




BMJ Open Physical activity and mental health in individuals with multimorbidity during COVID-19: an explanatory sequential mixed-method study

Leire Ambrosio ^{1,2}, James Faulkner,³ Jacqui H Morris ⁴, Beth Stuart ⁵, Danielle Lambrick,¹ Eric Compton,⁶ Mari Carmen Portillo^{1,2}

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For numbered affiliations see end of article.

Correspondence to
Dr Leire Ambrosio;
lag1v19@soton.ac.uk

ABSTRACT

Objective To understand the physical activity and mental health of individuals living with long-term conditions during the COVID-19 pandemic.

Design A sequential explanatory mixed-methods study with two phases: phase 1: quantitative survey and phase 2: qualitative follow-up interviews.

Setting For the quantitative phase, an online survey was launched in March 2021, using Microsoft Forms. For the qualitative phase, in-depth semistructured interviews were conducted via online.

Participants 368 adults over 18 years old living in the UK with at least one long-term condition completed the survey. Interviews were conducted in a subsample of participants from the previous quantitative phase, with 26 people. Data were analysed using thematic analysis.

Results Responses from the survey showed that people with one long-term condition were significantly more physically active and spent less time sitting, than those with two or more conditions, presenting with significantly higher well-being ($p < 0.0001$), and lower levels of anxiety ($p < 0.01$), and depression ($p < 0.0001$). Interviews found that people developed a range of strategies to cope with the impact of changeability and the consequences of their long-term condition on their physical activity.

Conclusions The number of long-term conditions influenced physical activity and how people coped with their condition during COVID-19. Findings will inform policy developments in preparation for future pandemics to support and remain people to remain physically active and mental health.

INTRODUCTION

From the beginning of the COVID-19 pandemic, government-mandated physical distancing/self-isolation/shielding guidelines were implemented to reduce the spread of the virus and the person-to-person transmission.¹ However, it is evident that the government response to the pandemic elicited substantial public health challenges, such as poor lifestyle behaviours (eg, reduced physical activity (PA) increased sitting time),

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is a sequential explanatory mixed-methods study.
- ⇒ A purposeful sampling strategy was used for the quantitative and qualitative phases.
- ⇒ Participants were approached using personal and professional networks.
- ⇒ The sample includes people living with at least one long-term condition in the UK.
- ⇒ As participants were white and largely living with Parkinson's disease, the generalisability of the findings may be limited.

impaired physical and psychological health and higher mortality.² Such effects of the pandemic may be exacerbated in individuals living with one or more long-term conditions (LTCs).^{3,4}

LTCs are defined as chronic conditions for which there is currently no cure but could be managed and/or controlled by medication and/or other therapies, such as diabetes, chronic obstructive pulmonary disease, arthritis and hypertension.⁵ Globally, having at least one LTC is associated with 41 million deaths each year, which is equivalent to 71% of all deaths worldwide.⁶ In the UK, over 15 million people have at least one LTC⁵ accounting for 70% of the country's health and social care expenditure.^{7,8} LTCs can be effectively managed by medication, treatments and/or healthy behaviours.^{7,9} For instance, PA is beneficial for managing LTCs symptoms while improving mental health and well-being.^{10,11}

Studies conducted pre-pandemic¹² involving 22 190 adults demonstrated an inverse association between multimorbidity and levels of PA participation in the youngest and oldest age groups. In addition, both low self-rated health status and functional limitations were related to lower PA in most



of the examined population groups.¹³ In an English nationally representative cohort of people aged ≥ 50 years ($n=15\,688$),¹⁴ compared with the physically inactive group, the OR for multimorbidity was 0.84 (95% CI 0.78 to 0.91) in the mild, 0.61 (95% CI 0.56 to 0.66) in the moderate and 0.45 (95% CI 0.41 to 0.49) in the vigorous PA groups.

Large epidemiological studies suggest that PA is associated with better mental health and resilience to psychological distress, such as depression and anxiety symptoms^{15,16} as PA has anxiolytic and antidepressant effects.¹⁷ When engaging in PA, the human body increases its release of neurochemicals such as dopamine and serotonin. These have been shown to enhance mood and self-esteem, while also decreasing stress tendencies.¹⁸ People who exercise regularly also have a better frame of mind and can improve attention, focus, memory, cognition and decision-making.^{19,20} During COVID-19, individuals who reported decreases in PA^{21,22} experienced poorer mental health compared with individuals who maintained or increased their PA.^{22,23} Mental health was an important parameter to monitor during the COVID-19 pandemic as it was a stressful period in people's life.²⁴ Participation in moderate-to-high volumes of PA was associated with better mental health and well-being, both during and following periods of COVID-19 containment, compared with participation in low volumes of PA.²⁵ When considering people with LTCs, ~18% of these individuals reported a positive change in their exercise behaviour during the early COVID-19 restrictions.²² Increases in PA may have helped mitigate the effects of COVID-19 on this subgroup of 'higher-risk' individuals by boosting immune function, which is essential to control COVID-19²⁶ and counteract prevalent LTCs such as obesity, diabetes, hypertension and vascular conditions.¹¹ However, a substantial proportion of people living with LTCs (~17.3%) also reported a negative change in their exercise behaviour during the COVID-19 pandemic.²² Indeed, a negative change may promote the development and/or progression of many LTCs, which may contribute to poorer outcomes for those who contract COVID-19.²²

The applicability of PA guidelines or recommendations for people living with LTCs during the COVID-19 pandemic was typically to stay at home and shield during the COVID-19 pandemic, without providing any specific guidance on how to become or remain physically active.³ Therefore, given that COVID-19 and future pandemics could affect the physical and psychosocial health of people living with LTCs, it is paramount to understand the barriers and enablers to PA, and the availability and adequacy of resources to support PA participation during periods of restriction (ie, shielding) caused by a pandemic. Understanding what happened to PA and mental health of people living with LTCs during COVID-19 would be beneficial to inform LTC policy development, and to better support people living with LTCs to be physically active during future periods of mobility restriction and/or pandemics.

With improvements in public health and access to good-quality care during non-pandemic periods, people are living longer but frequently with more than one LTC.²⁷ People with multimorbidity, often defined as the coexistence of two or more conditions,²⁸ have greater difficulty in managing their treatments and have poor health outcomes.²⁹⁻³² However, when considering PA data from prepandemic studies, contradictory evidence appears apparent. For example, although research has demonstrated that the absence of chronic conditions was associated with more frequent PA in late life,³³ Hudon *et al*³⁴ found that regardless of the number of chronic conditions an individual may have (from one to five or more chronic conditions), there was no association between multimorbidity and PA levels when long-term limitations on activity, psychological distress, perceived health status, age, sex, education, income and employment were controlled for.³⁴ Despite the interesting findings surrounding PA and mental health during COVID-19 with people with LTC,^{22,25} these previous studies did not allude to what proportion of their sample were actually living with multimorbidity. The effect of multimorbidity on PA and mental health during COVID-19 requires further investigation as the aforementioned associations observed by Faulkner *et al* may be exacerbated in people who live with more than one LTC.

Thus, the aim of this study was to explore the PA and mental health of individuals living with LTCs during the COVID-19 pandemic, and whether there were any differences between people with one LTC and those people with multimorbidity. It was hypothesised that people living with multimorbidity would experience poorer mental health and lower PA than those individuals living with one LTC. A mixed-method approach was chosen to enable broader understanding of peoples' experiences.

METHODS

Design

This was a sequential explanatory mixed-methods study,³⁵ with two phases: phase 1: quantitative survey and phase 2: qualitative follow-up interviews. Both quantitative and qualitative data were collected and analysed separately during the research process and then integrated. Particularly, findings from the qualitative phase were used to explain and provide a more comprehensive contextualisation of findings and interpretations drawn from the quantitative phase.

Phase 1: quantitative survey

Design

An online questionnaire was distributed by email using Microsoft Forms. Data were captured anonymously using closed questions whereby participants were asked to respond to questions that assessed the impact of physical distancing on PA behaviour and mental health, barriers and facilitators to PA participation, and appropriateness of PA resources, in individuals with LTCs.

Participants and sampling

The survey was intended for completion by any adult over 18 years old living in the UK with at least one LTC. There were no geographical restrictions although respondents did indicate their country of residence at the time of survey completion (England, Scotland, Wales and Northern Ireland). Participants were excluded if they were unable to read, understand and answer written questionnaires in English, access a device with an internet connection, provide informed consent and not have a medical-based LTC diagnosis at the time of survey completion.

Participants were approached using personal networks, via online social media engagement (eg, Twitter and Facebook). Likewise, professional networks, such as National and local LTC charitable and voluntary organisations, were also contacted (eg, British Heart Foundation, Stroke Association and Parkinson's UK). LTC organisations who supported participant recruitment approached potential participants via social media and from their email/newsletter distribution list on behalf of the researchers.

A purposeful sampling strategy (non-probability sampling), which included snowball sampling, was launched in March 2021 and continued for 110 days.

Survey development

The survey content was codesigned based on previous research studies in COVID-19 and PA^{22 25} and an iterative design process by members of the research team who were experts in LTCs and PA from the UK, until consensus on a final draft was achieved. The survey included sociodemographic questions such as age, gender, ethnicity and educational level. Data related to LTC including the age of diagnosis, current treatment and surgery for the LTC were collected. In addition, the following validated and short self-reported outcome measures were used:

International Physical Activity Questionnaire (IPAQ-SF) measures the previous week PA (days per week, total minutes per day), regard to walking and moderate and vigorous intensity activities.³⁶ For the IPAQ-SF, results are reported as a continuous variable and in categories (low, moderate or high PA levels). It is a valid ($r=0.67$) and reliable tool ($\rho=0.77-1.00$) and is acceptable for assessing PA in large populations across various age groups (eg, 18–70 years).³⁷

12-Item Short Form Survey (SF-12) to assess the impact of health on individuals' everyday life.³⁸ It is often used as a quality of life measure and it provides a mental and physical component score. The SF-12 comprised the following eight domains: (1) limitations in PAs because of health problems; (2) limitations in social activities because of physical or emotional problems; (3) limitations in usual role activities because of physical health problems; (4) bodily pain; (5) general mental health (psychological distress and well-being); (6) limitations in usual role activities because of emotional problems; (7) vitality (energy and fatigue) and (8) general health perceptions.³⁸ The SF-12 has been validated against the Medical Outcomes Study 36-item Short-form health survey (SF-36) with r^2

values >0.91 for both the physical and mental component summary scores.³⁸

WHO-Five Well-Being Index (WHO-5) to measure subjective well-being.³⁹ It includes the following items: (1) 'I have felt cheerful and in good spirits', (2) 'I have felt calm and relaxed', (3) 'I have felt active and vigorous', (4) 'I woke up feeling fresh and rested' and (5) 'My daily life has been filled with things that interest me'. Each of the five items was scored from 0 to 5. The total raw score was translated into a percentage ranging from 0 (absence of well-being) to 100 (maximal well-being). The WHO-5 is a valid and meaningful measure of general well-being.³⁹

Patient Health Questionnaire-9 (PHQ-9) is a valid and reliable measure of depression severity, with PHQ-9 scores ≥ 10 having a sensitivity and specificity of 88% for major depression.⁴⁰ It is a nine-item questionnaire with a dual-purpose that, with the same nine items, can establish provisional depressive disorder diagnoses as well as grade depressive symptom severity. The PHQ-9 score can range from 0 to 27 since each of the 9 items can be scored from 0 (not at all) to 3 (nearly every day). Scores less than 5 usually signify the absence of a depressive disorder; scores of 5–9 predominantly represented patients with either no depression or subthreshold (ie, other) depression; scores of 10–14 represented a spectrum of patients and scores of 15 or greater usually indicated major depression.⁴¹

Generalised Anxiety Disorder-7 (GAD-7) is a seven-item anxiety scale that has good reliability and strong criterion validity for identifying individuals with generalised anxiety diagnoses.⁴² The GAD-7 scale inquires about symptoms in the past 2 weeks and score ranges from 0 (low anxiety levels) to 21 (high anxiety levels).⁴² A score of 10 or greater represents a reasonable cut point for identifying cases of GAD. Cut points of 5, 10 and 15 might be interpreted as representing mild, moderate and severe levels of anxiety. It is commonly used with PHQ-9 as it is well known for the high comorbidity of anxiety and depressive disorders and the high correlation between depression and anxiety.⁴²

Data collection

Potential participants clicked on the survey link, and they were first taken to the participation information sheet. The participation information sheet acted as an invitation to take part in the study. Contact details of the researcher were included so that individuals could ask any question about the study. Those participants interested in participating gave consent online before moving on. They needed to tick the box for the following statement: 'Please tick (check) this box to indicate that you have read and understood information on this form, are aged 18 or over and agree to take part in this survey'. After giving the consent to participate, the online survey was completed. Data were held within Microsoft Forms and extracted as an Excel file for analysis. Those participants not interested in participating could close the survey and withdraw from the study at any point before submitting the survey (ie, the first page of the survey or last question

of the survey), if they felt they did not want to take part. In those cases, no record of them ever looking at the survey and no information about them was stored. To minimise missing data, all questions in the survey were compulsory. Accordingly, participants who completed all questions and submitted their responses on completion of the survey were included in the sample and proceeding with data analysis.

Data analysis

All quantitative analysis was completed in Stata V.16.0 (StataCorp). Prior to analysis, data distributions were checked for inconsistencies and outliers. Participants were classified as having either one (LTC1) or more than one LTCs (LTC2+). LTCs were presented as a percentage of the total study population, along with the age, sex, ethnicity, living situation and employment status. A series of independent sample t-tests were used to compare total PA (metabolic equivalent of task, MET/min/week) and sitting time, as calculated by the IPAQ-SF, as well as WHO-5, PHQ-9, GAD-7 and SF-12, between those participants classified as having either one or two (or more) LTCs. A multiple linear regression model, adjusting for age, sex, ethnicity, education and duration of LTC was conducted.²² Adjusted mean differences, 95% CIs and p values for each comparison were calculated. Correlations and their 95% CIs were used to assess the association between total PA and sitting time (IPAQ-SF) with WHO-5, PHQ-9, GAD-7 and SF-12 for the whole study population, LTC1 and LTC2+.

Phase 2: qualitative interviews

Design

In-depth semistructured interviews were conducted via online videoconferencing (Teams and ZOOM). In accordance with the sequential explanatory mixed-method approach,³⁵ qualitative interviews were used to expand and explain the quantitative findings from phase 1. In particular, the qualitative data addressed the primary research questions 'What perceived effects did shielding have on the physical and mental health of adults with LTCs living in the UK?' What coping strategies were used by adults with LTCs living in the UK to address the effects of self-isolation/shielding for those?

Participants and sampling

A subsample of participants from the previous quantitative phase was selected. A purposeful sampling strategy (non-probability sampling) was selected since it involves identifying and selecting individuals or groups of individuals who are knowledgeable about or experienced a specific phenomenon, such as the COVID-19 pandemic. A purposeful-maximum variation sampling was used,⁴³ addressing location with areas of deprivation, demographics and LTCs. Interviews were conducted until no new themes were generated from the narratives (data saturation).⁴⁴

Interview development

An interview guide was developed based on a prior literature review³ and the findings of the previous quantitative phase. Experiences of PA as a coping strategy for living with an LTC, barriers and facilitators to PA participation and use and perceptions of online/offline resources for PA at different stages of COVID-19 were explored. For further information on the interview guide, see online supplemental material 1.

Data collection

Participants expressing an interest in contributing to future COVID-19 and PA studies could provide consent at the end of the quantitative survey and provide their email address so the research team could contact them at a later date. Thereafter, and in relation to the qualitative study, those who consented to be contacted were emailed a participant information sheet regarding the qualitative study. If they decided to take part additional consent was obtained and an interview date was arranged. In-depth, audiorecorded, semistructured interviews were conducted by the researcher (LA) between January 2022 and April 2022. The audio recording of each interview was sent to a professional transcription service of the University of Southampton. Those participants indicating, they did not wish to take part in the qualitative phase of the study by answering 'no' and were not contacted. That decision did not affect their clinical care or rights and they did not have to give any reason for declining participation.

Data analysis

Qualitative data were analysed using thematic analysis to explore the content of question responses, identify patterns within data, and describe and interpret their meaning and importance⁴⁵ looking for explanations for the findings from the quantitative phase of the study. The analysis was undertaken by two researchers (LA and JHM). Both researchers read initial transcripts and agreed on a coding strategy. LA coded the remaining transcripts. Both researchers reviewed the codes and grouped them into categories relevant to participant experiences of PA during the COVID-19 pandemic.⁴ Both researchers next collated categories into themes, reviewing and defining them to ensure they provided detailed descriptions of participant experiences and perceptions and their interpretation. Early analysis was inductive and guided by the qualitative research questions but also involved a deductive component guided by the findings from the quantitative phase.⁴ Data were managed in analytical matrices within the Excel field, which also helped integrate qualitative and quantitative findings shown in the discussion section following mixed-methods guidelines.³⁵

Public and patient involvement and engagement

Public and patient involvement and engagement (PPIE) was an essential element throughout all the mixed-methods study. In our study, we facilitated advisory/consultative involvement which is characterised by

involving PPIE representatives at any point of the study to gather a lay perspective on a specific issue or issues, like in this care the study findings. PPIE supported the development of the survey as well as the interview guide. Particularly, four PPIE representatives who were living with more than one LTCs were consulted to gather their feedback in relation to the study findings and future recommendations. This session included the following components: (a) presentation of the research team and the project; (b) explanation of the main findings; (c) discussion about the findings; (d) future steps and dissemination strategy and (e) further collaboration at a later stage in the project. The PPIE event was totally voluntary, online and lasted ~90 min. Our four PPIE representatives were consulted on and contributed to the findings of this study. Our use of a multiplicity of perspectives supported the trustworthiness and rigour of the qualitative data analysis process. We recognised and welcomed the individuality of lived experience through which to refract our data analysis. Our approach endorsed the view that there is not a right or wrong perspective, just different perspectives on lived experience, which enriched the study findings. Based on the PPIE as well as the qualitative findings used to provide a more comprehensive contextualisation of the quantitative findings, a policy brief was developed as shown in online supplemental material 2.

RESULTS

Phase 1: quantitative results

Sample

368 participants (female, $n=192$; 63.1 ± 12.6 years) living with at least one LTC completed the online survey. Participants were generally >50 years of age (85.6% of respondents), retired (59.8%) and of white ethnicity (98.1%). For further sociodemographic characteristic, see table 1. The age, gender and ethnicity of those with LTC1 and those with LTC2+ were similar. Those with LTC2+ were more likely to be living with extended family and more likely to be unable to work due to disability.

A majority of the population identified Parkinson's disease (PD) as their primary LTC (56.3%), with cancer, diabetes mellitus and multiple sclerosis reported as other common LTC's (between 5.1% and 6.8% of participants). Over half (53%) of the participants reported living with more than one LTC, with asthma (5.4%), arthritis (5.2%), hypertension (4.9%) and depression (4.6%) most frequently reported. For further information, see table 2.

PA, mental health and well-being

As demonstrated in table 3, IPAQ-SF category data demonstrated that during the pandemic, people living with LTC1 engaged in more moderate and high-intensity PA compared with those with LTC2+. Particularly, people living with LTC1 were significantly more physically active during this time (mean difference (95% CI); 945 (MET/min/week) (434 to 1455); $p<0.0001$), and per day, spent

less time sitting (-64 min (-107 to -21); $p<0.01$), than those with LTC2+.

Participants with LTC1 presented with significantly higher well-being (WHO-5) results (12.8% (8.3, 17.2); $p<0.0001$) than those living with LTC2+. The GAD-7 (-1.4 (-2.3 to -0.5); $p<0.01$) and PHQ-9 (-3.0 (-4.3 to -1.8); $p<0.0001$) were significantly lower in participants with LTC1 (see table 3). Significant differences were also identified for the SF-12 'physical' subdomain ($p=0.0001$), with people with LTC1 reporting better overall quality of life than people with LTC2+. There were no differences between participants on mental health subdomains (table 3). These relationships were not changed in an adjusted model controlling for age, gender, ethnicity, education and duration of LTCs.

As shown in table 4, WHO-5, PHQ-9, GAD-7 and SF-12 had weak to moderate correlations with PA and sitting time for the total sample ($r=-0.11$ to 0.39). LTC1 ($r=-0.13$ to 0.40) had slightly stronger correlations than LTC2+ ($r=-0.08$ to 0.24) when comparing for all outcome variables with PA and sitting time.

Phase 2: qualitative results

Sample

A total of 26 people living with LTCs were subsampled from the survey in phase 1 and interviewed. 12 were female, and their ages ranged between 38 and 79 years old. 20 participants were from England, 4 were from Scotland and 2 were from Wales. 24 participants had white ethnicity and 2 had Asian or Asian British—Indian ethnicity. 17 participants were retired, and 9 had studied at postgraduate level. Participants were living with different LTCs such as PD, diabetes mellitus type 2, asthma, heart failure or arthritis (table 5).

Identified explanatory themes

The qualitative findings are intended to illustrate the context for the quantitative findings by providing analysis of the consequences pandemic on people living with LTCs and to evaluate the coping strategies used by participants during the pandemic to manage their condition. We describe the findings in an overarching theme, Living with LTCs during the pandemic, which has three subthemes: changeability, consequences of the pandemic and coping during the pandemic.

Findings showed that the precise nature and the consequences of the LTCs experienced by the study participants were diverse and that they used a wide range of coping strategies to manage their condition and its consequences through PA before and during the pandemic, depending on the perceived severity of their condition and the context they were in.

Changeability

The impact of the LTCs on peoples' lives during the pandemic was, for many, characterised by changeability. For some, changeability meant gradual worsening of the condition or conditions, characterised by increased

**Table 1** Sociodemographic characteristics and LTC data of the quantitative sample

	Total sample (n=368) n (%) or X (SD)	LTC1 (n=173)	LTC2+ (n=195)	P value (LTC1 vs LTC2+)
Age (years)	63.1 (12.60)	62.5 (12.43)	63.6 (12.8)	0.400
Age groups				0.874
18–29	4 (1.1%)	2 (1.2%)	2 (1.0%)	
30–39	21 (5.7%)	10 (5.8%)	11 (5.6%)	
40–49	28 (7.6%)	15 (8.7%)	13 (6.7%)	
50–59	70 (19.0%)	37 (21.4%)	33 (16.9%)	
60–69	114 (31.0%)	53 (30.6%)	61 (31.3%)	
70–79	113 (30.7%)	48 (27.8%)	65 (33.3%)	
80+	18 (4.9%)	8 (4.6%)	10 (5.1%)	
Ethnicity				0.329
White	361 (98.1%)	168 (97.1%)	193 (99.0%)	
Asian	5 (1.4%)	4 (2.3%)	1 (0.5%)	
Black	0 (0.0%)			
Mixed groups	2 (0.5%)	1 (0.6%)	1 (0.5%)	
Living situation				0.100
Live alone	65 (17.7%)	32 (18.5%)	33 (16.9%)	
Couple	219 (59.5%)	106 (61.3%)	113 (58.0%)	
Single parent family	4 (1.1%)	0 (0.0%)	4 (2.1%)	
Two parent family	41 (11.1%)	23 (12.3%)	18 (9.2%)	
Extended family—live with other family members	20 (5.4%)	4 (2.3%)	16 (8.2%)	
Flattening or group—live with (mainly unrelated) others in a shared household	2 (0.5%)	1 (0.6%)	1 (0.5%)	
Residential care	1 (0.3%)	0 (0.0%)	1 (0.5%)	
Other	16 (4.4%)	7 (4.1%)	9 (4.6%)	
Employment				0.006
Full time	61 (16.6%)	35 (20.2%)	26 (13.3%)	
Part time	35 (9.5%)	15 (8.7%)	20 (10.3%)	
Unemployed	9 (2.5%)	7 (4.1%)	2 (1.0%)	
Cannot work due to disability	28 (7.6%)	6 (3.5%)	22 (11.3%)	
Retired	220 (59.8%)	106 (61.3%)	114 (58.5%)	
Other	15 (4.1%)	4 (2.3%)	11 (5.6%)	
Currently undergoing treatment	282 (76.6%)	128 (74.0%)	154 (79.0%)	0.259
Sex				0.995
Male	174 (47.3%)	90 (52.0%)	102 (52.3%)	
Female	192 (52.2%)	82 (47.4%)	92 (47.2%)	
Non-binary	2 (0.5%)	1 (0.6%)	1 (0.5%)	

%, percentage; LTC, long-term condition; n, number; SD, Standard deviation.

symptoms and worsening of functioning, that for some was accelerated through the pandemic. Worsening of the condition for people with early onset, or only one condition, was often characterised by slowing and fatigue.

In terms of daily life, I don't think it stops me doing much. I still drive. I maybe get a bit tired sometimes and later on in the day, I maybe have got a wee bit

slower but other than that, I don't think it really impacts me a great deal (P17).

For others, loss of function was more severe, characterised for a few participants by the gradual decline in the ability to walk during the periods of lockdown, requiring a wheelchair for mobility or dependence on spouses for support.

Table 2 Long-term conditions of the quantitative sample

	First condition		Second condition	
	(n)	%	(n)	%
Total sample	368	100	368	100
Asthma	14	3.8	20	5.43
Atrial fibrillation	6	1.63	11	2.99
Cancer	21	5.71	9	2.45
Chronic kidney disease	3	0.82	3	0.82
COPD	4	1.09	4	1.09
Depression	5	1.36	17	4.62
Diabetes mellitus	25	6.79	13	3.53
Epilepsy	5	1.36	2	0.54
Heart failure	9	2.45	6	1.63
Hypertension	6	1.63	18	4.89
Mental health	1	0.27	10	2.72
Obesity	3	0.82	1	0.27
Osteoporosis	2	0.54	9	2.45
Parkinson's disease	207	56.25	5	1.36
Rheumatoid arthritis	10	2.72	19	5.16
Stroke	4	1.09	4	1.09
Other	11	2.99	24	6.52
Vascular	4	1.09	5	1.36
Colon	4	1.09	2	0.54
Skin	1	0.27	1	0.27
MS	19	5.16	0	0
Angina	2	0.54	7	1.9
Thyroid	0	0	5	1.36

%, percentage; COPD, chronic obstructive pulmonary disease; MS, multiple sclerosis; N, number.

I've lost quite a bit of mobility, it's got worse as we go on, but we try to do things that I can still, it's not what I can't do, it's what I can do. We look at it that way with my mobility and getting out and about. I can walk some distance but usually, I want to hold on to something, either my husband, or I have a walker (P20).

For some whose disease was characterised by minimal symptoms that they could ignore or minor symptoms that often fluctuated but which they could manage and live with. This meant sometimes having few symptoms and being able to function and engage in social and PAs and work, and at other times finding these activities more difficult.

Most of the time, no affect, only when there's certain times of the year when I'm more symptomatic if I'm wheezy that day then I'll still push myself, I'll still do what I normally do, but it's just a bit more difficult. I

stay as active as I possibly can because that's very important with any lung condition (P6).

Consequences of the pandemic restrictions

For many with a less severe disease, the changing nature of their ability to participate in usual PA that required exertion beyond activities of daily living, because of the suspension of usual exercise activities, and in some cases seemed to worsen the effects of the disease.

Well, yes, that stopped us, they closed the swimming pool. No, other than as I mentioned, because I wasn't swimming, my arthritic knee got weaker, and I wasn't walking as much and we had to force ourselves to go out. In fact, I bought a walking stick (P11).

Yes, it really affected it, but I did walk because that's all there was. I did want to start doing open water swimming, but the whole COVID thing I found so frightening that I really didn't want to go out if I thought there might be other people (P9).

The value of PA for managing their condition was, however, expressed by most participants, and most reported engaging in PA prior to the pandemic. However, restrictions of the pandemic influenced motivation to be active, leading to a cycle of low motivation and worsening of their general health and condition. For some, this was related to the monotony of lockdown; and for others, it related to the fear of being infected with COVID. For others, fear of catching COVID meant that despite motivation to be active, they were unwilling to risk infection and describe a decisional balance made in which fear of covid outweighs the impacts of not being active.

I mean, I'm trying to get back to physical fitness now and lose the weight I put on in COVID...I think if I could have motivated myself, I could have done a lot more activity because we had the time to do it. Every day is the same and, 'I'll do it tomorrow. Then, tomorrow never comes (P23).

I think the fear of getting COVID is stronger than the fear of the cancer, if that makes sense. I didn't really want to get out the house, I felt safe in my little bubble...I felt secure and looking back, yes, more walking but I was more concerned about getting COVID than anything (P20).

Coping during the pandemic

PA and functioning

Despite restrictions, many participants developed coping strategies to enable them to deal with their condition, during the pandemic, depending on how the condition affected their lives and their ability to function at a given time. For many, PA was a central strategy to control symptoms, improve their mood and well-being, and slow the progression of the condition.

Actually, now I'm walking faster than my husband because he's got problems with his hip! I think from

**Table 3** Measurement results in people with one or more than one LTC

	Total sample	Individuals LTC1	Individuals with LTC2+	P value	Adjusted mean difference (95% CI; p value)
IPAQ-SF (x/SD)					
Total PA (MET/min/week)	2132.7 (2519.82)	2633.4 (2918.00)	1688.8 (2010.59)	0.0003	-705.23 (-1220.07 to -190.40; p=0.007)
Sitting time (min)	437.3 (210.12)	403.5 (187.67)	467.7 (224.12)	0.004	59.68 (17.02 to 102.35; p=0.006)
IPAQ-SF classifications (n/%)					
Low	111 (30.2%)	38 (22.0%)	73 (37.4%)		
Moderate	172 (46.7%)	87 (50.3%)	85 (43.6%)		
High	85 (23.1%)	48 (27.8%)	37 (19.0%)		
WHO-5 score (x/SD)	51.3 (22.46)	58.1 (20.65)	45.3 (22.34)	<0.0001	-11.15 (-15.37 to -6.94; p<0.001)
PHQ-9	8.0 (6.25)	6.4 (5.44)	9.43 (6.59)	<0.0001	2.68 (1.51 to 3.86; p<0.001)
GAD-7	4.6 (4.64)	3.9 (4.07)	5.3 (5.01)	0.004	1.16 (0.27 to 2.05; p=0.011)
SF-12	0.6 (0.10)	0.7 (0.09)	0.6 (0.10)	0.0204	-0.03 (-0.06 to 0.001; p=0.055)
Physical	1.8 (0.80)	1.6 (0.72)	1.9 (0.84)	0.0001	0.27 (0.11 to 0.43; p=0.001)
Mental	3.5 (2.97)	3.6 (3.21)	3.3 (2.73)	p=0.3404	-0.36 (-0.98 to 0.26; p=0.259)

%, percentage; GAD-7, Generalised Anxiety Disorder Assessment; IPAQ-SF, International Physical Activity Questionnaire-Short Form; LTC1, living with one long-term condition; LTC2+, living with two or more long-term conditions; LTC, long-term condition; MET, metabolic equivalent of task; n, number; PA, physical activity; PHQ-9, Patient Health Questionnaire; SF-12, The 12-Item Short Form Health Survey; WHO-5, WHO-Five Well-Being Index.

what you read, all the research on Parkinson's, if you are active physically then it does just keep the disease at bay, really. It doesn't deteriorate as quickly and doesn't affect the quality of your life so that's what I want to do, is to make sure that it doesn't affect the quality of my life (P3).

Where participants saw PA as essential to managing their condition and maintaining their mental health, the activity needed to match their interests and abilities, with enjoyment as a primary motivating factor.

I think as long as I'm exercising, I'm helping myself, so I suppose it's like self-medicating almost. I view exercise as medicine. As long as I'm able to exercise, I've got that positivity that I'm helping myself (P17).

Participants often modified their PA during the pandemic to remain as physically active as possible within the constraints imposed by the condition as it progressed or fluctuated and by the pandemic restrictions. Despite the impact of the restrictions on organised PA, however, many participants with less severe disease found ways to be active within the restrictions posed by lockdown and by their own condition.

It is good to get out of the house, so I don't want to stop exercising, but to the level I want to live, the level I want to exercise, it doesn't really affect. I sort of live within my parameters rather than trying to do things and get frustrated because I can't because of emphysema, or COPD (P2).

Table 4 Correlations between measurements

	IPAQ-SF					
	Total sample		LTC1		LTC2+	
	Total PA (MET/min/week)	Sitting time (min)	Total PA (MET/min/week)	Sitting time (min)	Total PA (MET/min/week)	Sitting time (min)
WHO-5	0.39	-0.28	0.40	-0.14	0.24	0.02
PHQ-9	-0.34	0.34	-0.35	0.19	-0.13	0.19
GAD-7	-0.30	0.25	-0.23	0.15	-0.18	0.17
SF-12	0.22	-0.11	0.25	-0.13	0.15	-0.08

GAD-7, Generalised Anxiety Disorder Assessment; IPAQ-SF, International Physical Activity Questionnaire-Short Form; LTC1, Living with one long-term condition; LTC, long-term condition; LTC2+, living with two or more long-term conditions; PA, physical activity; PHQ-9, Patient Health Questionnaire; SF-12, The 12-Item Short Form Health Survey; WHO-5, WHO-Five Well-Being Index.

Table 5 Sociodemographic characteristics and LTC data of the qualitative sample

		Sample (n=26)
Country	England	20
	Wales	2
	Scotland	4
Local area	Rural area (<2500 habitants)	1
	Semirural area (between 2501 and 10 000 habitants)	11
	Urban (>10 000 habitants)	13
	Other (specify)	1
Gender	Male	14
	Female	12
Ethnicity	White—English, Welsh, Scottish, Northern Irish or British	24
	Asian or Asian British—Indian	2
Highest educational level	College	6
	Secondary school	2
	Undergraduate studies	8
	Apprenticeship	1
	Postgraduate studies	9
Employment status	Full time	3
	Part time	5
	Unable to work due to disability	1
	Retired	17
Number of LTCs	Individuals with one LTC	14
	Individuals with more than one LTC	12

LTC, long-term condition.

It's changed a bit. Instead of going to the gym I would go for a two-and-a-half mile walk, get some cardio workout going to keep the circulation going, etc. That takes time and time is something we don't always have. The weather's not always good for walking either! I started doing walking a bit more when I was, during lockdown, on my own (P22).

Some participants were helped to manage their condition with physiotherapy or pulmonary rehabilitation. Others managed their condition with careful medication regimes that controlled symptoms, creating an interactive strategy between medication and PA. Over time, however, some medications could become less effective, leading to a sequence in which PA became more difficult as the medication became less effective, limiting PA as a coping strategy. When these coping strategies diminished in

effects, this could lead to tension and frustration between what participants wanted to do and what they could do.

I can get very breathless, and I can lose my voice, and so with what's happened, it can make me think that it's an infection or whatever, but anyway, there is no medication for that. It's had to be breathing exercise, respiratory physio from the hospital, that went into online stuff during the pandemic (P26).

PA and mental health

During the pandemic, being unable to exercise through organised, PAs involving social participation often negatively influenced participants' mental health, leading to a cycle of inactivity and worsening mental health for some. Some described a cycle in which their mental health deteriorated if they were not physically active, leading to a loss in motivation to be active because they felt tired and lethargic, which further lowered their sense of well-being and motivation.

I certainly suffered depression throughout the COVID 19 period. There's plenty of things I should have done differently: I should have kept up the exercise, I should have forced myself and my wife to maintain exercise—that's what I should have done—but that was a personal failure. I do regret that, but I just lost hope in the whole exercise (P25).

Others, however, found that being physically active improved their mental health in parallel with their physical health, using PA as a coping mechanism to improve their mood or prevent deterioration in their well-being. Some described a cycle in which their mental health deteriorated if they were not physically active, leading to a loss in motivation to be active because they felt tired and lethargic, which further lowered their sense of well-being and motivation. Being aware of and proactive in using PA to overcome low motivation was very important for most participants during the pandemic.

Yes. I find, if I don't exercise or do something, I get very grumpy, bad tempered—because I'm used to exercising, all my life. So, when I couldn't, it was difficult. If you're not happy, you can go for a very long walk, until you felt better (P4).

I think I didn't have any real problems with my mental health throughout the period. I because I still kept going mainly doing the activities that I was normally doing. If it had completely stopped then probably, yes. I actually found during that period; I was probably a lot happier (P18).

In summary, living with LTCs was characterised by changeability stemming from fluctuations in the condition, sometimes deterioration. Coping strategies involved managing interactions between the condition's status, medication management, PA and motivation.



DISCUSSION

This mixed-methods study has investigated PA and mental health of individuals living with LTCs during the COVID-19 pandemic. The findings of this mixed-method study showed that people living with LTC1 were significantly more physically active, spent less time sitting, presented significantly higher well-being and lower depression and anxiety levels than those with LTC2+ during COVID-19 lockdowns. Qualitative and quantitative data showed that PA is beneficial for mental health and that COVID-19 pandemic was a period during which many people developed coping strategies to be physically active. In particular, the changeability of the LTC was the main contributing influence on PA.

Changeability of LTCs contributing influence on PA

Changeability, as described in our study, is a gradual worsening of the condition, characterised by increases in symptoms and worsening of functioning. In the present study, for many participants, the changeability of the LTC was the main reason to decrease or change their PA routine, and the qualitative findings illustrated how participants used PA to maintain and improve their condition and their mental health. Furthermore, our findings also showed that those with one LTC, instead of multiple LTCs, engaged with more PA and less sitting time. Indeed, people living with multiple LTCs are an important group to consider when designing guidelines or delivering recommendations to encourage PA during period of physical distancing and self-isolating (see online supplemental material 2). Therefore, PA guidelines are not flexible enough for people living with similar LTCs as they have to account for the range of symptoms and signs as well as their changeability.⁴ In this sense, more personalised information on how to remain physically active while shielding at home according to diverse categories of LTCs. For instance, PA guidelines and recommendations posted during COVID-19 pandemic should be developed based on conditions with similar symptoms and signs and stage of the condition, such as respiratory LTCs. Also, simple strategies like breaking up sitting time could be promoted as a safe and accessible option to reduce the negative change in PA routines during the COVID-19 pandemic.⁴⁶ In this sense, different health promotion strategies may be required from the government and policy-makers to draw a more individualised and person-centred plans and refine PA strategies during COVID-19 and future pandemics (see online supplemental material 2). Therefore, supporting people to tailor their PA according to how they manage and cope with their LTC and its changeability is recommended.

PA is associated with better mental health

It is already known that mental health was an important parameter to evaluate during COVID-19 pandemic.²⁴ This study, including the PPIE input, reinforced the findings of previous work,^{10 21–25} noting that overall, PA is correlated with higher well-being and quality of life as well as lower

depression and anxiety. This finding is consistent with those of other authors, showing that physical and social distancing during COVID-19 pandemic was linked with a decrease in PA, resulting in poorer mental health and well-being of general population including those living with LTCs.^{22 25 47} During the COVID-19 pandemic, individuals with LTCs were encouraged to stay at home self-isolating and/or shielding.³ In accordance with earlier COVID-19 research, higher sitting times were correlated with lower well-being and quality of life, and higher levels of depression and anxiety.^{10 21 25} In this sense, future policy should examine how adults living with LTCs could maintain or increase PA during periods of shielding. More concretely, policy recommendations for individuals living with LTCs should be individualised according to the circumstances and needs of each person (see online supplemental material 2). For instance, our findings showed that during COVID-19 pandemic people living with one LTC present lower levels of depression and anxiety than those with LTC2+. Despite these differences, it must be noted that the present study is unable to determine whether such differences were also evident between living with one LTC and LTC2+ before the start of the pandemic, and whether these findings are actually pandemic related or not. Our findings complement previous research from before⁴⁸ and during^{49 50} the pandemic that has shown that people living with LTCs are more likely to experience mental health issues (eg, anxiety, depression) than the general population. The qualitative and quantitative data show that most participants from our study showed that being physically active improved their mental health in parallel with their physical health. In this sense, most participants developed coping strategies, like PA to deal with their LTC in addition to their mental health. This finding could be explained by the fact that people with one LTC (eg, hypertension) were able to function and engage in physical and social activities with less difficulties and with more enjoyment as a motivating factor than those with LTC2+ (eg, PD or cancer). Therefore, changeability and severity of the LTC could be a barrier for PA as pointed before. There is evidence that shows that engaging in PA that is enjoyable, improves health and well-being, and provides continual novel stimulus, will improve engagement and adherence over time.^{51–53} In this sense, our findings have clearly showed that PA is essential to manage LTCs and maintaining the mental health in an enjoyable way. Therefore, once again our findings demonstrated that ‘one-size-fits-all’ is not working and more individualised PA guidelines according to the person and each LTC are needed.

Integration of healthcare and PA

According to our findings, the reduction of PA due to COVID-19 pandemic, led to the worsening of many LTCs. To face this situation, some participants reported medication and physiotherapy to be important in helping to manage the LTCs during the COVID-19 pandemic. Some participants created a strategy between medication,

physiotherapy and PA to better manage their condition during the lockdown. These findings are aligned with previous works in the LTCs field^{54 55} where the inclusion of physiotherapist and occupational therapist to support the person with LTCs has been proposed. Role collaborations between primary healthcare services and non-medical health professionals has been proposed as a way to answer the needs of people living with one or more than one LTCs.^{54 55} Currently, this is a challenge that National Health Service as well as other healthcare systems all over the world are facing to address the complex needs of LTCs population. Therefore, the inclusion of medical and non-medical healthcare professionals when developing PA guidelines or recommendations for those living with LTCs is paramount, as is drawing on the successful coping experiences of people with lived experience (see online supplemental material 2). Stakeholder coproduction will be needed to address the challenge of how to incorporate these into the personalised management of LTCs, weaken the social norms associated with the elderly, and strengthen the idea that PA and independent self-care go hand in hand. This approach will, in turn, strengthen responses to imposed restrictions, should there be another pandemic.

Strengths and limitations

There are limitations and strengths to this work that should be considered. One limitation is associated with the high proportion of respondents who had PD (>50%). The underlying reason for this lies on the key role of Parkinson's UK disseminating the survey. Therefore, the survey results and interpretation are skewed by PD participants and consequently, results are not generalisable to people living with other LTCs like diabetes mellitus, epilepsy or heart failure, for example. Similarly, another limitation is that a large majority of respondents in this study were white living in England. Therefore, the findings are not as representative of people living with LTCs in the other home nations (eg, Scotland, Wales or Northern Ireland) and/or other ethnic minority groups, such as black or Asian. Finally, a further limitation is that our findings may not be attributed exclusively to the COVID-19 pandemic because we did not have prepandemic data as a comparator. Future studies are recommended to compare prepandemic and postpandemic results and identify which of the findings are attributed to COVID-19 pandemic. Accordingly, there needs to be some caution when interpreting some of the findings as differences between LTC and LTC2+ may have been observed between groups prior to the pandemic. The main strengths to the study include the sample size when considering the challenge of recruiting people with LTCs during COVID-19 lockdown, the mixed-method design, as well as the speed with which the survey was disseminated through social media, ensuring a population response that was captured during the pandemic.

CONCLUSIONS

During COVID-19 pandemic, individuals with LTC2+ reported less PA and poorer mental health and well-being, than those with one LTC. Nevertheless, the qualitative research showed the range of coping strategies deployed by people with LTCs to remain physically active while living with their conditions. These findings have important implications for policy and guidelines development, particularly for those living with multiple LTCs. Therefore, the findings of this study support the development of person-centred policy recommendations to support and sustain individuals living with LTCs during and after COVID-19 or other pandemics.

Author affiliations

¹School of Health Sciences, University of Southampton, Southampton, UK

²National Institute for Health and Care Research, Applied Research Collaboration Wessex, Southampton, UK

³Department of Sport, Exercise and Health, University of Winchester, Winchester, UK

⁴School of Health Sciences, University of Dundee, Dundee, UK

⁵Wolfson Institute of Population Health, Queen Mary University of London, London, UK

⁶Person with long term conditions, Public and patient Involvement, Southampton, UK

X Jacqui H Morris @jacquimorris11

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ORCID iDs

Leire Ambrosio <http://orcid.org/0000-0002-9450-7210>

Jacqui H Morris <http://orcid.org/0000-0002-9130-686X>

Beth Stuart <http://orcid.org/0000-0001-5432-7437>

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