

Did physical activity and associated barriers change during COVID-19 restrictions in Ireland? Repeated cross-sectional study

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Summary

This repeated cross-sectional study investigated physical activity and associated barriers and facilitators during the first two waves of COVID-19 restrictions in Ireland. An online, anonymous questionnaire collated data from adults during May ($n = 1274$) and November ($n = 810$) 2020. Statistical analysis used a combination of traditional significance testing and Bayesian lasso logistic regression. The pattern of physical activity changed significantly between waves ($\chi^2 86.8$ on 3df; $p < 0.001$). During wave 1 restrictions, the majority [46.1% ($n = 587$)] of participants reported being more active than usual, decreasing to 26.3% ($n = 213$) during wave 2. More participants reported that their activity levels were less than usual [W1 29% ($n = 369$); W2 35% ($n = 283$)] during wave 2. Adherence to physical activity guidelines decreased from 56.5% ($n = 705$) to 43.7% ($n = 35$). Being unable to access their usual means of exercise [OR, 95% OR intervals; W1 1.611 (1.370–1.904), W2 1.638 (1.373–1.968)] and advice not to leave home [OR, 95% OR intervals; W1 1.401 (1.164–1.697), W2 1.367 (1.106–1.696)] predicted less activity than usual during both waves. Increased time [OR, 95% OR intervals; W1 2.326 (1.948–2.794), W2 1.809 (1.478–2.233)], and valuing physical activity as important [OR, 95% OR intervals; W1 1.192 (1.001–1.444), W2 1.253 (1.003–1.637)] predicted increased activity during both waves, whilst finding new ways to be active [OR, 95% OR intervals; 2.515 (1.641–3.887)] predicted more activity in wave 2 only. Increases in physical activity of Irish adults during the first phase of COVID-19 restrictions were not maintained during the second wave and barriers to physical activity persisted.

Lay summary

Our study looked at the physical activity levels of Irish adults during the first two waves of COVID-19 restrictions. We also examined the factors that helped or hindered people to be active at this time. We used an anonymous, online questionnaire to collect responses during May and November 2020. In total, 1274 people responded in May and 810 in November. We found that in May, almost half of the respondents reported they were more active than usual. By November this had reduced to just over a quarter and about one in three people reported they were doing less activity than usual. People who were less active than usual reported that the closure of their usual means of getting activity, and the advice not to outdoors were the main factors preventing them from being active. People who were more active than usual reported that having more time and feeling that physical activity was important helped them to be more active. The things that helped or hindered people from being active generally did not change between May and November.

Keywords: physical activity, exercise, COVID-19, barriers, facilitators

INTRODUCTION

In December 2019, the first cases of a new infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), were detected in

the city of Wuhan, China (Gabutti *et al.*, 2020). In an effort to curb the spread of the disease, many countries implemented strict criteria which limited the movement of their citizens to various degrees. In most countries, restrictions included the closure or suspension of

many normal opportunities for physical activities such as gyms, swimming pools, structured exercise classes and team sports. Despite these restrictions, many studies reported an increase of interest in, and engagement with physical activity during the early stages of the pandemic, likely influenced by altered working arrangements, reduced commuting times and positive perceptions of physical activity and its associated benefits at the time of crisis (Ding *et al.*, 2020; Savanta ComRes, 2020; Forde *et al.*, 2022).

The health benefits of physical activity are undisputed, with present evidence pointing to a reduced risk of many of the most common medical conditions such as heart disease, stroke, type 2 diabetes, cancer and falls in older populations (Powell *et al.*, 2019). In addition, physical activity is known to positively influence mental health, reducing feelings of anxiety and depression in healthy populations and in people with pre-existing clinical syndromes, lowering the risk of developing depression and improving the overall quality of life (Powell *et al.*, 2019; Dishman *et al.*, 2021).

In recognition of the many benefits of physical activity, both at times of relative stability and in the midst of a global pandemic, many governments and health bodies emphasized the importance of remaining active during periods of restrictions (Government of Ireland, 2020a; World Health Organisation, 2021). In Ireland, citizens were encouraged to meet the national physical activity guidelines of at least 30 minutes of moderate intensity activity, five days a week and resources from multiple sporting and health bodies featured as a part of governmental national campaigns (Department of Health and Children, 2009; Government of Ireland, 2020b). With the onset of the pandemic, mental health issues have come into sharp focus with increased stress related to sickness, unemployment, financial pressures reported, and also the potential negative impact of social isolation on a person's quality of life (Murphy *et al.*, 2021; O'Connor *et al.*, 2021). Unhealthy lifestyles synonymous with an elevated risk of chronic disease are also thought to be a risk factor for more severe cases of COVID-19, with physical inactivity associated with a 32% increased risk of hospitalization from the disease (Hamer *et al.*, 2020). In older adults, social isolation impacting negatively on physical activity can have a deleterious effect on the immune system potentially increasing their susceptibility to infection and exacerbating many of the medical conditions typically seen in this cohort (Damiot *et al.*, 2020).

Maintaining or indeed improving physical activity during the COVID-19 crisis would appear a judicious approach to public health. With the ongoing evolution of COVID-19 and the continuing need for restrictions, establishing how people's physical activity levels change over time is important. Emerging data suggest

declining physical activity levels over the course of the pandemic (Caputo and Reichert, 2020; Strain *et al.*, 2022) and indeed it would seem reasonable to expect people's behaviour to change as they accommodate to ongoing and fluctuating levels of restrictions. Currently, there is limited data on the impact of ongoing COVID-19 restrictions on the physical activity levels of adults and how this compares to their usual physical activity levels before the pandemic. Additionally, whilst barriers and facilitators to physical activity are generally well established, we cannot assume that these remain consistent given the unique set of circumstances associated with the COVID-19 pandemic. Therefore, there is a need to establish the key barriers and facilitators to physical activity in adults, specifically during COVID-19 restrictions. This data will inform physical activity priorities and associated promotional strategies during these unprecedented times.

The aim of this study was to determine how the physical activity levels of Irish adults were impacted by restrictions imposed to limit the spread of COVID-19 during the first two waves of the disease. Specifically, we sought to determine if there was a change in self-reported physical activity between waves 1 and 2 of COVID-19 restrictions and to determine the relevant barriers/facilitators to physical activity during these timepoints. We hypothesised that there would be a change in physical activity levels and behaviours, as well as in associated barriers and facilitators to physical activity between successive waves of COVID-19 restrictions.

MATERIALS

This was a repeated cross-sectional study which utilised an anonymous, online, study specific questionnaire to collate data from Irish adults at two timepoints. The first survey (wave 1) was live from the 1 to 20 May 2020 during the first period of nationwide restrictions, and the second survey (wave 2) was live from 2 to 28 November 2020 during the second period of nationwide restrictions. In Ireland, nationwide stay-at-home restrictions were launched by the Government at the end of March 2020; however, people were permitted to exercise outdoors within 2 and later 5 km radius from home. Indoor sports and exercise facilities remained closed and organized team sport and exercise activities were discontinued during this time. By June 2020, there was a phased reopening of most sporting and exercise facilities including gyms and swimming pools, and a return to team sports. However, by the end of October 2020, deteriorating levels of the disease prompted a second phase of nationwide restrictions imposed for a period of 6 weeks. Once again, most sporting and exercise facilities were closed, and exercise was again restricted to a 5 km distance from home.

Questionnaire design

The research team used a multi-step process to develop an instrument informed by previously validated surveys and influenced by factors relating to good questionnaire design (Sechrist *et al.*, 1987; Salmon *et al.*, 2003; Bull *et al.*, 2009; Hoffman *et al.*, 2018; Department of Health 2019; Ipsos MRBI, 2021a). Several pre-existing questionnaires examining motivators and barriers to physical activity were considered; however, due to the unique set of circumstances associated with COVID-19, a study-specific questionnaire was created. Following several iterations of the questionnaire and piloting with 10 members of the public, the final survey consisted of four sections totalling 14 questions and is provided as supplementary material (wave 1 questionnaire). Physical activity was measured using the widely used single item measure which reads as follows:

In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate? This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places but should not include housework or physical activity that may be part of your job (Milton *et al.*, 2011).

Respondents select from one option ranging from 0 to 7 days. This single item measure has demonstrated strong test-retest reliability (Spearman correlation coefficients ranging from 0.72 to 0.86) and reasonable criterion validity against objectively measured accelerometry (Spearman correlation coefficients of 0.46 to 0.57) (Milton *et al.*, 2011, 2013). Additionally, participants were asked whether they were exercising more/less or the same as before the restrictions and the types of activities carried out. A full description of the questionnaire is provided in a previous publication (Forde *et al.*, 2022).

The wording of one question in the survey was modified prior to wave 2 to reflect changes in government terminology. Question 11 ‘Are you currently cocooning (advised for those aged over 70 or with certain medical conditions)?’ was changed to ‘Are you considered medically vulnerable?’ (Supplementary material wave 1 questionnaire Q 11, wave 2 questionnaire Q 12). Additionally, two new questions, one relating to weekday sitting time (data not included in this report) and a second asking the participant whether they were working from home were included in the wave 2 questionnaire (Supplementary material wave 2 questionnaire Q4 and Q16). Other than these modifications, all other wording and formatting of the questionnaires remained identical between waves.

The opening page of the survey contained a link to the participant information leaflet which provided full details of the survey, data management procedures and contact details for the researchers. Consent to the study was assumed on submission of the survey and a statement explaining this was provided on the opening page. Ethical approval for this study was granted by the Trinity College Dublin, School of Medicine Research Ethics Committee (Application number 20201007).

Data collection

Both surveys were hosted on Microsoft Forms and the distribution process was the same between waves. A link to each survey was posted on the Twitter accounts of the research team inviting any person over the age of 18 to participate. The inclusion criteria were purposely broad to include adult participants, of all ages and all physical activity levels who were able to answer the questionnaire in English. A link was also posted on the website of the university for whom the research team worked and emailed to several professional organizations targeting groups traditionally underrepresented by online surveys which included older people and males (for example, the Irish Senior Citizens Parliament <https://seniors.ie/> and the Irish Mens Shed Association <https://menssheds.ie/>) (Shih and Fan, 2008; Smith 2008). Participants were encouraged to distribute the questionnaire amongst their family and peers.

Statistical analysis

Cleaning and analysis of both datasets was carried out in R version 4.1.1 (R Core Team, 2020). Raw data from both survey waves were imported from Microsoft Forms and explored to identify any errors or omissions. Inconsistencies (e.g., in free text typos) were resolved when this could be done unambiguously, otherwise individuals with ambiguous answers were removed. Participants failing to give a response to one or more questions were removed before analysis. Some subgroups in the data set (e.g., the highest education to primary level) had a small representation amongst participants. With an anticipated large uncertainty attached to estimation for such groups through statistical modelling, these subgroups were excluded from the analysis. Data visualizations were carried out using base R plotting functions and ggplot2 (Wickham, 2016). For the purpose of analysis any Likert scale fields were treated numerically as running from 1 to 5 with 1 representing ‘strongly disagree’ and 5 representing ‘strongly agree’.

The Bayesian lasso (Park and Casella, 2008) was used to determine potential facilitators for those exercising more than usual and barriers for those exercising less than usual during the restrictions. The waves of the survey were modelled separately using logistic regression

with Bayesian lasso penalties through the R package *bayesreg* (Makalic and Schmidt, 2016). Waves were analysed separately to allow for comparison between survey waves. The lasso method includes all potentially relevant questionnaire fields from the survey and then distinguishes those which discriminate individuals for self-reported activity levels. This enables identification of facilitators or barriers to exercise whilst preventing overfitting. In total, four Bayesian logistic regression models were fitted, two for each wave of the survey. Within a wave, one regression model compared those exercising more with the ‘same as usual’ and the second compared those exercising less with the ‘same as usual’. In each model, exercising more or less than usual was considered the case (outcome 1) and those exercising ‘the same as usual’ the control (outcome 0). Comparisons of more and less than usual with the same as usual were separated to account for different questionnaire fields emerging as indicators of barriers or facilitators to exercise.

Bayesian logistic regression lasso models were fitted using the Markov chain Monte Carlo (MCMC) through the R *bayesreg* package (Makalic and Schmidt, 2016). Visual inspection of MCMC trace-plots confirmed convergence. Results are reported in

graphical form with posterior credible intervals for the odds ratios (ORs) associated with each variable. The posterior OR interval is a natural way to interpret logistic regression output, with credible intervals not containing 1 suggesting a variable to have predictive value. Differences between wave 1 and wave 2 demographics and activity levels were investigated using chi-square (all variables except age) and Wilcoxon test (age) with corresponding *p*-values shown. For all tests a *p*-value of ≤ 0.05 was considered to be statistically significant.

RESULTS

In total, 1568 people participated in the wave 1 survey and 1097 people took part in wave 2. Following data cleaning and preparation, 1274 participants were included from wave 1 (81% completion rate) and 810 from wave 2 (74% completion rate). Demographics for both the waves are presented in Table 1. Of note, there were more student and less unemployed and retired participants in wave 2, resulting in a somewhat younger mean age in wave 2. In addition, wave 2 had significantly more participants who identified as medically vulnerable.

Table 1: Demographic details of participants for wave 1 and wave 2 surveys.

		Wave 1 <i>n</i> = 1274	Wave 2 <i>n</i> = 810	Difference
		% (n)	% (n)	<i>p</i> -value
Gender	Female	71.4 (909)	74.7 (605)	0.11
	Male	28.6 (365)	25.3 (205)	
Employment status	Employed	71.8 (915)	75.7 (613)	<0.01*
	Unemployed	9.7 (123)	4.3 (35)	
	Student	7.0 (89)	12.7 (103)	
	Retired	11.5 (147)	7.3 (59)	
Highest education level	Junior Certificate or Equivalent	1.6 (21)	0.6 (5)	0.01*
	Leaving Certificate or Equivalent	9.6 (122)	10.4 (84)	
	Diploma/Certificate	16.2 (207)	12.3 (100)	
	Third Level Degree or Higher	72.5 (924)	76.7 (621)	
Advised to cocoon/medically vulnerable	No	92.2 (1175)	86.5 (701)	<0.01*
	Yes	7.8 (99)	13.5 (109)	
Age (years)	All participants	44.3 (14.1)	41.6 (14.3)	<0.01*
Working from home	Full time	n/a ^a	23.6 (191)	<0.01*
	Part time		12.8 (104)	
	No		51.9 (420)	
	Did not respond		11.7 (95)	

^aNot applicable: working from home data were not collected in wave 1.

*Denotes significant result.

Change in physical activity between waves

Figure 1 presents the change in physical activity levels reported by participants during both waves of COVID-19 restrictions. It can be noted that there was a significant change in reported activity levels between waves (χ^2 86.9 on 2 degrees of freedom; p -value < 0.001). One of the sample proportions tests indicated that the change between waves was significant for each of the reported activity levels of interest less than usual (p -value = 0.002), same as usual (p -value < 0.001) and more than usual (p -value < 0.001).

During wave 1 over half (56.5%, $n = 705$) of participants reported being physically active for at least 30 minutes on 5 or more days of the preceding week; thus, meeting the national physical activity guidelines (Department of Health and Children, 2009). During wave 2, the percentage of the population meeting the physical activity guidelines had decreased to 43.7% ($n = 354$). More than half (54.5%, $n = 679$) of wave 1 respondents and 34.7% ($n = 281$) of wave 2 respondents reported finding new ways to be active. The main types of physical activities reported by participants for both waves are detailed in Figure 2. Participation in all but one (running/jogging) of the most commonly reported physical activities declined between waves 1 and 2, although the decline in walking was negligible at 1.5% and its overall participation rate remained very high at 84.9% ($n = 688$). Gardening/home or yard

work (22.2% decline) and cycling (11.5% decline) demonstrated the largest decline between waves.

Barriers and facilitators to physical activity

Figure 3 presents results from the Bayesian logistic lasso regression comparing those reporting less physical activity than usual to those reporting the same activity as usual. The centipede plot gives 95% credible intervals of the ORs for survey questions when reporting less physical activity than usual for waves 1 and 2 of the survey. OR intervals in the centipede plots which intersect with the vertical line at 1 indicate questionnaire fields with predictive value. The wave 1 questionnaire number and an abbreviated format of the questionnaire statement are shown. Please see supplementary material (wave 1 Questionnaire) for a complete list of questionnaire items. Two questionnaire fields were predictive of being less active than usual in both survey waves. These were ‘My usual means of getting exercise are not currently available to me’ (statement 8.8) [OR, 95% OR intervals; W1 1.611 (1.370–1.904)] W2 1.638 (1.373–1.968)] and ‘I find it hard to be active because I’m advised not to go outside my home’ (statement 8.1) [OR, 95% OR intervals; W1 1.401 (1.164–1.697), W2 1.367 (1.106–1.696)]. Additional analysis in the supplementary material (File 1) presents a violin plot of all responses to ‘My

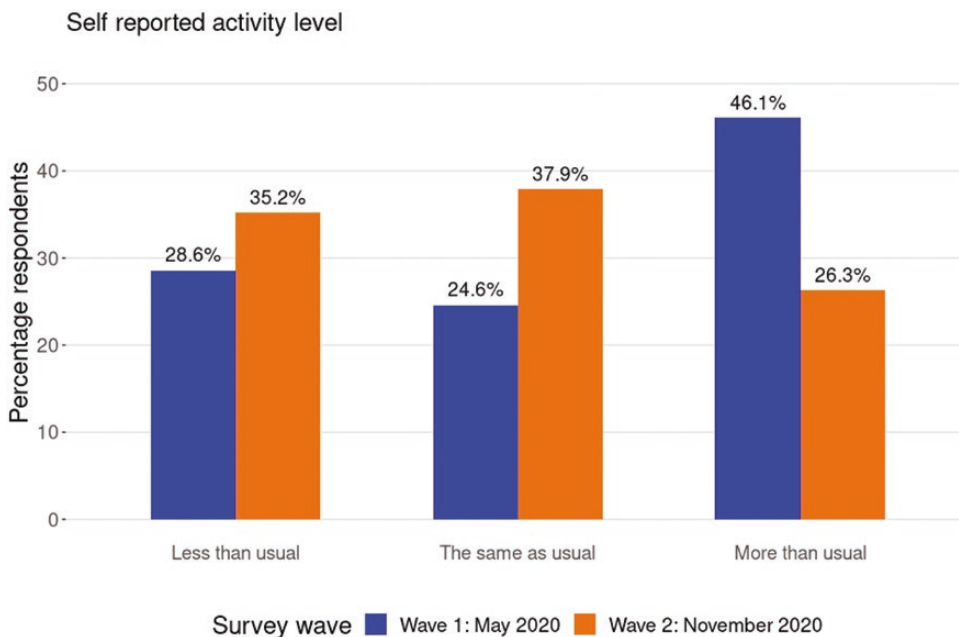


Fig. 1: Self-reported change in physical activity during waves 1 and 2 COVID-19 restrictions. Percentages add up to 99.3% for wave 1 and 99.4% for wave 2 with outstanding respondents having responded as ‘Don’t know/Unsure’ about changes in their physical activity level.

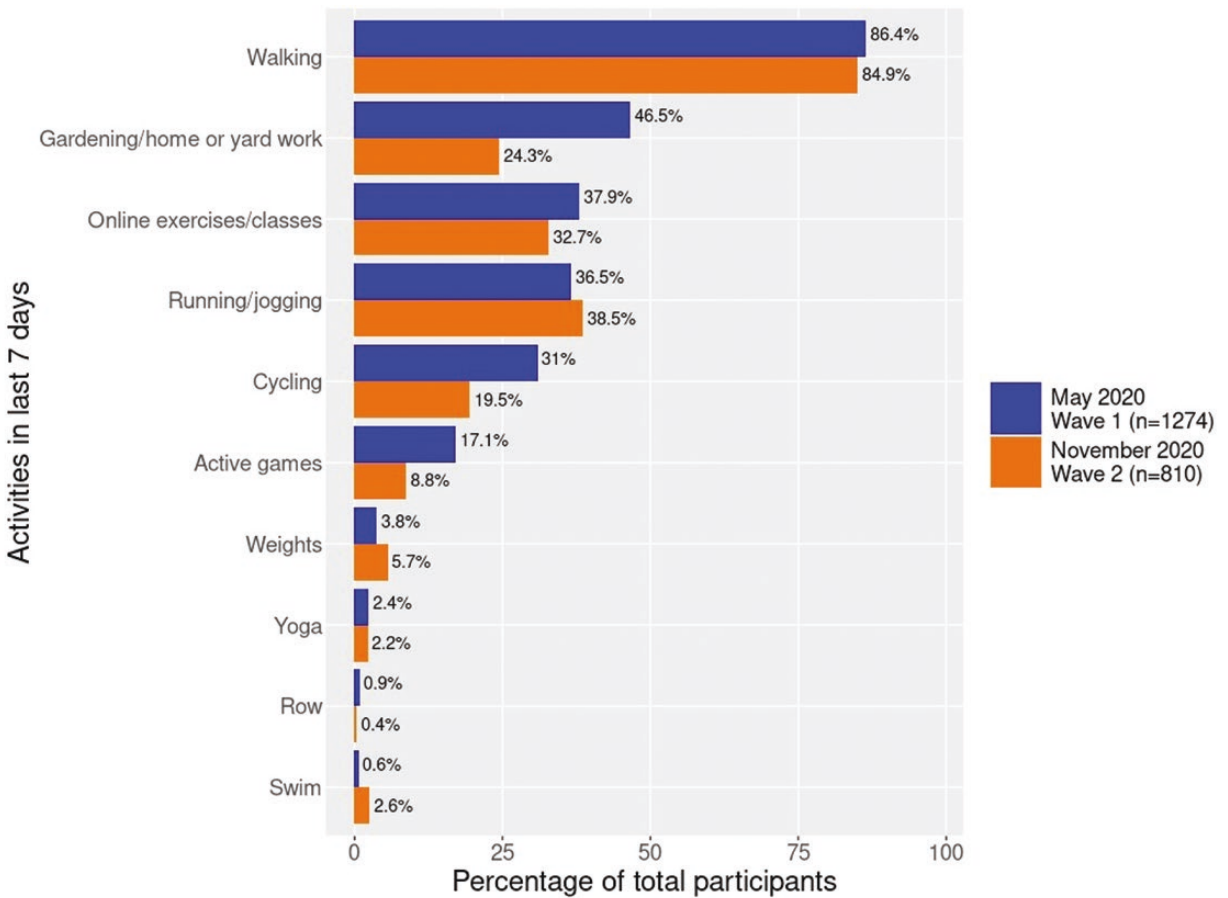


Fig. 2: Types of physical activities reported during waves 1 and 2 COVID-19 restrictions.

usual means of getting exercise are not currently available to me' (statement 8.8) and demonstrates that participants reporting less physical activity than usual recorded higher scores with a higher frequency of responses at 4 or 5 (corresponding to agree and strongly agree).

The centipede plot in [Figure 4](#) shows the Bayesian logistic regression results comparing those reporting more physical activity than usual to those reporting the same physical activity as usual. Both waves indicated that the following statements 'Since the COVID-19 outbreak, I feel it is more important to exercise' (statement 6.11) [OR, 95% OR intervals; W1 1.192 (1.001–1.444), W2 1.253 (1.003–1.637)] and 'Since the COVID-19 restrictions I have more time to be physically active' (statement 6.1) [OR, 95% OR intervals; W1 2.326 (1.948–2.794), W2 1.809 (1.478–2.233)] distinguished those who were more physically active. Additional analysis in the supplementary material (File 2) presents a violin plot of all responses to 'Since the COVID-19 restrictions I have more time to

be physically active' (statement 6.1) and demonstrates that those reporting being more physically active than usual agreed more strongly with the statement that they had more time to do so. In wave 2, a third facilitator appeared to play a role. A positive (yes) response to 'Since the COVID-19 restriction I have found new ways to be active' (statement 4) [OR, 95% OR intervals; 2.515 (1.641–3.887)] played a stronger role in wave 2 for those engaging in more physical activity.

File 3 in the supplementary material provides side by side bar plots showing percentages of participants in each wave and activity level who found new ways to be active. In wave 2, the proportion of more active individuals reporting new ways to be active is more pronounced and distinguished from the other activity levels compared with wave 1. Of those who reported being more active in wave 2 (wave 1), 61% (63.5%) found new ways to be active compared with 27.4% (49.8%) who were as active as usual and 23.2% (39.7%) who were less active than usual.

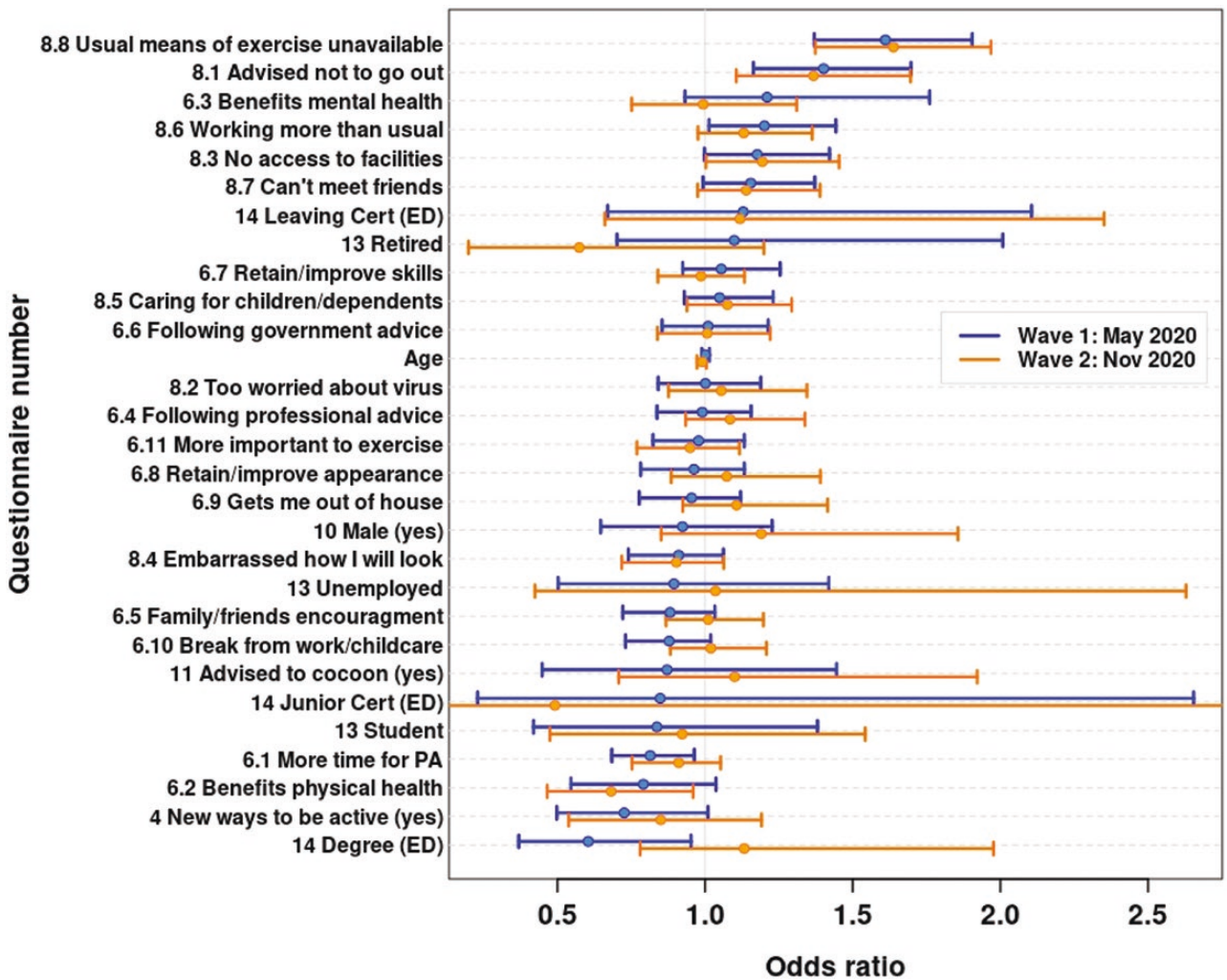


Fig. 3: Odds ratio 95% credible intervals for participants reporting less physical activity than usual during waves 1 and 2 COVID-19 restrictions.

DISCUSSION

This study found that increases in self-reported physical activity of Irish adults during the initial stages of the COVID-19 pandemic were not maintained as the pandemic progressed. As restrictions continued, overall physical activity levels and rates of adherence to national physical activity guidelines decreased, and changes in physical activity behaviours were seen. The proportion of Irish adults meeting the national physical activity guidelines decreased by 13% between the first and second waves of national restrictions, falling to 43.7% in wave 2 which is below national pre-pandemic estimates of 46% (Department of Health, 2019). This result is corroborated by a 7% increase in respondents who reported being less active than usual from wave 1 to wave 2

(W1 28.6%; W2 35.2%) and a decrease of almost 20% of participants who reported being more active than usual between waves (W1 46.1%; W2 26.3%). Decreasing physical activity is a cause for concern as a failure to meet physical activity guidelines during the pandemic is associated with increased depression, loneliness and stress (Meyer *et al.*, 2020). In general, decreases in physical activity as a result of the pandemic have been reported in the literature (Caputo and Reichert, 2020; Strain *et al.*, 2022), with for example, population levels of physical activity in England declining significantly on introduction of national restrictions (Strain *et al.*, 2022). A systematic review investigating changes in physical activity during the first 7 months of the pandemic (November 2019 to June 2020) found that the majority of the 66

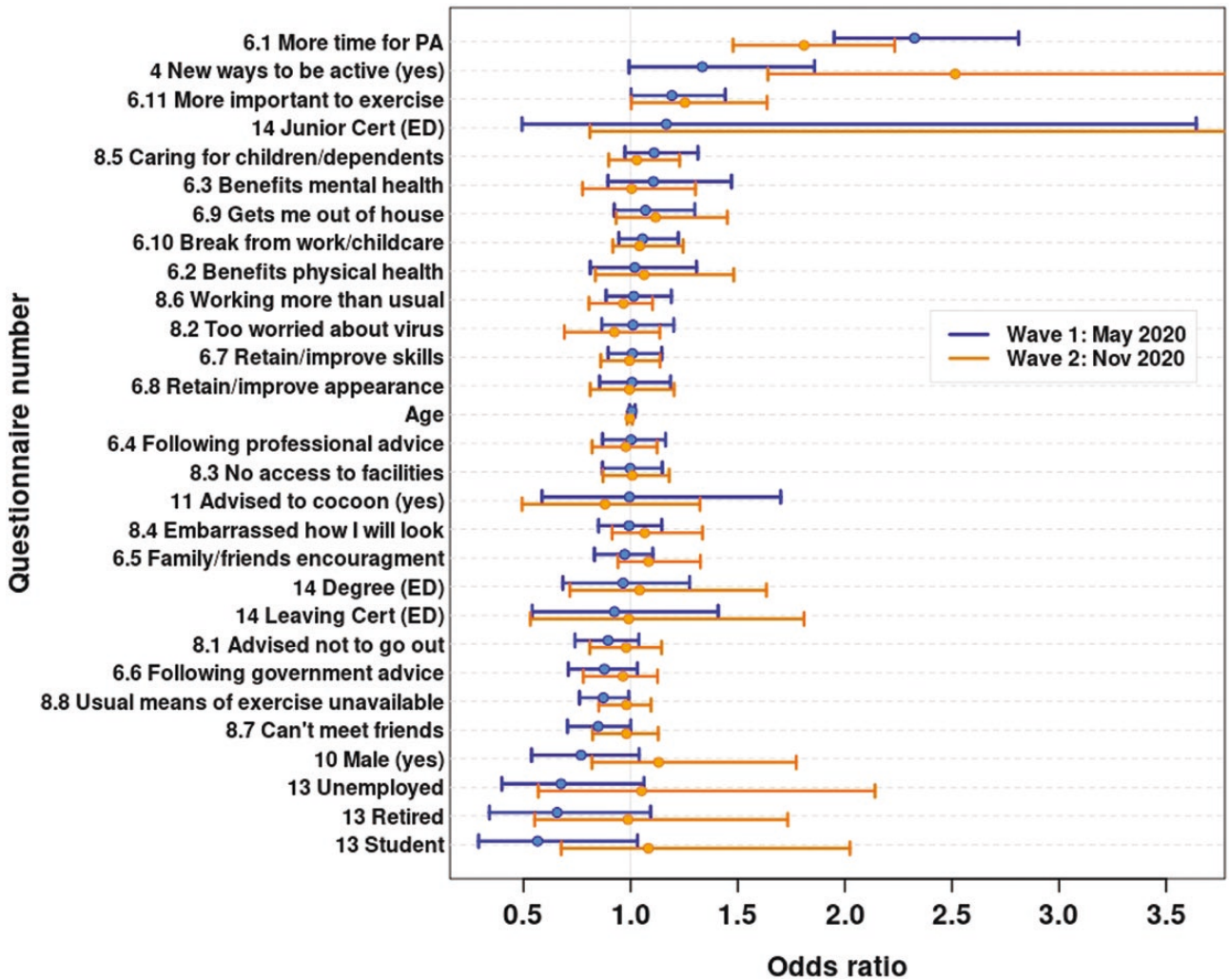


Fig. 4: Odds ratio 95% credible intervals for participants reporting more physical activity than usual during waves 1 and 2 COVID-19 restrictions.

studies included, reported decreases in physical activity. This was irrespective of the population studied (healthy adults and children and adults with medical conditions) or methods used to assess physical activity (Stockwell *et al.*, 2021).

Our study adds to this work by examining the ongoing impact of two consecutive phases of the COVID-19 restrictions on physical activity, however, with data on physical activity type as well as barriers and facilitators, our work offers additional insights into the potential reasons for such change. While few differences in facilitators and barriers were seen between waves, certain variables helped differentiate people who had a greater likelihood of becoming more active during the pandemic from those who had a greater likelihood of becoming less active.

What changed as restrictions continued?

This study found that as restrictions continued, people were less likely to adopt a more physically active lifestyle. Despite living in a society with varying degrees of social restrictions over a 7-month period, barriers to physical activity remained consistent. These results highlight the need for renewed action to actively promote and engage people in physical activity opportunities during times of social restrictions and to improve our understanding of the specific barriers faced by people when trying to engage in physical activity during this time.

During the initial stages of restrictions which equated with late spring in Ireland, a majority of people chose to be active outdoors with walking and gardening, both arguably seasonal past-times, being the

most popular activities (Forde *et al.*, 2022). This study found a change in activity types between waves with perhaps, somewhat predictably, a reduction in gardening (W1 46.5%; W2 24.3%) and cycling (W1 31%; W2 19.5%). Walking showed a very marginal decline (1.5%) between waves and remained by far the most popular activity during both waves being reported by almost 9 of 10 adults. This result is corroborated by data from a large, repeated population study of Irish adults carried out by Sport Ireland, which reported levels of engagement with recreational walking at 80% during the early months (April/May 2020) of the pandemic, which was an increase of 15% from the same time period in the year previous (Ipsos MRBI, 2021a). Although the most recent data available from this study reports a decrease in walking to 76% for 2021, levels of engagement remain higher than before the pandemic (Ipsos MRBI, 2021b). Consistently, high levels of walking highlight its almost universal acceptance amongst the adult population and cements the importance of walking as a physical activity regardless of seasonal effects or social restrictions. While the high proportion engaging with walking is encouraging, the overall decrease in physical activity noted in this study may indicate that people were not walking at levels sufficient to meet national physical activity guidelines and/or were no longer engaging in other activities that may have supplemented their overall physical activity beyond that achieved by walking alone. It is likely that walking for transport or commuting purposes was reduced during the pandemic, a finding supported by the literature (Ipsos MRBI, 2021b; Strain *et al.*, 2022) and that increases in leisure time walking may not have been sufficient to compensate for this change. With such large numbers of the population engaging in walking, investment in policies and green spaces that improve accessibility to walking and interventions that promote longer or more intense walking routes may help support active lifestyles, in particular during times when other means of physical activity are limited.

What can we learn from the data on barriers and facilitators?

Interestingly, barriers and facilitators to physical activity reported by participants remained stable over both waves, indicating ongoing difficulties overcoming barriers related to pandemic restrictions. When examining people who reported being less active than usual, two important barriers, relevant for both the waves, were identified. The first barrier related to the participants' usual means of physical activity being unavailable and the second was being advised not to outside their home. Levels of agreement identifying the former as a barrier increased in wave 2, indicating that ongoing restrictions which limited access to normal physical or sporting

activities were felt more strongly as time progressed. This result could also reflect an interaction between seasonality and restrictions with a greater dependence on indoor activities, many of which were closed, being felt more keenly during the late autumn months of wave 2. Similar results were reported by Farah *et al.* (Farah *et al.*, 2021) who found that a lack of appropriate facilities/space/equipment was the barrier most strongly associated with a change in activity levels during the pandemic. In older adults, the closure of exercise facilities, cancellation of group activities and the unavailability of equipment were reported as the greatest barriers to physical activity (Ng *et al.*, 2022). Possible means of tackling this barrier would be to emphasize and accommodate alternative ways of engaging in typically restricted activities, as well as encouraging new activities. This could include incentives to exercise at home; promoting methods of safely engaging in home exercise programs; providing equipment and internet access to enable engagement with exercise classes outside of a gym; promoting access and use of local parks or natural amenities and emphasizing the similarities between 'usual' and 'restriction-adapted' activities (for example, ensuring classes took place at the usual time and with the usual instructors and classmates where relevant). Maintaining the social aspect of exercise including support from peers and teammates where possible, appears to be an important consideration during periods of restrictions (McGrath *et al.*, 2020). Being advised not to go outside of their home was a notable barrier across both the waves. During wave 1, government advice recommended that vulnerable and older people stay indoors. Despite this advice changing in wave 2, to encouraging people to use their own discretion about going outdoors, many people still perceived this as a barrier to physical activity. This was likely because of the ongoing fears about contracting the virus in public areas.

Two main facilitators, consistent across both waves, were identified amongst participants who reported they were more active than usual, these were reporting more time for physical activity and believing in the importance of exercise. Finding new ways to be active was considered an important predictor of being more active than usual for wave 2 but not for wave 1. Time has been reported as an important facilitator to physical activity for decades (Sallis and Hovell, 1990); however, reporting 'more time' as a result of the pandemic indicates that a proportion of people may have benefited from reduced commuting times and arrangements facilitating working from home. Our data from wave 2 indicate that 36% of respondents were working from home on either a part-time or full-time basis. This is increased from figures provided by the Central Statistics Office in Ireland (Central Statistics Office

in Ireland, 2021) in which 23% of the population reported working remotely at some point before the pandemic, but much lower than the 80% who reported working remotely at some point during the pandemic. However, we caution direct comparison with this data due to differences in terminology, data collection methods and the time period of the pandemic during which they were collected. Although time was a relevant facilitator in both the waves, levels of agreement were higher in wave 1 which may reflect the fact that more people had returned to their workplace by November 2020 or had been accommodated to work more successfully from home.

The proportion of people who reported having found new ways to be active decreased overall in wave 2 (W1 54.5%; W2 34.7%) but remained high amongst those who were more active than usual (File 3 supplementary material). This result indicates that those who could adapt to new ways of being active or had the means, knowledge, or ability to access new ways of being active were more likely to be successful in increasing activity levels. Supporting people to build self-efficacy to identify and access alternate means of activity may be an important consideration for those involved in physical activity promotion during periods of ongoing restrictions. Predicting and understanding fitness trends and the potential benefits to promoting them have previously been reported in the literature (Thompson, 2021). In 2021, online or virtual training which can include pre-recorded or live classes directed at individuals or groups was reported to be the number one worldwide fitness trend (Thompson, 2021). This is unsurprising given the closure of many exercise facilities during the pandemic and indeed online exercise featured strongly in both our surveys. Harnessing fitness trends has obvious benefits for the commercial health and fitness industry; however, it also has potential benefits for those charged with designing and delivering physical activity in the community, workplace and healthcare settings. By responding quickly to develop high quality, online resources from reputable and respected providers and making them widely and easily accessible we can harness the potential interest and enthusiasm for new fitness trends.

Strengths and limitations

There are several strengths to this study, not least were the good participation numbers in both surveys and the repeated nature of the study which enabled a comparison of physical activity levels of Irish adults at two discrete time points corresponding to two consecutive waves of the pandemic. We acknowledge however, that the overall number of participants was lower in

wave two, this may be attributable to survey fatigue, a known phenomenon during the COVID-19 pandemic (de Koning *et al.*, 2021).

Data from wave 1 were collected during May 2020 which equates to late spring in Ireland whereas data for wave 2 were collected during November 2020 which is late autumn. Seasonal changes in physical activity have been well reported in the literature and consistently show reduced activity levels during colder or winter months (Uitenbroek, 1993; Tudor-Locke *et al.*, 2004; Tucker and Gilliland, 2007). Reductions in the proportion of people engaging in physical activity, as well as reductions in activity levels of those who remain somewhat active are common. Previous studies using doubly labelled water (Haggarty *et al.*, 1994), pedometers (Levin *et al.*, 1999) and questionnaires (Uitenbroek, 1993) have reported decreases in physical activity of approximately 10% in winter when compared with summer months. More recently, a repeated cross-sectional study on physical activity levels of people in England reported decreases in physical activity, equating to a 10% reduction related to COVID-19 restrictions independent of expected seasonal changes (Strain *et al.*, 2022). It could be considered a limitation of our study that seasonal changes were not accounted for, nonetheless a strength of this work is that participants were asked to compare their current physical activity levels with what they would consider as 'usual' for them in pre-COVID times. However, due to the extended timeframe associated with this question the potential for recall bias cannot be excluded. While it is acknowledged that shorter days and poor weather conditions synonymous with autumn in Ireland lead to reductions in physical activity, the fact that our results are similar to those outlined by Strain *et al.* (Strain *et al.*, 2022) and that many respondents reported barriers directly related to social restrictions, indicate that our results are likely to reflect pandemic-related changes.

As this research was survey based, limitations associated with self-reported physical activity outcomes apply and it could be argued that results reflect perceived rather than actual behaviours (Cross *et al.*, 2021). Whilst we attempted to distribute the survey link as widely as possible and specifically contacted groups generally underrepresented in online surveys, we acknowledge that the use of Twitter and posting the survey on the university website may have resulted in selection bias, limiting generalization to the wider Irish population. In general, our study samples were older, had a greater representation of females and a higher proportion of people in employment and with a third level/university degree than that of the general population (Central Statistics Office, 2016). Despite this, given the overall diversity in responses given by individuals, and controlling for variables through the regression

analysis, our findings are likely to represent patterns in the larger population. Finally, due to the unique set of circumstances attributed to COVID-19 we were unable to identify a standardized questionnaire that fully captured the potential barriers and facilitators to physical activity and thus needed to create a study specific tool. Whilst this was used primarily to compare data between waves, the lack of formal psychometric testing may limit direct comparability with other studies.

CONCLUSION

Results of this study indicate that as restrictions related to the COVID-19 pandemic continued, levels of physical activity of Irish adults decreased. Within a 7-month period, the proportion of Irish adults meeting national physical activity guidelines dropped by 13%. Increases in physical activity associated with the first wave of restrictions were not maintained. Barriers to physical activity were identified as a consequence of restrictions and social distancing. These were not overcome with time, but rather increased in importance. These point to the specific areas that need addressing by exercise and health professionals aiming to support people to maintain or increase physical activity in times of restricted socialization.

Our results indicate a tale of two pandemics; for some, restrictions resulted in increased time to be physically active and finding novel ways to maintain or increase activity levels. For others, COVID-19 restrictions resulted in reduced access to their usual means of physical activity without the ability to identify alternative or new ways to be active. Further investigation is required to determine the potential reasons and personal characteristics that allowed some people to successfully adapt, whilst others could not.

Supplementary Material

Supplementary material is available at *Health Promotion International* online.

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Ethical Approval

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