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Original Article

The impact of Covid-19 on lifestyle and dietary habits during and after lockdown in people with neurological conditions, and their perceptions of how these changes have impacted their physical and mental health: A cross-sectional survey study

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SUMMARY

Introduction: Research has shown that the Covid-19 pandemic may have had negative effects on lifestyle factors of people in the UK, however research is limited in terms of the impact on people living with neurological conditions such as Multiple Sclerosis (MS), Parkinson's (PD) and spinal cord injury (SCI). This study explores the impact that the pandemic had on mental health and lifestyle factors such as dietary habits, supplement use and exercise in those with MS, PD and SCI.

Methods: A cross-sectional, online, questionnaire study was carried out on a cohort of 134 people in the United Kingdom during the Covid-19 pandemic. Participants completed the questionnaire between June 2021–February 2022. Eligibility criteria included being over the age of 18 years, and declaring having been formally diagnosed with either MS (n=27, female=81%), PD (n=84, female=35%), SCI (n=23, female=61%).

Results: 33% of participants reported an increased consumption of alcohol and 29% a decreased consumption of fruit and vegetables. However, 64% of participants reported no change in diet ($p < 0.001$). Vitamin D, multivitamin/minerals, probiotic and fish oil

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were the most commonly consumed supplements by participants. Although intake of any supplement was not significantly impacted by Covid-19 for the total cohort, by condition, and by sex, a generalised linear mixed model indicated SCI participants consumed more supplement types during Covid-19 than before (OR:1.98; 95% CI [1.04, 3.77]). Additionally, 29% of participants reported they contacted their families less than pre-pandemic (p=0.001), and 60% reported they experienced more fatigue since the pandemic. Open-ended questions added quality context to the categorical data.

Conclusion: This study suggests that the impact Covid-19 has had on people with neurological conditions is complex and individual, yet the negative effects may be more pronounced than the general public. Overall, there were changes in lifestyle behaviours, some which may be detrimental to health and life quality in these already vulnerable groups. Therefore, these changes need to be considered in the aftermath of the pandemic.

Introduction

In the United Kingdom, during the coronavirus-19 (Covid-19) pandemic, legal restrictions in the first lockdown were initiated including leaving the house only for essential work, 30 minutes of exercise and/or seeking essential goods/services. People with neurological conditions are considered a vulnerable group and were advised to shield during the UK pandemic until the 1st of May 2020 [1,2]. This period may have been longer for some who were categorised as extremely vulnerable, due to neurological-associated breathing problems [3]. Further to the additional risk, the lockdowns may have had other lifestyle implications for people with neurological conditions, such as lack of access to necessary care, medications and/or activities that improve health and wellbeing, such as physiotherapy, general physical activity, and access to foods [4]. Since the first set of guidelines were released, lockdown restrictions continued to change, and the extent of impact this may have had on such individuals' lifestyle, specifically dietary, supplement and/or physical activity habits, is unknown. Due to the untreatable nature of neurological conditions, diet and physical activity are considered key to ease condition-specific symptoms and to improve quality of life. Understanding whether any changes to these factors have occurred, and are continuing to occur, will allow pre-emptive insight into treatment advice, and guide research, moving forward. Conditions such as Parkinson's (PD), Multiple Sclerosis (MS) and Spinal Cord Injury (SCI) are long-term incurable conditions, and people with any of these neurological conditions may have been impacted significantly by the pandemic.

To date, research on the pandemic has assessed dietary and physical activity changes in the general population. Balanzá-Martínez *et al.* [5] indicated that 93.6% of participants reported a decline in outdoor time and 70.3% a decline in physical activity. In turn, it was reported people felt they had poorer health as well as higher levels of depression and anxiety. Similarly, Robinson *et al.* [6] assessed weight related behaviours and barriers in n=2002 UK adults during the pandemic and concluded three main barriers in weight management: difficulties in accessing healthy food, lack of healthy eating motivation and control, and lack of social support [6]. Of the sample, 56% reported snacking more frequently and 40% reported being less physically active, whilst 45% stated they have been more physically active; of those who had become less physically active the majority were reported as having a high-risk condition, including those that are neurological [6]. It has been shown that reduced time outside, alongside a declined level of physical activity and a negative dietary pattern, can be detrimental to overall mental

health, and therefore it can be hypothesised that people with neurological conditions may have suffered from this during, and after, the pandemic.

In addition, Covid-19 caused disruption of health care services worldwide and has limited the ability of patients with a range of neurological conditions to receive adequate care. This has led to mitigation strategies such as self-care, which is defined by the World Health Organization (WHO) as "the ability of individuals, families and communities to promote health, prevent disease, maintain health, and cope with illness and disability with or without the support of a health-care provider" [7,8]. One aspect of self-care behaviour that has increased during Covid-19 is the use of supplements, as indicated by the increase of supplement sales during Covid-19 for the general population [9]. Supplementation is especially relevant to people with neurological conditions, as it has been reported that a range of supplements (vitamins/minerals, botanicals, etc.) provide health benefits for neurological disorders [10]. However, during Covid-19 there were mixed messages about the benefits of supplementation, especially regarding immune modulation [11]. At this time, it remains unclear how those with neurological conditions altered their self-care behaviours, particularly diet, exercise and supplementation, during Covid-19. As different neurological conditions require different treatment strategies, information about these behaviours could help health practitioners better understand any risks or benefits these behaviours provide.

Survey research has been used to assess lifestyle in those with neurological conditions [12], however limited research has been carried out in light of Covid-19. The impact of the pandemic is far from over, especially in vulnerable groups who may continue to withdraw from social or 'normal' activity. In addition, the impacts of the pandemic on these participant groups could have long lasting effects on the NHS and may contribute to ongoing health consequences, even after the pandemic has ceased. Therefore, the primary aim of this research was to explore the perception of people with neurological conditions (MS, PD, and SCI) regarding changes in lifestyle, self-care, and dietary habits during and in the aftermath of Covid-19 lockdowns, to understand the impacts on health in these vulnerable groups. In addition, we qualitatively explored the barriers and facilitators to maintaining a healthy diet during the pandemic in this particular sample. This study presents the implications of Covid-19 in a descriptive manner.

Methods

Study design and participants

A cross-sectional study on the following neurological conditions: MS, PD, SCI, was carried out by questionnaire in the UK, during the Covid-19 pandemic. The study aimed to recruit between June 2021–February 2022 and due to the novel nature of Covid-19 and the implications surrounding this responsive research, a convenience sample was used. Eligibility criteria included being over the age of 18 years, and declaring having been formally diagnosed with either MS, PD, or SCI (all sub-types). Participants were recruited from relevant societies, social media, and support groups (local MS, PD and SCI support groups throughout the Thames Valley, targeted groups on Facebook, Twitter and Instagram, and through previous participant lists of those who consented to being contacted for future research studies). The study was voluntary, and no payments or incentives were offered. Ethical approval was granted from Oxford Brookes University Research Ethics Committee (UREC) registration number: 201437.

Questionnaire

All data were collected by an online questionnaire, using the survey software QualtricsXM UK, using adapted versions of validated questionnaires, which included a total of 39 questions, including eight free text and 31 multiple choice questions. All data were self-reported. The questionnaire was separated into six sections: demographics, diet habit, supplementation, physical activity, mental wellbeing, and healthcare access-related questions. The questionnaire was piloted by five relevant volunteers prior to data collection (including those with a BSc degree minimum in a nutrition science subject or

people with MS, PD or SCI who have previously been patient and public involvement members (PPI) in previous studies by our research team). The pilot sample provided feedback, based on Sørensen et al. [13], and feedback was taken into consideration and the final questionnaire was edited appropriately.

Demographics

Demographic data were self-reported, including sex (at birth), condition, year of diagnosis, age (years), and medication/s.

Diet habits

Diet habits were assessed in both a qualitative and quantitative manner. Participants were asked to rate the healthiness of their diet since the Covid-19 lockdowns on a four-point Likert-scale; from 'more healthy', 'the same as before Covid-19', 'less healthy', to 'I do not know'. They were then asked whether they had 'increased consumption', 'the same as before Covid-19', 'decreased consumption', or 'I do not eat/drink this' for the following food groups: fruit and vegetables, sugary foods/soft drinks, microwave meals, processed foods, low fat milk and dairy products, high fat milk and dairy products, whole grains, refined grains, lean low fat milk and poultry, and alcohol [14]. Participants were also asked open-ended questions to assess the following: whether they had sought dietary advice since Covid-19, and which, if any, sources were used; whether they faced any obstacles if attempting to consume a healthy diet; and whether they found any factors that helped them consume a healthy diet since Covid-19.

Supplements

Supplement intake was assessed retrospectively (3–4 months pre-Covid-19) and during the pandemic. A full list of supplements (vitamins/minerals, botanicals etc.) assessed can be found in supplementary Table 1. Supplement selection was based on two surveys as per Mischley *et al.* [15] and Bastyr University [16].

Physical activity

Changes in physical activity were assessed by a four-point scale: from "I do not exercise", "less", "the same as before Covid-19", and "more". Participants were also asked whether lockdown prevented them from participating in their usual activities or sports and asked to specify which activities these were.

Lifestyle, physical and mental health

Regarding lifestyle, changes in time outside, sleep, and contact with family and friends were assessed. Regarding mood, participants were asked if they felt depressed, anxious, angry, hostile, or fatigued. Questions were phrased to assess change since before the pandemic; by use of the four-point scale previously described In addition, participants were asked to report their stress level using a 6-point Likert Scale.

Healthcare access

Participants were asked (yes/no/I do not know) whether they felt they had support from their doctors and other health care professionals during this time, and if they had any appointments cancelled or rescheduled. Their opinion on the matter was also sought, in a qualitative manner.

Statistical analyses

SPSS was used throughout the quantitative analysis (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 26.0. IBM Corp.). All tests were 2-tailed, with $p<0.05$ considered statistically significant. For the quantitative assessment of Diet Habit (excluding supplements), Lifestyle Factors,

and Mood (Mental Wellbeing), frequency of responses in the total cohort was assessed by Chi-Squared Goodness of Fit and frequency of responses between cohorts was assessed by Chi-Squared Test of Association (or Fisher's Exact with cell counts of <5), with Bonferroni corrections applied where relevant. All variables were assessed in the total cohort, then associations were assessed by condition (MS, PD, SCI), and lastly the cohort was stratified by biological sex.

For analysis of supplement used, the total percentage of participants consuming any of the supplements per cohort was assessed before and during the pandemic by Chi-Squared of Association Test. The total number of types of supplements consumed per participant was evaluated using a generalised linear mixed model (GLMM) with fixed effects for sex, age, condition, time and the interaction between time and condition using R software version 4.30. A forest plot of the odds ratio with 95% confidence intervals was created with each predictor in the GLMM.

Qualitative analysis was used to analyse the open-ended responses descriptively and thematically.

Results

Demographics

A total of 134 participants completed the questionnaire; 84 people with PD, 27 people with MS, and 23 people with SCI. Participant characteristics can be found in Table 1.

Reported change to diet

When participants were asked whether or not the healthiness of their diet changed since Covid-19, the frequency of responses was not equal across response options for the total cohort ($p<0.001$), 17% reported they ate less healthily, 18% reported they ate more healthily, with the rest (65%) reporting no change in diet Figure 1).

Condition type was associated with reported healthiness of diet change ($p<0.05$). More participants with PD reported their diet remained the same ($n = 65$, 78%, $p <0.001$; Figure 1).

When the cohort was stratified by sex no associations were found.

The same pattern was seen in the total cohort with individual diet components, for both healthy food groups (Figure 2A) and unhealthy food groups (Figure 2B); the majority of participants reported no change ($p<0.001$). The two largest unhealthy changes reported were an increased consumption of alcohol ($n = 34$, 33%) and a decreased consumption of fruit and vegetables ($n = 37$, 29%).

Condition type was associated with differences in processed foods ($p<0.05$) and refined grains ($p<0.05$). Specifically, MS was associated with an increased consumption of processed foods ($p <0.001$), and an increased consumption of refined grains ($p <0.001$). All results can be found in Tables 2A and B.

When the cohort was stratified by sex no associations were found.

The open-ended questions provided some insight into the challenges with maintaining a healthy diet. A number of obstacles were reported across the participant groups. The presence of health-related conditions were mentioned as a barrier to consuming healthy food by four participants (1 PD, 3 SCI).

> *'Reflux & stomach issues - think I developed an ulcer. Ate a lot less during [the] first few months & tried to remove acidic foods.'* - Female, 30, SCI

Table 1
Demographics for the total cohort, by condition and sex

	Total	PD	MS	SCI	Male	Female
	(n =134)	(n = 84)	(n = 27)	(n = 23)		
Male n (%)	70 (52)	55 (65)	5 (19)	9 (39)	–	–
Female n (%)	64 (48)	29 (35)	21 (81)	14 (61)	–	–
Age (years ± SD)	63 ± 16	70 ± 11	55 ± 14	45 ± 18	67 ± 14	59 ± 16
Year of diagnosis ± SD	2011 ± 11	2012 ± 11	2004 ± 11	2009 ± 11	2012 ± 13	2009 ± 9

PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury, SD; Standard Deviation.

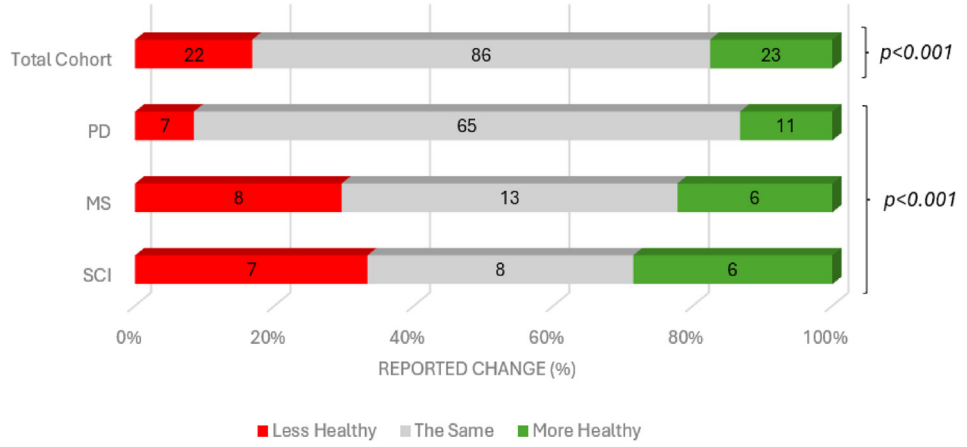

Figure 1. Reported change (%) of responses to overall dietary change Participant number is displayed on figure bars per response category, PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury. *Chi-Squared Goodness of Fit Test was used to assess the total cohort ($p<0.001$) *Fishers Exact Test was used to compare conditions (PD, MS, and SCI; $p<0.001$).

> *'Progression of my diagnosis [of] PD.'* - Female, 71, PD

Knowledge of maintaining a healthy diet was expressed as a barrier in one participant (PD) whilst access to healthy food (13 participants, 6 MS, 5 PD, 2 SCI) and food availability (5 MS, 14 PD, 1 SCI) were also two key barriers to eating healthy during the pandemic.

> *'I barely eat. One meal a day with family (lunch) due to a myriad of reasons like gastroparesis and lower oesophageal ulcer. But if anything less energy and harder to secure food outside that 1 meal a day at home.'* - Male, 28, MS
>
> *'Reduced access to supermarkets as [I was] shielding.'* - Female, 41, SCI
>
> *'Having to rely on supermarket deliveries rather than going to shops/supermarkets and choosing the things we wanted. It was the fresh food items that we found were most likely to be substituted for other items.'* - Male, 79, PD.
>
> *'Only making one visit per week to a supermarket made it more difficult to buy fresh food / fruit / vegetables.'* - Female, 64, SCI

Access to food was seen as a facilitator by 15 participants (13 PD, 2 SCI), as was the opportunity for healthy food in 17 participants (5 MS, 11 PD, 1 SCI).

> '*Online shopping and home delivery.*' - Male, SCI, 78
>
> *'Not going to shops and being tempted.'* - Female, MS, 74
>
> *'I moved away from the major supermarkets as I couldn't get any delivery slots and moved to smaller suppliers. This has been a revelation. I buy organic fruit and veg, fish from Cornwall, wholefoods, make my own bread with organic flour, cheese from a cheese maker, organic meat.'* - Female, PD, 78

More time to cook during the pandemic was seen as a facilitator for 13 participants (2 MS, 5 PD, 6 SCI) to eating healthy during the pandemic.

> *'More time, due to lockdown, for preparing fresh food, therefore less microwave meals / processed foods.'* - Female, SCI, 64

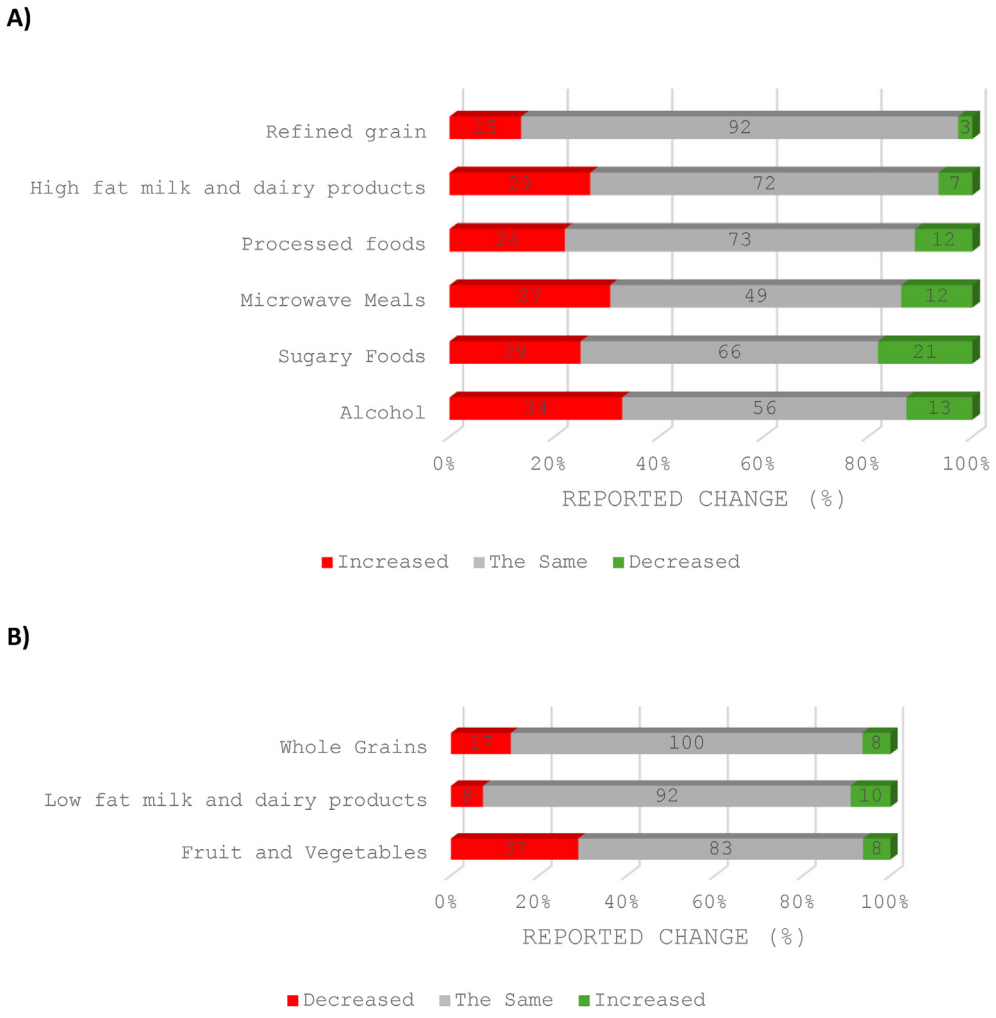

Figure 2. A) Reported change (%) in unhealthy diet categories, **B)** Reported change (%) in healthy diet categories, both figures represent the total cohort. In all food groups the majority of participants reported no change ($p<0.001$). Chi-Squared Goodness of Fit Test was used were appropriate.

'*Less time at work, more time to cook*.' - Male, MS, 28

Some participants reported multiple barriers to eating a healthy diet (2 MS, 2 SCI), and a high number of participants also reported no barriers 57 participants (10 MS, 45 PD, 5 SCI).

As with barriers, some participants reported multiple facilitators to eating a healthy diet., (3 MS, 6 PD), and a high number of participants also reported no barriers (2 MS, 6 PD, 2 SCI).

Supplements

No significant differences were found between the percentage of participants that consumed any type of supplement before and during Covid-19 for the total cohort, by condition, and by sex (Table 3). However, the percentage of participants consuming any type of supplement during Covid-19 with MS or for the cohort as a whole tended to decrease slightly, whereas those participants with PD or SCI

Table 2A
Percentage distribution of responses to change in unhealthy diet components by condition

	Condition	PD		MS		SCI	
		% Within disease	Adjusted residual	% Within disease	Adjusted residual	% Within disease	Adjusted residual
Refined Grain	Decrease	11.4	-0.9	23.8	1.5	10.5	-0.4
	The Same	88.6	1.9	61.9*	-3.0	89.5	0.8
	Increase	0.0	-2.3	14.3*	3.6	0.0	-0.8
High Fat Milk and Dairy	Decrease	26.5	-0.1	37.5	1.3	1.9	-1.4
	The Same	67.6	0.3	54.2	-1.5	12.0	1.3
	Increase	5.9	-0.3	8.3	0.4	0.9	0
Processed Foods	Decrease	19.4	-0.8	18.2	-0.5	35.0	1.6
	The Same	74.6	2.1	50.0	-1.9	60.0	-0.7
	Increase	6.0	-2.1	31.8*	3.5	5.0	-1.0
Microwave Meals	Decrease	25.0	-1.7	35.3	0.5	54.5	1.8
	The Same	60.0	1.2	47.1	-0.8	45.5	-0.7
	Increase	15.0	0.5	17.6	0.5	0.0	-1.4
Sugar Foods and Soft Drinks	Decrease	28.8	1.2	26.1	0.1	10.0	-1.7
	The Same	57.5	0.2	43.5	-1.5	70.0	1.3
	Increase	13.7	-1.6	30.4	1.7	20.0	0.2
Alcohol	Decrease	33.8	0.2	30.0	-0.3	33.3	0
	The Same	58.8	1.3	55.0	0.1	33.3	-1.8
	Increase	7.40	-2.2	15.0	0.4	33.3	2.6

Table 2B
Percentage distribution of responses to change in healthy diet components by condition

	Condition	PD		MS		SCI	
		% Within disease	Adjusted residual	% Within disease	Adjusted residual	% Within disease	Adjusted residual
Whole Grain	Decrease	3.80%	-1.5	8.00%	0.4	13.60%	1.5
	The Same	83.30%	1.2	80.00%	0	68.20%	-1.5
	Increase	12.80%	-0.3	12.00%	-0.3	18.20%	0.7
Low Fat Milk and Dairy	Decrease	8.20%	-0.4	9.50%	0.1	12.50%	0.5
	The Same	87.70%	1.6	71.40%	-1.7	81.30%	-0.3
	Increase	4.10%	-1.8	19.00%	2.3	6.30%	-0.2
Fruit and Veg	Decrease	6.20%	0	8.00%	0.4	4.50%	-0.4
	The Same	66.70%	0.6	64.00%	-0.1	59.10%	-0.6
	Increase	27.20%	-0.6	28.00%	-0.1	36.40%	0.8

PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury. Chi-Squared Test or Fisher's Exact used where appropriate. Bonferroni correction is applied, therefore results are considered significant if <0.005.

tended to increase slightly. Similar non-significant effects were found for the percentage of participants consuming specific supplements. Overall, the most commonly consumed supplements before vs. during Covid-19 were vitamin D (35.8% vs 37.3%), multivitamin/minerals (12.1% vs. 13.4%) probiotics (13.4% vs 11.9%) and fish oil (13.4% vs 11.2%) (Supplement Figure A and B). Similar results were found for each type of neurological condition, with the exception of SCI. In this case vitamin C was the second

Table 3
Impact of Covid-19 on percentage of participants consuming any of the supplements

Any supplement n (%)	Before Covid-19	During Covid-19	*p*-value
PD	43 (49.4)	44 (50.6)	0.8773
MS	23 (85.2)	19 (70.4)	0.1904
SCI	16 (69.6)	17 (73.9)	0.7433
Overall	82 (61.2)	80 (59.7)	0.8027

PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury.

most commonly consumed supplement during Covid-19 (21.7%) and multivitamin/mineral supplements were the second most commonly consumed supplement before Covid-19 (17.4%).

The output of a generalised linear mixed model evaluating the number of different types of supplements participants consumed, is shown in Figure 3. It was found that the proportion of different types supplements consumed was slightly reduced in men compared to women, but this was not significant (OR = 0.72; 95% CI [0.43, 1.22]). As participants aged there was a slight non-significant reduction in the number of supplements consumed (OR = 0.98; 95% CI [0.96, 1.0]. For MS participants, the number of supplements slightly decreased during Covid-19 compared to before, although this was also not significant (OR=0.74 95% CI [0.50, 1.10]). Covid-19 had minimal effects on the number of supplements consumed for participants with PD (OR=1.16; 95% CI [0.705, 1.91]). The only significant findings in this analysis indicated that participants with SCI consumed a lower number of supplements compared to participants with MS (OR=0.36; 95% CI [0.16, 0.82]) and that SCI participants consumed a greater number of supplements during Covid-19 than before (OR:1.98; 95% CI [1.04, 3.77]).

Lifestyle factors

Overall, it is important to note here that, more participants reported changes (both positive and negative, 62%) when compared to remaining the same (38%). Distribution of responses differed for time spent exercising, time sleeping, and time spent contacting family and friends ($p<0.05$). Specifically, fewer participants reported they participated in more physical activity ($p<0.05$). The largest percentage of participants reported their sleep remained the same (p $p<0.05$) and they contacted friends the same ($p<0.05$). The largest percentage of participants reported they contacted family less ($p<0.001$; Figure 4).

Condition type was associated with differences in reported frequency in contacting friends ($p<0.05$). Fewer participants with MS reported an increased frequency of contacting friends when compared to the other conditions ($p<0.05$; Table 4).

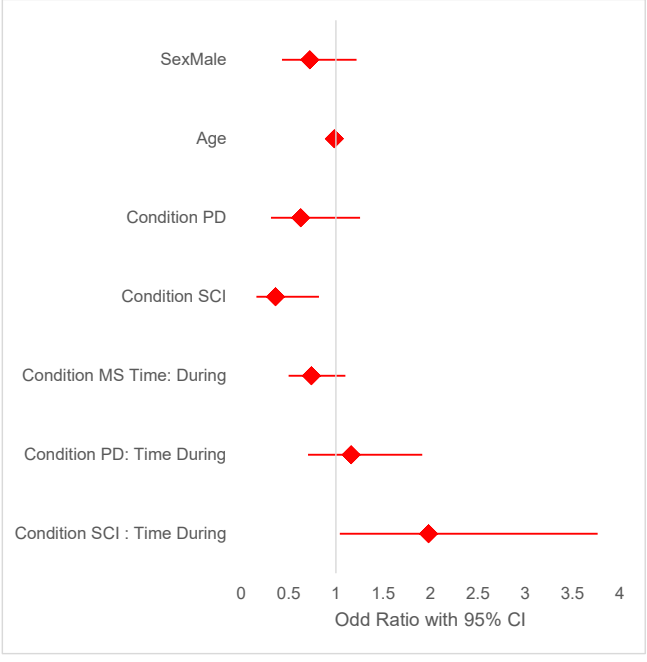

Figure 3. Forest plot of odds ratio with 95% confidence intervals (CI) for each predictor in the generalized linear mixed model showing the effects on the proportion of supplements participants consumed for sex (male vs female), age (continuous variable) conditions (vs condition MS) and time durations (vs Before COVID-19). PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury.

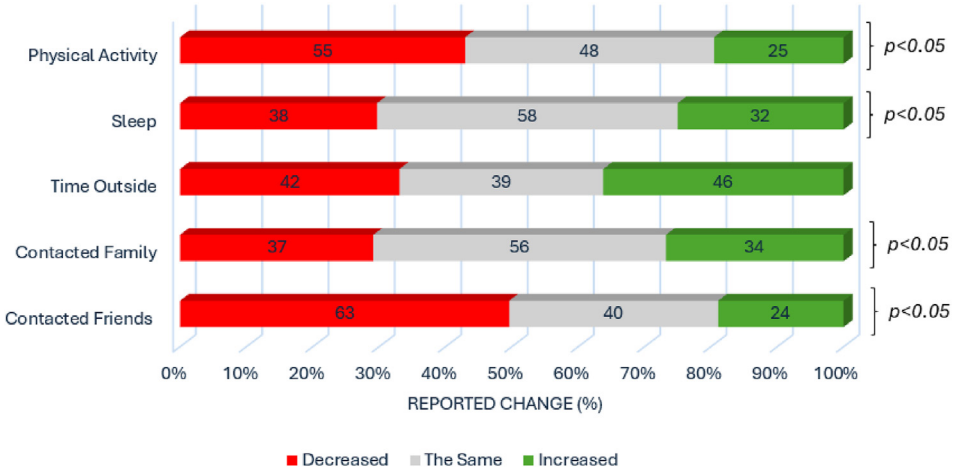

Figure 4. Reported change (%) in lifestyle in the total cohort Participant number is displayed on figure bars per response category. *Chi-Squared Goodness of Fit Test was used to assess the total cohort throughout.

When the cohort was stratified by sex no associations were found.

The open-ended questions highlighted barriers and facilitators to understand these changes. Exercise was also expressed as a barrier related to maintaining a healthy diet during the pandemic by one participant (SCI).

> *'My activity level was down meaning my calorie intake needed to be reduced. Often I get fibre from breakfast cereal which is high in calories.'* - Female, 45, SCI

Family influence (PD) and cost of foods (2 PD) were two barriers that were considered, although less so than other reasons as barriers.

> *'Money … on benefits.'* - Female, PD, 57

Table 4
Percentage distribution of responses to change in lifestyle by condition

	Condition	PD		MS		SCI	
		% Within disease	Adjusted residual	% Within disease	Adjusted residual	% Within disease	Adjusted residual
Physical Activity	Decrease	39.5	-1	50.0	0.8	47.6	0.5
	The Same	42.0	1.4	26.9	-1.2	33.3	-0.4
	Increase	18.5	-0.4	23.1	0.5	19.0	-0.1
Sleep	Decrease	35.8	2	15.4	-1.8	23.8	-0.6
	The Same	42.0	-1	57.7	1.4	42.9	-0.2
	Increase	22.2	-1	26.9	0.3	33.3	1
Time Outside	Decrease	32.5	-0.2	26.9	-0.7	42.9	1
	The Same	28.7	-0.6	38.5	1	28.6	-0.2
	Increase	38.8	0.8	34.6	-0.2	28.6	-0.8
Contacted Family	Decrease	51.2	0.5	57.7	0.9	33.3	-1.6
	The Same	27.5	-1.3	34.6	0.4	42.9	1.2
	Increase	21.3	0.9	7.7	-1.6	23.8	0.6
Contacted Friends	Decrease	28.7	-0.1	38.5	1.2	19.0	-1.1
	The Same	41.3	-0.8	57.7	1.6	38.1	-0.6
	Increase	30.0	1.1	3.8[a]	-3	42.9	1.8

PD; Parkinson's Disease, MS; Multiple Sclerosis, SCI; Spinal Cord Injury. Chi-Squared Test or Fisher's Exact used where appropriate. Bonferroni correction is applied, therefore results are considered significant if <0.005.

[a] denotes responses that are <0.005.

'My wife passed away 18 months ago and she did most of the cooking so I have had to cook. Nowhere as good as my wife.' - Male, 84, PD

Following suit, exercise was also expressed as a barrier and a facilitator to maintaining a healthy diet during the pandemic by 3 participants (1 MS, 2 PD).

'Daily exercise. Two mile walk daily. Gardening. PD Dance for Parkinson's Zoom class. Could afford delivery charge[s] and larger food bills.' - Male, PD, 82

Friends and family influence (2 SC, 11 PD, 1 MS) and social context (1 SC) were two factors that helped to maintain a healthy diet.

'Friends and family shopped for me.' - Female, PD, 65

'My wife's excellent cooking of balanced meals.' - Male, PD, 60

'Less social opportunities which lead to less eating out.' - Female SCI 45

Routine was also reported as a facilitator to eating healthy during Covid-19 by eight participants (2 MS, 7 PD, 1 SCI).

'Being sensible. Moderation.' - Male, PD, 73

'Weekly meal planning and continuing to be the main cook in the household.' - Male, MS, 65

Mood

Across all mood factors the lowest percentage of participants reported a reduction in their negative feelings ($p<0.001$; Figure 5). The percentage of those feeling more fatigued was noticeably higher ($n = 75$, 60%).

No differences were found in reporting of mood changes by condition (data not shown).

When the cohort was stratified by sex, differences between reported feeling anxiousness ($p<0.05$) and depression ($p<0.05$) were apparent. Specifically, more female participants reported they felt more anxious (67%) and more depressed (63%), than male participants (33% and 33%, $p<0.001$, and $p<0.05$, respectively; Table 5).

Ability to cope with stress was also assessed. There was a difference in frequency of reported ability to cope with stress in the total cohort; 27% ($n = 32$) reported a decreased ability to cope with stress, 64% ($n = 75$) reported no change, and 9% ($n = 10$) reported an increased ability ($p<0.001$). Reporting frequency did not differ based on condition or sex. Participants were also asked to rate their stress on a scale of 1–6, the average rating was 3; this did not differ based on condition or sex.

Mood was reported as a barrier to eating healthy during Covid-19 by 13 participants (3 MS, 5 PD, 5 SCI).

'Lack of motivation due to isolation, no weekly physio and oxygen treatments at the MS Therapy Centre causing depression and lack of control on what I was eating.' - Female, 45, MS

'Feeling I needed some treats to keep me going through lockdown.' - Female, 63, PD

Discussion

The aim of this study was to explore the potential impact of the pandemic on mental health and lifestyle factors in those with chronic neurological conditions. Although a majority of participants reported no change in their diet from before to during the pandemic, some unhealthy changes in dietary intake patterns were reported. Likewise, there was largely no change in supplement use, however those with a SCI reported consuming more supplement types during Covid-19 compared to before. There was also an overall trend for participants to report that they contacted their families less

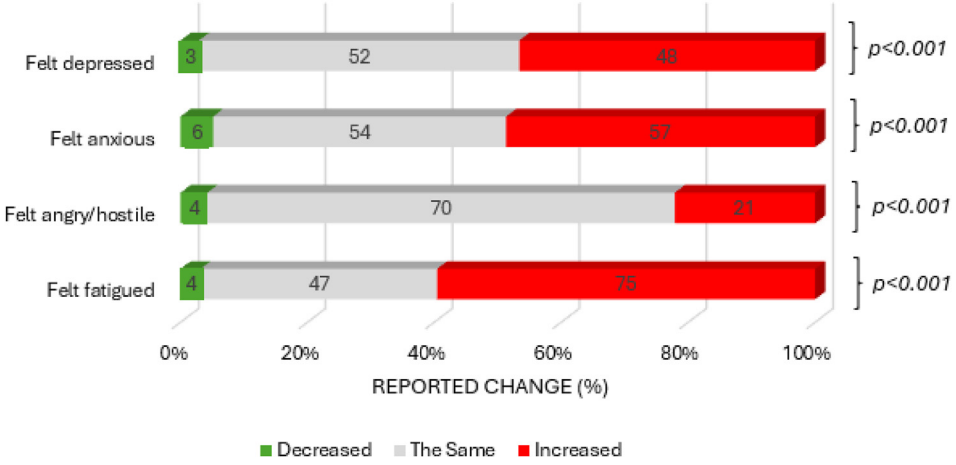

Figure 5. Reported change (%) in mood-related factors in total cohort Participant number is displayed on figure bars per response category. *Chi-Squared Goodness of Fit Test was used to assess the total cohort throughout.

Table 5
Percentage distribution of responses to change in mood by sex

	Sex	Male		Female	
		% Within disease	Adjusted residual	% Within disease	Adjusted residual
Felt Fatigued	Decrease	3.0	-0.1	3.4	0.1
	The Same	43.3	1.5	30.5	-1.5
	Increase	53.7	-1.4	66.1	1.4
Felt Hostile	Decrease	5.7	0.8	2.4	-0.8
	The Same	79.2	1.4	66.7	-1.4
	Increase	15.1	-1.8	31.0	1.8
Felt Anxious	Decrease	6.3	0.6	3.7	-0.6
	The Same	60.3[a]	3.3	29.6[a]	-3.3
	Increase	33.3[a]	-3.6	66.7[a]	3.6
Felt Depressed	Decrease	5.3	1.6	0.0	-1.6
	The Same	61.4	2.5	37.0	-2.5
	Increase	33.3[a]	-3	63.0[a]	3

Chi-Squared Test or Fisher's Exact used where appropriate. Bonferroni correction is applied, therefore results are considered significant if <0.005.
[a] denotes responses that are <0.005.

compared to pre-pandemic and many reported experiencing more fatigue since the pandemic. Therefore, there were some negative changes in overall lifestyle habits and potential impacts on both mental and physical health in these vulnerable groups as a result of the pandemic.

Diet

A consequence of the Covid-19 lockdowns was a drastic change to everyday activities, and from this it can be hypothesised that dietary patterns may also have changed. Participants mostly reported no change in the healthiness of their diet however when food groups were assessed separately a change towards an unhealthy diet pattern was noted. Specifically, the two largest unhealthy changes reported were an increased consumption of alcohol and a decreased consumption of fruit and vegetables. This pattern is reflected in O'Connell *et al.* [17] who reported a modest decline in diet quality over the period March to June 2020, based on density of food purchased. However, O'Connell *et al.* [17] assessed UK

household purchasing patterns, rather than opinion on change, in a cohort unspecified by health status. Although the impact of Covid-19 on dietary change may differ based on individual circumstance, for example Ingram *et al.* [18] reported that students and those who had lost their job had a slightly unhealthier diet in contrast to the whole population, overall research demonstrates a negative trend. These similar findings in diverse cohorts supports the hypothesis of Covid-19 leading to dietary change. However, the long-term implications of this are yet to be established. We are the first to report such dietary changes in a neurological cohort, and to demonstrate differences between cohorts: more participants with PD reported their diet remained the same than those with MS and SCI. However, when changes in food groups were assessed more participants from the MS group reported an increased consumption of processed foods and refined grains when compared to the other conditions. From this, as previously discussed, it is apparent that individual circumstance may have determined how much Covid-19 influenced lifestyle [18]. Notably, people with MS reported difficulties in following a healthy diet regime prior to Covid-19 [19,20], which may have been heightened due to the pandemic. Our data collection was based on perception of change and thus we are not able to determine quantitative change, however perception in relation to dietary choice has been shown to be imperative to achieve change [21–23].

Supplements

Although Covid-19 did not significantly impact the percentage of participants consuming any type of supplement, a GLMM indicated that SCI participants consumed significantly more types of supplements during Covid-19. Unsurprisingly, it was also found that overall SCI participants consumed fewer types of supplements than MS participants. Previous studies have indicated CIM (complementary and integrative medicine) use is common in individuals with MS, especially in the form of vitamin and mineral supplementation [24,25]. In general, there appears to be more literature available on supplement use by individuals with MS and PD compared to SCI [26,27]. The impact Covid-19 had on supplementation in participants with SCI aligns with the increased supplement intake and sales during Covid-19 in the general population (e.g., 63% increase in vitamin sales in the UK), but contrasts with the lack of effect in participants with MS and PD in this study [9,28]. These effects may be partially explained by the more established and recognized supplementation of people with MS and PD compared to those with SCI, who may behave more similar to the general population. Predictably, vitamin D intake was the most common supplement consumed overall and for each condition (both before and after covid-19), as it is recommended for people with a range of neurological conditions [29]. However, Covid-19 only had a minimal impact on Vitamin D intake. Some of the most commonly consumed supplements in this study both before and after Covid-19 (vitamin D, probiotics, multivitamin, and fish oil-a source of omega 3) were found to contribute to a significantly lower risk of testing positive for SARS CoV-2 in women [28]. However, these effects were minute, and the study found no clear benefits for other supplements popular with SCI participants, such as vitamin C, or for the use of any supplements in men. Overall, the increased amount of supplements consumed by participants with SCI could possibly lead to some positive health outcomes for a condition less understood in this context. Future studies should evaluate the overall impact of CIM (not just supplements) with exercise and diet to better understand its health care benefits or contraindications for a range of neurological conditions with variable needs that may have to rely on self-care strategies during a pandemic.

Other lifestyle factors

Overall, across conditions, fewer participants reported they participated in more exercise, whereas the largest percentage of participants reported their sleep remained the same and they contacted friends the same. The largest percentage of participants reported they contacted family less. Specifically fewer participants with MS reported an increased frequency of contacting friends when compared to the other conditions. The importance of maintaining a physically active lifestyle in those with long term conditions has been repeatedly shown [30,31]. This current study supports evidence of physical activity having been reduced in people with long term illnesses since Covid-19. One survey found that participants who reported being less physically active, this was most common in those with

chronic medical conditions compared to those without (Robinson et al., 2021). This is similar to the role the pandemic has reported to have played in the lives of the general public with restrictions having been put on outdoor activity including reduction in access to outdoor green areas commonly used for exercise and walking [32]. Remote physical activity opportunities have also increased for those with disabilities who in pre-pandemic times may have had to travel long distances to access specialised activities [33]. The reduction in self-reported physical activity in people with SCI specifically is supported by Marco-Ahulló *et al.* [34] who found lower levels of physical activity in 20 thoracic SCI participants questioned, when compared to pre-lockdown in all areas besides housework. In another cross-sectional study, it was shown that mental health and physical activity worsened in those with Parkinson's, and reduce physical activity was associated with thoughts of death in this population during the pandemic [35]. In addition, one review concluded that due to the negative impacts that MS had on mobility, people had difficulty getting outside of their house and integrating with society [36]. During the pandemic, an online survey found that people with MS were not only more likely than the control group to be depressed and have higher levels of stress, but they also felt they had less social support during this time [37]. Therefore, the reduction in physical activity and exercise that was seen in this study is likely to be linked to feelings of depression and anxiety, and reduced communication with and feeling of support from social networks.

Mood

Across all mood factors, the lowest percentage of participants reported a reduction in their negative feelings, and across conditions the percentage of those feeling more fatigued was noticeably higher. Specifically, more female participants reported they felt more anxious and more depressed, compared to male participants. The outcomes on mood in this study were in line with the aforementioned study by Bonavita *et al.* [37] in those with MS, yet were in contrary to the work carried out by Chiaravalloti *et al.,* [38] who found the pandemic made insignificant changes to anxiety and depression in those with MS. However, some research found that fatigue and anxiety had been shown to increase since Covid-19 when looking at the UK population as a whole [39]. Smith *et al.,* [39] found this was common in those with multimorbidity, the presence of more than one long term health condition. Indeed, Koc *et al.* [40] found that those with more severe MS who were in quarantine during the pandemic, had higher mental and physical health issues post pandemic [40]. In another study, in 175 Spanish individuals with SCI, who were assessed online between June to November 2020 by García-Rudolph *et al.* [41] depression was significantly higher than before Covid-19, which supports the data found in this study. As mentioned previously, the benefit of communicating with friends and family was more important during the pandemic, yet in a study of 902 Austrian citizens by Nitschke *et al.* [42], it was found that those with smaller social networks or who felt less socially connected, were highly distressed and felt more fatigued. When assessing the association of Covid-19 stressors with mental health in people with Parkinson's, it was found that this link was most prominent in a subset of people including women, people with higher education status, those with more advanced PD and people prone to distancing or seeking social support [43]. This study looked at hypothetical interventions as a way to reduce the stressors and mental health issues in this sub-population. In another study in this group, it was found that those with higher income and educational status were more likely to assess telehealth during the pandemic, while those in the lower socioeconomic group of people with PD were not, resulting in poor health care during this time [44].

Limitations

Although this study provides a good starting point for the effect of Covid-19 and potentially future pandemics on the diet, lifestyle habits and mood of those with neurological conditions it is acknowledged that this study does have limitations. Firstly, the sample size is limited by convenience sampling during the pandemic, thus it is more difficult to generalise these findings to the wider population for each condition represented. However, due to the uniqueness of the Covid-19 pandemic the findings presented are novel and highlight that people with neurological conditions may have experienced wider negative health impacts throughout the lockdown period.

In addition, the questions asked throughout the questionnaire were mostly subjective and answers were self-reported which introduces bias without objective measures. Possible answers given in the form of categories including the words 'more, same and less' are somewhat reductionist and relied on individual interpretation by each participant, meaning potential differences about what constitutes 'same'. Also, previous research has specified amounts of 'healthy' food such as an increase of fruit and vegetables by one cup per day [45] but this current study does not measure the quantity of food change. In this survey study we relied on self-reported diagnosis of MS, PD and SCI and therefore we did not objectively check for a neurologist confirmed diagnosis. Finally, the start of recruitment for this survey was months after the initial lockdown, and therefore the impact of lockdown on the initial behaviours and symptoms in these conditions may have been less accurate compared to if this survey was delivered immediately after the initial lockdown.

Conclusion

This study suggests that the impact Covid-19 has had on people with neurological conditions is complex, and that the negative effects may have been more pronounced than the general public. Overall, there were changes in lifestyle behaviours, some which may be detrimental to health and life quality in these already vulnerable groups. This study shows that there were changes to diet and lifestyle factors in participants with MS, PD and/or SCI during the pandemic compared to before. Future studies should explore whether these changes had longer lasting effects, to ensure appropriate support and health provision is considered.

Author contributions

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O Akrane: Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Software; Roles/Writing - original draft.

A Field: Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Software; Roles/Writing - original draft.

D Zdrava: Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Software; Roles/Writing - original draft.

S Coe: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

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Conflicts of interest

All authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nutos.2024.07.009.

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