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Parkrun as self-managed cardiac rehabilitation: secondary analysis of a cross-sectional survey of parkrun in the UK

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ABSTRACT

Objectives

Cardiac rehabilitation following a cardiovascular disease (CVD)-related illness has been shown to reduce the risk of heart attack and hospital admission. The American College of Sports Medicine recommends three to five days per week of moderate to vigorous exercise. Despite this, only 38% of those eligible complete rehabilitation programmes. Parkrun organises free, weekly, timed, 5 km running or walking events. The aim of this study was to investigate whether parkrun can support self-managed cardiac rehabilitation.

Methods

We undertook a secondary analysis of a survey of UK parkrunners, comparing responses of those reporting no health conditions (n=53,967) to those with one or more CVD-related conditions (n=404). Thematic analysis was used to analyse 53 open-ended text comments from the latter.

Results

Four hundred and four respondents (0.7% of the total) reported CVD-related conditions with the largest proportions amongst those walking the event (24% of males and 5% of females). For those doing <3 days per week of physical activity at registration, 47% increased activity to ≥3 days per week. Among those with CVD-related conditions, participation in parkrun led to perceived improvements in fitness (81% of participants), physical health (80% or participants) and happiness (74% of participants). Two thirds reported improvements to their ability to manage their condition(s) and half to their lifestyle choices. Analysis of 53 open text comments revealed that those with CVD-related conditions used parkrun to monitor their condition and were motivated by encouragement from the parkrun community. Enjoyment and fun were important for engagement, although some individuals were dispirited by poor performance due to their conditions.

Conclusions

Individuals with CVD-related conditions used parkrun to self-manage their rehabilitation; this applied to those attending parkrun following disease onset as well as those engaged with parkrun prior to their condition. Parkrun, or events with similar characteristics, could support self-managed cardiac rehabilitation.

KEYWORDS

Cardiac Rehabilitation, Epidemiology, Delivery of Health Care, Coronary Artery Disease

What is already known on this topic

Exercise-based cardiac rehabilitation can reduce the risk of all-cause mortality, heart attack and hospital re-admission; before the pandemic, only 38% completed cardiac rehabilitation programmes, and disruption due to COVID-19 caused a move to self-managed options. There is little evidence on the effectiveness of interventions to maintain or increase adherence.

What this study adds

Parkrun is a free, weekly, timed, 5 km run or walk that has the potential to support exercise for those with CVD-related conditions. A large cross-sectional study showed that a small proportion of parkrun participants had CVD-related conditions. Of these individuals, some used parkrun as part of cardiac rehabilitation to improve and monitor fitness and help manage their condition.

How this study might affect research, practice or policy

This study identifies the attributes of parkrun that sustain engagement in exercise for those with CVD-related conditions, often over many years. An existing GP prescribing scheme with parkrun could be extended to support those in cardiac rehabilitation. Further research should identify potential risks, monitor outcomes and determine whether parkrun could be used to improve adherence to self-managed cardiac rehabilitation.

INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of death worldwide [1], representing almost a third of all global deaths; preventative therapies are essential following a diagnosis of CVD. Prevention tends to emphasise pharmacotherapy despite lifestyle factors (including smoking cessation, physical activity, and diet) demonstrating strong associations with long-term survival.[2]

A systematic review of longitudinal physical activity showed that maintenance or adoption of an active lifestyle was associated with a survival advantage.[3] The British Association of Cardiovascular Prevention and Rehabilitation (BACPR) suggests that patients experiencing acute coronary syndrome (ACS) should be provided with a programme of cardiac rehabilitation that includes supervised exercise, risk factor management, nutritional education and psychosocial support.[4] In terms of the necessary volume of exercise, the American College of Sports Medicine (ACSM) propose that those in cardiac rehabilitation should do 20-60 minutes of moderate or vigorous aerobic exercise three to five days per week.[5] A recent Cochrane review reported that exercise-based cardiac rehabilitation reduces the risk of all-cause mortality, heart attack, hospital re-admission and improves health-related quality of life.[6]

Despite the benefits of rehabilitation programmes, only half of those eligible in the UK actually attend, of which there is a 38% completion rate.[7] Additionally, the COVID-19 pandemic has caused major disruption to cardiac services [8] and some face-to-face cardiac rehabilitation was withdrawn in favour of self-managed options.[9] If cardiac rehabilitation programmes evolve to include self-managed components, the individual, social and environmental factors that encourage engagement and promote long-term adherence need to be identified. Such a programme should have the capability to be implemented at scale to have the greatest impact on population health. Currently, there is only weak evidence to suggest that self-managed interventions positively impact adherence to cardiac rehabilitation.[10]

Parkrun (generally written with a small ‘p’) is a registered charity, which organises free, weekly, timed, 5 km runs or walks at more than 700 locations in the UK (and across 22 countries). Parkrun has more than 7 million registrants and hundreds of thousands of regular participants.[11] Events take place each Saturday morning and are organised by volunteers supported by a core team of parkrun employees. Mass running or walking events, such as

parkrun, have the potential to improve physical and mental health in large numbers of people and at low cost.[12]

In 2018, a cross-sectional survey was conducted on UK parkrun participants to examine the impact of participation on an individual's health and wellbeing.[13] Respondents self-reported whether they were limited by a chronic condition lasting 12 months or more, some of which were CVD-related. A comparison of parkrun participants with and without CVD-related conditions could provide a better understanding of the motivations and potential benefits provided by self-managed, community-based physical activity.

The aim of this paper is to conduct a secondary analysis of the 2018 survey to understand the impact of parkrun on those with CVD-related conditions and consider its potential as a form of self-managed exercise for cardiac rehabilitation.

METHODS

Survey questions

A cross-sectional survey comprising 47 questions was emailed to all UK registered parkrunners aged 16+ between 29th October and 3rd December 2018; 59,999 completed the survey using Qualtrics survey software [14] with findings reported previously [13]. The following questions were used in the current study:

Participation type: Participants self-selected 'runner/walker', 'runner/walker and volunteer', 'volunteer only', or 'registered but not yet participated'.

Long-term health conditions: Participants were asked: 'Are your day-to-day activities limited because of a health condition or disability which has lasted, or is expected to last, at least 12 months?' Responses were: 'rather not say, don't know; no; yes, limited a little; yes, limited a lot'. If answering yes, participants were offered a list of 56 health conditions or 'other' plus a free-text option.

Mental health: The Short Warwick-Edinburgh Mental Wellbeing Scale. Responses to seven items were scored from 1 to 5. The total raw scores were transformed into metric scores using the validated protocol identified by the original researchers.[15] Scores range from 7 to 35 with a higher score indicating higher positive mental well-being.

Life satisfaction: Office of National Statistics:[16] 'Overall, how satisfied are you with your life nowadays?' An 11-point visual analogue scale was given with 0 identified as 'not at all', and 10 as 'completely'.

Overall health: The vertical visual analogue scale (VAS) from the EuroQol-5 survey[17] asked the following: 'We would like to know how good or bad your health is TODAY. This scale is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine. Please enter a number in the box below to indicate how your health is TODAY.'

Activity level: A bespoke question created by parkrun for the purpose of assessing activity level at parkrun registration asked the following: 'Over the last 4 weeks, how often have you done at least 30 minutes of moderate exercise (enough to raise your breathing rate)?' Possible responses were: 'less than once per week; about once per week; about twice per week; about three times per week; four or more times per week; rather not say, don't know'.

Motives for initial participation: The researchers created a bespoke question: 'What motivated you to first participate at parkrun as a runner or walker?' Respondents could select a maximum of three motives from the 20 offered or 'other' and a free-text box.

Impact of participation: The researchers created a bespoke question: 'Thinking about the impact of parkrun on your health and wellbeing, to what extent has running or walking at parkrun changed:' Respondents were given 15 possible responses (plus 'Other' and a free-text box) with possible answers 'much worse, worse, no impact, better and much better'.

Open text comments: Open text responses were prompted by the following: "If there is anything else you would like to mention about the impact of parkrun on your health and wellbeing, please insert your comments here."

Demographics

Respondents were matched to the parkrun database to give age, gender, years registered, number of parkruns completed, mean 5 km time in minutes, index of multiple deprivation (IMD: derived from postcode provided at registration) and activity level at registration.

Participants were segmented by 5 km time from front runners with mean 5 km times <20 minutes to walkers with mean 5 km times ≥50 minutes. Ten categories 2.5 minutes wide were

used to categorise participants ≥20 and <45 minutes, plus a further category 5 minutes wide for runners/walkers:| this made 13 categories in all. This segmentation was used to assess the prevalence of CVD-related conditions from fastest to slowest parkrunner using the median time for each category.

Quantitative data: statistical analysis

Data were initially assessed using Microsoft Excel (for Mac v 16.46) using descriptors (counts, averages, ranges, skewness and kurtosis) and duplicates were removed by searching for identical combinations of age, gender, home parkrun and parkrun. Free text was redacted to remove any personally identifying words. The analysis included only those who identified as runners/walkers or runners/walkers who volunteer: those who volunteered only were excluded. Not all questions were compulsory and matching of survey data to parkrun data was not total. Thus, counts vary for each question are specified in all tables.

Responses for the impact question were dichotomised into 'not improved' (0: 'much worse', 'worse' and 'no impact') and 'improved' (1: 'better' and 'much better').

Those who answered 'no' to the health conditions question were coded as 0; those who answered 'yes, limited a little' or 'yes, limited a lot' were coded as 1. The following conditions (using the survey descriptors) were selected as CVD-related conditions:

1. Coronary artery disease (including angina, peripheral vascular disease)
2. Heart condition inc. arrhythmia (abnormal heart rate) or atrial fibrillation (irregular heart rate)
3. Heart failure
4. Stroke (trans-ischemic attack and cerebrovascular accident)
5. Venous thromboembolism (deep venous thrombosis & pulmonary embolism)

Individuals who were identified as having a CVD-related condition were compared to those reporting no health conditions. Averages were compared using Mann-Whitney U tests with effect size calculated using $r=Z^2/n$, where Z is the standardised test statistic and n the number of ranked respondents.[19] Differences between categorical data were calculated using the χ^2 test with effect size calculated using $\varphi_C=\chi 2/n(k-1)$ where $\chi 2$ is the test statistic, n is the number of respondents and k-1 is the number of rows or columns (whichever is the smaller).

Qualitative data: thematic analysis

Open-text comments were extracted for thematic analysis if they had one or more CVD-related condition using Microsoft Excel v26. The approach was an iterative process carried out by author SH as follows:

1. Familiarisation with the data by reading through the comments several times.
2. Creation of a conceptual framework of *a priori* themes generated by selecting the most commonly selected motives (e.g., fitness), the impacts showing greatest proportions with improvement (e.g., sense of personal achievement) and those impacts or motives where statistical analysis showed differences between those with CVD-related conditions and no conditions (e.g., being active in a safe environment).
3. Re-reading of the comments and allocation of quotes to the *a priori* themes.
4. Reviewing and revising the *a priori* themes including generation of additional themes arising from the data.
5. Additional reading of the comments to allocate appropriate verbatim quotes to sub-themes.
6. Re-reading of the comments and quotes to check intra-theme and intra-sub-theme consistency.
7. Removal of themes with zero comments, and collapse of smallest themes into larger ones where relevant.

Comments were categorised into *new* parkrunners (registered 2 years or less) or *long-term* parkrunners (registered more than 2 years). Their participation was categorised as *occasional* (1-4 parkruns per year), *regular* (5-12 parkruns per year), or *committed* (>12 parkruns per year). The number of parkruns per year was only calculated for those registered at least a year (since periods less than one year tended to give artificially large values).

RESULTS

Demographics

There were 445 CVD-related conditions from 404 participants or 0.7% of the total sample (Table 1, supplementary file S1); 53,967 reported that they had no health conditions. Of those with CVD-related conditions, 37% had arrhythmia or atrial fibrillation, 24% had coronary

artery disease, 23% had a stroke, 20% had heart failure and 6.1% had venous thromboembolism.

Table 1. Demographics of participants with CVD-related conditions (lasting 12 months or more) compared to participants with no health conditions for runners/walkers and runners/walkers who volunteer. Counts are given to indicate how many answered each question since not all questions were compulsory.

		No health conditions	All cardiovascular disease-related conditions	Coronary Artery disease (including angina peripheral vascular disease)	Heart condition (inc. arrhythmia (abnormal heart rate) or atrial fibrillation (irregular heart rate)	Heart failure	Stroke (trans-ischemic attack and cerebrovascular accident)	Venous thromboembolism (deep venous thrombosis & pulmonary embolism)
Age	*n*	53,625	401	95	149	80	93	25
	Median (interquartile range)	48.6 (18.5)	62.9 (15.5)	65.0 (11.1)	63.7 (17.3)	63.8 (15.9)	60.2 (12.7)	56.9 (14.9)
	Mean (standard deviation)	47.64 (13.00)	60.86 (11.37)	64.09 (8.53)	60.95 (12.41)	61.48 (11.76)	58.89 (11.31)	56.17 (9.20)
	p		<0.001	<0.001	<0.001	<0.001	<0.001	0.001
	Test statistic		19.44	11.98	11.70	9.05	8.12	3.35
	Effect size		0.08	0.05	0.05	0.04	0.04	0.01
Gender	*n*	42,146	325	76	124	58	78	21
	% female	51.4%	24.6%	15.8%	24.2%	10.3%	34.6%	42.9%

% male			75.4%	84.2%	75.8%	89.7%	65.4%	57.1%
p			<0.001	<0.001	<0.001	<0.001	0.003	0.436
Test statistic			92.30	38.41	36.51	38.99	8.73	0.61
Effect size			0.04	0.03	0.03	0.03	0.01	0.00
IMD	*n*	41,632	319	75	117	60	78	21
	Q1	9.2%	8.8%	5.3%	6.8%	10.0%	10.3%	14.3%
	Q2	20.2%	19.4%	18.7%	23.9%	20.0%	20.5%	9.5%
	Q3	30.0%	36.1%	34.7%	36.8%	41.7%	37.2%	14.3%
	Q4	40.6%	35.7%	41.3%	32.5%	28.3%	32.1%	61.9%
	p		0.119	0.598	0.160	0.174	0.420	0.119
	Test statistic		5.86	1.88	5.16	4.98	2.18	5.86
	Effect size		0.01	0.01	0.01	0.01	0.01	0.01
Activity level at registration	*n*	38,614	284	69	104	53	72	17
	<1	4.9%	5.6%	1.4%	3.8%	1.9%	11.1%	11.8%
	≈1	11.4%	9.5%	5.8%	9.6%	11.3%	15.3%	5.9%

≈2	22.9%	20.1%	18.8%	16.3%	20.8%	19.4%	23.5%
≈3	33.9%	31.0%	34.8%	26.0%	32.1%	36.1%	35.3%
≥4	27.0%	33.8%	39.1%	44.2%	34.0%	18.1%	23.5%
p		0.099	0.098^	0.003	0.719^	0.055^	0.700^^^
Test statistic		7.79	7.84	15.85	2.09	9.27	2.20
Effect size		0.01	0.01	0.02	0.01	0.02	0.01
Total parkruns *n*	41,277	320	75	123	57	76	21
Median (interquartile range)	21 (56)	20.5 (93)	12 (95)	25 (97)	17 (81)	17 (66)	17 (44)
Mean ± standard deviation	46.03 (60.84)	58.22 (4.31)	49.48 (64.99)	61.85 (76.64)	53.25 (70.45)	53.04 (77.26)	51.33 (73.98)
p		0.194	0.305	0.152	0.939	0.696	0.962
Test statistic		1.30	1.026	1.43	0.077	0.39	0.05
Effect size		0.01	0.01	0.01	0.00	0.00	0.00
Years registered *n*	42,146	325	76	124	58	78	21
Median (interquartile range)	2.62 (3.86)	3.26 (4.52)	2.86 (4.02)	4.14 (5.01)	2.52 (4.47)	2.10 (4.57)	1.31 (4.09)
Mean ± standard deviation	3.13 (2.52)	3.68 (2.95)	3.50 (2.77)	4.25 (3.07)	3.23 (2.71)	3.06 (2.81)	2.91 (2.94)

p		0.003	0.258	<0.001	0.916	0.510	0.497
Test statistic		2.97	1.13	4.09	0.11	0.66	0.680
Effect size		0.01	0.01	0.02	0.00	0.00	0.00
Parkruns per year (only those registered > 1 year) *n*	30,909	251	60	106	43	53	15
Median (interquartile range)	11.3 (19.2)	12.4 (20.4)	8.82 (19.5)	11.3 (19.0)	12.4 (20.3)	12.9 (23.4)	11.5 (22.1)
Mean ± standard deviation	14.62 (12.12)	14.63 (12.43)	12.66 (12.46)	14.03 (12.55)	14.30 (11.66)	15.18 (12.60)	15.46 (13.27)
p		0.631	0.070	0.311	0.917	0.909	0.815
Test statistic		0.48	1.81	1.01	0.10	0.11	0.234
Effect size		0.00	0.01	0.01	0.00	0.00	0.00
Activity level at survey *n*	53,898	403	96	150	80	93	25
<1	2.5%	5.5%	3.1%	4.7%	6.3%	8.6%	8.0%
≈1	6.5%	8.2%	7.3%	7.3%	13.8%	7.5%	12.0%
≈2	16.4%	15.6%	10.4%	17.3%	20.0%	12.9%	16.0%
≈3	31.0%	27.5%	19.8%	29.3%	23.8%	31.2%	36.0%
≥4	43.6%	43.2%	59.4%	41.3%	36.3%	39.8%	28.0%

p		0.002	0.020	0.511	0.007	0.005	0.218
Test statistic		17.08	11.63	3.29	13.95	14.69	5.76
Effect size		0.02	0.02	0.01	0.02	0.02	0.01
Activity change between registration and survey *n*	38,570	282	69	103	53	72	17
Decreased	16.0%	21.3%	14.4%	27.2%	33.1%	11.2%	29.4%
-4	0.2%	0.7%	0.0%	1.0%	0.0%	1.4%	0.0%
-3	0.9%	1.1%	1.4%	2.9%	0.0%	1.4%	0.0%
-2	3.0%	7.8%	5.8%	7.8%	17.0%	4.2%	5.9%
-1	11.9%	11.7%	7.2%	15.5%	15.1%	4.2%	23.5%
No change	42.4%	42.4%	50.7%	42.7%	39.6%	41.7%	41.2%
1	27.0%	26.5%	29.0%	22.3%	20.8%	34.7%	11.8%
2	10.5%	7.1%	5.8%	4.9%	3.8%	9.7%	11.8%
3	3.2%	1.8%	0.0%	1.9%	1.9%	1.4%	5.9%
4	0.8%	1.1%	0.0%	1.0%	1.9%	1.4%	0.0%
Increased	41.3%	36.5%	34.8%	30.1	28.4	47.2%	29.5%

p		<0.001	0.356^^	0.008^^	<0.001^^	0.156^^	0.802^^
Test statistic		29.65	8.84	20.60	39.08	11.90	4.57
Effect size		0.03	0.02	0.02	0.03	0.02	0.01
Life satisfaction *n*	53,967	404	96	151	80	93	25
Median (interquartile range)	8 (2)	8 (2)	8 (2)	8 (2)	7.5 (2)	8 (2.5)	8 (2)
Mean ± standard deviation	7.84 (1.40)	7.43 (1.79)	7.64 (1.74)	7.39 (1.62)	7.04 (1.96)	7.30 (2.08)	7.08 (2.08)
p		<0.001	0.380	0.002	<0.001	0.015	0.058
Test statistic		4.18	0.88	3.15	3.67	2.44	1.90
Effect size		0.02	0.00	0.01	0.02	0.01	0.01
Health VAS 0-100 *n*	51,577	384	95	143	72	90	24
Median (interquartile range)	85 (15)	75 (19)	73 (15)	75 (15)	70 (20)	75 (20)	72.5 (19)
Mean ± standard deviation	82.14 (11.67)	71.15 (15.58)	72.12 (13.98)	72.81 (14.75)	67.35 (15.54)	68.29 (17.63)	67.71 (17.44)
p		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Test statistic		15.04	7.43	8.12	8.45	8.32	4.72
Effect size		0.07	0.03	0.04	0.04	0.04	0.02

SWEMWBS *n*	50,763	371	87	139	69	85	24
Median (interquartile range)	25.0 (4.68)	24.1 (6.3)	25.0 (4.7)	24.1 (5.5)	24.1 (5.8)	23.2 (5.3)	24.1 (7.5)
Mean ± standard deviation	25.02 (4.14)	24.27 (4.41)	25.12 (4.14)	24.34 (4.18)	24.00 (4.52)	23.39 (4.48)	23.62 (4.76)
p		0.001	0.764	0.073	0.036	<0.001	0.181
Test statistic		3.38	0.30	1.79	2.10	3.75	1.34
Effect size		0.01	0.00	0.01	0.01	0.02	0.01

^10% cells have expected count less than 5;^^ 27.8% of cells have expected count less than 5; ^^^40% of cells have expected count less than 5.

Table 1 shows that participants with CVD-related conditions compared to those with no health conditions tended to be older (median 62.9 vs 48.6 years), male (75.4 vs 51.4%), and registered longer with parkrun (median 3.3 vs 2.6 years) and completed a similar number of parkruns per year (11 and 12 respectively). The IMD profile did not differ between groups, with greater than two thirds of all respondents in the two least deprived quartiles. Activity levels at registration were similar for both groups with 35.2% of those with CVD-related conditions doing less than three days of physical activity per week.

Figure 1 shows the prevalence of CVD-related conditions for males and females segmented by 5 km completion time (see also Table 3, supplementary file S1). The number of participants is shown in Figure 1a, the number of participants with CVD-related conditions in Figure 1b, and the ratio between them in Figure 1c (i.e., the proportion with a CVD-related condition). Figures 1a and 1b show that the number of male participants reached a peak at around 30 minutes, while for females, it reached a peak around 35 minutes. The distribution for both genders had positive skew with a tail of runner/walkers and walkers. Figure 1c shows that the proportion of those with CVD-related conditions increased with completion time to 24% of male walkers and 5% of female walkers.

Physical activity, health and wellbeing

Both individuals with CVD-related conditions and those with no health conditions showed increased levels of physical activity (Table 1). Specifically, 36.5% of those with CVD-related conditions increased their physical activity levels while 41.3% of individuals with no health conditions reported an increase. Conversely, 21.3% of those with CVD-related conditions reported a decrease in physical activity which was higher than those with no health conditions (16.0%).

Further analysis (Table 2 in supplementary file S1) shows that, of the 35.2% with CVD-related conditions doing <3 days of activity per week at registration, 47.5% of them increased their activity to 3 or more days per week by the time of the survey.

Compared to those with no health conditions, having a CVD-related condition was associated with reduced scores of life satisfaction (7.43 vs 7.84), health VAS (71.15 vs 82.14) and mental wellbeing (24.27 vs 25.02), although effect sizes tended to be small.

Motives

Figure 2a shows motives for first participating in parkrun for those with CVD-related conditions compared to those with no health conditions (see also Table 4, supplementary file S1). The most frequently chosen motives for both groups were 'to contribute to my fitness' and 'to contribute to my physical health'. In addition, individuals with CVD-related conditions commonly reported using parkrun as a means to managing their health condition, disability or illness (26%). This group were also motivated 'to be active in a safe environment' (8%) compared to 4% of those with no health condition. They were also more likely to choose 'a health professional advised me to', although this was only 2% of the cohort. Conversely, those with CVD-related conditions were less likely to choose 'to contribute to my fitness' (49 vs 57%) and 'to get a recorded time for a 5k' (12 vs 22%).

Figure 2b compares motives for females and males with CVD-related conditions; due to low numbers, statistical significance was set at $p<0.05$. There were common motives between males and females including a desire to improve physical health and manage their health conditions. However, some motivational differences were identified. Specifically, females selected more frequently than males 'my friends, family or colleagues encouraged me to' (15 vs 7%) and 'to be active in a safe environment' (14 vs 5%). Males selected more frequently than females 'to compete with others' (14% vs 3%).

Perceived impact of parkrun participation

Figure 3 shows the proportions of respondents reporting improvements in a range of outcomes (see also Table 5, supplementary file S1). The largest proportions reporting improvements reflect the most commonly selected motives, i.e., 'fitness', 'physical health' and a 'sense of personal achievement'. Two thirds of those with CVD-related conditions reported improvements in the management of their condition, disability or illness and half improved their ability to control their weight and lifestyle choices.

The presence of a CVD-related condition (Figure 3a) reduced the proportions reporting improvements for all but one measure ('the number of new people you meet', although not significantly different), in comparison to those without a health condition. Specifically, proportions were lower for those with a CVD-related condition compared to those with no health conditions for the following: 'fitness' (81 vs 90%), 'a sense of personal achievement' (78 vs 91%), 'mental health' (59 vs 69%), 'enjoyment of competition' (61 vs 74%), 'happiness' (71 vs 79%) and 'confidence' (53 vs 61%).

Figure 3b compares perceived impact for females and males with CVD-related conditions; due to the low numbers, statistical significance was set at $p<0.05$. Females with CVD-related conditions were more likely than men to select improved 'mental health' (73 vs 54%), 'the ability to spend more time outdoors' (81 vs 65%) and 'be active in a safe environment' (69 vs 50%). In comparison, more males than females identified the 'enjoyment of competing' as an impact (65% vs 51%).

Qualitative outcomes: thematic analysis

Open text comments were received from 53 participants with CVD-related conditions (13% of those reporting CVD-related conditions). Almost half of the comments came from those who were new parkrunners (registered <2 years) and there was a mix of occasional (19), regular (7) and committed (16) participants. Six themes were identified: (1) community; (2) fitness; (3) encouragement; (4) enjoyment; (5) managing the health condition; and (6) performance. Table 2 outlines the themes and sub-themes and gives sample verbatim quotes.

Comments on community from both new and long-term parkrunners reflected views about the social context, parkrun's overarching atmosphere, philosophy and inclusiveness, the camaraderie, and the commitment it engenders (Table 2.1, a-d). Parkrun was considered a general way to keep fit and active, regardless of whether the participant was using it for rehabilitation or not (Table 2.2).

Participants often mentioned encouragement from others at parkrun and encouragement from health professionals was mentioned, for instance: "both my cardiologist and GP support me doing this activity". Enjoyment was commented upon by many (e.g., "Park run give me a feel good factor" (*sic*)) while a feeling of satisfaction was found for at least one participant in the process of rehabilitation: "After quite a heavy operation in April I have been very pleased to be able to return to park running".

The theme of 'managing my health condition' showed evidence of rehabilitation at parkrun with medication being balanced with fitness with one participant (ID 47443) describing how participation in parkrun had led to reductions in medication following a lowered resting heart rate.

Table 2. Theme and sub-themes from analysis of 53 participants with CVD-related conditions (see supplementary file S2). Sample full unedited comments are shown with quotes in bold identifying the part relevant to the theme and sub-theme (comments could appear in more than one theme but only in one sub-theme within them).

Theme	**Sub-themes**	**Full comments**	**Participant characteristics**
1. Community: value placed on being part of the parkrun community (n=16)	a. Belonging to a community(n=6)	"I had a major heart attack / cardiac arrest two years ago from which I all but died. It has been a long road back to health. My GP recommended Parkrun to me. **It's a fantastic organisation** and has made an immense difference to my recovery in terms of my overall health, fitness, confidence, well being etc. **The camaraderie and support of the participants has been invaluable**, and I appreciate the new friends I've made though it. I'd recommend it to anyone and I hope my survey answers convey all this adequately!" Participant 69735	• New committed parkrunner • Male, 58 years old, IMD Q4 • Heart failure • 69 parkruns in 2.0 years • From ≥4 to ≈2 days per week • Evidence of rehabilitation at parkrun
	b. Taking part with other people (n=6)	"well organised event ever week with no pressure or onus to attend .**great social outing amazing amount of different people you meet** .help to keep your fitness level up with the add incentive to compete against the clock ." Participant 87977	• New committed parkrunner • Male, 63 years old, IMD Q2 • Heart condition (inc. arrhythmia/AF) • 72 parkruns in 2.1 years • ≈2 to ≈2 days per week
	c. Commitment to the community (n=2)	"**There is a commitment to take part, and to volunteer, for your self and for others**." Participant 1606	• Long-term occasional parkrunner • Female, 63 years old • Heart condition (inc. arrhythmia/AF) • 21 parkruns in 6.5 years • ≈2 to ≈3 days per week

	d. Perceived inclusivity of the community (n=2)	"I live in [ ] Canada. The nearest Parkrun is a 30 minute drive away at [ ]. I am hoping there will be a Parkrun that opens closer to my home ([ ]) so that I won't have to drive to get to it. I would love it to be part of "my" neighbourhood, and will definitely volunteer as well as run. **I love the philosophy and inclusiveness of Parkrun.** I would like to see more walkers, families, jogger-walkers taking part. Right now most participants are pretty competitive, and the walkers do not come back." Participant 86833	• Long-term occasional parkrunner • Female, 63 years old, IMD Q4 • Coronary artery disease • 10 parkruns in 4.2 years • ≈2 to ≈3 days per week
2. Fitness: using parkrun to build fitness (n=15)	a. Perceived improvements to general health (n=8)	"Having been a runner for many years the ageing process and medical conditions i have prevented me from enjoying my running as much as i used to. Fortunately **parkruns have enabled me to keep fit and active as well as all the other benefits**." Participant 25297	• Long-term committed parkrunner • Male, 74 years old, IMD Q3 • Heart condition (inc. arrhythmia/AF) and hypertension • 136 parkruns in 6.4 years • ≥4 to ≥ 4 days per week
	b. parkrun for rehabilitation (n=4)	"As I am in phase 4 of my Cardiac Rehab, **using parkrun to measure improvements to my fitness**." Participant 27647	• Long-term occasional parkunner • Male, 66 years old, IMD Q3 • Heart condition (inc. arrhythmia/AF) and heart failure • 5 parkruns in 5.9 years • ≥4 to ≥ 4 days per week • Evidence of rehabilitation at parkrun
	c. With fitness comes confidence (n=3)	"From a position of low confidence after a heart attack I now feel able to turn up to a Park Run and take part without any problems. **This brings together fitness, ability and confidence**. I can turn up on my own or with friends. I have met and made new friends as a result of getting involved in running at a Park Run." Participant 28374	• New occasional parkrunner • Male, 64 years old, IMD Q4 • Coronary artery disease • 5 parkruns in 1.2 years • ≥4 to ≥ 4 days per week • Evidence of rehabilitation at parkrun

3. Encouragement: support to take part in parkrun (n=13)	a. Parkrun as a whole (n=5)	"The Joy of Park Run is the all inclusive feel it brings to me , as **people of all abilities and walks of life all feel to be in one big happy group encouraging each other** , to run , jog or walk its such a nice feeling ." Participant 59676	• Long-term committed parkrunner • Male, 58 years, IMD Q1 • Heart condition (inc. arrhythmia/AF) • 77 parkruns in 5.2 years • ≈2 to ≈2 days per week
	b. Social support to take part (n=4)	"Even though I can no longer run (Heart failure) parkrun still give me the opportunity to walk with like minded parkrunners**. Lots of support from everyone**. LOVE IT." Participant 2632	• Long-term committed parkrunner • Male, 71 years old, IMD Q4 • Heart failure • 302 parkruns in 8.4 years • 2 days per week at survey
	c. Supported by health professionals (n=5)	"Since starting park run I feel much fitter. **Both my cardiologist and GP support me doing this activity.** I have noticed that my heart rate has dropped, so much so that I have now been taken off bisoprolol (beta blockers)." Participant 85927	• Coronary artery disease • ≥4 days per week at survey • Evidence of rehabilitation at parkrun • No other data available
4. Enjoyment: parkrun's feel-good factor (n=13)	a. parkrun elicits feelings of joy (n=10)	"**Park run give me a feel good factor** after the event that last all day". Participant 27950	• Male, 49 years old, IMD Q3 • Heart condition (inc. arrhythmia/AF) • New committed parkrunner • 5 parkruns in 0.8 years • <1 to ≈3 days per week
	b. parkrun provides a sense of satisfaction (n=3)	"After a quite heavy operation in April **I have been very pleased to be able to return to park running** with only a slight deterioration in my time." Participant 24017	• New regular parkrunner • Male, 84 years old, IMD Q4 • Heart condition (inc. arrhythmia/AF) and hypertension • 7 parkruns in 1.1 years

			• ≥4 to ≈1 day per week • Evidence of rehabilitation at parkrun
5. Managing health conditions: using parkrun to help monitor and manage (n=12)	a. Managing conditions (n=6)	"**My resting heart rate has fallen to the low 40's from the mid 50's since starting parkrun. After consultation my my GP, he reduced my dose of bisoprolol** (beta blocker) from 5.0mg to 2.5mg and then to 1.25mg (each time failed to increase my heart rate. I have now been taken off the beta blocker completely and recording a heart rate in the low 50's. My cardiologist is investigating bradycardia but suggests the low heart rate is probably due to increased fitness levels." Participant 47443	• New regular parkrunner • New committed parkrunner • Male, 61 years old, IMD Q4 • Coronary artery disease • 41 parkruns in 1.0 years • ≥4 to ≥4 days per week • Evidence of rehabilitation at parkrun
	b. Monitoring conditions (n=6)	"I had a pacemaker fitted 14 months ago. Swimming was my sport, but pacemakers do not respond to swimming exercise, they better respond to demands from running. In consultation with cardiology, I completed the NHS C25K course as I used to be a runner, though at my age I would prefer a non impact sport. **It seemed logical to try some parkruns to sort of benchmark my progress.** At home I have a flat 5.4K course that I try and complete 3-4 times a week. I am still listening to the C25K week 9 podcast. The pacemaker does limit how fast I can run as if I push myself I hit a brick wall where the computer limits my maximum pulse rate to 135bpm. I had a cold recently that stopped me running for 10 days, it took 4 runs to recover to my normal running times." Participant 23245	• Male 67 years old, IMD Q1 • Heart condition (inc. arrhythmia/AF) • 3 parkruns in 0.5 years • ≈2 to ≈3 days per week • Evidence of rehabilitation at parkrun
6. Performance: participating against the clock (n=11)	a. Feelings of frustration (n=5)	"**I was so slow it depressed me,** ur perhaps that was me, not the way I was treated." *Participant 15513*	• New parkrunner • Female, 75 years, IMD Q3 • Coronary artery disease • Registered 1.9 years • ≈3 to ≥4 days per week

	b. Competing against yourself (n=3)	"I had heart attack on 4 September and now on appropriate medication. I am slowly building back up my fitness mainly through walking. Will start cycling and golf this week. **My goal is to resume park run and better my previous best time.**" *Participant 22060*	• New occasional parkrunner • Male, 62 years old, IMD Q2 • Heart failure • 3 parkruns in 1.0 years • ≈3 to ≈3 days per week • Evidence of rehabilitation at parkrun
	c. parkrun as a low-pressure environment (n=3)	"**A less competitive environment (than a race)** has enabled me to check on my health progress following a heart procedure, and it's side effects." *Participant 5687*	• Long-term occasional parkrunner • Male, 59 years old, IMD Q2 • Heart condition (inc. arrhythmia/AF) • 6 parkruns in 5.4 years • ≈2 to ≈2 days per week • Evidence of rehabilitation at parkrun

Finally, comments about competition revealed how some participants felt they were competing against themselves or about the feeling that parkrun was a low-pressure environment. Some with CVD-related conditions, however, were frustrated at their poor performance with one participant saying, “I was so slow it depressed me”.

DISCUSSION

Our analysis identified 0.7% of parkrunners reporting CVD-related conditions, demonstrating that this population do participate in parkrun, albeit with a much lower disease prevalence than the general population.[20] Given that heart disease effects 8.5% of men and 5.4% of women in the UK [7], individuals with CVD-related conditions are under-represented in parkrun. Barriers to parkrun adoption by both individual and healthcare professionals may include the perception that parkrun is for individuals who are already fit, combined with a potential fear of disease exacerbation. In the current survey only 2% said that parkrun was recommended by a healthcare professional. Despite this, our qualitative analysis revealed that encouragement from healthcare professionals was an important motivation for participation, allowing them to monitor fitness, physiological changes such as resting heart rate, and the reduction of medication usage.

Since the survey, the Royal College of GPs and parkrun have set up ‘parkrun practice’ with around 1800 GP practices in the UK registered; the aim is for GP practices to recommend parkrun to their patients.[23] Encouragement and monitoring by healthcare professionals could mitigate for health-related risks and give individuals the confidence to participate. Further research should investigate the perceived barriers to increased physical activity, both for individuals with CVD and healthcare professionals prescribing exercise.

Three-quarters of parkrunners with CVD-related conditions were males, despite an equitable split of respondents in the overall survey. While there were several similarities in the motivations for taking part in parkrun between genders (i.e., improve physical health, improve fitness), important differences were observed. Males were more motivated to engage in parkrun for competition, while females were motivated by exercising in a safe environment, being outdoors and improving their mental health. These gender differences must be considered when promoting self-managed cardiac rehabilitation and referring patients to parkrun. Further qualitative research is needed to explore these differences in-depth to identify the individual, social and environmental factors that impact males and females with CVD-related conditions engaging in parkrun.

The proportion of individuals with CVD-related conditions increased with 5 km completion time, with almost a quarter of male walkers reporting CVD. The benefits of walking for those with CVD have been found to be largely similar to those of running [21] and parkrun's introduction of 'parkwalking' [22] could be used to attract those with CVD who would otherwise be deterred. Analysis of the open-text comments suggested that some individuals with CVD-related conditions were using parkrun as part of their rehabilitation, either joining following the onset of a medical condition, or returning to parkrun to try to restore previous levels of fitness and health. These individuals reported using parkrun as a focal point to manage and monitor their health, driving confidence and commitment to continue. Feeling part of a community and the social aspects of parkrun were important contributors to their enjoyment.

The ACSM suggests that those in cardiac rehabilitation should do 20-60 minutes of aerobic exercise 3 to 5 days per week.[5] Two thirds of those with CVD-related conditions already undertook 3 or more days of activity per week at parkrun registration, representing a relatively active cohort. Of those undertaking less than 3 days per week at registration, almost half reported an increase in activity levels in line with the ACSM recommendations. The vast majority reported improvements in their fitness and physical health following engagement in parkrun, two of the primary motivations for participation. About half of those with CVD-related conditions reported improvements in their ability to control their weight and their overall lifestyle choices, such as diet and smoking. Furthermore, two thirds of individuals felt that engagement in parkrun enabled them to better manage their health condition. Thus, parkrun may successfully address core elements of cardiac rehabilitation [4], with the additional benefit of longevity, since parkrun engagement typically lasts years rather than months, far beyond most rehabilitation programmes.

Strengths and limitations

This is the first to study to explore whether parkrun is a suitable activity for those with CVD-related conditions and the extensive nature of the survey provides high volume data for both quantitative and qualitative analysis. However, survey responses are limited by their subjective nature and a selection bias reflecting the attitudes of individuals more likely to respond to surveys. As such, the responses obtained may not reflect the overall parkrun population; for example, 13.1% of all parkrun registrants derive from the most deprived IMD quartile compared to 9.2% in this study. Differences between the CVD-sample, the no-health conditions sample and the male/female sample could be confounded by differences in

demographic for each sub-sample. Binomial logistic regression modelling (see Tables 5 and 6, supplementary file S1) indicated that, when these were accounted for, the conclusions of this paper are not changed.

CONCLUSIONS

Individuals with CVD-related conditions participate in parkrun; however, there is scope to increase adoption, especially for females. Engagement in parkrun resulted in enhanced fitness and health, with two thirds reporting improvements to their ability to manage their health conditions and half their ability to manage their weight or lifestyle choices. Qualitative analysis reinforced the benefits of the community aspect of parkrun, the encouragement and confidence it gave, and the enjoyment it stimulated. Further research is needed to assess the benefits and enhance healthcare professional engagement in promoting and prescribing exercise. Parkrun, or events with similar characteristics, could support self-managed cardiac rehabilitation.

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COMPETING INTERESTS

Steve Haake is Chair and Alice Bullas and Helen Quirk are Deputy Chairs of the parkrun Research Board, while other authors are parkrun participants. For the purpose of open access, the authors have applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising from this submission.

DATA AVAILABILITY STATEMENT

The datasets used for this study can be found in the Sheffield Hallam University Research Database (SHURDA: DOI: http://doi.org/10.17032/shu-180037). Access to the full anonymised dataset is possible through the parkrun research board, as outlined in original the participant information sheet.

ETHICS STATEMENTS

Ethical approval for the study was granted by Sheffield Hallam University Research Ethics Committee on 24th July 2018 (reference ER7034346).

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FIGURE CAPTIONS

Figure 1. (a) Total count in each time category; (b) count within each time category for those with CVD-related conditions; and (c) percentage of those with a CVD-related condition as a proportion of the total in each time category (Figure 1b divided by Figure 1a).

Figure 2. Proportions selecting motives for first participating in parkrun as a runner/walker: (a) those with CVD-related conditions compared to no health conditions (* indicates differences at $p \leq 0.001$); and (b) males compared to females for those with CVD-related conditions (* indicates differences at $p < 0.05$).

Figure 3. Proportions reporting perceived improvements ('better' or 'much better') following participating in parkrun as a runner/walker: (a) those with CVD-related conditions compared to no health conditions (* indicates differences at $p \leq 0.001$); and (b) males compared to females for those with CVD-related conditions (* indicates differences at $p < 0.05$).