternative ways to stay connected and even widen their social network, several younger low-PA participants stated that virtual interactions are "not the same" and were inadequate to meet their social needs. This may increase psychological distress and feelings of loneliness, which make transitioning out of lockdown "stressful".

In addition to the (physical) social disconnection, a sense of listlessness coupled with boredom when "stuck" at home were frequently acknowledged. Most high/low-PA participants asserted a need to keep busy or establish some structure to their day, including through PA. However, this appeared to be insufficient considering the circumstances: "[…] there were some times when it was just like no walking is going to fix this. I'm just too sad to know that the world is going to hell" (P05, age 46). Furthermore, some low-PA participants mentioned their usual coping strategies were "taken away", suggesting that this need for maintaining their mental wellbeing were "denied" forcibly.

In some cases of the low-PA group, these feelings of being “trapped” caused by the constraints of COVID-19 policies have resulted in sedentary behaviour and under- or over-eating:

> “Initially when the first lockdown came, I must admit I hit the sugar quite badly […] what we really did with being at home all the time and not able to go out, we just basically gorged on everything. We didn’t stop eating at all.” (P14, age 56).

1.3 Heightened Awareness of the Mind-Body Connection. Many participants described having more time compelled them to focus on their physical and psychological health during lockdown. Most participants in the high-PA group felt the benefits on their wellbeing by doing more in lockdown. However, almost all acknowledged the challenges of maintaining PA due to competing demands post-lockdown. Specifically, one individual described feeling “panic” and a sense of “guilt” when they had less time to exercise when transitioning out of lockdown (P03, age 33). Conversely, others from the low-PA group acknowledged an awareness of the “proven” health benefits of PA, but this idea that “motivating yourself is the most difficult” (P07, age 27) was frequently described:

> “[…] from March 2020 till last September, it didn’t change because I was always at home sitting at my desk with my PC, eating ((laughs)) and I never thought to do better. I thought I have to start to do exercising, but I never started because I didn’t have the motivation, so it was very difficult” (P19, age 45)

A mixture of internal and external factors affected motivation for PA. In particular, accounts from the low-PA group frequently described the influence of external factors, such as limited space for exercising, unmotivating surroundings, missing usual exercise partner or groups, and seasonality. Consequently, some felt that PA was less rewarding and "pointless". Others from the low-PA group acknowledged the contributions of psychological distress and symptoms of existing health conditions:

> "I mean fatigue is a part of my condition anyway […] when I wasn't doing anything, things like stamina definitely dropped off…my energy levels were really low. And because I was really stressed, I wasn't sleeping well, so I was even more tired, and that additional stress was making me feel so much more exhausted and there just wasn't really any way to kind of get any of that out." (P10, age 24)

Several accounts, particularly those with disability or mobility issues, emphasised feeling "different" and a frustration that their fitness has been negatively impacted. These seemed to indicate that people with existing or recently diagnosed health conditions may have fared worse as the pandemic unfolded with a loss of independence and health consequences. This sense of lost confidence and fear of worsening health symptoms were commonly articulated. One participant from the low-PA group described their experience with Long COVID: "I didn't feel able to try or at times I was even afraid to try in case I brought on a symptom flare-up or went backward, took a step backwards in my recovery." (P08, age 29).

2. COVID-19 Recovery Solution: Barriers and Recommendations for Social Prescribing

Almost all participants endorsed SP as an intervention, but many acknowledged the barriers to access, engagement and maintaining involvement. The feasibility of SP may involve changes on multiple levels: interpersonal (e.g., the role of healthcare professionals), policy (e.g., resources and accessibility issues) and population (e.g., repositioning health systems – medical/social model). As such, recommendations are suggested to overcome the identified barriers – in order of feasibility.

2.1 Listen to individuals' concerns, collaborate and provide interventions to address doubts and needs. Some participants have experienced or predicted SP as an insufficient standalone intervention. Support needed to be "more regular and in-depth" (P08, age 29) and SP as "part of a package of care":

> "the thing that I worry about with social prescribing is thinking that is going to fix the system […] And it can't. ((laughs)) So I would be really insulted if I came to my GP and described the traumatic ordeal I've been through and that I really need some professional mental health support. And they said, 'Mmm. Well, we can't do that, but have you tried gardening?' …would be really upsetting for me because I am working so hard on trying to do everything I can to make links in the community. But I also need this professional support as well." (P13, age 38)

As well as concerns around difficulties in accessing help, many have highlighted this idea of "doing things with you" (P04, age 56). Some indicated that people are sceptical

of being “told” and prescribed with suggestions, implying a sense of mistrust exacerbated by COVID-19. This highlighted the role of healthcare professionals, including GPs and link workers, to work collaboratively with people who are seeking help and “to break it down for them” (P11, age 64). It should involve active listening, empathy, curiosity, modelling and problem-solving, which aim to improve and maintain engagement, increase motivation, and enhance self-efficacy.

2.2 Provide options to increase personal capital through purposeful activities. A commonly acknowledged theme is the importance of engaging in purposeful work or activity. Some have described limited opportunities and information for non-vulnerable groups during COVID-19, others have described a need to feel “useful”, to have “purpose”, and to feel “grounded”.

> “[…] everybody needs to work out and identify what feeds them in life. What gives them strength? What makes them feel good? What gives them energy? [...] for some people, it will be connecting to nature or gardening […] that was something which I learned about myself. Thanks to this pandemic.” (P05, age 46)

2.3 Support individuals to (re)kindle relationships in the community to enhance wellbeing. Most participants endorsed SP to reduce loneliness and cultivate social connection. In particular, community spirit was apparent during COVID-19 and the need to connect has become of greater significance. They also acknowledged groups could help link people to peer support in recognition that individuals can feel as though they are “the only one” struggling, but also creating a sense of belonging:

> "I've always been interested in what's going on in the community […] it's a great sense of belonging. So even if people don't have family around them, they can feel that they do belong somewhere […] they've got a sort of a social group […] not just friends. There's something a lot deeper than that" (P17, age 54)

2.4 Offer diverse SP to meet various needs. Much of the feasibility of SP expressed in the data were related to practical challenge (e.g., cost, transport, disability, vaccination status, working hours), which seemed to derive from this idea of inequality and "what you can or can't get now" (P04, age 56). Across the data, participants have described the emotional barriers to engaging in groups. Some stated that they would avoid or refuse SP due to a fear of social interaction, rejection, being "insecure" and "an introvert" (P20, age 60). There is a notion that others who are "socially anxious" might do the same despite the benefits of SP groups:

> "[…] you feel that you wouldn't fit in with other people or like other people know each other and you don't, or you don't know what you're doing or like you won't meet anyone who's like you, and then that will just make you feel more alone because you've tried, and you've still not found anything." (P16, age 32)

2.5 Destigmatise mental health and its treatment. Many participants acknowledged the tensions between medical and social models that influence individuals' attitudes towards mental health and its treatment. A few participants

indicated that “negative connotation” creates shame that prevents people from “admitting” feelings of loneliness and/or isolation, and therefore seeking help. Others have acknowledged that participating in activities and the name itself - social prescribing - is more approachable. Most felt that SP could be effective as a preventative measure or in conjunction with medication. However, further changes in attitudes towards mental health, and a change to the idea of medication as “a quick fix” are needed to improve its acceptability:

> “[…] I think we as a population have to understand what is best for us and work hard to do those things before immediately going to the doctor and saying ‘I feel anxious. Can I have some medication?’ And I think also the doctors as well probably have got to say do the social prescribing first before offering the medication as well, so it’s a bit of both.” (P01, age 58)

In summary, these excerpts suggest that we need to rethink how we promote individuals’ engagement with SP from a population and systemic perspective. This should involve healthcare professionals facilitating positive experiences in relationship to support, alongside policy changes to address health inequalities and reposition current health systems.

Discussion

To inform social prescribing as a potential COVID-19 recovery solution, this mixed-method study sought to understand how and why PA and mental health were related during the COVID-19 pandemic. Our wave 1 quantitative findings showed that, compared to individuals with higher levels of PA (i.e., high/moderate group), individuals self-identified as having low levels of PA had more depressive symptoms and higher

levels of self-perceived loneliness, after controlling for covariates. Individuals with more depressive symptoms were also more likely to be in the low-PA group at wave 1, while anxiety and self-perceived loneliness were not significant predictors of low-PA group membership relative to moderate-PA. Anxiety, depression and self-perceived loneliness were not associated with a higher likelihood of being highly active (high-PA) compared to moderate-PA. Our qualitative findings from UK participants self-identified as low or high-PA at wave 1 gave additional explanations into these quantitative findings by illustrating the various challenges of PA participation during COVID-19. We found three themes that promoted and hindered their PA during the pandemic, which included the 1) threats of contracting COVID-19, 2) impacts of COVID-19 policies, and 3) heightened awareness of the mind-body connection. Whilst some participants reported positive changes and adjustment during and post-lockdowns, others have fluctuated in their PA and mental health. To improve people's psychosocial wellbeing, the majority have endorsed SP to address loneliness and social isolation. All participants acknowledged practical and emotional barriers to accessing support and engaging with this intervention. Therefore, five recommendations were identified to increase the viability of SP: working collaboratively to address doubts and needs, providing options in purposeful activities, (re)kindling relationships for wellbeing, offering diverse SP to meet various needs, and destigmatising mental health and its treatment.

The current quantitative findings showed that, during wave 1 of COVID-19, 32.2% did not meet the WHO PA guidelines. This was higher than the estimated level of physical inactivity of the global population pre-COVID-19 (27.5%) (Guthold et al., 2018), and comparable to a large cross-sectional survey conducted in 14 countries (*n* = 13,503) that reported 37.5% of the sample did not meet the WHO PA guidelines in

Spring 2020 (Wilke et al., 2021). Furthermore, our qualitative analyses suggest that high/low-PA participants expressed limited opportunities for usual out-of-home PA (e.g. walking, cycling or commuting to work or other activities) when adhering to COVID-19 policies. Similar to regular gym users (Kaur et al., 2020), the high-PA participants in our sample adapted their usual PA routines while some of the low-PA participants spoke about a lack of motivation to be physically active during the pandemic.

Consistent with prior cross-sectional research that included the IPAQ-SF (Ding et al., 2021), our wave 1 quantitative data showed that individuals who engaged in low levels of PA during COVID-19 reported more depressive symptoms but not anxiety symptoms compared to individuals who engaged in higher levels of PA. This finding is inconsistent with a previous UK cross-sectional study that found more time spent on moderate-to-vigorous PA per day was negatively associated with moderate-to-severe anxiety symptoms (OR = 0.88, 95% CI = 0.79-0.97) and depressive symptoms (OR = 0.85, 95% CI = 0.73-0.96) after adjusting for covariates (Jacob et al., 2020) – this is perhaps due to different assessment points during COVID-19. A brief, unstandardised assessment was used to measure PA, which makes it hard to draw comparison to the current study using the IPAQ-SF. Conversely, a Chinese cross-sectional study with IPAQ-SF data conducted from February to March 2020 showed that college students who engaged in moderate or high-PA reported fewer depressive symptoms compared to those who engaged in low-PA (Xiang et al., 2020). Only individuals who engaged in high-PA but not moderate-PA had fewer anxiety symptoms relative to individuals who engaged in low-PA. Together, these findings suggest that the relationship between PA and mental health are likely to be bi-directional. These are also in line with the literature that indicated the mixed evidence around PA for reducing anxiety and consistent

findings of the antidepressive effects of PA in both clinical and non-clinical populations (Rebar et al., 2015).

The health benefits of PA on physical and mental wellbeing are widely acknowledged (e.g., Arem et al., 2015; Molarius et al., 2009; Rebar et al., 2015; Warburton et al., 2006). Increased awareness of the mind-body connection during COVID-19 were endorsed by low/high-PA participants in our qualitative sample, yet with diverse outcomes over time. Indeed, a longitudinal research among the UK general population during COVID-19 found that several sociodemographic and health-related factors had predicted the different pathways of PA during and after easing of lockdown (21 March – 23 August 2020) (Bu et al., 2021). For instance, individuals in solitary living and with long-term physical and mental health problems tended to be inactive relative to the fairly/highly active groups, highlighting the role of health status and social support in PA. One US cross-sectional study conducted in April 2020 found that those participants who reduced their PA levels during COVID-19 and were no longer meeting the PA guidelines had significantly more depressive symptoms and higher levels of loneliness relative to those who maintained their PA levels (Meyer et al., 2020). Interestingly, our wave 1 logistic regression analysis indicated that loneliness was not a significant predictor to distinguish those in the low or high-PA group. Yet, our qualitative analyses suggest that participants with high/low-PA needing or wanting in-person social contacts to maintain their psychosocial wellbeing, while some participants in the low-PA group described a lack of intrinsic motivation without the social aspects of PA participation, which make it less rewarding or fun.

These barriers to PA participation can be understood using the COM-B model (Michie et al., 2011) which suggests that behaviour and behaviour change are influenced by three interacting domains: capability (i.e. physical and psychological),

opportunities (i.e. physical and social) and motivation (i.e., reflective and automatic motivational processes). In accordance with existing qualitative research of UK and Canadian adults (Hailey et al., 2022; Petersen et al., 2021), our qualitative data suggests that COVID-19 policies have restricted normal daily activities and social interactions (i.e. physical/social opportunities based on the COM-B model), which resulted in reduced PA and sedentary behaviour amongst participants in the low-PA group. Although the UK participants in the present study expressed an increased awareness of the importance of PA for physical and mental health (i.e. psychological capability), other factors associated with psychological distress and physical health issues would result in lowered physical and psychological capability to be physically active. These factors would also affect some people's self-efficacy to be physically active that would, in turn reduce PA motivation, particularly when opportunities were seen to be limited. Furthermore, findings from a recent Danish cross-sectional study (October-December 2020) indicated that adults who reported low wellbeing, namely worse emotional and physical health and lowered happiness, had higher levels of loneliness during COVID-19. Greater adherence to COVID-19 policies (i.e., avoiding crowded places/ public transport, staying at home and reducing travels) and solitary living were also associated with high loneliness (Christoffersen et al., 2023). Altogether, policy makers should consider the impact of lockdowns on people's physical and psychosocial wellbeing, while creative ways to reduce persistent feelings of loneliness and/or physical inactivity are necessary.

As such, the present qualitative findings suggest that participants recognised the benefits of SP for maintaining psychosocial wellbeing as a result of learnings from COVID-19. Indeed, in accordance with previous research (Hossain et al., 2020; Jetten et al., 2012; Younan et al., 2020), the fundamental human need to feel socially

connected with others and the values in belongingness were acknowledged. However, social fears of being in groups, feelings of loneliness and social isolation were some of the barriers identified that may prevent people from accessing support in the first place or engaging with SP, even though one of the aims of this approach is to reduce loneliness and social isolation (Stuart et al., 2022). Healthcare professionals therefore need to work collaboratively with individuals to offer appropriate levels of support where SP could be offered alongside psychological interventions. Finding ways to (re)build trust and engage people with SP should be thoroughly considered given that participants predicted people may resist a social model to healthcare and being prescribed with activities compared with a predominant medicalised healthcare model. One possible remedy is for link workers/ social prescribers to act as a support, taking a personalised approach rather than adopting a 'prescriptive' role. This was identified as a key component in moderating the effectiveness of a PA intervention on reducing loneliness among older adults (60+ years), alongside shared experiences and more opportunities to meet with peers (Franke et al., 2021).

While link workers could support individuals in increasing their engagement with SP, self-efficacy and overcome potential barriers, changes on wider levels including policy and population beliefs about mental health and its treatment are also needed. Thus, in line with prior research (e.g., Gibson et al., 2021; Moscrop, 2023), providing opportunities to engage with purposive activities in local communities are important, but overt barriers of practical challenges and inequality would need to be considered by healthcare professionals as well as at the organisational and policy levels.

Limitations

This study has several limitations. There was an over-representation of participants who self-identified as White (80.0%) at wave 1, which limits the

generalisability of current findings to the general population. Previous research has found that participants from Black, Asian and minority ethnic (BAME) groups were more likely to report moderate symptoms of depression and anxiety during and after the first UK lockdown (March 21, 2020 – July 10, 2020) compared to White people (Saunders et al., 2021). They were also less likely to consistently meet PA guidelines before the pandemic compared to White people, which may increase the risk of severe COVID-19 outcomes (Sallis et al., 2021). Future research should engage participants from the BAME communities, considering that health disparities were more apparent due to the COVID-19 pandemic. Of note, our follow-up UK sample had a greater proportion of participants in the low-PA (71.4%) than high-PA group (28.6%). This may have led to a lack of understanding into the experiences of those who were highly active. There was an over-representation of females in the follow-up sample (81%), and the average age of interviewees (M = 45.91, SD = 15.55) were significantly older than those who were not interviewed (M = 36.43, SD = 12.61; t(21.91) = -2.73, p = .012). The current findings showed that gender and age were not significantly correlated with PA levels at wave 1 of COVID-19. Previous research also found no gender differences in PA levels during COVID-19 but being younger was related to reduced PA (Bu et al., 2021).

It is also important to acknowledge that participants for the present study were recruited from a population sample, but five participants (23.8%) met the clinical threshold for anxiety and depression (≥10 on GAD-7 and PHQ-9, respectively) at follow-up. Of these, two participants (9.5%) reported severe levels of anxiety and depression, indicating that individuals in the general population were meeting clinical cut-offs. A UK longitudinal study with a follow-up survey between May 23 and June 20, 2021 reported that 11.2% and 18.6% scored ≥10 on anxiety and depression (i.e., PHQ-

8), respectively (Solomon-Moore et al., 2022). However, the mean scores for anxiety and depression collected in the current follow-up survey were marginally lower than those reported in another longitudinal study with data collected between April 17 and July 31, 2021 (Wong et al., 2021). Therefore, it is possible that the current findings were influenced by higher levels of psychological distress reported, though this may also reflect a smaller proportion of people experiencing persistent or worsening mental health problems over time.

The current findings are potentially susceptible to recall biases. Firstly, participants were asked to report their PA prior to COVID-19 when completing the wave 1 survey. Secondly, primacy and recency effects may have affected how accurate the UK participants were able to recall their experiences across time. They may have different reference points at the time of the interview question, thus could cause discrepancy in findings. To address this, future study should examine changes in PA and MH using waves 2 and 3 of the Global COVID-19 study datasets (Wong et al., 2021).

Lastly, while the researcher was blinded to the PA group memberships of those invited for the follow-up study and a second coder was involved to increase the reliability of coding, every interview was conducted by one researcher T.H. This could lead to bias and knowledge of participants' PA levels from the interviews.

Research implications

This study contributes several important aspects to the literature on COVID-19 and mental health. Firstly, a sample of UK participants with distinct PA levels were interviewed. This allowed comparisons to be made between those who engaged in low or high levels of PA at wave 1. Secondly, a mixed-method design provides

qualitative insights and knowledge in making sense of the quantitative relationships observed between PA and mental health during COVID-19. Finally, it followed up with UK participants to examine how they may have fared 18-months later. The qualitative findings showed different patterns of how people's PA levels and mental health have changed as the pandemic unfolded. While some people have returned to pre-pandemic levels of PA and improved their mental health over time, reduced PA and psychological distress have continued for others. Moreover, a minority may have become less physically active and felt more stressed when transitioning out of lockdowns. In particular, those who were recently diagnosed with health conditions, living alone or experiencing Long COVID. It also contributed to the literature on the feasibility of SP as a potential COVID-19 recovery solution, suggesting the important roles of healthcare professionals and link workers in fostering supportive relationships, reducing mistrust and addressing stigma of loneliness and mental health. Future research can continue to monitor changes in PA and mental health over time and examine whether addressing mistrust by developing an understanding of the values of SP may help to increase the feasibility of this approach.

Clinical implications

Our findings have significant implications for clinical practice. Participants recognised the importance of maintaining physical and psychosocial wellbeing as a result of learnings from COVID-19. Therefore, clinical psychologists should utilise valuable local community resources and work collaboratively across health, social and voluntary sectors. SP is also a model endorsed by the World Health Organisation in the Western Pacific, emphasising the values in meeting individuals' needs by connecting them to diverse community-based resources (WHO, 2022). While non-

clinical support can be integrated into people's treatment, challenges and barriers of accessing and engaging with SP were identified. Stigma around mental health issues, lengthy waiting time and feeling unheard may prevent people from seeking help in the first place. Further, scepticism stemmed from mistrust of healthcare systems and the notion of being prescribed with groups may also affect engagement with SP. Therefore, building rapport and using a person-centred approach that takes into account individuals' circumstances, needs and strengths are important. Healthcare professionals should consider SP as part of an intervention when undertaking consultation and assessment. Services should make SP access equitable and continue to foster good working relationships with community and voluntary sectors in providing diverse options to meet people's needs.

Conclusions

The current findings support PA as a means to alleviate psychological distress caused by COVID-19 pandemic, as people had more time to focus on maintaining their physical and psychological health during lockdown. Despite this, the threat of contracting COVID and impacts of COVID-19 policies on mental health, including more depressive symptoms, may have resulted in reduced PA level. Although some participants spoke about improvement in their PA levels and mental health following the easing of lockdowns, others described ongoing psychological distress and/or reduced PA. While researchers have suggested SP as a potential COVID-19 recovery solution and this approach was generally supported by the participants for promoting social connectedness and psychosocial wellbeing, practical and emotional barriers were identified. Therefore, changes on multiple levels, including interpersonal, policy

and population, may be necessary to encourage collaborative working and overcoming barriers.

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Part 3: Critical Appraisal

Introduction

This critical appraisal aims to provide a reflective account and exploration into the process of conducting this research project. Firstly, I will reflect on how my background and previous experiences have influenced how I approached this study and informed the assumptions I held. Secondly, I will provide a reflective account of how these assumptions have changed throughout this research project. Quotes from the interviews will be used to aid my reflections and learnings. Thirdly, I will share how I negotiated dilemmas and methodological choices that arose during this research and provide an extended discussion of the strengths and weaknesses of this research. Lastly, I will share some suggestions of future directions for research.

The process of reflexivity and the effect of personal assumptions

Influences of My Background and Previous Experience on the Research Process

As discussed in my researcher's perspective within the empirical paper, I think my experiences of the severe acute respiratory syndrome (SARS) outbreak in Hong Kong in 2003 have increased my awareness of the potential effects of COVID-19 pandemic on people's wellbeing. Many of my family members have also shared these fears and this heightened sense of needing to protect themselves and others from COVID-19. As such, I think one of my assumptions that I brought to this research and data was that the ramifications of lockdowns were unequivocally 'bad'. Although my daily activities have returned to 'normal', I still have a heightened sense of awareness and remain cautious because of my work with vulnerable patient groups within a medical setting. I also recognised that I have not intentionally set aside the time for exercising despite my knowledge of the importance of staying active and having more

opportunities to access sports facilities or classes as we come out of the pandemic. Instead, physical activity is part of my daily activities, such as commuting to my work and walking to places, and protecting my time for socialising has since become increasingly important.

In addition, I think my work before and during training has informed this research process. I was working as a practitioner in a primary mental health care NHS setting during the initial phase of the COVID-19 pandemic across the first national lockdown. I recall speaking to people who were feeling anxious, overwhelmed and threatened by this virus that was novel and deadly, even before the lockdown announcement and particularly prior to the rollout of vaccine programmes. This context has skewed my perceptions of how people were faring and assumed that most people have experienced heightened levels of psychological distress. As the pandemic unfolded and I started doctoral clinical psychology training in autumn 2020, I became even more aware of the adverse implications of COVID-19 on people's physical and psychological wellbeing whilst on placements. I spent time working with people who have severe and enduring mental health difficulties and supporting patients with long-term health conditions and were mostly identified as clinically vulnerable. These contexts have further influenced my feelings about the detrimental impacts of COVID-19 on people. In particular, I think these experiences have further enhanced my awareness of the stresses and challenges faced by particular groups of people during COVID-19 and re-adjustment to life after the easing of lockdowns or shielding. I think this has meant that I might have been less curious and aware of some of the unanticipated benefits of COVID-19 and often focused on the negatives.

Another assumption that I brought to the data was the view that people *should* participate in social activities for their mental wellbeing. I think this

reflects the emphasis on doctorate clinical psychology training where relationships are paramount inside and outside of the therapeutic space. I believe that one of the fundamental human needs is to connect and relate with others. I think this stems from my Chinese collectivist cultural background that group harmony, cohesion and supporting others are recognised as important values. This was particularly prominent during lockdown when many described the risks of being socially isolated and loneliness on individuals' wellbeing while community support was valued. It promoted a sense of belonging and unity when faced with a crisis. As such, my initial views of how social prescribing may have a positive impact on people is by creating more opportunities for people to come together, socialise and connect. I perceive relationships built through a common interest or shared activity will promote people's psychosocial wellbeing. I think this position meant that I was less able to appreciate the value of solitary activities for one's wellbeing. Often, I might have overlooked the impacts of social fears and COVID-19 vaccination status in stopping people from engaging in social prescribing, yet this intervention sought to reduce loneliness and social isolation. In particular, lockdowns made it harder for some people to re-engage in social activities and interactions, which could lead to avoidance. Conversely, a group of people may be excluded if there is a lack of perceived safety being in a group to prevent them from contracting COVID-19.

Lastly, I held the view that individuals have the autonomy and influence to change their behaviours. I believe this may stem from the Cognitive Behavioural approach I learned prior to and on training. Specifically, my experience and knowledge in using behavioural activation for reducing symptoms of depression and increasing individuals' self-efficacy have meant that my focus is on the links between one's behaviours, thoughts, emotions and physiological feelings. I also believe that physical

activity is widely accessible to many. Some advantages include low financial cost and flexibility depending on the person's availability and time. A plethora of research has proved that physical activity is good for our physical and mental wellbeing. However, I think my privileged position in being healthy, without dependents and having the time for physical activity has meant that I may have located the ‘problems’ with physical inactivity within the individuals. I may not have looked at alternative explanations, such as systemic issues.

In summary, three main assumptions I held during the interviewing and analysis processes were:

1) The ramifications of lockdowns were unequivocally ‘bad’
2) People *should* participate in social activities for their mental wellbeing
3) Individuals have autonomy and influence to change their behaviours

Challenges to My Assumptions

In the following section, I will outline how these three assumptions were challenged when conducting this research. I will reflect on my reactions and include some excerpts to illustrate how my assumptions were modified.

The ramifications of lockdowns were unequivocally ‘bad’. During the interviews and analysis phases, I was surprised to hear the unanticipated benefits or advantages from COVID-19 that were described by some participants. These constituted several domains: positive changes to their PA levels – included having more time to focus on their physical and/or mental health as well as importance of maintaining good health, community spirit, new opportunities to connect with people from around the world via online platforms, and strengths in overcoming challenges associated with the

pandemic. For instance, several participants from the high-PA group described having "more time" to focus on their physical health during the pandemic. This included one participant who spoke about the "gift" of this pandemic: "[…] thanks to the three times a week of conditioning my body and being able to move more. It's actually given me the opportunity to dance, which I've never thought I'd be able to do."

Another participant from the low-PA group also expressed positive changes to his PA habits from being sedentary during the first lockdown to overcoming the challenges of exercising:

> "[…] everything is back to normal for me, but not back to normal as such because I'm a lot healthier now…I've lost three stone, and I absolutely feel wonderful so I'm not back to how I was before the pandemic. I am the new me. The pandemic has brought on a completely different person […]"

As a result, there were more nuances to people's experiences of physical activity participation during COVID-19, and how the impacts of the pandemic might not be negative for all. In light of this, I might have been less inclined to explore the advantages from this pandemic during the interviewing process. However, it was evident that some of these were captured when coding and analysing the data. When discussing findings with my supervisor K.W. and peers, I also reflected on the participants' accounts of the positive aspects coming from the pandemic. I hoped that the current findings have communicated both the challenges and unanticipated benefits from this pandemic to reflect on people's lived experiences through transparency of the assumptions that I held.

In addition to some of the unanticipated positives that came out of COVID-19, participants also shared how their prior experiences of serious physical and/or mental health issues have shaped their responses to this pandemic. Meanwhile, other

participants also described a process of adjustment as the pandemic unfolded. For some, this pandemic has increased their awareness of the importance of maintaining good health through staying active, as well as reconnecting with their social network or community:

> "And I really like that model (referring to Mutual Aids) that it could be just so open. And in some ways, I thought, well, actually that's something that we could probably do with all the time. You know, it's just the need was highlighted because of the situation"

> "[…] especially us during the pandemic asked ourselves, the people on either side of us in the houses next to us. How are they doing? Say "Hello" over the garden wall. Just a little communication makes people realise that this, you know, somebody sees you. It's important to be seen. Somebody knows you're still there, so we tried to do that as much as possible."

These excerpts brought to my attention people's strengths and the significance of local resources, highlighting a sense of belongingness and community spirit. As such, some participants' stories of their experiences reminded me of how things could be *both* good *and* bad. In particular, one participant from the high-PA group has reflected on how this pandemic "allow(s) people to see what's taking place and what isn't taking place". This has resonated with me and encouraged me to consider how this research could make a difference in the field of clinical psychology and among mental health treatment.

People should participate in social activities for their mental wellbeing. Although many participants described the benefits of social connectedness for their mental wellbeing, solitary activities were also endorsed. In particular, almost all participants from high-PA group and a few from low-PA group preferred to engage in physical activity, including exercising or walking, on their own.

> "[…] I really don't like running with other people actually ((laughs)) because it's really just a time for me to clear my head and to have time on my own really. Just to have that space on your own without being able to justify being on your own. Because friends of mine don't like running, so it's kind of a nice excuse for me ((laughs)) to just find that time to go."

Others also described solitary PA participation as a time to connect with themselves and/or nature. This was often conceptualised as a form of self-care – to "ground" them and "refresh" their mind. Government imposed lockdown restrictions/changes have forced people to adapt their PA participation. For example, some participants transitioned to online exercise classes or home-based workouts. These are convenient alternative ways to staying active, including a few participants describing not needing to socialise with other attendees in a group class setting. However, others cited the social components (e.g., dancing with friends, meeting grandchildren to do outdoor activities) as one of their motivators to help them remain active.

In addition to engaging in PA on their own, most participants described how joining groups, for instance as part of a social prescribing approach, will require courage and how this could be off putting for some people, including themselves. Therefore, social prescribing can be problematic or difficult for some people despite its aim is to reduce loneliness and/or social isolation and promote social connectedness. For example, some participants described how they "prefer my [their]

own company", others shared concerns of how people might perceive them, particularly in relation to their mental health issues. Others expressed worries that they "wouldn't fit in with other people". As such, one participant who said "it very much depends on the person" has highlighted that there is no one-size-fits-all rule. Therefore, a more collaborative and flexible approach is needed.

Individuals have autonomy and influence to change their behaviours. I have frequently felt disheartened by how people were treated during the pandemic. Many participants have described being let down by health services, other organisations and institutions, including across workplace and educational settings. I frequently felt saddened and disappointed by people's negative experiences with the NHS during COVID-19. For example, one participant said she "fought tooth and nail and waited over a year to finally get mental health support from a clinical psychologist". Another participant also shared their journey of doing "psychotherapy by myself ((laughs))" as she was unable to get support through the NHS. Although these accounts showed strengths, resources and determinations, they also highlighted the lack of timely support and frustration when trying to seek help. These views have highlighted increasing pressure and demands on mental health services, yet a lack of capacities/resources to meet people's needs. It prompted me to think about how we balance these tensions as clinicians and how services could do better. While thinking about 'solutions/interventions' are important, I think we need to provide the right level of intervention based on an individual's needs and in a timely way. Further, other participants have shared that lack of inputs, reasonable adjustment or timely support from workplaces and educational institutions have added another layer of stress - in what was already a stressful situation of an unprecedented pandemic.

Many have shared that the longer-term effects of COVID-19 policies had on people's physical and mental health were yet to be actualised. In particular, some felt that the "delayed effects" of the pandemic were more detrimental than the acute impacts during lockdowns. In particular, COVID-19 had a disproportionate impact on particular groups, highlighting inequalities. To name a few: those who were living alone, those who were vulnerable and/or afraid, those whose lives were affected from delays in receiving their treatments, those with children, young people and those whose families live abroad. While there was a sense of community support and unity during the height of the pandemic, I too shared this worry of particular groups being "forgotten" and feeling "powerless" over health inequality and systemic issues stated by one participant. Finally, one participant referred to Michel Foucault, a French philosopher, to highlight that individuals, organisations, institutions and society ought to learn from this pandemic:

> "So, people get back to trying not to change things, not do things differently as a consequence. I'm trying personally to do things differently. I know some colleagues and friends of mine are doing that as a result of the pandemic, which I think is a good thing."

Reflections and Learning from the Interviewing Process

This was the first time I conducted qualitative interviews for research. Before going into the interview, my expectations were that people may describe a better mood since coming out of lockdowns and returning to their usual activities. Therefore, I assumed that the interview contents and materials would be less emotive compared to my clinical work on placements of working with people who have long-term physical and/or mental health conditions. Without a doubt, it came with challenges. The

interviewing process was moving and occasionally distressing as many participants candidly shared their struggles during the pandemic. In particular, the disproportionate impacts it had on people who were clinically vulnerable, expressed loneliness and/or socially isolated, and had experienced bereavement/losses. Many participants have shared frustration, anger and disappointment in governmental responses of this pandemic as well as healthcare services, including GPs. In particular, I interviewed one participant who is clinically vulnerable and had been shielding for two years. When she described to me how her mobility is now “badly compromised” while laughing, she said “I’m laughing about it because otherwise I’ll cry. And I was independent.” Following this interview, I reflected on my feelings of anger, disappointment, powerlessness and sadness at the repercussions of lockdowns and COVID-19 policies on people’s physical and mental health. As a research-clinician, these feelings have made me more determined to highlight the “lingering effects” of COVID-19 shared by other participants. Many spoke about the importance of researchers to continue investigating the longer-term effects caused by this pandemic, particularly when they felt “forgotten” by the government. Further, several participants have expressed dissatisfaction with government actions, including government officials not following COVID-19 social distancing legislations, and implied a sense of mistrust towards authority. Through self-reflection and discussion with supervisor and peers, I considered how the emotional contents of these interviews influence my reflexivity. I became more aware of how I was more primed to people’s distress rather than the unanticipated benefits and their strengths and resources, which were equally important.

Negotiating Dilemmas/ Methodological Choices

From the onset of recruiting UK participants, I sought to compare the experiences of those who self-identified as engaging with low or high physical activity levels at wave 1 of COVID-19. Specifically, I was curious to find out what made it possible for people to engage in very high levels of physical activity and what factors made it harder for others to keep up with any physical activity during wave 1 (April 17 – July 17, 2020). Therefore, the inclusion criteria were pre-determined to recruit participants from the highest and lowest ends of the high/low physical activity categories to explore the stark contrasts in physical activity levels (see Figure 1 of the Empirical Paper). The low response rate made me question the likelihood of people meeting those rigorous criteria. Further, this might negatively impact the generalisability of findings. Thus, high or low physical activity levels categories were used independently instead of in conjunction with MET-minutes/week. Although this might not have captured the experiences of those at the more extreme ends of this continuum, it might have provided a fuller picture of what most people in the community were doing in terms of PA at wave 1.

The UK follow-up sample included participants with severe and enduring mental health difficulties. Out of a sample of 21 participants, one participant had scored in the severe ranges for both depressive and anxiety symptoms at wave 1. Although this sample recruited is of the general population and an extension with mental health outcomes was collected 18 months later, two participants reported severe depression and anxiety at follow-up. It is conceivable that other confounding factors (e.g., pre-pandemic mental health) may influence the findings. Nonetheless, the current quantitative and qualitative findings reflect the different trajectory in mental health, and a small minority have persistent or worsened mental health over time. As such, timely

and appropriate levels of support are needed to help people who continue to struggle with their mental health to alleviate distress. It also highlighted that longitudinal research into the longer-term impacts of COVID-19 on people's physical and psychosocial wellbeing are necessary to monitor changes over time.

Extended Discussion of Strengths and Weaknesses

As outlined in the Discussion within the Empirical Paper, this study has several strengths and weaknesses. The use of a mixed methods approach in the current study is advantageous. Firstly, it allowed a more in-depth exploration into people's lived experiences during COVID-19 and in making sense of the quantitative relationships observed between physical activity and mental health. To the best of my knowledge, qualitative research examining people's physical activity during the pandemic have predominately focused on specific groups, such as older adults (Adams et al., 2021), people with severe and enduring mental health difficulties (Newbronner et al., 2022), regular gym users (Kaur et al., 2020), or young people, parents of young children and individuals with chronic physical or mental health conditions (Roche et al., 2022). Only a handful of studies have examined experiences of physical activity among the general population (e.g., Hailey et al., 2022; Petersen et al., 2021), yet none of these studies have examined this topic by recruiting participants who have reported high or low physical activity levels on a standardised physical activity measure (i.e., the IPAQ-SF; Craig et al., 2003). This measure is community used in 'motor control research'. Furthermore, it extended beyond the challenges of PA during COVID-19 by understanding the viability of 'social prescribing' as a potential COVID-19 recovery solution, which helped to narrow the research-practice gap.

Indeed, like all research the current study has some weaknesses. One of the weaknesses is the potential different reference points in how people remembered the COVID-19 pandemic. Some participants shared how the passage of time made it more difficult to recall their experiences and how they felt across the multiple waves of COVID-19. In hindsight, it would be beneficial to remind them about their wave 1 responses as a prompt to minimise recall bias. It may also allow more accurate reflections of how they felt and what their physical activity was at the time. It may also have been useful to present a timeline with key COVID-19 restrictions (e.g., entering and transiting out of subsequent lockdowns) during the interviews. This may have allowed us to refer to the different phases in a more consistent way. Secondly, it was inevitable that knowledge and insights into the participants' PA levels were gained from interviewing them, influencing the way questions were asked and prompts were used. However, different methods were used to increase the trustworthiness of the current findings. These included being blinded to the participants' PA group memberships during recruitment and interviewing by having my supervisor K.W. check the match and provide follow-up ID, involving a second coder for 10% of the interviews (n = 2), and keeping a reflexive journal.

Suggestions of Future Directions for Research

Evidently, more research is needed to monitor the changes in people's physical activity and mental health over time. In particular, many participants have cited the long-term effects of this pandemic remain unclear, and individuals who are vulnerable and/or afraid may struggle more with the transition out of COVID-19.

The current findings indicated that social prescribing is a feasible COVID-19 recovery solution and identified recommendations to overcome numerous practical

and emotional barriers to improve engagement, which involve changes across multi-levels, including interpersonal, policy and population. One area of research that may require further attention is the influence of stigma, social fear and mistrust of others hindering the engagement with social prescribing. In particular, qualitative research to explore ways in which health, social and voluntary sectors could involve the general population and consult with patients in working collaboratively and offering diverse social prescribing to meet various needs may provide directions to support this idea of co-production and “doing things with you”.

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Appendices

Appendices 1-2. COVID-19 Timeline

Appendix 1

UK COVID-19 Policies Timeline

	Key dates	England's lockdown laws timeline
Global COVID Study – wave 1 data collection (April 17 – July 17, 2020)	23rd March 2020	**First full national lockdown** These include: People had to stay at home, had to minimise their social contact, and non-essential high street businesses had to close. Only permitted to leave home to shop for basic necessities, for any medical need, and to travel to and from work where absolutely necessary.
	13th May 2020	Changes were made: People who could not work from home were encouraged to go to work. People encouraged to 'take more and even unlimited amount of outdoor exercise' People can meet one person from outside their household in open air spaces for recreation or exercise.
	1st June 2020	New rules were introduced on gathering – restricted indoor gatherings of two or more and outdoor gatherings of more than six.
	15th June 2020	Retail businesses permitted to reopen, people who live alone or in a single parent household were able to form a 'support bubble' with one other household
	4th July 2020	**Minimal lockdown restrictions** Further relaxing of lockdown rules included: reopening the hospitality sector, some leisure facilities, two households were able to meet indoors.
	14th September 2020	**Tightening of restrictions** Introduced a new "rule of six" to prohibit people from meeting socially in groups of more than six
	22nd September 2020	A return to working from home. All hospitality venues must operate table service only and close by 10pm
	14th October 2020	A new three-tier restriction system introduced: Tier 1: Medium alert – 'rule of six', hospitality venues closed by 10pm Tier 2: High alert – 'rule of six' but not allowed to socialise in an indoor setting

	Tier 3: Very high alert – not permitted to socialise with others outside their household outdoors; work from home if you could; avoid close contact outdoor exercise; group exercise activities and sports indoors should only take place with your household or bubble; organised activities for elite athletes, under-18s and disabled people continued; and indoor leisure remained open, but group activities and classes should not take place.
5th November 2020	**Second national lockdown imposed** Same restrictions to the "full lockdown" except schools remained open
2nd December 2020	National lockdown ended and all-Tiers Regulations reintroduced
14th December 2020	Rapid rising cases with the Alpha variant
20th December 2020	Tier 4 rules - similar to national lockdown in November - imposed in London, South East and East of England.
4th January 2021	**Third national lockdown imposed**
8th March 2021	School reopened. Two people were permitted to meet outside for recreation
29th March 2021	Outdoor gathering of six people or two households allowed. Outdoor sports facilities reopened.
12th April 2021	Non-essential retail, outdoor venues and indoor leisure (e.g., gym) opened. Social contact rules still applied – no indoor mixing between different households.
17th May 2021	Indoor social gathering permitted under 'rule of six' or two households. Indoor venues reopened (e.g., pubs and restaurants)
19th July 2021	Most COVID-19 restrictions terminated. Social distancing rules and self-isolation still apply.
8th December 2021	Rising cases of the Omicron variant and Winter plan for COVID-19 'Plan B' applied. These included: compulsory face masks wearing in most public indoor venue, mandatory NHS COVID-19 pass in specific settings e.g., nightclubs

Note. Dates and timeline in relation to COVID-19 were drawn from the House of Commons Library (2021). Coronavirus: A history of 'Lockdown laws' in England. Retrieved from https://researchbriefings.files.parliament.uk/documents/CBP-9068/CBP-9068.pdf. Further details as outlined in the Institute for Government (2022). Timeline of UK government

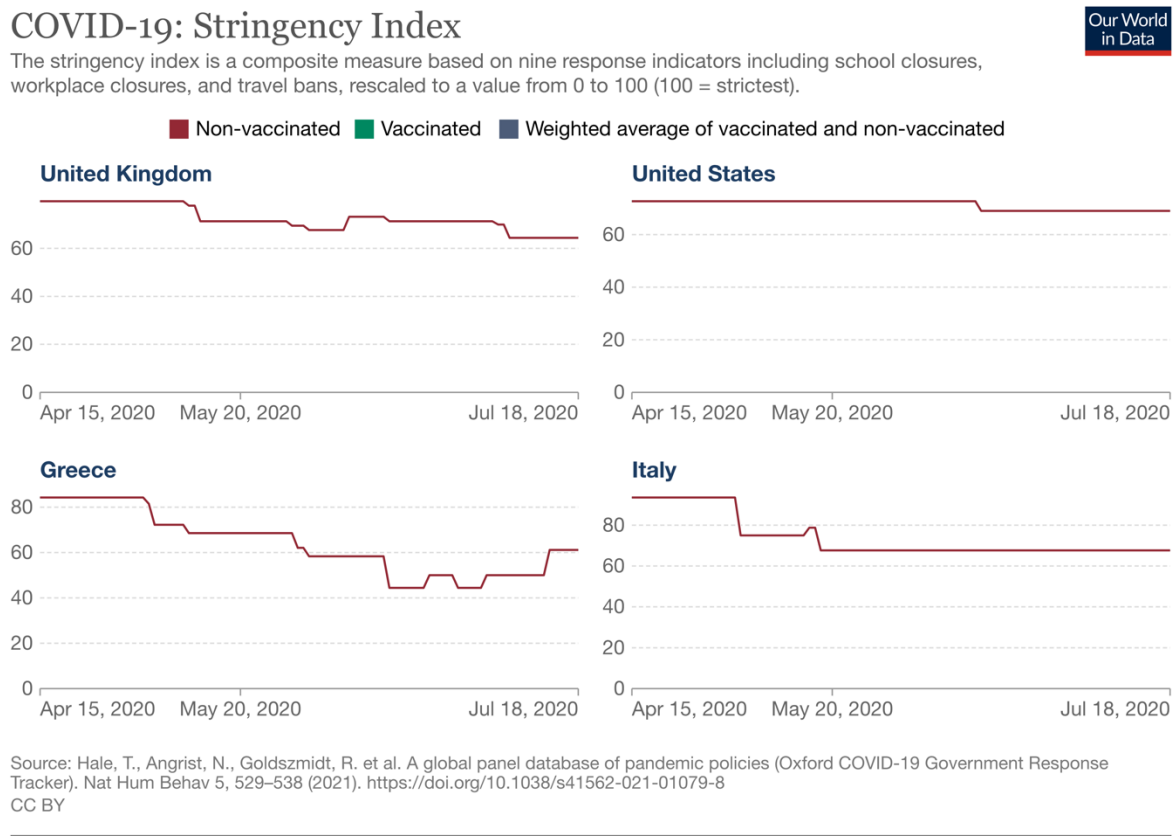
coronavirus lockdowns and restrictions. [data visualisation] Retrieved from https://www.instituteforgovernment.org.uk/data-visualisation/timeline-coronavirus-lockdowns

Appendix 2

Oxford COVID-19 Government Response Tracker on Stringency Index

Figure 2.1

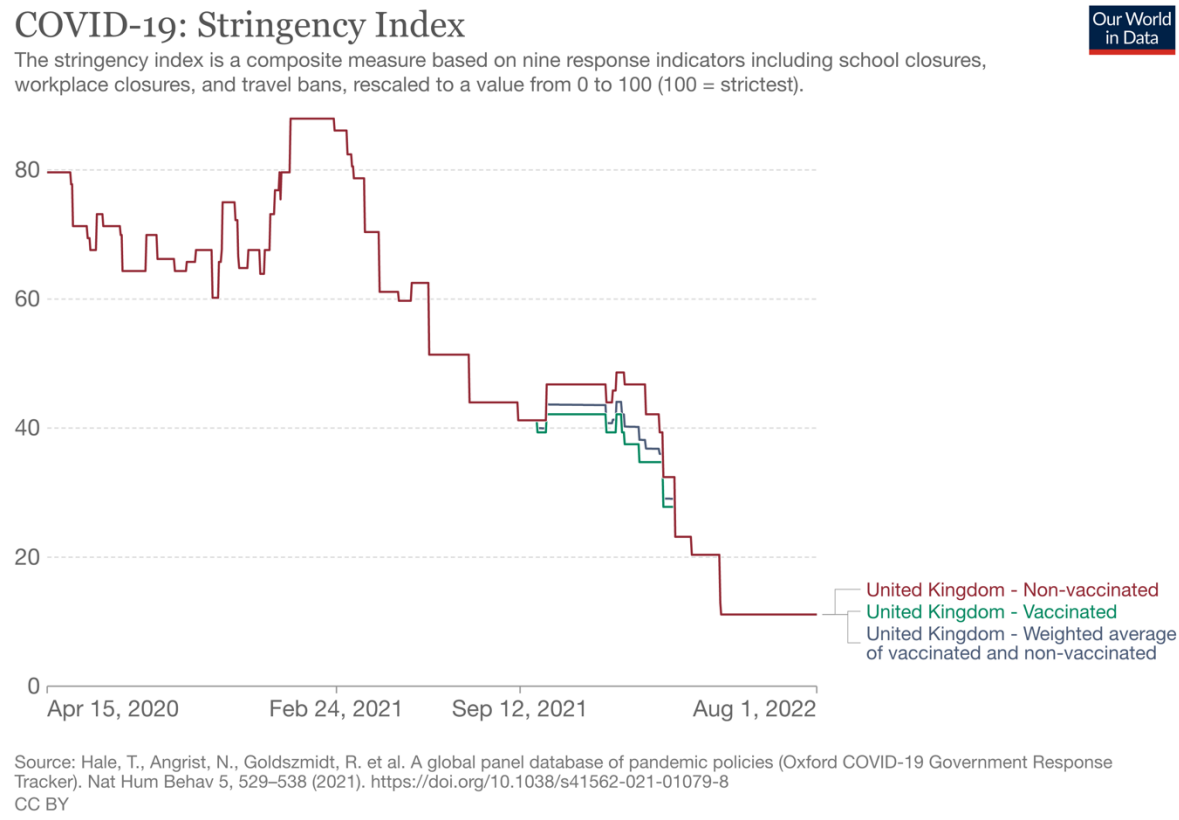
COVID-19 Stringency Index for countries included in this study at Wave 1



Note. COVID-19 Stringency Index in UK, US, Greece and Italy. COVID-19 Stringency index is a composite measure of nine response indicators (0-100;100 = strictest) encompassing wave 1 of Global COVID-19 study period (April 17 – July 17, 2020). From *A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker)* (Hale et al., 2021). Retrieved from Our World in Data https://ourworldindata.org/covid-stringency-index.

Figure 2.2

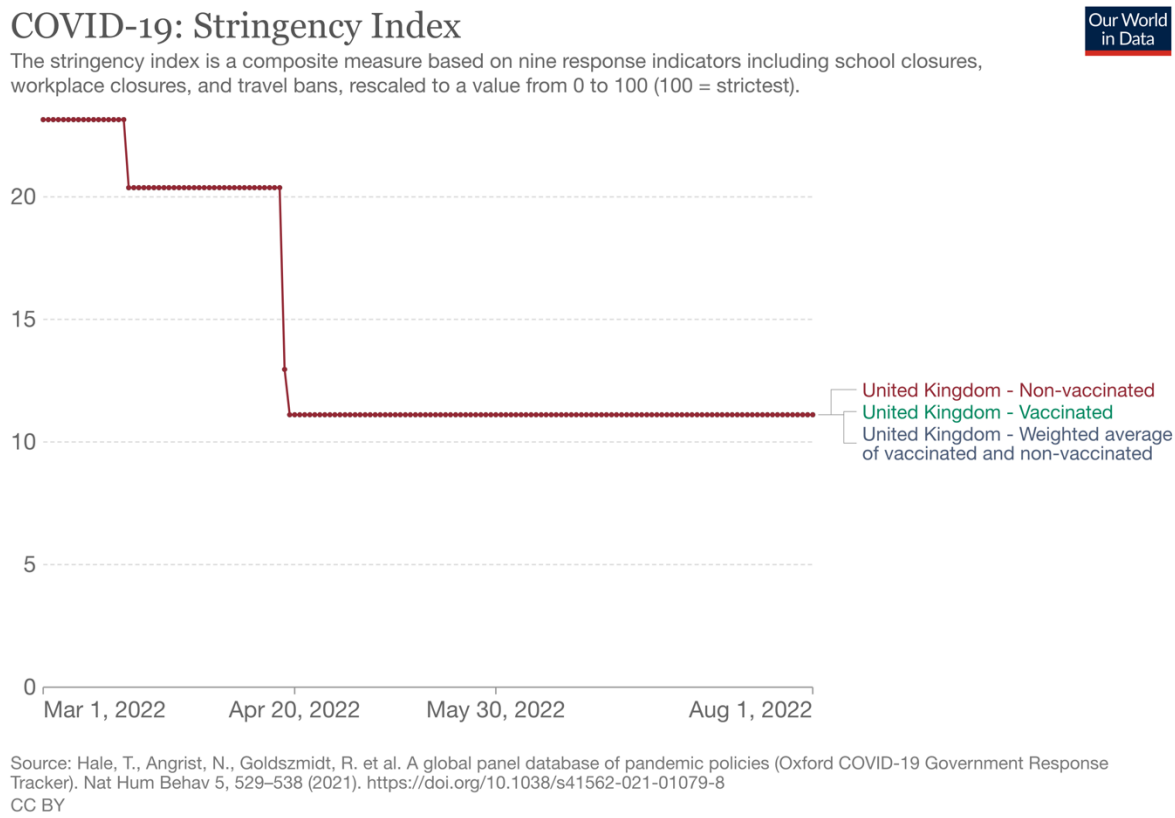
COVID-19 Stringency Index for UK between April 2020 and August 2022



Note. COVID-19 Stringency index is a composite measure of nine response indicators (0-100;100 = strictest) encompassing wave 1 of Global COVID-19 study period (April 17, 2020 – July 31, 2021) and two years later for this follow-up study (March 18 – August 1, 2022). From *A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker)* (Hale et al., 2021). Retrieved from Our World in Data https://ourworldindata.org/covid-stringency-index.

Figure 2.3

COVID-19 Stringency Index for UK during follow-up period (March 1, 2022 and August 1, 2022)



Note. COVID-19 Stringency index is a composite measure of nine response indicator (0-100;100 = strictest) encompassing the follow-up period (March 18 – August 1, 2022). From *A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker)* (Hale et al., 2021). Retrieved from Our World in Data https://ourworldindata.org/covid-stringency-index.

Appendices 3-8. Qualitative Interviews Material

Appendix 3

Email invitation for recruiting participants for follow-up study: Study advert and an online Qualtrics survey link

Email heading: ***COVID-19's impact on adult's physical and mental health *Invitation****

Attachment: Participants Information Sheet and Study Poster.

Dear Sir/Madam,

I hope this email finds you well.

I am Tammy Hung, a 2nd Year Trainee Clinical Psychologist at University College London. I am contacting you because in 2020 you took part in the *UCL-Penn Global COVID Study*, led by Dr Keri Wong (UCL). We'd like to invite you to take part in an exciting new project on the impacts of the COVID-19 pandemic on people's exercise habits and mental health and learn what type of support may be beneficial. This study has been approved by the University College London Institute of Education Research Ethics Committee and the UCL Global Engagement Fund.

By taking part in the study, you will help us better understand:

1) the impact that the COVID-19 pandemic has had on people's exercise habits and mental health
2) the type of support people may find helpful to improve their wellbeing

You will receive a £10 honorarium for completing both a:

1) 15-minute questionnaire: to help us understand your exercise habits and mental health recently
2) 30-minute 1-on-1 Zoom interview: to help us understand the impact that COVID-19 has had on your exercise habits and mental health and what type of support might be helpful.

If you are interested in taking part or hearing more, please submit your interest here:

https://uclpsych.eu.qualtrics.com/jfe/form/SV_3kq11TrnQW2kfpc

Alternatively, you can also access the survey via this QR code:

This study would involve completing a short online survey and an informal interview with myself which would be conducted via Zoom. It should take about 35-40 minutes altogether. All information will be treated confidentially and identifying information anonymised. As a thank you for participation we are offering a £10 voucher.

All eligible participants will be contacted for follow-up after completion of the brief survey.

I have attached the research poster to this email. I look forward to hearing from you. If I can answer any of your study questions, please do not hesitate to email me at wai.hung.18@ucl.ac.uk.

Warmest regards,
Tammy

Tammy Hung (*she/her*)

Trainee Clinical Psychologists (DClinPsy)
Research Department of Clinical, Educational and Health Psychology
UCL Faculty of Brain Sciences
Division of Psychology and Language Sciences
University College London

Email: wai.hung.18@ucl.ac.uk

RESEARCH DEPARTMENT OF CLINICAL, EDUCATIONAL AND HEALTH PSYCHOLOGY

UCL

How has COVID19 impacted your physical and mental health?

Why take part in the study?

The COVID-19 pandemic has had significant impacts on people's lives in many ways. This study aims to examine how the COVID-19 pandemic has affected your physical activity habits and mental health. It is part of the **UCL-Penn Global COVID Study** (GlobalCovidStudy.com/).

By taking part you will help us better understand the support people would like to help improve their wellbeing and develop best practices to inform policies in the coming months and/or assist in future crisis management strategies.

Who are we looking for?

UK residents who have completed the UCL-Penn Global COVID study

What will taking part involve?

There are two parts to the study:

1. Completing a 15-minute online survey on basic demographic information and existing health conditions
2. Taking part in a one-to-one 30-minute online conversation with Tammy about your experiences of COVID-19 pandemic

- Your participation is entirely voluntary, and you may withdraw your consent during and after the research.
- The interviews will be audio-recorded and will be used only for analysis.
- Please note that if you decide to take part you will be asked for some personal information, including your age, gender, ethnicity and existing physical/ mental health conditions. All data will be kept secure, confidential, and stored in strict accordance with the Data Protection Act (2018) and GDPR.
- Once you have completed **both parts** of the study, you will receive a **£10 Amazon voucher** as a thank you for your time and participation.

Want to know more?
Contact: Tammy Wai Tung Hung (wai.hung.18@ucl.ac.uk)

Principal Researcher: Dr Keri Wong
Email: keri.wong@ucl.ac.uk
Address: UCL Institute of Education, Department of Psychology & Human Development, 25 Woburn Square, London

Study Advert
UCL IOE REC 1331, approved February 2022

Appendix 4

Online Survey for Follow-up Study hosted on Qualtrics.

Examining the impact of COVID-19 on physical and mental health

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Start of Block: Information & consent

Information Sheet This study is being run by UCL Trainee Clinical Psychologist, Tammy Wai Tung Hung, under the supervision of Dr Keri Wong.

It has been approved by the UCL Institute of Education. Project ID number: 1331.

We would like to invite you to participate in this research project. You should only participate if you want to. Choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to read the following information carefully and discuss it with others if you wish. Please contact the researchers by email if anything is not clear, if you have questions, or if you would like more information about the study. You can also contact the researchers with any queries or concerns related to this study after completion.

What does taking part involve?
Taking part will involve **two parts**: completing a 15-minute online questionnaire on demographic information (e.g., gender, date of birth, ethnicity) and health conditions **AND** taking part in a one-to-one informal interview for 20 minutes via Zoom or Microsoft Teams.

In this interview, I will ask you how the COVID-19 pandemic has affected your physical activity habits and mental health. I will ask for your views on the support that can improve mental health and wellbeing for you and your families. In particular, I will be curious whether social prescribing (e.g., referred to social sources of support within the community) can help improve people's health and wellbeing.

We appreciate you volunteering your time and contributing directly to our research endeavour and potential policy guidelines in the future.

Do I have to take part?
It is up to you to decide whether or not to take part. If you choose not to participate, you won't incur any penalties or lose any benefits to which you might have been entitled. Even after agreeing to take part, you can still withdraw at any time and without giving a reason, simply by closing your browser or informing the researcher during the interview. If you feel uncomfortable with any of the questions or interview conversation, you can refuse to answer or ask for part of the conversation to be removed from the transcript. Only those who complete both parts of the study will receive a **£10 Amazon voucher** as a thank you for your

time and participation.

Data Protection Privacy Notice: The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's research privacy notice can be read here.

Your personal data will be processed for the purposes outlined in this notice.

The legal basis that would be used to process your personal data will be performance of a task in the public interest.

The data will be stored anonymously, such that your individual responses will not be traceable back to you. The audio recordings of your interview during this research will be used only for analysis. They will only be accessible to the researchers of this project. They will be stored securely, and the recording files will be labelled with the randomly assigned participants ID number so they cannot be traced back to you in any way. They will be deleted once the analyses are completed. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

Consent **If you wish to take part in this study, please tick the box at the end of all statements:** I have read the information above and understand I can email the researchers with any questions. (1) I understand that my personal information will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing. (2) I understand that the interview will be recorded and only the audio file will be used to assist the researchers in transcribing the interview and will not be used in another way. (3) I understand that all personal information will remain confidential and that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications. (4) I understand that my anonymised research data may be shared with, and used by, others for future research (no one will be able to identify you when these data are shared). (5) I understand that I am free to withdraw from the study without penalty if I so wish, simply by closing my browser. (6)

- ○ **I consent to take part in the study.** (1)
- ○ **No, I don't want to take part.** (2)

Page Break

Email confirmation What is the email address that you received this study's invitation email? We are asking this to ensure we have the correct email address to contact you again for scheduling an informal follow-up interview.
*Your email will **not** be used for commercial purposes and will be deleted once the study is complete.*

_____

End of Block: Information & consent

Start of Block: Demographics

Q1 What is your **Date of Birth** (i.e. DD/MM/YYYY)

- Day (DD) (1) _____
- Month (MM) (2) _____
- Year (YYYY) (3) _____

Q2 Which of the following best describes your **Gender**?

- Male (1)
- Female (2)
- Non-binary (3)
- Prefer not to say (4)
- Other (5) _____

Q3 Which of these best describe your **Ethnic** origin?

▼ White - English / Welsh / Scottish / Northern Irish / Irish (1) ... Prefer not to say (23)

End of Block: Demographics

Start of Block: Existing health conditions

Q4 Now we would like you to reflect on your mental health and physical health.

Q4 Have **you** or your **immediate family members** received a diagnosis from a GP or physician for any **health conditions**?

- ○ Yes, Me. (1)
- ○ Yes, Family Member (2)
- ○ Yes, Me and Family Member (3)
- ○ No, this does not apply (4)

Q5 Which **health condition** applies to **you**? Please check all that applies.

- [ ] **Alcohol or substance use disorder** (e.g., Gambling disorder, tobacco use disorder, substance abuse, substance dependence, cannabis withdraw, caffeine withdrawal) (1)

- [ ] **Anxiety Disorder** (e.g., generalized anxiety disorder, panic disorder, phobias, social anxiety disorder) (2)

- [ ] **Neurodevelopmental Disorders** (e.g., autism spectrum disorder, ADHD, specific learning disorder, motor disorder, intellectual disabilities, communicative disorders) (3)

- [ ] **Bipolar Disorder** (e.g., Bipolar I, Bipolar II, major depressive disorder, hypomanic episode, manic episode, mixed specifier) (4)

- [ ] **Depression** (e.g., postpartum depression, seasonal affective disorder, disruptive mood dysregulation disorder) (5)

- [ ] **Disruptive, Impulse-Control, and Conduct Disorders** (e.g., CD, ODD, antisocial PD, intermittent explosive disorder, pyromania) (6)

- [ ] **Feeding/Eating Disorder** (e.g., Binge eating disorder, bulimia nervosa, anorexia nervosa) (7)

- [ ] **Neurocognitive Disorders** (e.g., Dementia, amnestic disorder) (8)

- [ ] **Obsessive-Compulsive Disorder** (e.g., Trichotillomania, excoriation (skin-picking) disorder, hoarding disorder) (9)

- [ ] **Schizophrenia & Psychotic Disorders** (e.g., schizophrenia, schizoaffective disorder, delusion disorder, catatonia) (10)

- [ ] **Trauma and Stressor-Related Disorders** (e.g., PTSD, acute stress disorder, reactive attachment disorder, disinhibited social engagement disorder) (11)

- [ ] **Personality Disorder** (e.g., antisocial PD, paranoid PD, avoidant PD, schizoid/schizotypal PD) (12)

- [ ] **Respiratory Conditions** (e.g., asthma, chronic obstructive pulmonary disease) (13)

☐ **Heart conditions** (e.g., heart attacks, heart murmurs etc.) (14)

☐ **Circulatory problems** (e.g., high blood pressure) (15)

☐ **Diabetes** (16)

☐ **Other medical conditions** (e.g., cancer, epilepsy, lupus, sleep apnea, obesity) (17)

☐ **Pregnant** (18)

☐ **Other** (19) _____

Q6 Which **health condition** applies to your **immediate family member(s)**? Please check all that applies.

- ☐ **Alcohol or substance use disorder** (e.g., Gambling disorder, tobacco use disorder, substance abuse, substance dependence, cannabis withdraw, caffeine withdrawal) (1)
- ☐ **Anxiety Disorder** (e.g., generalized anxiety disorder, panic disorder, phobias, social anxiety disorder) (2)
- ☐ **Neurodevelopmental Disorders** (e.g., autism spectrum disorder, ADHD, specific learning disorder, motor disorder, intellectual disabilities, communicative disorders) (3)
- ☐ **Bipolar Disorder** (e.g., Bipolar I, Bipolar II, major depressive disorder, hypomanic episode, manic episode, mixed specifier) (4)
- ☐ **Depression** (e.g., postpartum depression, seasonal affective disorder, disruptive mood dysregulation disorder) (5)
- ☐ **Disruptive, Impulse-Control, and Conduct Disorders** (e.g., CD, ODD, antisocial PD, intermittent explosive disorder, pyromania) (6)
- ☐ **Feeding/Eating Disorder** (e.g., Binge eating disorder, bulimia nervosa, anorexia nervosa) (7)
- ☐ **Neurocognitive Disorders** (e.g., Dementia, amnestic disorder) (8)
- ☐ **Obsessive-Compulsive Disorder** (e.g., Trichotillomania, excoriation (skin-picking) disorder, hoarding disorder) (9)
- ☐ **Schizophrenia & Psychotic Disorders** (e.g., schizophrenia, schizoaffective disorder, delusion disorder, catatonia) (10)
- ☐ **Trauma and Stressor-Related Disorders** (e.g., PTSD, acute stress disorder, reactive attachment disorder, disinhibited social engagement disorder) (11)
- ☐ **Personality Disorder** (e.g., antisocial PD, paranoid PD, avoidant PD, schizoid/schizotypal PD) (12)

☐ **Respiratory Conditions** (e.g., asthma, chronic obstructive pulmonary disease) (13)

☐ **Heart conditions** (e.g., heart attacks, heart murmurs etc.) (14)

☐ **Circulatory problems** (e.g., high blood pressure) (15)

☐ **Diabetes** (16)

☐ **Other medical conditions** (e.g., cancer, epilepsy, lupus, sleep apnea, obesity) (17)

☐ **Pregnant** (18)

☐ **Other** (19) _____

End of Block: Existing health conditions

Start of Block: Depression & Anxiety (PHQ-9 & GAD-7; 16 items)

Q7 Over the last **2 weeks**, how often have you been bothered by any of the following problems?

	Not at all (0)	**Several days** (1)	**More than half the days** (2)	**Nearly every day** (3)
Little interest or pleasure in doing things. (1)	○	○	○	○
Feeling down, depressed, or hopeless. (2)	○	○	○	○
Trouble falling/ staying asleep, sleeping too much. (3)	○	○	○	○
Feeling tired or having little energy. (4)	○	○	○	○
Poor appetite or overeating. (5)	○	○	○	○
Feeling bad about yourself or that you are a failure or have yourself or your family down. (6)	○	○	○	○
Trouble concentrating on things, such as reading the newspaper or watching television. (7)	○	○	○	○
Moving or speaking so slowly that other people could have noticed. Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual. (8)	○	○	○	○
Thoughts that you would be better off dead or of hurting yourself in some way. (9)	○	○	○	○

Q8 If you checked off *any problem* on this questionnaire so far...

	Not difficult at all (0)	**Somewhat difficult** (1)	**Very difficult** (2)	**Extremely difficult** (3)
How *difficult* have these problems made it for you to do your work, take care of things at home, or get along with other people? (1)	○	○	○	○

Q9 Over the last **2 weeks**, how often have you been bothered by any of the following problems?

	Not at all (0)	**Several days** (1)	**More than half the days** (2)	**Nearly every day** (3)
Feeling nervous, anxious or on edge. (1)	○	○	○	○
Not being able to stop or control worrying. (2)	○	○	○	○
Worrying too much about different things. (3)	○	○	○	○
Trouble relaxing. (4)	○	○	○	○
Being so restless that it is hard to sit still. (5)	○	○	○	○
Becoming easily annoyed or irritable. (6)	○	○	○	○
Feeling afraid as if something awful might happen. (7)	○	○	○	○

End of Block: Depression & Anxiety (PHQ-9 & GAD-7; 16 items)

Start of Block: Physical Activity (12-items)

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

Q10 Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

	Over the **past 7 days**, how many **days** did you engage in:	How much time did you usually spend doing **vigorous** physical activities on one of those days?	
		Hours per day (1)	Minutes per day (2)
Vigorous physical activities? (e.g., heavy lifting, digging, aerobics, or fast bicycling) (1)	▼ 1 day (1 ... No vigorous physical activities (8)		

Q11 Think about all the **moderate activities** that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

	Over the **past 7 days**, how many **days** did you engage in:	How much time did you usually spend doing **moderate** physical activities on one of those days?

		Hours per day (1)	Minutes per day (2)
Moderate physical activities? (e.g., carrying light loads, bicycling at a regular pace, or doubles tennis (excluding walking.) (2)	▼ 1 day (1 ... No moderate physical activities (8)		

Q12 Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

	Over the **past 7 days**, how many **days** did you engage in:	How much time did you usually spend **walking** on one of those days?	
		Hours per day (1)	Minutes per day (2)
Walking for at least 10 minutes at a time? (3)	▼ 1 day (1 ... No walking (8)		

End of Block: Physical Activity (12-items)

Start of Block: Loneliness (Russell et al., 1995; 20-items)

Q13 Indicate how often each of the statements below is descriptive of you.

	Never (1)	**Rarely** (2)	**Sometimes** (3)	**Often** (4)
How often do you feel that you are "in tune" with the people around you? (1)	○	○	○	○
How often do you feel that you lack companionship? (2)	○	○	○	○
How often do you feel that there is no one you can turn to? (3)	○	○	○	○
How often do you feel alone? (4)	○	○	○	○
How often do you feel part of a group of friends? (5)	○	○	○	○
How often do you feel that you have a lot in common with the people around you? (6)	○	○	○	○
How often do you feel that you are no longer close to anyone? (7)	○	○	○	○
How often do you feel that your interests and ideas are not shared by those around you? (8)	○	○	○	○
How often do you feel outgoing and friendly? (9)	○	○	○	○
How often do you feel close to people? (10)	○	○	○	○
How often do you feel left out? (11)	○	○	○	○
How often do you feel that your relationships with others are not meaningful? (12)	○	○	○	○

How often do you feel that no one really knows you well? (13)	○	○	○	○
How often do you feel isolated from others? (14)	○	○	○	○
How often do you feel you can find companionship when you want it? (15)	○	○	○	○
How often do you feel that there are people who really understand you? (16)	○	○	○	○
How often do you feel shy? (17)	○	○	○	○
How often do you feel that people are around you but not with you? (18)	○	○	○	○
How often do you feel that there are people you can talk to? (19)	○	○	○	○
How often do you feel that there are people you can turn to? (20)	○	○	○	○

End of Block: Loneliness (Russell et al., 1995; 20-items)

Start of Block: Scheduling Interview

Q14
Are there days or times (Monday-Friday between 8am -8.30pm) you know you can take part in a 1-on-1 30-minute Zoom interview?

If so, please let us know your availabilities below.

_____

_____

_____

_____

_____

End of Block: Scheduling Interview

Start of Block: Debrief

Debrief

Thank you for participating in Part One of this study!

You have completed a series of questions measuring: physical activity, mental wellbeing (i.e. depression and anxiety), loneliness, and demographic factors.

What will happen now?

I will contact you as soon as possible to schedule a 30-minute 1-on-1 Zoom interview, to learn more about your experiences of the COVID-19 pandemic.

At the start of the interview, I will ask and record your verbal consent for audio recording. If you feel uncomfortable with any of the questions or interview conversation, you can refuse to answer or ask for part of the conversation to be removed from the transcript.

In this interview, I will ask you questions on how the COVID-19 pandemic has affected your exercise habits and mental health. I will ask for your views on the support that can improve mental health and wellbeing for you and your families. In particular, I will be curious whether social prescribing (e.g., referred to social sources of support within the community) can help improve people's health and wellbeing.

When you have completed **both parts of the study**, you will receive **a £10 Amazon** voucher to thank you for taking part. We will contact you again if you wish to review the transcript of your interviews and/or learn about the impact of our research.

Further Assistance?

If you feel uncomfortable after answering these questionnaires and would like to seek assistance, please speak to the researcher - Tammy Hung (wai.hung.18@ucl.ac.uk) or the Principal Investigator, Dr Keri Wong (keri.wong@ucl.ac.uk).

If you are concerned about your mental health or would like further support on coronavirus, please visit the NHS site or contact Samaritans at 116 123. Other online resources for mental health information and support can be found at Mind.

Many thanks for your help. I look forward to speaking with you!

If you have any concerns about your mental health or would like further support, please consult the NHS website.

End of Block: Debrief

Appendix 5

Participant Information Sheet

Participant Information Sheet for Online participants

Examining the impact of COVID-19 on adult's levels of physical and mental health across a 12-month period.

This study has been approved by the UCL Institute of Education. Project ID ethics number: REC 1331.

This study is being run by UCL Trainee Clinical Psychologist, Tammy Wai Tung Hung (wai.hung.18@ucl.ac.uk), under the supervision of Dr Keri Wong (keri.wong@ucl.ac.uk).

What is the project's purpose?

The COVID-19 pandemic has had significant effects on people's lives in many ways. As part of the UCL-Penn Global COVID Study (GlobalCovidStudy.com/), you can help us:

- Learn how the COVID-19 pandemic has affected your physical activity habits and mental health
- Better understand the support people would like to help improve their wellbeing
- Develop best practices to inform policies in the coming months and/or assist in future crisis management strategies.

Why have I been invited?

You are invited to take part in this research project because you completed the UCL-Penn Global COVID-19 Study, aged 18 or older and are based in the UK.

Do I have to take part?

Your participation is completely voluntary. We hope that if you do choose to be involved you will find this a valuable experience. We appreciate you volunteering your time and contributing directly to our research endeavour and potential policy guidelines in the future. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form online.

What will happen to me if I take part?

Taking part will involve two parts:

1) completing a 15-minute online questionnaire on demographic information (e.g., gender, date of birth and ethnicity) and health conditions
2) taking part in a one-to-one informal interview for 30 minutes via Zoom

- At the start of the interview, I will ask and record your verbal consent for audio recording. You may refuse to answer any question at any time during the interview.
- In this interview, I will ask you questions on how the COVID-19 pandemic has affected your physical activity habits and mental health. I will ask for your views on the support that can improve mental health and wellbeing for you and your families. In particular, I will be curious whether social

prescribing (e.g., referred to social sources of support within the community) can help improve people's health and wellbeing.

- When you have completed both parts of the study, you will receive **a £10 Amazon** voucher to thank you for taking part. We will contact you again if you wish to review the transcript of your interviews and/or learn about the impact of our research.

Will I be recorded and how will the recorded media be used?
Yes. The audio recordings of our interview made during this research will be used only for analysis. No other use will be made of them without your written permission, and no one outside the project will have access to the original recordings. All recording files will be deleted once transcribed and anonymised.

What are the possible disadvantages and risks of taking part?
We do not foresee any specific disadvantages from participating in the study. You will be asked about sensitive information, such as your health status. You may find questions related to your mental health to be personal and sensitive. There are no right or wrong answers to any of the questions and we encourage you to answer as honestly as possible. If you feel uncomfortable with any of the questions or interview conversation, you can refuse to answer or ask for part of the conversation to be removed from the transcript. We will destroy your data if you wish to withdraw from the study.

Should you require additional help, a list of useful resources including UCL psychological services and the contact details of various UK mental health services are available, so you can access extra support.

What are the possible benefits of taking part?
Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will help to shape future research and inform policies in the coming months and/or assist in future crisis management strategies.

What if something goes wrong?
If you wish to complain or have any concerns about any aspect of the way you have been treated during this study, then you should immediately inform the Principal Investigator, Dr Keri Wong (keri.wong@ucl.ac.uk).

Will my taking part in this project be kept confidential?
All the information that we collect about you during the research will be kept strictly confidential. Only our team of researchers will have access to the data. Your data will not be used for commercial purposes. All data files will be encrypted, stored securely, kept confidential, and a unique identification number will be generated for you so that the data cannot be traced back to you in any way. You will not be able to be identified in any ensuing reports or publications.

Limits to confidentiality
Please note that confidentiality will be maintained as far as it is possible unless, during our conversation I hear anything which makes me worried that someone might be in danger of harm, I might have to inform relevant agencies of this.

What will happen to the results of the research project?
Any information you give us will be analysed with the rest of the participants' data. The key results from this project will be published and presented in a Doctorate in Clinical Psychology thesis, scientific journals and conferences. Individual data will not be presented,

and pseudonyms will be used where possible to ensure anonymity. Data will be kept for at least 10 years in accordance with the UCL Research Data Repository Guidelines.

Local Data Protection Privacy Notice

Notice:
The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

For participants in health and care research studies, click here

The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:

Personal email
Date of birth
Existing health conditions

The lawful basis that would be used to process your *personal data* will be performance of a task in the public interest.

The lawful basis used to process *special category personal data* will be for scientific and historical research or statistical purposes.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

Contact for further information
If you would like to be involved, please respond below, or if you have any further questions before deciding whether to take part, please do not hesitate to contact Tammy Hung (wai.hung.18@ucl.ac.uk).

Thank you for taking the time to consider taking part in this research study.

Appendix 6

Follow-up Contacts - Timeline

i) Survey – Qualtrics
Data collection: March 3, 2022 – July 29, 2022

ii) Initial sample (*n* = 93)
Low-PA group: *n* = 44 (defined as IPAQ-SF Low-PA and <120 MET-minutes/week)
High-PA group: *n* = 49 (defined as IPAQ-SF High-PA and >3000 MET-minutes/week)

Email invites sent to recruit participants on
1) March 3, 2022
2) March 24, 2022
3) April 27, 2022
4) May 11, 2022
5) June 20, 2022

Interviews completed - initial sample: *n* = 13

(*n* = 1 non-respondent who had completed the survey)

iii) Extended recruitment (*total N* = 227, including *n* = 97 from the initial sample)
Reviewed inclusion criteria:
Low-PA group: defined as IPAQ-SF low-PA
High-PA group: defined as IPAQ-SF high-PA

An email invite sent to recruit on July 20, 2022.

(*n* = 2 non-respondents who had completed the survey)

Interviews completed - extended recruitment: *n* = 8

Total interviews completed between March 18 and August 1, 2022: *N* = 21

Appendix 7

Semi-structured Interview Schedule

(30 minutes)

The following table outlines the interview schedule and contains the interview guide.

Before the interview	Prepare and familiarise with the interview guide. Prepare verbal and written information about the research and consent. Ensure participants have completed the brief questionnaire on Qualtrics prior to interview.
Introduction	Researcher will introduce herself, including name and UCL Clinical Psychologist Trainee status. *Welcome and thank you for agreeing to take part in this interview.* *The aim of this interview is to learn about your experiences of COVID-19 and how it may have impacted your physical activity habits and mental health. Part 1 of the interview will focus on exercise and mental health during the pandemic, and part 2 will focus on support. The questionnaires you've already completed asked specific questions, and this interview is to help us understand the details and nuances that didn't get addressed in the questionnaires. I'd like to learn from you about things that would be helpful to improve people's mental wellbeing.* *There are no right or wrong answers – I just want to hear your opinion! The interview should last for about 30 minutes. You can take a break at any time just let me know. If at any point you want to stop the interview and no longer take part, that is fine too just let me know.* *If you say something that you don't want to be on record, we can also remove that afterwards from the interview transcript. This interview is completely confidential, only the research team will hear the recording and all personal details will be removed. Any quotes will be anonymous. Are you happy to continue?* *If you don't want to turn the video on, that's ok – but I will leave mine on.*

I will turn on the audio recording on now. The audio will not be used for any other commercial purposes. Does this sound okay? Thank you. Do you have any questions before we begin?

- **Turn on audio recording.**

Interview Guide		
Topic	Questions	Prompts & probes
Impacts of COVID-19 on physical activity level and mental health	**1. Can you tell me a little bit about your physical activity habits?** **a. What types of exercise did you do before the pandemic?** **b. What types of exercise did you do during the pandemic?** **c. How important is physical activity to you?**	Gauge activity levels before the pandemic and if PA level has changed. Probe details e.g., *how often? Indoor/ outdoor/ gym? Did you exercise alone or with other people?*
	2. In what way (if any) has the pandemic affected your exercise habits? **a. What kind of impact has this had?** **b. How have your exercise habits changed throughout the pandemic, for example, during the first lockdown back in March 2020 versus the Omicron variant in December last year?** **c. What types of physical activity would you like to return to?**	Probe: changes in PA over the course of the pandemic
	3. What did you find easiest about staying physically active during the pandemic? **a. What helped/ motivated you to be active during the pandemic?**	*What normally motivates you to exercise? What would've helped you to stay active during the pandemic?* *Can you give an example.* Probe: Motivation and barriers to physical activity e.g., capacity/ opportunity/ routine/ self-motivation/social support/ self-esteem/ health/ time/ environmental – access e.g., gym/ weather/ nature *Who are you active with? Did you notice a difference when you are active with someone instead of alone?*

	4. What did you find most challenging about staying physically active during the pandemic? **a. What made it difficult to stay active or engage in physical activities that you used to do?**	Prompts: *If you were feeling tired/ stressed/ having a bad day, did this impact on your physical activity?*
	5. How would you describe your mental health during the pandemic? **a. Did your mood predict how active you were?** **b. In what way (if any) has staying physically active/ becoming less active affected your mental health?**	Probe: what kind of impacts - e.g., energy. Probe: if PA is a coping strategy- *How does physical activity help maintain mental wellbeing?*
Support	**6. What support do you think you need to improve your mental health during the pandemic?**	*If people around you needed support, what might it look like? What do you think would benefit them?* Probe: What types of support (e.g., community, social)? What do you hope to get from these supports? -Timing of support? -Delivery of support – e.g., by whom, where? Group/ structured vs 1-1 vs befriending/ unstructured?
Social prescribing	**7. Have you heard of social prescribing before?** *Can give reassurance if people don't know about social prescribing as not that many people have heard of 'social prescribing'.*	Social prescribing focuses on 'what matters to me'. It connects people to resources within their community, usually through the support of a link worker. It is personalised to help people stay healthy and maintain wellbeing. Examples, including healthy eating/ exercise, walking football, singing groups etc. If people have heard of it:

		- ***Can you tell me what you know about it?*** - ***Have you/ do you know anyone who has accessed it?*** - ***What has your experience of social prescribing been like? (if they have accessed it)?***
	8. What are your thoughts on social prescribing as a way to improve people's mental health as a result of COVID-19?	*What is it about this intervention that you think might be particularly helpful to people's mental health?* *Is there anything which might get in the way of people engaging with social prescribing even if you felt that it can be helpful?*
Winding down/ ending	**9. If the pandemic were to end tomorrow, what would you like to do the most?**	
	10. What was this interview like for you?	
	11. Is there anything you feel that we did not talk about or that you would like to add?	
Debrief/ Ending	*Researcher will make sure participant is mentally well before ending the meeting. "Ok Now I'm going to debrief you" Remind them how valuable their contribution is and how their comments may help (implication of your research) - **The results will form part of my thesis and may also be presented in conference and submitted to a scientific journal. Your data is confidential. No names or personal data will ever be presented. Findings may inform mental health initiatives and crisis management policies in the future**	
	Some of the things we talked about today can be quite difficult for people. How are you feeling? ***Can you tell me something you do to relax/ make you feel better? Can you do it after our call/ later?*** Direct participants to any helplines if needed.	

	I have some helplines number if you are concerned about your mental health and would like further support. Would you like them? **Samaritans (free advice 27/7, 365 days a year). Helpline: 116 123. Email: jo@samaritians.org** **SHOUT (free confidential support 24/7, 365 days a year). Text 'SHOUT' to 85258.** **NHS – can find out how to access local services on nhs.co.uk or visit your GP.** Thank you very much for talking to me about your experiences. I learnt a lot from you. This is the end of the interview. Do you have any questions? Would you like to review the transcript once they have been typed up? If so, can I contact you via email? Would you like to stay in touch in the future or receive a copy/ URL link to the thesis or other outputs, such as published article or paper? I'd be happy to share that with you! Yes Please feel free to contact me at any time with any questions, comments or concerns. -> Ending meeting for all.
After the interview	**Make a note if the participant wants to review the transcript and/or receive any study output.** **Check audio recording and change the name of audio recording file to participant's randomly assigned ID. Ensure these are saved on UCL S: Drive with restricted access to researcher and PI only.**

Appendix 8

Debrief Sheet

Debriefing Form

Examining the impact of COVID-19 on adult's levels of physical and mental health across as 12-month period.

Thank you for taking part in this study.

The sheet will provide you with details of the study in which you took part.

The COVID-19 pandemic has had significant effects on people's lives in many ways. Your contributions have helped us to better understand the protective and risk factors relating to COVID-19 and physical activity habits and mental health. This project also explored what support people would like to improve their wellbeing, and we hope this information may inform our understanding of how to best mange future crises.

What did we ask today?
Today, you completed a series of questions measuring: physical activity and mental wellbeing (i.e. depression, anxiety), loneliness and demographic factors.

You also took part in an informal interview on the impact of the pandemic on your physical activity habits and whether it has affected your mental wellbeing. You also helped us to better understand on the support that can improve mental health and wellbeing for you and your families. You also shared your thoughts on social prescribing (e.g., referred to social sources of support within the community) as an intervention to help people improve their health and wellbeing.

What will happen now?
You will receive an email with a £10 Amazon Voucher to thank you for taking your time and participating in this project.

The results will form part of my thesis and may also be presented in conference and submitted to a scientific journal. Your data is confidential. No names or personal data will ever be presented. Findings may inform mental health initiatives and crisis management policies in the future. If you would like to receive a copy of our findings when it is complete or stay in touch for future study opportunities, please contact me, Tammy Hung, wai.hung.18@ucl.ac.uk or principal investigator, Dr Keri Wong, keri.wong@ucl.ac.uk. We will also provide a summary of the study findings at the end.

Further Assistance?
If you feel uncomfortable after participating in this project today and would like to seek assistance, please first contact the researcher or principal investigator above.

If you are concerned about your mental health or would like further support, please visit the NHS website on https://www.nhs.uk/nhs-services/mental-health-services/ It has information on how to access NHS mental health in your local area. You can also contact Samaritans at 116 123. Other online resources can be found at Mind (https://www.mind.org.uk/ ;infoline: 0300 123 3393).

THANK YOU ONCE AGAIN FOR TAKING THE TIME TO PARTICIPATE IN THIS PROJECT.

Tammy Hung (Doctorate in Clinical Psychology Student)

Supervised by Dr. Keri Wong (Lecturer in Psychology)
University College London

Appendix 9. Official Letter for Ethical Approval

UCL Data Protection Policy reference: No **Z6364106/2022/01/24 social research**

(email confirmation received on 6th January 2022).

Institute of Education

UCL

Dr Keri Wong
UCL Institute of Education
20 Bedford Way
London
WC1H 0AL

8th April 2020

Dear Keri

Full ethical approval for REC 1331: Covid-19: Global social trust and mental health study
Data protection registration number: TBC

Thank you for your application to the UCL IOE Research Ethics Committee for ethics approval of the above named project. I am pleased to inform you that following a panel review, your application has been approved. Please note that registration with the UCL Data Protection Office is still outstanding and you will be unable to collect data until this point. Once registration has been confirmed we will let you know promptly.

As part of the continued process of monitoring ethics at the Institute, the committee would be interested to hear if you encounter any ethical challenges throughout the course of your project. This will help us to develop our policies and training in line with the needs of researchers. If certain issues are raised during your research, a short summary of how these challenges were addressed can be submitted upon completion of the project.

Please note that a decision by the UCL Institute of Education's Research Ethics Committee to approve a research project does not imply an expert assessment of all possible ethical issues nor does it detract in any way from the ultimate responsibility which researchers must themselves have for all research which they carry out, including its effects on all those involved.

The UCL IOE Research Ethics Committee's consideration of all ethics applications are dependent upon the information supplied by the researcher. This information is expected to be truthful and accurate.

It is your responsibility to notify the Research Ethics Committee if any of the following occur:

• A complaint of any kind from any person involved or affected by your research. These may include parents/carers, gatekeepers, junior researchers and also members of the group being researched who may be adversely affected by the research reports.

• Changes in the research design, instruments, setting or participants.

• Any other events during the course of the research which give rise to ethical concerns.

If there are any ethics queries, please contact ioe.researchethics@ucl.ac.uk. For data protection enquiries, please contact the data protection team at data-protection@ucl.ac.uk

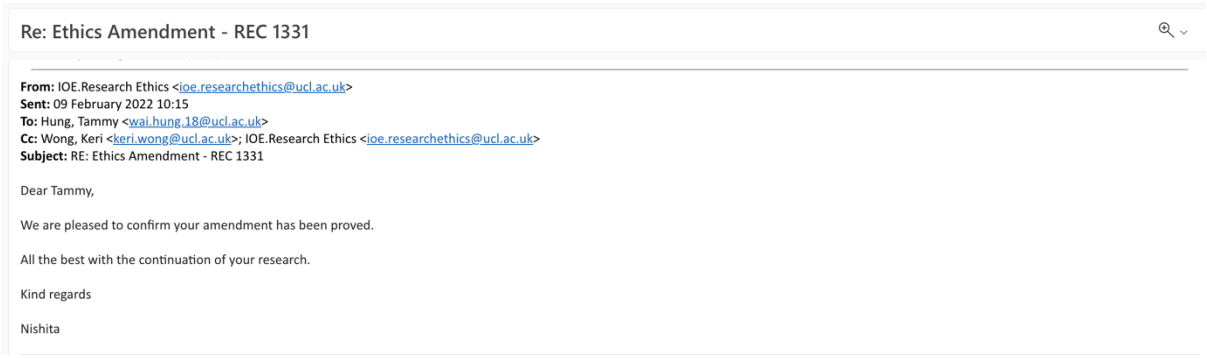
When all essential research documents are ready to archive, contact the UCL Records Office by email records.office@ucl.ac.uk to arrange ongoing secure storage of your research records unless you have made specific alternative arrangements with your department, or funder.

I would like to wish you every success with the project. Please do not hesitate to contact me if you have any queries.

Kind regards,
Calum

Calum Gordon
On behalf of UCL Institute of Education Research Ethics Committee
Research Ethics Officer
UCL Institute of Education

Email confirmation regarding IOE ethics amendment (REC 1331)



Re: Ethics Amendment - REC 1331

From: IOE.Research Ethics <ioe.researchethics@ucl.ac.uk>
Sent: 09 February 2022 10:15
To: Hung, Tammy <wai.hung.18@ucl.ac.uk>
Cc: Wong, Keri <keri.wong@ucl.ac.uk>; IOE.Research Ethics <ioe.researchethics@ucl.ac.uk>
Subject: RE: Ethics Amendment - REC 1331

Dear Tammy,

We are pleased to confirm your amendment has been proved.

All the best with the continuation of your research.

Kind regards

Nishita

Appendix 10. IPAQ-SF Scoring and Analysis

International Physical Activity Questionnaire (IPAQ-SF) Short Forms – Scoring and Analysis (IPAQ Research Committee, 2005)

To calculate the continuous scores in MET-minutes/week = MET level x minutes of activity/day x days per week.

METs for walking = 3.3; METs for moderate-intensity activity = 4.0; and METs for vigorous-intensity activity = 8.0.

Walking (MET-mins/week) = 3.3 x walking minutes x walking days

Moderate (MET-mins/week) = 4.0 x moderate-intensity activity minutes x moderate days

Vigorous (MET-mins/week) = 8.0 x vigorous-intensity activity minutes x vigorous days

Total physical activity (MET mins/week) = walking + moderate + vigorous MET mins/week

Continuous scores should be presented in median values and interquartile range

To identify the categorical score

IPAQ-SF PA levels	Criterion
High-PA	i) 3 or more days of vigorous-intensity activity which equate to at least 1500 MET-minutes/week in total *OR* ii) 7 or more days of any combination of walking, moderate/ vigorous-intensity activities which equate to at least 3000 MET-minutes/week in total
Moderate-PA	iv) 3 or more days of vigorous-intensity activity for a minimum of 20 minutes per day *OR* v) 5 or more days of moderate-intensity activity and/or walking for a minimum of 30 minutes per day *OR* vi) 5 or more days of any combination of walking, moderate/ vigorous-intensity activities which equate to at least 600 MET-minutes/week in total
Low-PA	Participants who did not met moderate or high-PA OR reported no activity

Appendix 11. Testing of Assumptions

11.1 Normality and Homogeneity of Variance Tests

Table 11.1.1

Test of Normality (Shapiro-Wilk) for Wave 1 Dataset (N = 1,037)

Variable	*W*	*p* value
Total PA levels during COVID-19 in MET·min^{-1}·week$^{-1;}$ (IPAQ-SF)	0.849	**<.001**
Depression (PHQ-9 total score)	0.929	**<.001**
Anxiety (GAD-7 total score)	0.904	**<.001**
Loneliness (LS total score)	0.975	**<.001**

Note. Significant results suggest a deviation from normality. Abbreviations: PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalised Anxiety Disorder Scale 7; LS = Loneliness Scale; IPAQ-SF = International Physical Activity Questionnaire – Short Form. PA, Physical activity.

Bold = significant at *p* = .05 level.

The Shapiro-Wilk tests were conducted to test for assumptions of normality for all study variables (Post-COVID PA MET·min^{-1}·week^{-}, LS, PHQ-9, GAD-7, and LS) are presented in Table 2.1. Results are significant, suggesting that data was not normally distributed. However, the Shapiro-Wilk tests are robust to violations of normality when using larger sample sizes (e.g., *n* > 300), so these could be unreliable (Field, 2013; Kim, 2013). Therefore, skewness and kurtosis measures were used to assess normality of the distribution alongside Q-Q plots and histograms (see Figure 1).

Table 11.1.2

Skewness and Kurtosis Statistics for Wave 1 Dataset (N = 1,037)

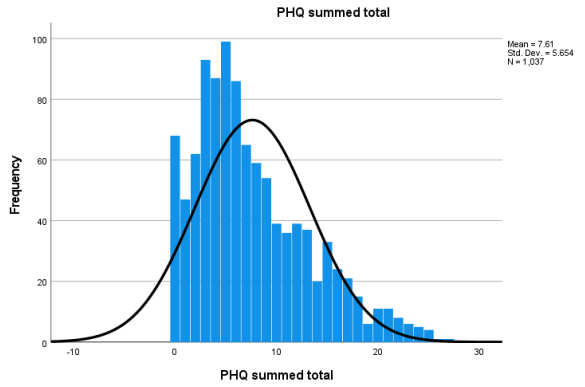
Variable	Skewness	$SE_{skewness}$	Kurtosis	$SE_{Kurtosis}$
Total PA levels during COVID-19 in MET·min^{-1}·week^{-1} (IPAQ-SF)	1.890	0.076	5.950	0.152
Depression (PHQ-9 total score)	0.891	0.076	0.275	0.152
Anxiety (GAD-7 total score)	0.942	0.076	0.127	0.152
Loneliness (LS total score)	0.433	0.076	-0.502	0.152

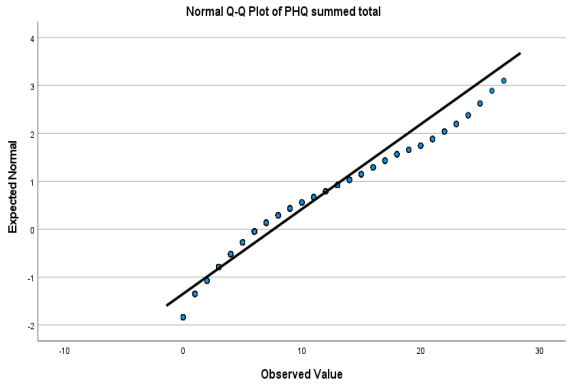
Abbreviations: PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalised Anxiety Disorder Scale 7; LS = Loneliness Scale; IPAQ-SF = International Physical Activity Questionnaire – Short Form. PA, Physical activity. SE = Standard Error.

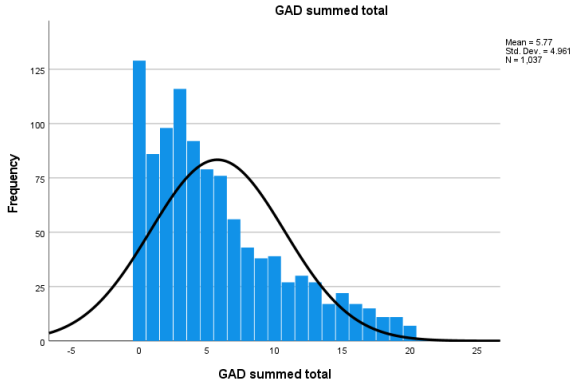
For a larger sample size (n >200), histograms and the values of skewness and kurtosis statistics are used to determine whether the distribution is normal or not, instead of calculating their significance (i.e., Z-values) (Field, 2013; Kim, 2013). An absolute value of skewness >2 or an absolute kurtosis >7 is indicated to be reference values suggesting that the distribution of the sample is non-normal (Kim).

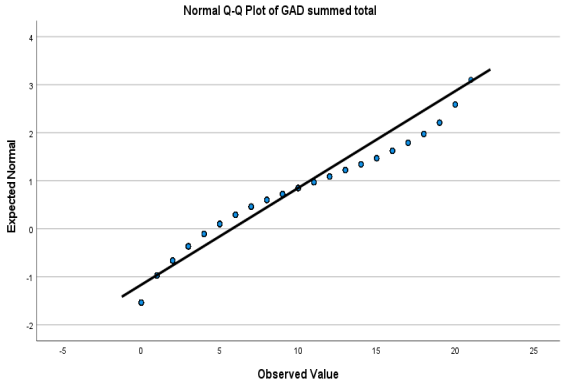
Figure 11.1.1

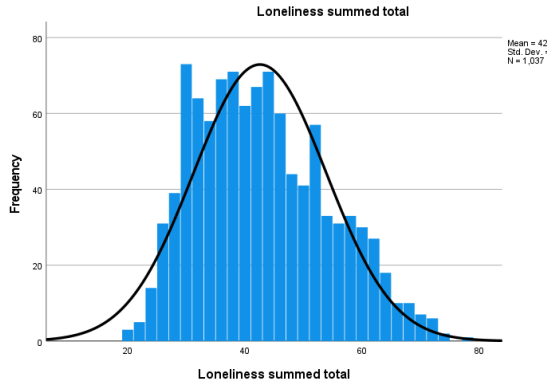
Q-Q plots and histograms for PHQ-9, GAD-7, LS and IPAQ-SF during COVID-19

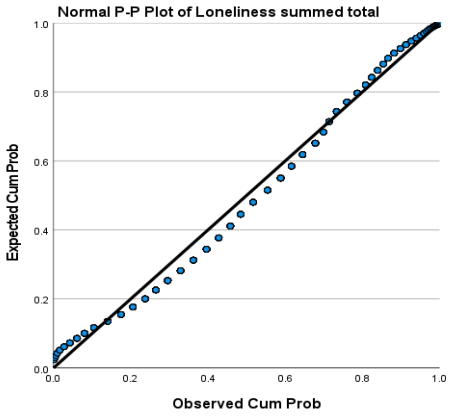


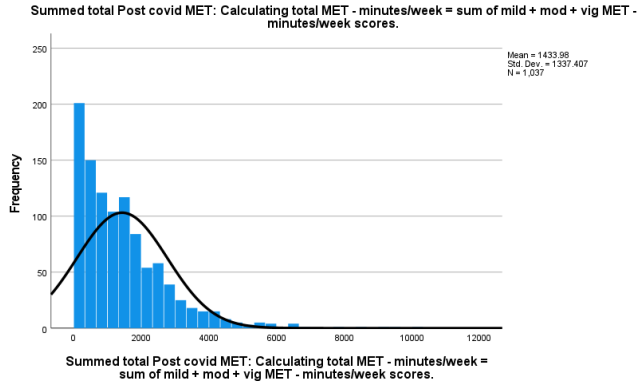


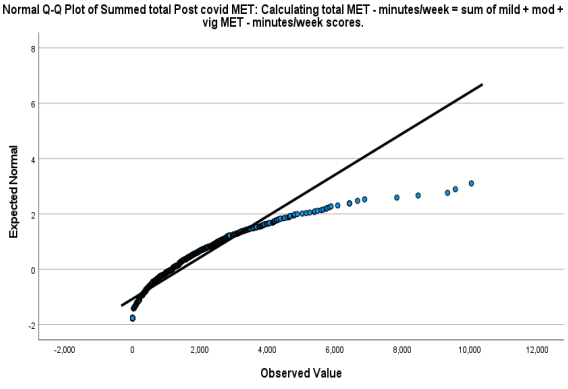












11.2 **Testing for Homogeneity of Variance**

Table 11.2.1

Test of Equality of Variances (Levene's) by IPAQ-SF PA Levels (ow, moderate and high) at Wave 1 (N = 1,037)

Variable	*F*	*df*	*df2*	*p*
Depression (PHQ-9 total score)	6.922	2	1034	**0.001***
Anxiety (GAD-7 total score)	5.799	2	1034	**0.003***
Loneliness (LS total score)	2.101	2	1034	0.123

Note. Abbreviations: PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalised Anxiety Disorder Scale 7; LS = Loneliness Scale; IPAQ-SF = International Physical Activity Questionnaire – Short Form. PA, Physical activity.

Bold = significant at *p <.05 level.

Levene's test for equality of variance for PHQ-9 and GAD-7 are significant (see Table 2.3), therefore homogeneity of variance assumptions is violated. For the loneliness scale, we do not reject the null hypothesis of equal population variances. However, significant results rejecting the null hypothesis of equal population variances for PHQ-9 and GAD-7 need to be interpreted cautiously due to the larger sample as Levene's test is robust in detecting small differences in group variances in large samples.

11.3 **Testing for Multicollinearity**

Table 11.3.1

Testing for Multicollinearity Amongst the IVs of Dummy Sociodemographic Variables and Pre-COVID PA Levels of Wave 1 data (N = 1,037)

Variable	Tolerance	VIF
Gender (male = 0 vs. female = 1)	0.959	1.043
Age group (25-34 years = reference category)		
18-24	0.631	1.584
35-44	0.771	1.297
44-54	0.794	1.259
55-64	0.791	1.264
65+	0.765	1.307
Countries (UK = reference category)		
US	0.818	1.222
Greece	0.684	1.462
Italy	0.757	1.321
Employment status (Full/part time employment = reference category)		
Students	0.621	1.610
Unemployed	0.711	1.406
Marital status (single/separated/divorced/widowed = 0 vs. married/in a civil partnership/cohabiting = 1)	0.633	1.579
Education (Graduate Degree = reference category)		
High school or below/ associate degree	0.683	1.464
Bachelor's degree	0.852	1.174
Annual income (low income <£30k = reference category)		
Medium income (£30-60k)	0.739	1.353
High income (>£60k)	0.533	1.878
Household size (total number of people in a household including themselves; 1 = 1 vs 2+ = 2)	0.793	1.261
Number of chronic physical health conditions (0 = none vs 1+ = 1)	0.778	1.285
Number of pre-existing mental health conditions (0 = none vs 1+ = 1)	0.778	1.285
IPAQ-SF Pre-COVID PA levels (Moderate-PA = reference category	0.741	1.349
Low-PA Pre-COVID	0.825	1.211
High-PA Pre-COVID	0.963	1.159

Note. VIF = variance inflation factor.

Table 11.3.2

Testing for Multicollinearity Amongst the Mental Health Variables (Depression, Anxiety and Loneliness) at Wave 1 (N = 1,037)

Variable	Tolerance	VIF
Depression (PHQ-9 total score)	0.362	2.763
Anxiety (GAD-7 total score)	0.399	2.509
Loneliness (LS total score)	0.691	1.448

Note. VIF = variance inflation factor. Abbreviations: PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalised Anxiety Disorder Scale 7; LS = Loneliness Scale.

Tolerance values below 0.1 and VIF values above 10 would indicate concerns with multicollinearity (Field, 2013). As shown in Table 2.4.1 and Table 2.4.2, the tolerance values for all variables were greater than 0.1 and VIF values were less than 10. Therefore, there are no concerns about multicollinearity between the variables.

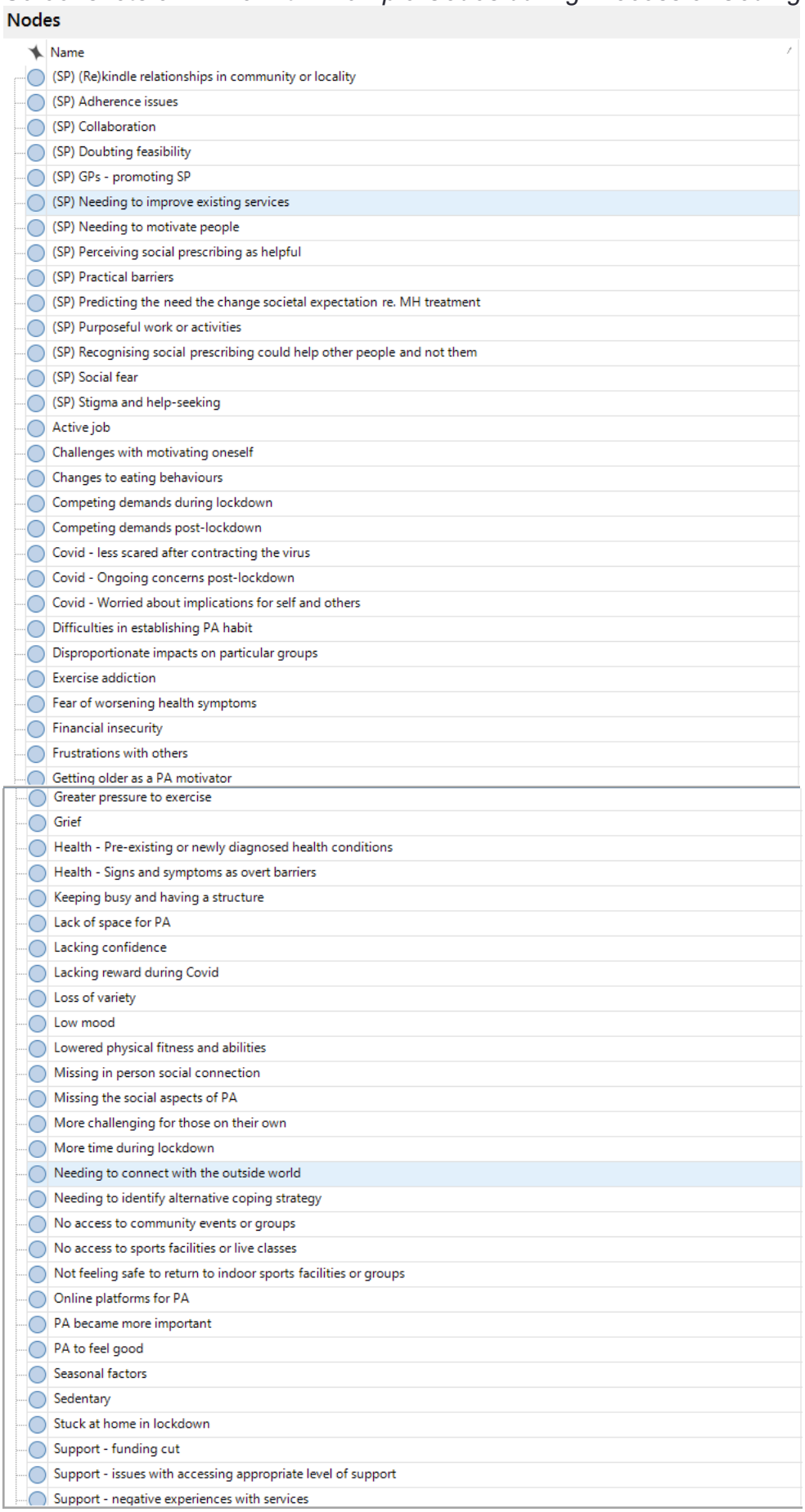
Appendix 12. Process of Qualitative Data Analysis

Process of qualitative data analysis using six-step thematic analysis (Braun & Clarke, 2006, 2022)

1. Familiarisation with the data: All recordings and transcripts were listened to and read at least once. Any initial ideas or observations were noted.
2. Coding: researcher used a systematic approach by going through one transcript at a time and line by line using NVivo 12 (see Table 12.1, Screenshots of NVivo Example Codes). Coding labels were created to capture each data item based on verbatim. Each code represented a singular meaning from the data and was relevant to the research question. After coding 10 transcripts, the researcher revisited the initial codes to check for consistency. Codes were reviewed and refined through repeated process of reading and further coding of the meanings.
3. Code discussion: Two transcripts were coded independently by a second coder, an undergraduate psychology student independent of the current project who has experience in qualitative research, using the exact process as outlined above. Any variations were discussed and remediated.
4. Generating initial themes: Thematic maps of candidate themes were created
5. Developing and reviewing themes: Initial themes were refined and reviewed against coded data extracts and original dataset. These were discussed with a course peer and supervisor (K.W.) to review theme definitions and coded extracts.
6. Refining and naming themes: The researcher reviewed the mappings and met with K.W. to discuss names.

Figure 12.1.

Screenshots of NVivo with Example Codes during Process of Coding



- Support - wanting in-person support
- Transitioning out of lockdown
- Unmotivating surroundings for PA
- Vaccine - not a cure
- Worried about how others perceive them

Appendices 13-17. Quantitative Findings at Wave 1 of COVID-19

Appendix 13

Characteristics and Chi-Square Tests for IPAQ-SF PA Levels at Wave 1

Table 13.1

Characteristics and Chi-Square Results for IPAQ-SF PA Levels at Wave 1 (April 17 – July 17, 2020) during COVID-19 (N = 1,037)

Characteristics	Category	Full sample (N = 1,037)		Low PA (n = 370)		Moderate PA (n = 411)		High PA (n = 256)		X^2	*p*	*df*	Cramer's V
		n	%	n	%	n	%	n	%				
Gender	Female	782	76.67	277	75.68	310	77.59	195	76.77	0.36	.837	2	.02
	Male	238	23.33	89	24.32	90	22.50	59	23.23				
Age group	18-24	145	14.04	52	14.09	58	14.15	35	13.78	10.44	.403	10	.07
	25-34	448	43.37	170	46.07	164	40.00	114	44.88				
	35-44	200	19.36	70	18.97	76	18.54	54	21.26				
	45-54	110	10.65	31	8.40	53	12.93	26	10.24				
	55-64	88	8.52	34	9.21	37	9.02	17	6.69				
	65 years or older	42	4.07	12	3.25	22	5.37	8	3.15				
Ethnicity	White	830	80.04	268	75.28	342	84.65	220	86.27	**15.78**	**< .001*****	2	.13
	People of Colour	185	17.84	88	24.72	62	15.35	35	13.73				
Countries	UK	589	56.80	191	51.62	246	59.85	152	59.38	**20.76**	**.002****	6	.10
	US	158	15.24	50	13.51	68	16.55	40	15.63				
	Greece	157	15.14	60	16.22	62	15.09	35	13.67				
	Italy	133	12.83	69	18.65	35	8.52	29	11.33				
Employment status	Employed	555	53.99	186	50.82	225	55.15	144	55.69	8.50	.075	4	.06
	Unemployed	120	11.67	52	14.21	50	12.25	18	7.09				
	Student	353	34.34	128	34.97	133	32.60	92	36.22				
Marital status	Single/ divorced/ widowed/ separated	501	48.36	191	51.62	191	46.59	119	46.48	2.45	.293	2	.05
	Married/ civil partnership/ cohabiting	535	51.64	179	48.38	219	53.41	137	53.52				
Education	High school or below/ Associate Degree	174	16.78	78	21.08	62	14.84	35	13.67	8.31	.081	4	.06
	Bachelor's Degree	265	25.55	85	22.97	111	27.01	69	26.95				
	Graduate Degree	598	57.67	207	55.95	239	58.15	152	59.38				
Annual income (GBP £)	Low (<30k)	419	42.76	178	51.00	149	38.40	92	37.86	**27.83**	**< .001*****	4	.12
	Medium (30-60k)	230	23.47	86	26.54	98	25.26	46	18.93				
	High (>60k)	331	33.78	85	24.36	141	36.34	105	43.21				

Characteristics	Category	Full sample (N = 1,037)		Low PA (n = 370)		Moderate PA (n = 411)		High PA (n = 256)		X^2	*p*	*df*	Cramer's V
		n	%	n	%	n	%	n	%				
Household size (including themselves)	1	148	14.79	59	16.16	58	14.80	31	12.70	1.39	.499	2	.04
	2+	853	85.21	306	83.84	334	85.20	213	87.30				
Number of self-reported chronic physical health conditions [a]	0	867	83.61	295	79.73	341	82.97	231	90.23	**12.38**	**.002****	2	.11
	≥ 1	170	16.39	75	20.27	70	17.03	25	9.77				
Number of pre-existing mental health conditions [a]	0	870	83.90	291	78.65	350	33.75	229	89.45	**13.88**	**< .001*****	2	.12
	≥ 1	167	16.10	79	21.35	61	14.84	27	10.55				
IPAQ-SF before COVID-19	Low PA	213	20.54	145	39.19	49	11.92	19	7.42	**212.69**	**< .001*****	4	.32
	Moderate PA	508	48.99	172	46.49	246	59.85	90	35.16				
	High PA	316	30.47	53	14.32	116	28.22	147	57.42				
Met PA guideline before COVID-19 [b]	Sufficiently active	831	80.14	236	63.78	352	85.64	243	94.92	**105.14**	**< .001*****	2	.33
	Insufficiently active	206	19.86	134	36.22	59	14.36	13	5.08				
PHQ-9	Total score (Mean ± SD)	7.61 ± 5.65		8.79 ± 6.02		7.13 ± 5.39		6.69 ± 5.24					
	No to Minimal (≤4)	357	34.43	103	27.84	148	36.01	106	41.41	**24.79**	**.002****	**8**	**.11**
	Mild (5-9)	363	35.00	127	34.32	148	36,01	88	33.38				
	Moderate (10-14)	171	16.49	66	17.84	68	16.55	37	14.45				
	Moderately Severe (15-19)	99	9.55	49	13.24	33	8.03	17	6.64				
	Severe (20-27)	47	4.53	25	6.76	14	3.41	8	3.13				
	Sub-clinical (PHQ-9 <10)	720	69.43	230	62.16	296	72.02	194	75.78	**15.37**	**< .001*****	2	.12
	Clinically relevant (PHQ-9 ≥10)	317	30.57	140	37.84	115	27.98	62	24.22				
GAD-7	Total score (Mean ± SD)	5.77 ± 4.96		6.32 ± 5.35		5.52 ± 4.77		5.39 ± 4.61					
	No to Minimal (≤4)	521	50.24	175	47.30	210	51.09	136	53.13	8.93	.178	6	.07
	Mild (5-9)	292	28.16	104	28.11	116	28.22	72	28.13				
	Moderate (10-14)	140	13.50	49	13.24	58	14.11	33	12.89				
	Severe (15-21)	84	8.10	42	11.35	27	6.57	15	5.86				
	Sub-clinical (GAD-7<10)	813	78.40	279	75.41	326	79.32	208	81.25	3.39	.183	2	.06
	Clinically relevant (GAD-7 ≥10)	224	21.60	91	24.59	85	20.68	48	18.75				
LS [c]	Total score (Mean ± SD)	42.56 ± 11.35		44.55 ± 11.57		41.64 ± 10.77		41.17 ± 11.58					
	Lower loneliness (total LS score <56)	880	84.86	299	80.81	356	86.62	225	87.89	**7.54**	**.023***	**2**	**.09**
	Highest level of loneliness (top 15%; total LS score ≥56)	157	15.14	71	19.19	55	13.38	31	12.11				

Note. Participants were on average 36.5 years old (*SD* = 13.0). IPAQ-SF, International Physical Activity Questionnaire – Short Form. PHQ-9, Patient Health Questionnaire. GAD-7, General Anxiety Disorder scale. LS, UCLA-Loneliness Scale. PA, Physical activity.

[a] Reflects the number and percentage of participants responding with one or more physical and/or mental health conditions to this question (Appendix 15, details on self-reported physical and mental health conditions).

[b] Sufficiently active: Met WHO's PA guidelines, ≥ 150 minutes of moderate PA, ≥ 75 minutes of vigorous PA or a combination of both (equivalent to ≥ 600 MET-minutes/week) based on IPAQ-SF. Insufficiently active: Did not meet the WHO's PA guidelines based on IPAQ-SF.

[c] Loneliness group was dichotomised: highest level of loneliness identified using top 15% (LS ≥ 56) vs. lower level of loneliness (LS < 56).

Bold = significant at the $*p < .05$; $**p < .01$; $***p < .001$ level.

Appendix 14

One-way Analysis of Variance (ANOVA) Tests

One-way analysis of variance (ANOVA) tests was conducted to examine differences in levels of depressive symptoms (PHQ-9 total score), anxiety (GAD-7 total score) and loneliness (LS total score) across sociodemographic variables and PA levels (see Table 14.1). Post hoc tests using Bonferroni comparisons were conducted (see Table 14.2).

Table 14.1

One-Way Analysis of Variance of Total PHQ-9 Score, Total GAD-7 Score and Total LS Score by Sociodemographic Variables and IPAQ-SF PA Levels Before and During COVID-19

Variables	Total PHQ-9 score		ANOVA				Total GAD-7 score		ANOVA				Total LS score		ANOVA			
	M	SD	F	*df*	*p*	η^2	M	SD	F	*df*	*p*	η^2	M	SD	F	*df*	*p*	η^2
Gender (*n* = 1,020)																		
Male (*n* = 238)	6.49	5.31	12.62	1	**< .001*** **	.01	4.23	4.07	31.10	1	**< .001*** **	.03	43.13	11.02	1.11	1	.292	.00
Female (*n* = 782)	7.97	5.70					6.25	5.12					42.25	11.34				
Age (*n* = 1,033)																		
18-24 (*n* = 145)	9.29	5.79	7.25	5	**< .001*** **	.03	6.90	4.82	6.64	5	**< .001*** **	.03	43.04	11.20	0.23	5	.952	.00
25-34 (*n* = 448)	7.96	5.41					6.13	5.00					42.49	11.05				
35-44 (*n* = *200)*	7.55	5.83					5.97	5.19					42.45	11.00				
45-54 (*n* = 110)	6.42	5.83					4.69	4.81					43.26	12.22				
55-64 (*n* = 88)	6.17	5.45					4.26	4.22					42.03	12.98				
65+ (*n* = 42)	4.83	4.85					3.48	4.17					41.74	11.05				
Ethnicity (*n* = 1,015)																		
White (*n* = 830)	7.51	5.62	1.63	1	.202	.00	5.79	4.92	0.00	1	.998	.00	42.28	11.46	1.51	1	.220	.00
People of Colour (*n* = 185)	8.10	5.83					5.79	5.13					43.41	10.84				
Countries (*n* = 1,037)																		
UK (*n* = 589)	8.17	6.09	10.54	3	**< .001*** **	.03	6.07	5.16	5.05	3	**.002****	.01	43.31	11.88	4.70	3	**.003****	.01
US (*n* = 158)	7.11	5.57					5.97	5.21					41.03	10.70				
Greece (*n* = 157)	5.48	4.10					4.37	4.35					40.17	10.82				
Italy (*n* = 133)	8.26	4.63					5.91	4.11					43.45	9.71				
Employment status (*n* = 1,028)																		
Employed (*n* = 555)	6.43	5.00	27.72	2	**< .001*** **	.05	5.04	4.58	13.27	2	**< .001*** **	.03	41.27	10.66	15.00	2	**< .001*** **	.03
Unemployed (*n* = 120)	9.57	7.25					6.83	5.66					47.40	12.77				
Student (*n* = 353)	8.73	5.56					6.54	5.12					42.82	11.44				
Marital status (*n* =1,036)																		
Single/divorced/ widowed/separated (*n* = 501)	8.74	5.86	39.80	1	**< .001*** **	.04	6.40	5.12	15.78	1	**< .001*** **	.02	44.67	11.56	34.50	1	**< .001*** **	.03
Married/civil partnership/cohabiting (*n* = 535)	6.56	5.25					5.18	4.74					40.59	10.78				
Education (*n* = 1,037)																		
High school or below/ Associate Degree (*n* = 174)	9.98	6.63	20.83	2	**< .001*** **	.04	7.27	5.43	10.874	2	**< .001*** **	.02	46.24	12.27	12.55	2	**< .001*** **	.02
Bachelor's Degree (*n* = 265)	7.67	5.43					5.86	4.98					42.77	11.09				
Graduate Degree (*n* = 598)	6.90	5.24					5.30	4.73					41.10	10.97				
Annual income (*n* = 980)																		
Low (<£30k) (*n* = 419)	8.44	6.00	10.46	2	**< .001*** **	.02	6.24	5.27	4.15	2	**.016***	.01	44.25	12.04	13.58	2	**< .001*** **	.03
Medium (£30-60k) (*n* = 230)	7.80	5.46					5.93	5.11					43.45	11.34				
High (>£60k) (*n*=331)	6.56	5.18					5.20	4.41					10.07	10.02				

Variables	Total PHQ-9 score		ANOVA				Total GAD-7 score		ANOVA				Total LS score		ANOVA			
	M	SD	F	*df*	*p*	η^2	M	SD	F	*df*	*p*	η^2	M	SD	F	*df*	*p*	η^2
Household size (including themselves) (*n* = 1,001)																		
1 (*n* = 148)	9.01	6.20	9.95	1	**.002****	.01	6.49	5.35	3.59	1	.059	.00	47.09	12.28	28.12	1	**< .001*****	.03
2+ (*n* = 853)	7.42	5.57					5.65	4.86					41.78	11.06				
Number of self-reported chronic physical health conditions (*n* = 1,037)																		
0 (*n* = 867)	7.21	5.41	27.45	1	**< .001*****	.03	5.50	4.82	16.35	1	**< .001*****	.02	42.08	13.26	9.78	1	**.002****	.01
≥ 1 (*n* = 170)	9.66	6.40					7.17	5.33					45.04	13.26				
Number of pre-existing mental health conditions (*n* = 1,037)																		
0 (*n* = 870)	6.90	5.12	123.62	1	**< .001*****	.11	5.16	4.61	88.94	1	**< .001*****	.08	41.38	10.69	62.52	1	**< .001*****	.06
≥ 1 (*n* =167)	11.83	6.42					8.96	5.51					48.87	12.65				
IPAQ-SF before COVID-19 outbreak (*n* = 1,037)																		
Low (*n* = 213)	8.26	6.05	1.78	2	.169	.00	5.82	4.98	0.63	2	.531	.00	44.07	11.98	3.03	2	**.049***	.01
Moderate (*n* = 508)	7.43	5.46					5.61	4.89					42.54	11.05				
High (*n* = 316)	7.48	5.67					6.01	5.07					41.59	11.32				
Met PA guideline before COVID-19 [a] (*n* = 1,037)																		
Insufficiently active (*n* = 206)	8.63	6.05	8.39	1	**.004****	.01	6.29	5.15	2.80	1	.095	.00	44.55	11.94	7.92	1	**.005****	.01
Sufficiently active (*n* = 831)	7.36	5.53					5.65	4.91					42.07	11.15				
IPAQ-SF during COVID-19 outbreak (*n* = 1,037)																		
Low (*n* = 370)	8.79	6.02	13.18	2	**< .001*****	.03	6.32	5.52	3.57	2	**.028***	.01	44.55	11.57	9.13	2	**<.001*****	.02
Moderate (*n* = 411)	7.13	5.39					5.52	4.77					41.64	10.77				
High (*n* = 256)	6.69	5.24					5.39	4.61					42.56	11.35				
Met PA guideline during COVID-19 [a] (*n* = 1,037)																		
Insufficiently active (*n* = 334)	8.77	6.02	20.89	1	**< .001*****	.02	6.32	5.25	5.93	1	**.015***	.01	44.81	11.53	19.74	1	**< .001*****	.02
Sufficiently active (*n* = 703)	7.07	5.39					5.52	4.80					41.49	11.11				

Note. M = Mean; SD = Standard deviations. IPAQ-SF, International Physical Activity Questionnaire – Short Form. PHQ-9, Patient Health Questionnaire. GAD-7, General Anxiety Disorder scale. LS, UCLA-Loneliness Scale.

[a] Sufficiently active: Met WHO's PA guidelines, ≥ 150 minutes of moderate PA, ≥ 75 minutes of vigorous PA or a combination of both (equivalent to ≥ 600 MET-minutes/week) based on IPAQ-SF. Insufficiently active: Did not meet the WHO's PA guidelines based on IPAQ-SF.

Bold = significant at the *$p < .05$; **$p < .01$; ***$p < .001$ level.

Table 14.2

Results of Post-hoc Analyses using Bonferroni Correction

Variable		PHQ-9		GAD-7		LS	
I	J	Mean Difference (I-J)	*p*	Mean Difference (I-J)	*p*	Mean Difference (I-J)	*p*
		Age (*n* = 1,033)					
18-24	25-34	1.33	.193	0.77	1.000	—	—
	35-44	1.74	.063	0.93	1.000	—	—
	45-54	**2.87**	**<.001*****	**2.21**	**.006****	—	—
	55-64	**3.12**	**<.001*****	**2.64**	**.001****	—	—
	65+	**4.46**	**<.001*****	**3.42**	**.001****	—	—
25-34	18-24	-1.33	.193	-0.77	1.000	—	—
	35-44	0.42	1.000	0.16	1.000	—	—
	45-54	1.54	.141	1.43	.091	—	—
	55-64	1.79	.089	**1.86**	**.017***	—	—
	65+	**3.13**	**.008****	**2.65**	**.013***	—	—
35-44	18-24	-1.74	.063	-0.93	1.000	—	—
	25-34	-.42	1.000	-0.16	1.000	—	—
	45-54	1.13	1.000	1.28	.422	—	—
	55-64	1.37	.814	1.71	.098	—	—
	65+	2.71	.064	**2.49**	**.042***	—	—
45-54	18-24	**-2.87**	**<.001*****	**-2.21**	**.006****	—	—
	25-34	-1.54	.141	-1.43	.091	—	—
	35-44	-1.13	1.000	-1.28	.422	—	—
	55-64	0.25	1.000	0.43	1.000	—	—
	65+	1.58	1.000	1.21	1.000	—	—
55-64	18-24	**-3.12**	**<.001*****	**-2.64**	**.001****	—	—
	25-34	-1.79	.089	**-1.86**	**.017***	—	—
	35-44	-1.37	.814	-1.71	.098	—	—
	45-54	-.25	1.000	-0.43	1.000	—	—
	65+	1.34	1.000	0.79	1.000	—	—
65+	18-24	**-4.46**	**<.001*****	**-3.42**	**.001****	—	—
	25-34	**-3.13**	**.008****	**-2.65**	**.013***	—	—
	35-44	-2.71	.065	**-2.49**	**.042***	—	—
	45-54	-1.58	1.000	-1.21	1.000	—	—
	55-64	-1.34	1.000	-0.79	1.000	—	—
		Countries (*n* = 1,037)					
UK	US	1.06	0.207	0.10	1.000	2.38	.113
	Greece	**2.69**	**<.001*****	**1.70**	**<.001*****	**3.24**	**.009****
	Italy	-0.08	1.000	0.16	1.000	-0.04	1.000
US	UK	-1.06	0.207	-0.10	1.000	-2.38	.113
	Greece	1.64	0.056	**1.60**	**.025***	0.86	1.000
	Italy	-1.14	0.493	0.06	1.000	-2.42	.413
Greece	UK	**-2.69**	**<.001*****	**-1.70**	**<.001*****	**-3.24**	**.009****
	US	-1.64	0.056	**-1.60**	**.025***	-0.86	1.000
	Italy	**-2.78**	**<.001*****	**-1.54**	**.049***	-3.28	.083
Italy	UK	0.08	1.000	-0.16	1.000	0.04	1.00)
	US	1.14	0.493	-0.06	1.000	2.42	.413
	Greece	**2.78**	**<.001*****	**1.54**	**.049***	3.28	.083
		Employment (*n* = 1,028)					
Employed	Unemployed	**-3.14**	**<.001*****	**-1.79**	**<.001*****	**-6.13**	**<.001*****
	Student	**-2.30**	**<.001*****	**-1.50**	**<.001*****	-1.55	.128
Unemployed	Employed	**3.14**	**<.001*****	**1.79**	**<.001*****	**6.13**	**<.001*****
	Student	0.84	.444	0.30	1.000	**4.58**	**<.001*****
Student	Unemployed	-0.84	.444	-0.30	1.000	**-4.58**	**<.001*****
	Employed	**2.30**	**<.001*****	**1.50**	**<.001*****	1.55	.128
		Education (*n* = 1,037)					
High school or below/ Associate Degree	Bachelor's Degree	**2.31**	**<.001*****	**1.41**	**.010***	**3.47**	**.005****
	Graduate Degree	**3.08**	**<.001*****	**1.97**	**<.001**	**4.83**	**<.001*****
Bachelor's Degree	High school or below/ Associate Degree	**-2.31**	**<.001*****	**-1.41**	**.010***	**-3.47**	**.005****
	Graduate Degree	0.77	.183	0.56	.370	1.37	.298
Graduate Degree	High school or below/ Associate Degree	**-3.08**	**<.001*****	**-1.97**	**<.001*****	**-4.83**	**<.001*****
	Bachelor's Degree	-0.77	.183	-0.56	.370	-1.37	.298
		Annual income (*n* = 980)					
Low (<£30k)	Medium (£30-60k)	0.65	.484	0.30	1.000	0.80	1.000
	High (>£60k)	**1.88**	**<.001****	**1.04**	**.013***	**4.18**	**<.001*****
Medium (£30-60k)	Low (<£30k)	-0.65	.484	-0.30	1.000	-0.80	1.000

	High (>£60k)	**1.23**	**.032***	0.74	.253	**3.38**	**.001****
High (>£60k)	Low (<£30k)	**-1.88**	**<.001*****	**-1.04**	**.013***	**-4.18**	**<.001*****
	Medium (£30-60k)	**-1.23**	**.032***	-0.74	.253	**-3.38**	**.001****
	PA levels before COVID-19 outbreak‡ (IPAQ-SF)						
Low	Moderate	0.84	.209	0.21	1.000	1.53	.295
	High	0.79	.352	-0.18	1.000	**2.47**	**.042***
Moderate	Low	-0.84	.209	-0.21	1.000	-1.53	.295
	High	-0.05	1.000	-0.40	0.797	0.94	.740
High	Low	-0.79	.352	0.18	1.000	**-2.47**	**.042***
	Moderate	0.05	1.000	0.40	0.797	-0.94	.740
	PA levels during COVID-19 outbreak‡ (IPAQ-SF)						
Low	Moderate	**1.65**	**< .001*****	0.80	.072	**2.92**	**< .001*****
	High	**2.10**	**< .001*****	0.93	.063	**3.38**	**< .001*****
Moderate	Low	**-1.65**	**< .001*****	-0.80	.072	-2.92	**< .001*****
	High	0.45	.948	0.13	1.000	0.47	1.000
High	Low	**-2.10**	**< .001*****	-0.93	.063	**-3.38**	**< .001*****
	Moderate	-0.45	.948	-0.13	1.000	-0.47	1.000

Note. "—" indicates that results of one-way ANOVA were not statistically significant.

Bold = significant at the *$p < .05$; **$p < .01$; ***$p < .001$ level.

Appendix 15

Participants Characteristics - Self-reported Physical and Mental Health Conditions

Table 15.1

Breakdown of Chronic Physical Health Conditions Reported at Wave 1

Chronic physical health conditions	n	%
Respiratory conditions	68	30.1
Heart conditions	20	8.8
Circulatory problems	41	18.1
Diabetes	15	6.6
Other medical conditions (e.g., cancer, epilepsy, lupus, sleep apnea, obesity)	82	36.3
Total	**226**	**100.0**

Note. N = 170 reported having ≥ 1 chronic physical health conditions.

Table 15.2

Breakdown of Pre-existing Mental Health Conditions Reported at Wave 1

Pre-existing mental health conditions	n	%
Alcohol/ substance use disorder	10	3.0
Anxiety disorder	112	33.2
Bipolar disorder	15	4.5
Depression	111	32.9
Disruptive, Impulse-Control, and Conduct Disorders	0	0.0
Feeding/ Eating disorder	17	8.0
Obsessive-Compulsive Disorder	19	5.6
Schizophrenia & Psychotic Disorders	5	1.5
Trauma and Stressor-Related Disorders	28	8.3
Personality Disorder	10	3.0
Total	**337**	**100.0**

Note. N = 167 reported having ≥ 1 pre-existing mental health conditions.

Appendix 16

ANOVA and Post-hoc Tests: IPAQ-SF PA levels during COVID-19 (IVs) by Mental Health Outcomes (DVs; Depression (PHQ-9), anxiety (GAD-7) and loneliness (LS))

Table 16.1

Results for all relations between low-moderate PA, high-moderate PA, and low-high PA levels during COVID-19 (IVs) and mental health outcomes (DVs)

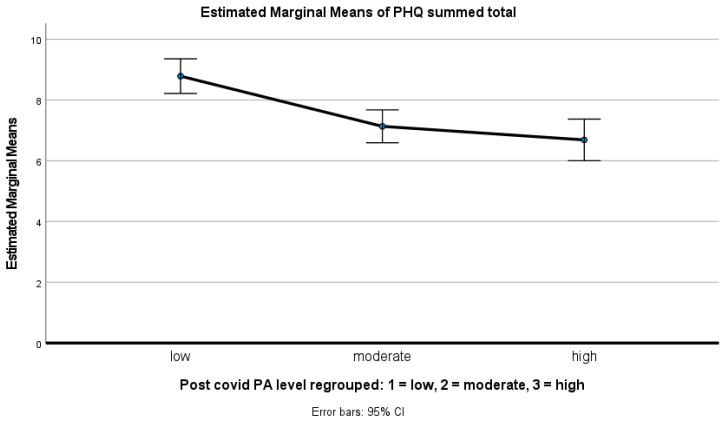
Variable		PHQ-9		GAD-7		LS	
I	J	Mean Difference (I-J)	*p*	Mean Difference (I-J)	*p*	Mean Difference (I-J)	*p*
Moderate PA	Low PA	-1.65	**< .001*** **	-0.80	.072	-2.92	**< .001*** **
Low PA	Moderate PA	1.65	**< .001*** **	0.80	.072	2.92	**< .001*** **
Moderate PA	High PA	0.45	.316	0.13	1.000	0.47	1.000
High PA	Moderate PA	-0.45	.316	-0.13	1.000	-0.47	1.000
Low PA	High PA	2.10	**< .001*** **	0.93	.063	3.38	**< .001*** **
High PA	Low PA	-2.10	**< .001*** **	-0.93	.063	-3.38	**< .001*** **

Note. Low-PA, *n* = 370; Moderate-PA, *n* = 411; High-PA, *n* = 256. IPAQ-SF, International Physical Activity Questionnaire – Short Form. PHQ-9, Patient Health Questionnaire. GAD-7, General Anxiety Disorder scale. LS, UCLA-Loneliness Scale. PA, Physical activity.

Bold = significant at the **p* < .05; ***p* < .01*;* ****p* < .001 level.

Figure 16.1

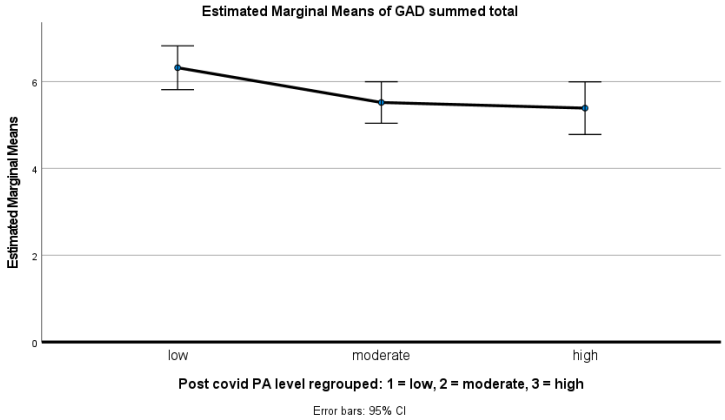
Depression - PHQ-9 total summed scores by PA levels during COVID-19 as measured by IPAQ-SF



Note. Abbreviations: Levels of depression symptoms measured by PHQ-9, Patient Health Questionnaire 9. PA, physical activity level measured by IPAQ-SF, International Physical Activity Questionnaire – Short Form.

Figure 16.2

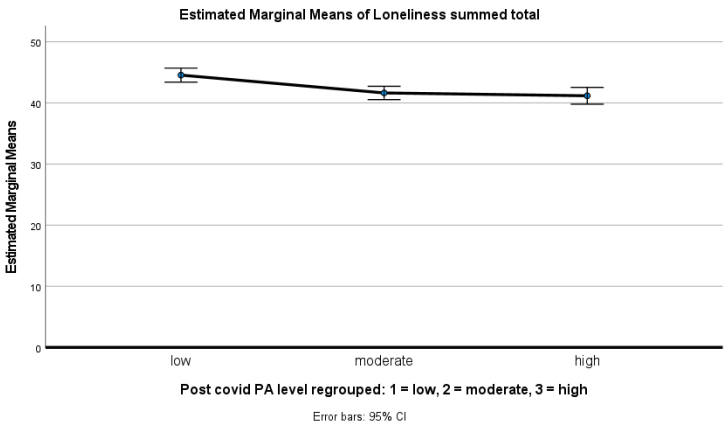
Anxiety - GAD-7 total summed scores by PA levels during COVID-19 as measured by IPAQ-SF



Note. Abbreviations: Levels of anxiety symptoms measured by GAD-7, GAD-7 = Generalised Anxiety Disorder Scale 7. PA, physical activity level measured by IPAQ-SF, International Physical Activity Questionnaire – Short Form.

Figure 16.3

Loneliness - LS total summed scores by PA levels during COVID-19 as measured by IPAQ-SF



Note. Abbreviations: Levels of loneliness measured by LS, Loneliness Scale. PA, physical activity level measured by IPAQ-SF, International Physical Activity Questionnaire – Short Form.

Appendix 17

Descriptive Statistics and Correlations for Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1. IPAQ-SF during COVID - Low PA [a]	—																										
2. High PA [a]	**-.43****	—																									
3. Gender [b]	-.02	.00	—																								
4. Age - 18-24 years [c]	.00	-.01	.05	—																							
5. 35-44 years [c]	-.01	.03	-.05	**-.20****	—																						
6. 44-54 years [c]	-.05	-.01	.02	**-.14****	**-.17****	—																					
7. 55-64 years [c]	.02	-.04	.00	**-.12****	**-.15****	**-.11****	—																				
8.. 65+ years [c]	-.03	-.03	-.02	**-.08****	**-.10****	**-.07***	**-.06***	—																			
9. Ethnicity [d]	**.12****	**-.07***	-.03	-.02	.00	-.02	**-.11****	**-.07***	—																		
10. Countries – US [e]	-.04	.01	.02	**-.12****	.04	.00	.03	**.09****	.05	—																	
11.Greece [e]	.02	-.02	**-.07***	**-.10****	**.07***	.04	-.01	-.05	**-.17****	**-.18****	—																
12. Italy [e]	**.13****	-.03	**-.09****	**.27****	**-.09****	**-.12****	-.02	-.05	**-.12****	**-.16****	**-.16****	—															
13.Employment - Student [f]	.01	.02	.04	**.41****	**-.22****	**-.19****	**-.18****	**-.13****	**.08****	**-.14****	**-.15****	**.18****	—														
14. Unemployed [f]	.06	**-.08****	**.06***	**-.10****	.03	.01	**.10****	**.35****	-.04	**.06***	-.03	**-.07***	**-.26****	—													
15. Marital status [g]	-.05	.02	.03	**-.33****	**.14****	**.18****	**.15****	**.08****	-.02	**.13****	-.02	**-.19****	-.28**	-.03	—												
16. Education - High school or below/associate degree [h]	**.09****	-.05	.02	**.31****	-.06	.02	.04	**.08***	**-.10****	**-.11****	-.01	**.24****	**.02**	**.19****	**-.10****	—											
17. bachelor's degree [h]	-.04	.02	.00	**.06***	-.05	-.03	.04	-.05	-.03	.01	.05	-.03	**-.07***	.03	**-.07***	**-.26****	—										
18. Annual income - Medium (£30-60k) [i]	.02	-.06	.01	.02	-.04	-.03	.03	**.07***	.04	**-.08***	**-.14****	-.01	-.02	-.02	-.02	.03	-.03	—									
19. High(>£60k) [i]	-.14	**.11****	.01	**-.11****	**.10****	**.08***	.02	.02	**.07***	**.38****	**-.28****	**-.17****	**-.17****	**-.07***	**.29****	**-.18****	.02	**-.37****	—								
20. Household size [j]	-.03	.03	.04	**.08***	-.04	.00	.04	**-.07***	-.05	-.02	**-.07***	.05	**.08****	**-.12****	**.35****	.04	-.01	.04	**.08****	—							
21. Self-reported chronic physical health conditions [k]	**.08***	**-.10****	**.08***	-.08**	-.01	.05	**.18****	**.11****	**-.07***	.05	**-.09****	**-.15****	**-.07***	**.17****	.06	.02	.03	.03	.00	-.06	—						

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
22. Pre-existing mental health conditions [k]	**.11****	**-.09****	**.07***	.01	-.01	.03	.05	.04	-.04	.02	**-.13****	**-.12****	-.02	**.21****	-.04	**.16****	.03	.03	**-.10****	**-.09****	**.39****	—					
23. Pre-COVID IPAQ-SF – Low-PA [a]	**.34****	**-.19****	.02	-.03	-.04	.03	**.08***	.05	-.03	-.05	**.14****	**.10****	**-.08***	**.08***	.01	**.13****	.03	-.05	**-.11****	-.01	.03	**.07***	—				
24. Pre-COVID IPAQ-SF – High-PA [a]	**-.26****	**.34****	**-.07***	.06	.00	-.02	**-.07***	-.05	-.03	**.06***	-.01	-.06	.04	**-.10****	.01	**-.07***	.02	-.02	**.07***	.02	**-.07***	-.04	**-.34****	—			
25. Depression (PHQ-9 total)	**.12****	**-.08****	**.10****	**.11****	-.01	**-.08****	**-.08****	**-.10****	.03	-.04	**-.13****	**.07***	**.14****	**.07***	**-.17****	**.14****	.02	.02	**-.11****	**-.08****	**.12****	**.25****	.04	-.02	—		
26. Anxiety (GAD-7 total)	**.05***	-.03	.15**	**.09****	.01	**-.08****	**-.08****	**-.09****	-.01	.01	**-.11****	.04	**.10****	**.14****	**-.11****	**.11****	.01	.01	-.05	-.04	**.11****	**.22****	.00	.03	**.77****	—	
27. Loneliness (LS total)	**.11****	**-.07****	-.03	.02	.00	.01	-.02	-.02	.04	-.04	**-.08****	.04	.02	**.11****	**-.15****	**.11****	.01	.04	**-.12****	**-.12****	**.06***	**.18****	**.05***	**-.05***	**.55****	**.48****	—
Mean	———		—			———			———		———		———		—	———		———		—	—	—	———		7.61	5.77	42.56
SD	———		—			———			———		———		———		—	———		———		—	—	—	———		5.65	4.96	11.35
Mdn	———		—			———			———		———		———		—	———		———		—	—	—	———		6	4	42
Min	———		—			———			———		———		———		—	———		———		—	—	—	———		0	0	20
Max	———		—			———			———		———		———		—	———		———		—	—	—	———		27	21	77
Kurtosis	———		—			———			———		———		———		—	———		———		—	—	—	———		0.275	0.127	-0.502
Skewness	———		—			———			———		———		———		—	———		———		—	—	—	———		0.891	0.942	0.433
α	———		—			———			———		———		———		—	———		———		—	—	—	———		0.870	0.905	0.934
Missing (%)	———		1.6			0.4			2.1		———		0.9		0.1	———		5.5		3.5	—	—	———		—	—	—
n	1037		1020			1033			1015		1037		1028		1036	1037		980		1001	1037	1037	1037		1037	1037	1037

Note. Kendall's tau-b correlations were conducted for all categorical variables. Person's correlations were conducted for continuous variables (namely, PHQ-9, GAD-7 and LS total scores). PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

[a] IPAQ-SF PA levels: Moderate PA = reference category.

[b] 0 = male and female = 1.

[c] Age group: 25-34 years = reference category.

[d] Ethnicity: White = 0, People of Colour = 1

[e] Countries: UK = reference category.

[f] Employment status: full/part time employment = reference category.

[g] Marital status: single/separated/divorced/ widowed = 0, married/ in a civil partnership/ cohabiting = 1

[h] Education: Graduate degree = reference category

[i] Annual income: Low income <£30k = reference group.

[j] Household size as defined by total number of people in the household including themselves: 1 = 1, 2+ = 2

[k] Reflects the number and percentage of participants responding with one or more physical and/or mental health conditions to this question, 0 = none, ≥1 = 1.

Bold = significant at the *$p < .05$; **$p < .01$ level (2-tailed).

Appendix 18. PA and Mental Health Outcomes at Wave 1 and Follow-up Interview

Details for PA levels and mental health outcomes collected at wave 1 (T1; April 17 – July 17, 2020) and follow-up interview (T2; March 18 – August 1, 2022) are presented in this appendix.

Table 18.1

Levels of PA and Scores for Mental Health for UK follow-up participants (N = 21)

Variable		Wave 1 (T1; April 17-July17, 2020)		Follow-up Interviews (T2; March 18-August 1, 2022)		Difference (T2-T1)	
		Low-PA (*n* = 15)	High-PA (*n* = 6)	Low-PA[b] (*n* = 15)	High-PA [b] (*n* = 6)	Low-PA [b] (*n* = 15)	High-PA[b] (*n* = 6)
Physical activity measure (IPAQ-SF)							
Total PA levels during COVID-19 in MET·min^{-1}·week^{-1}	Mean ± SD	176.10 ± 264.59	2007 ± 495.09	1904.17 ± 1813.63	5075.00 ± 3580.84	1728.07 ± 1885.25	2068.00 ± 3517.52
	Median (interquartile range)	0 (264)	3051 (1040)	1645.5 (2205)	5049 (6028.50)	1525.5 (2353.5)	2005.5 (5214.75)
	Range: min - max	0 - 859	2379 - 3594	0 – 7398	297 – 10506		
IPAQ-SF PA levels, n (%)	Low PA	15 (71.4%)	—	5 (33.3%)	1 (16.7%)		
	Moderate PA	—	—	9 (60.0%)	0 (0.0%)		
	High PA	—	6 (28.6%)	1 (6.7%)	5 (83.3%)		
Mental health outcomes							
Depression (PHQ-9 total score)	Mean ± SD	9.67 ± 7.41	6.67 ± 5.39	6.73 ± 6.20	6.00 ± 9.47	-2.93 ± 3.86	-0.67 ± 9.58
	Median	10	6.50	6	2.50	-3	-1.5
	Range: min - max	2 – 27	0 – 15	0-25	0-25		
Severity, n (%)	No to Minimal (≤4)	6 (40.0%)	3 (50.0%)	6 (40.0%)	4 (66.7%)		
	Mild (5-9)	1 (6.7%)	2 (33.3%)	5 (33.3%)	1 (16.7%)		
	Moderate (10-14)	4 (26.7%)	0 (0.0%)	3 (20.0%)	0 (0.0%)		
	Moderately Severe (15-19)	3 (20.0%)	1 (16.7%)	0 (0.0%)	0 (0.0%)		
	Severe (20-27)	1 (6.7%)	0 (0.0%)	1 (6.7%)	1 (16.7%)		
	Sub-clinical (PHQ-9 <10)	7 (46.7%)	5 (83.3%)	11 (73.3%)	5 (83.3%)		
	Clinically relevant (PHQ-9 ≥10)	8 (53.3%)	1 (16.7%)	4 (26.7%)	1 (16.7%)		
Anxiety (GAD-7 total score)	Mean ± SD	7.20 ± 6.47	4.00 ± 4.94	5.20 ± 4.41	5.00 ± 6.45	-2.00 ± 4.64	1.00 ± 6.7
	Median	5	2.50	4	2.50	-1	1
	Range: min - max	1– 20	0 - 13	1 - 15	1 - 18		
Severity, n (%)	No to Minimal (≤4)	7 (46.7%)	4 (66.7%)	9 (60.0%)	5 (83.3%)		
	Mild (5-9)	5 (33.3%)	1 (16.7%)	2 (13.3%)	0 (0.0%)		
	Moderate (10-14)	0 (0.0%)	1 (16.7%)	3 (20.0%)	0 (0.0%)		
	Severe (15-21)	3 (20.0%)	0 (0.0%)	1 (6.7%)	1 (16.7%)		

Variable		Wave 1 (T1; April 17-July17, 2020)		Follow-up Interviews (T2; March 18-August 1, 2022)		Difference (T2-T1)	
		Low-PA (*n* = 15)	High-PA (*n* = 6)	Low-PA[b] (*n* = 15)	High-PA [b] (*n* = 6)	Low-PA [b] (*n* = 15)	High-PA[b] (*n* = 6)
	Sub-clinical (GAD-7<10)	12 (80.0%)	5 (83.3%)	11 (73.3%)	5 (83.3%)		
	Clinically relevant (GAD-7 ≥10)	3 (20.0%)	1 (16.7%)	4 (26.7%)	1 (16.7%)		
Loneliness (LS total score)	Mean ± *SD*	47.14 ± 14.63	39.83 ± 15.94	46.07 ± 14.00	39.33 ± 20.00	-1.64 ± 9.54	-0.50 ± 4.51
	Median	43.50	35	47	33	-1.5	-1/5
	Range: min - max	24 - 77	24 - 68	24 - 69	22 - 75		
Top 15% on loneliness (LS total score ≥56) [a], n (%)	Lower loneliness (LS total score <56)	10 (71.4%)	5 (83.3%)	11 (73.3%)	5 (83.3%)		
	Highest level of loneliness	4 (28.6%)	1 (16.7%)	4 (26.7%)	1 (16.7%)		

Note. Changes in outcomes measures of low-PA and high-PA groups are presented at wave 1 and follow-up.

[a] Missing data on loneliness at wave 1 (*n* = 1)

[b] PA levels group membership based on Time 1 data.

PHQ-9, Patient Health Questionnaire 9; GAD-7, Generalised Anxiety Disorder Scale 7; LS, Loneliness Scale; IPAQ-SF, International Physical Activity Questionnaire – Short Form. PA, Physical activity.

Table 18.2

Descriptive of Mental Health Outcomes at Wave 1 and Follow-up

	Depression				Anxiety				Loneliness			
	W1		Follow-up		W1		Follow-up		W1		Follow-up	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	15	6	15	6	15	6	15	6	14	6	15	6
Missing	0	0	0	0	0	0	0	0	1	0	0	0
Mean	9.67	6.67	6.73	6.00	7.20	4.00	5.20	5.00	47.14	39.83	46.07	39.33
SE_{Mean}	1.91	2.20	1.60	3.86	1.67	2.02	1.14	2.63	3.91	6.51	3.61	8.16
SD	7.41	5.39	6.20	9.47	6.47	4.94	4.41	6.45	14.63	15.94	14.00	20.00
Skewness	0.93	0.46	1.90	2.27	1.12	1.49	0.97	2.31	0.22	1.27	-0.14	1.38
$SE_{Skewness}$	0.58	0.85	0.58	0.85	0.58	0.85	0.58	0.85	0.60	0.85	0.58	0.85
Kurtosis	0.39	-0.38	4.90	5.31	-0.06	2.1`	-0.05	5.48	0.10	1.45	-1.08	1.54
$SE_{Kurtosis}$	1.12	1.74	1.12	1.74	1.12	1.74	1.12	1.74	1.15	1.74	1.12	1.74
Shapiro-Wilk	0.887	0.953	0.828	0.667	0.822	0.841	0.865	0.645	0.955	0.897	0.959	0.867
p-value	0.060	0.766	**0.009***	**0.003***	**0.007***	0.134	**0.028***	**0.002***	0.636	0.358	0.674	0.213
Min	2	0	0	0	1	0	1	1	24	24	24	22
Max	27	15	25	25	20	13	15	18	77	68	69	75

Note. W1; measured at wave 1. Follow-up; measured at follow-up interviews. Low or High represent low-PA or high-PA IPAQ-SF measured at wave 1.

Bold = significance at $p < .05$ level.

Table 18.3

Paired t-test/ Wilcoxon Signed Rank Tests to Examine Changes Over Time (N =21)

Variables	W1		Follow-up		*t/T*	*df*	*p*	Cohen's
	M/ Mdn	*SD/ IQR*	*M/ Mdn*	*SD /IQR*				*d/ r*
Depression†	10.00	12.00	6.00	8.00	35.000	-	.028	-0.340
Anxiety†	5.00	7.00	4.00	9.00	82.500	-	.398	-0.130
Loneliness [a]	44.95	15.01	43.65	15.95	0.706	19	.245	0.158

Note. W1; measured at wave 1. Follow-up; measured at follow-up interviews. Depression, measured by PHQ-9; anxiety, measured by GAD-7; and loneliness, measured by LS. M = Mean, Mdn = Median, SD = Standard deviation, IQR = Interquartile range.

[a] Loneliness missing data at wave 1, *n* = 1.

[†] Wilcoxon tests were conducted for depression and anxiety because results from Shapiro-Wilk tests showed that these variables were not normally distributed. Median and interquartile range presented for depressive and anxiety symptoms scores.

*Significance at $p < .05$ level.

Table 18.4

Independent t-tests/ Mann-Whitney U test for Mental Health Outcomes at Wave 1 (N =21)

Variables	Low-PA		High-PA		*t/U*	*df*	*z*	*p*	Cohen's
	M/ Mdn	*SD/ IQR*	*M/ Mdn*	*SD/ IQR*					*d/ r*
Depression	9.67	7.41	6.67	5.39	0.895	19	-	.382	0.432
Anxiety[†]	5.00	7.00	2.50	8.00	28.500	-	-1.290	.205	-0.282
Loneliness [a]	47.14	14.63	39.83	15.94	0.998	18	-	.331	0.487

Note. M = Mean, Mdn = Median, SD = Standard deviation, IQR = Interquartile range.

[a] Loneliness missing data at wave 1, *n* = 1.

[†] A Mann-Whitney test was conducted for anxiety due to a violation of normally distributed data. Median and interquartile range presented for anxiety symptoms scores.

*Significance at $p < .05$ level.

Table 18.5

Independent t-tests/ Mann-Whitney U test for Mental Health Outcomes at Follow-up (N =21)

Variables	Low-PA		High-PA		*t/U*	*df*	*z*	*p*	Cohen's
	M/ Mdn	*SD/ IQR*	*M/ Mdn*	*SD/ IQR*					*d/ r*
Depression†	6.00	8.00	2.50	9.00	31.000	-	-1.095	.302	-0.239
Anxiety†	4.00	9.00	2.50	6.00	40.000	-	-0.393	.733	-0.086
Loneliness	46.07	14.00	39.33	20.00	0.882	19	-	.475	0.426

Note. M = Mean, Mdn = Median, SD = Standard deviation, IQR = Interquartile range.

† Mann-Whitney tests were conducted for anxiety and depression due to a violation of normally distributed data. Median and interquartile range presented for anxiety symptoms and depressive symptoms scores.

*Significance at $p < .05$ level.

Table 18.6

Levene's Test for Equality of Variance

T1-T2	Levene statistic	*p*
Depression	2.448	.137
Anxiety	0.132	.722
Loneliness	1.836	.194

Note. Levene's tests were not statistically significant *(ps* > .05), suggesting equal variances across low-PA and high-PA groups. Depression, measured by PHQ-9; anxiety, measured by GAD-7; and loneliness, measured by LS.

Table 18.7

Means, Standard Deviations, and One-Way ANOVA/ Kruskal-Wallis Tests in Differences in Mental Health Outcomes between Wave 1 (T1) and Follow-up (T2) by PA Groups

Difference (T1-T2)	Low-PA		High-PA		*F/ H*	df_1	df_2	*p*	η^2
	M	*SD*	*M*	*SD*					
Depression†	3.00	4.31	0.67	9.59	0.098	1	-	.755	-
Anxiety†	2.33	4.79	-1.00	6.72	1.119	1	-	.290	-
Loneliness	3.42	9.14	0.50	4.51	0.534	1	16	.476	0.032

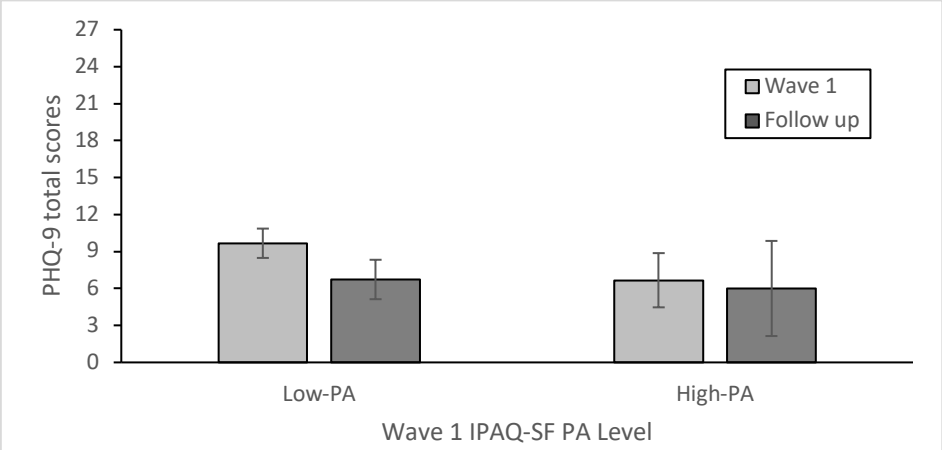
Note. df_1 = degree of freedom between groups. df_2 = degree of freedom with groups. Depression, measured by PHQ-9; anxiety, measured by GAD-7; and loneliness, measured by LS. M = Mean, SD = Standard deviation.

† Kruskal-Wallis H was conduct for depression (low-PA: mean differences in PHQ-9 scores = 11.27, high-PA: mean differences in PHQ-9 scores = 10.33) and anxiety (low-PA: mean differences in GAD-7 scores = 11.90, high-PA: mean differences in GAD-7 scores = 8.75)

*Significance at $p < .05$ level.

Figure 18.1

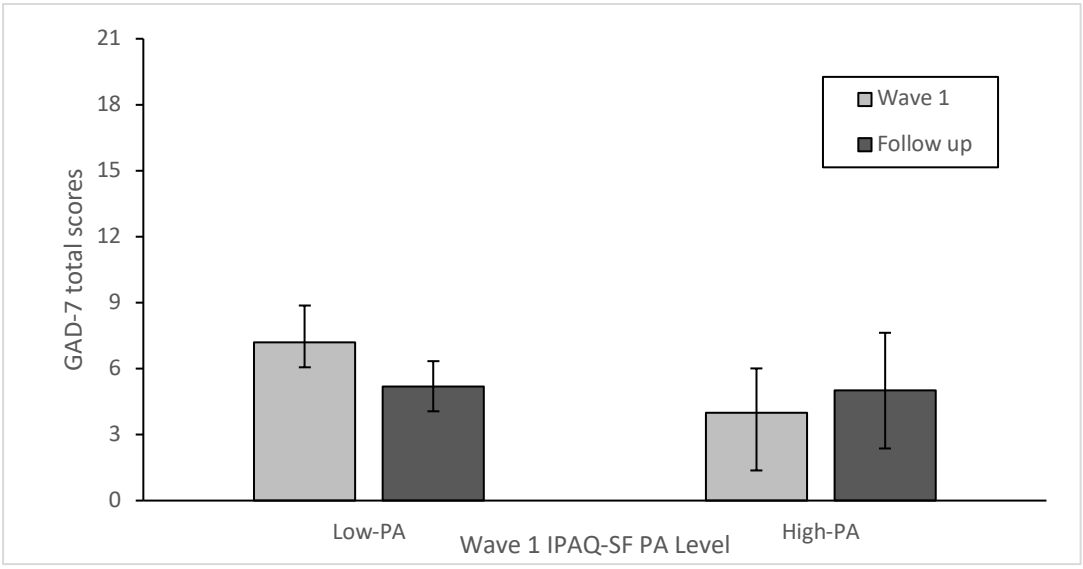
Depression for Low-PA and High-PA Groups at Wave 1(T1; April 17 – July 17, 2020) and Follow-up (T2; March 18 – August 1, 2022)



Note. Depressive symptoms (PHQ-9 scores) of low-PA and high-PA groups at wave 1 and follow-up are presented (error bars show standard errors of means).

Figure 18.2

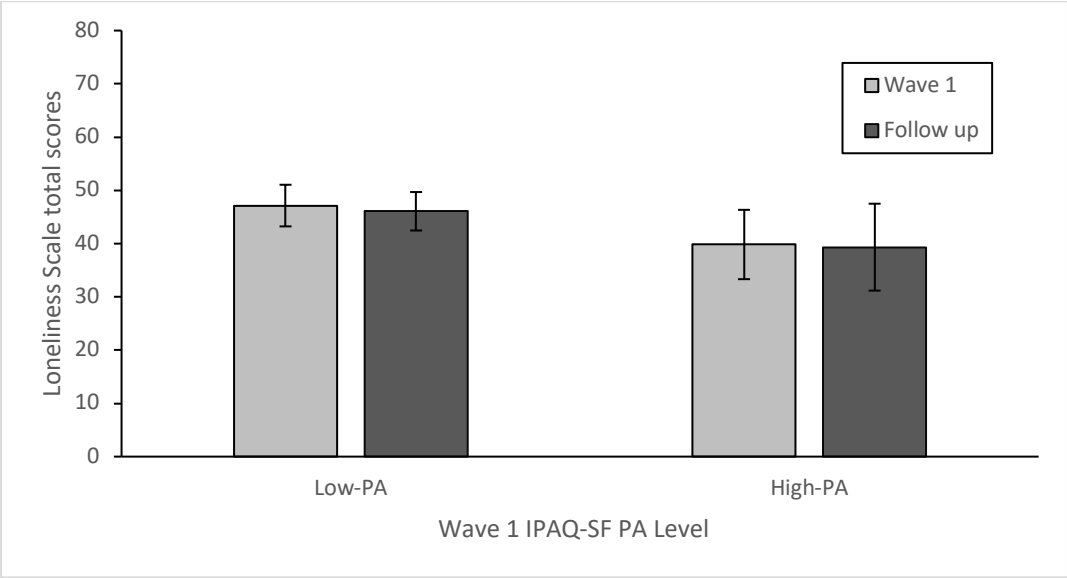
Anxiety for Low-PA and High-PA Groups at Wave 1(T1; April 17 – July 17, 2020) and Follow-up (T2; March 18 – August 1, 2022)



Note. Anxiety symptoms (GAD-7 scores) of low-PA and high-PA groups at wave 1 and follow-up are presented (error bars show standard errors of means).

Figure 18.3

Loneliness for Low-PA and High-PA Groups at Wave 1 (T1; April 17 – July 17, 2020) and Follow-up (T2; March 18 – August 1, 2022)



Note. Levels of loneliness (LS scores) of low-PA and high-PA groups at wave 1 and follow-up are presented (error bars show standard errors of means).

Appendix 19. Further Details on Themes and Example Quotes

Table 19.1

Overarching Theme 1. Challenges for PA Participation during COVID-19

Themes and characteristics	Example quote
The threat of contracting COVID-19 virus	
Fearful responses for themselves and/or their social network associated with a lack of control and feeling vulnerable.	"I was scared of getting it […] the death rates looked very high, it seemed to be spreading quickly [...] I can remember those first few weeks using a dilute solution of bleach when the post came and not touching anything […] And basically, for two years I got very little exercise whatsoever." (P12, age 65)
Ongoing lack of perceived safety in PA and other activities as the pandemic unfolded, and "still" having to be precautious.	"[…] it was the fact that whereas before I might have gone to a lot of exercise classes in big groups with others inside. That no longer felt safe or viable anymore, so that had an impact as well […] definitely pre-pandemic and post-pandemic, my exercise habits are just like night and day." (P08, age 29)
COVID-19 policies – "Groundhog Day"	
Strong sense of (physical) social disconnection caused by COVID-19 policies. Missing physical contact with their social network and opportunities for socialising.	"For example, when I was at my dad's house […] if this happened at any other time, his friends would have been around to help me tidy up…we could have been supporting each other, but because that couldn't happen, I was just there on my own […] it was the isolation there that was more stressful than anything else." (P17, age 54)
Affected daily activities and coping strategies were "taken away", which led to boredom, PA being repetitive and a lack of reward.	"I started to feel complacent because I thought if I can't go outside, what's the point? Like it's not like I'm going to get that same effect to do it […] I think I tried it once walking in the garden like six times so it just wasn't the same as like walking outside […] I thought like, "What's the point if I can't go outside to do it properly?" There's no point doing [it] at home." (P18, age 23)
Heightened awareness of the mind-body connection	
Two main outcomes: Physical and psychological benefits from increasing PA and reduced fitness levels from being less physically active and becoming less confident. More difficult for individuals with long-term physical and/or mental health conditions or long-COVID. Longer-term impacts on people's mental health as the pandemic unfolded.	"I've become unfit. And therefore, I think that puts me off a bit as well because whereas I could walk five miles, now I find I'm puffed out after two. So, it's a bit frustrating, I think." (P21, age 65) "But I started dancing three months ago, and I dance once a week and that's quite aerobic. And I think that's thanks to the three times a week of conditioning my body and being able

Themes and characteristics	Example quote
	to move more. It's actually given me the opportunity to dance, which I've never thought I'd be able to do." (P05, age 46) "[…] I was so fine for most of it and then everything just completely crashed more than it ever has in my life […] the kind of lingering effects but also delayed effects […] I guess it's just a whole other ballgame." (P06, age 38)

Table 19.2

Overarching Theme 2. COVID-19 Recovery Solution: Barriers and Recommendations for Social Prescribing

Themes and characteristics	Example quote
Listen to individuals' concerns, collaborate and provide interventions to address doubts and needs	
Health care professionals to work collaboratively with patients Include: listening to concerns (e.g., SP as insufficient on its own, accessibility issues), increasing motivation, building rapport, enhancing self-efficacy and reducing adherence issues.	"So, I think it's a good idea, but how do you get people to actually engage in that if they don't want to? And how do you get people to engage in that if they don't see the relevance of it?" (P04, age 56)
	"[…] also people they can say something, so it's not only volunteers or people that decide for the community. I mean, is the community that can have ideas." (P19, age 45)
Provide options to increase personal capital through purposeful activities	
Offers should be individualised based on the person's needs, values and interests. Using an "open invitation" approach and offering choices in the local areas.	"[…] that sounds like [it] would've been an ideal thing for me to get involved with at the start of the pandemic, because that would have sort of stopped me from becoming a couch potato if I had known […] groups or things that I could get involved with or just basically get information from." (P14, age 56)
Support individuals to (re)kindle relationships in the community to enhance wellbeing	
SP or community support to reduce loneliness, cultivate social connection, a sense of belonging and community spirit. Linking people to peer support. The need to connect has become of greater significance since COVID-19.	"And this crisis really, really proved it […] of course, you have these very individualistic needs […] just protect yourself first of all, but as a next level […] you want to participate, you want to help. You want to feel useful […] to contribute […] you have to develop new forms in a way to get involved and to feed those needs that you have still as a social animal, and I think it means a lot." (P09, age 39)
Offer diverse social prescribing to meet various needs	
Main barriers to help-seeking or engaging with SP included practical barriers (e.g., cost, transport, disability), social fears (e.g., fear of social interaction, rejection, not knowing what to expect) and concerns about safety of attending group-based activities due to unvaccinated status.	"I think it's important if you're working on projects for people, they want to recover from COVID [pandemic]. That they know what's available in their own area that they could preferably walk to. Or if they can't walk, at least have a short bus ride […] I imagine, [a lot of people] don't have the ability or the resources to go further afield." (P02, age 72)
	"Because I know that people would have been vaccinated. And then I'm entering an

Themes and characteristics	Example quote
	area where I'm not vaccinated, so I could pass something onto them, or they could pass something onto me." (P15, age 58)
Destigmatise mental health and its treatment	
Stigma associated with loneliness and mental health may affect help-seeking/ engagement. Need to reposition the medical/social model. For example, societal changes in understanding mental health and learning that behavioural change (e.g., becoming more active) is more beneficial in the longer term when compared to medications.	"I think there's a lot of people who still got that medical modelling built into them. It's like well, actually, I went to the doctor because I want them to give me a pill to make me better." (P21, age 65) "I think obviously when you are struggling with things like anxiety and depression, it can feel very isolating. And whilst medication can help, you can't just prescribe medication in isolation like that's not effective." (P10, age 24)

Note. SP, Social Prescribing; PA, Physical activity.

Appendix 20. Ad-hoc Analyses

Ad-hoc Analyses of Participants Invited and Responded to Follow-up Study by Sociodemographic Variables (N = 320)

Characteristics	Category	Follow-up Sample (*n* = 21)		Did not follow-up (*n* = 300)		X^2	*p*	*df*	Cramer's V
		n	%	n	%				
Gender‡	Female	17	81.0	233	78.1	—	1.000	—	0.017
	Male	4	19.0	65	21.9				
Age group	18-24	2	9.5	39	13.1	—	—	—	—
	25-34	4	19.0	132	44.4				
	35-44	4	19.0	60	20.2				
	45-54	3	14.3	30	10.1				
	55-64	6	28.6	25	8.4				
	65+	2	9.5	11	3.7				
Ethnicity‡	White	17	81.0	234	79.3	—	1.000	—	0.010
	People of Colour	4	19.0	61	20.7				
Employment status	Employed	10	47.6	154	52.0	2.233	.327	2	0.084
	Unemployed	5	23.8	37	12.5				
	Student	6	28.6	105	35.5				
Marital status	Single/ divorced/ widowed/ separated	8	38.1	143	47.8	0.746	.388	1	0.048
	Married/ civil partnership/ cohabiting	13	61.9	156	52.2				
Education	High school or below/ Associate Degree	2	9.5	52	17.4	0.964	.618	2	0.055
	Bachelor's Degree	6	28.6	70	23.4				
	Graduate Degree	13	61.9	177	59.2				
Annual income (GBP £)	Low (<30k)	13	65.0	96	33.1	9.421	**.009***	2	0.174
	Medium (30-60k)	5	25.0	87	30.0				
	High (>60k)	2	10.0	107	36.9				
Household size‡ (including themselves)	1	5	26.3	44	15.1	—	.198	—	0.074
	2+	14	73.7	247	84.9				

Note. Interpretation of Cramer's V = 0.174, signifying a strong relationship (Cramer's V > 0.05 = weak relationship, > 0.10 as medium, > 0.15 as strong; > 0.25 as strong; Akoglu, 2018). An independent sample t-test was conducted to compare the age of participants who we did not interview to participants who took part in the follow-up study. Age for participants who were interviewed (M = 45.91, SD = 15.55) were significantly older than those who were not interviewed (M = 36.43, SD = 12.61), $t(21.91) = -2.73$, $p = .012$.

‡ Fisher's exact test was used when the count was less than 5.

Bold = significant at the $*p < .05$ level.