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REVIEW ARTICLE

Spontaneous coronary artery dissection: a systematic review of physical and psychosocial recovery following discharge from hospital

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Background Spontaneous coronary artery dissection (SCAD) is increasingly recognized as an important cause of myocardial infarction, particularly among women. Spontaneous coronary artery dissection survivors may not know what physical activity is safe and effective, and there may be a psychosocial burden of living with a SCAD diagnosis.

Objectives This review aimed to determine the evidence regarding physical activity, cardiovascular risk factors, or associated factors, and the psychosocial impact of SCAD for SCAD survivors after hospital discharge.

Design A systematic review was completed in accordance with PRISMA guidelines.

Data Sources We searched Medline, Embase, CinAHL, PsychInfo, and Google Scholar until November 2021.

Eligibility criteria for study selection Outcomes of interest were physical activity participation levels, cardiovascular risk factors and associated risk factors, and psychosocial recovery from SCAD. We included any study (qualitative or quantitative) that reported data pertinent to understanding the impact of SCAD on physical activity and psychosocial aspects of recovery. We also included papers that reported cardiovascular risk or associated risk factors where studies reported outcomes of SCAD survivors. We excluded papers that only provided information on in-hospital management. Any reports that were non-empirical were excluded.

Results The review included 28 studies. These used a range of methods. None were randomized controlled trials. There were 4167 SCAD participants although some were sourced from the same SCAD registries, so they may not be unique. They were mainly female ($n = 3897$, 93.5%, range = 57.7–100%), with mean age 48.0 ± 9.8 years at index event. Participants mostly came from the USA, Canada, or The Netherlands. We found very limited evidence for cardiorespiratory fitness improvements following cardiac rehabilitation (CR). Existing CR was not tailored to SCAD specific needs and SCAD survivors lacked guidance about appropriate physical activity. Some participants had high levels of psychosocial distress. Spontaneous coronary artery dissection survivors highlighted the need for tailored support that included family members. Many SCAD survivors have traditional risk factors including hypertension, hyperlipidaemia, and overweight/obesity. Chest pain following SCAD is common.

Conclusion There is an urgent need to develop physical and psychological recovery programmes for SCAD survivors and test effectiveness via randomized controlled trials. Psychosocial support is particularly required, given the high burden of psychosocial issues.

Data registration Prospero CRD42021254798.

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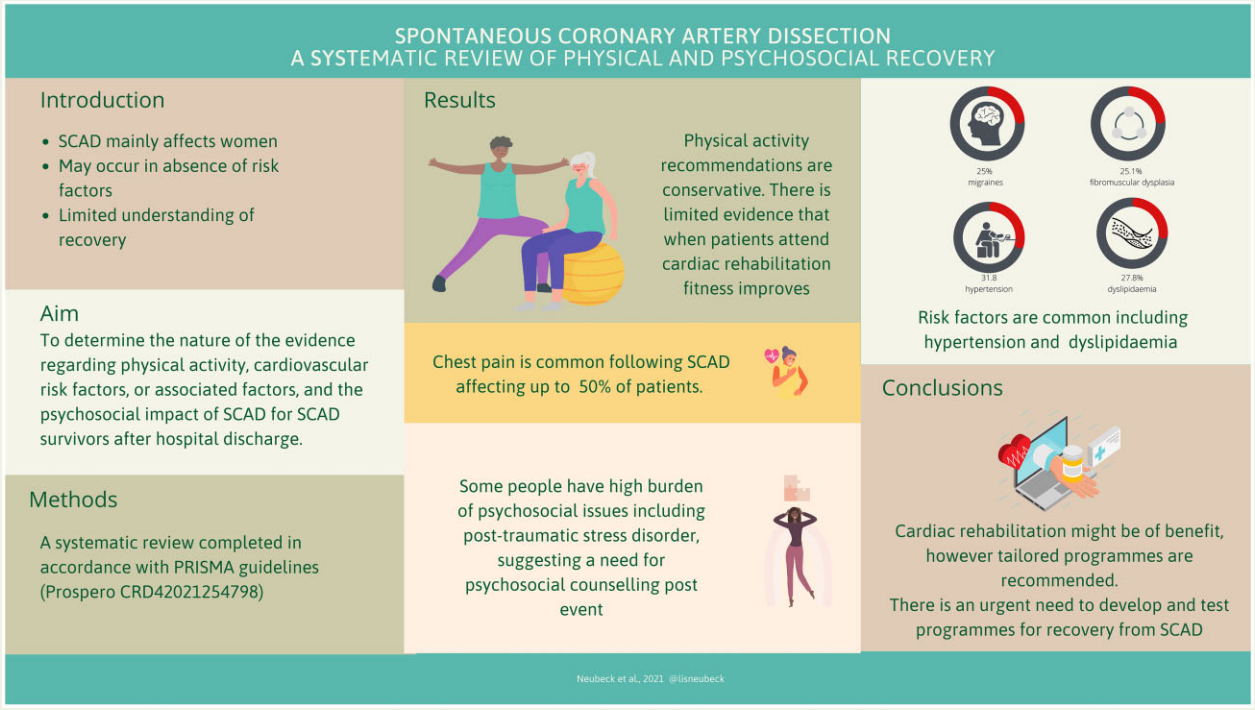
Graphical Abstract



Keywords Spontaneous coronary artery dissection • Cardiac rehabilitation • Recovery • Risk factors • Physical activity • Psychosocial health

Implications for practice

- There is limited evidence that cardiac rehabilitation is of benefit to spontaneous coronary artery dissection (SCAD) survivors.
- Exercise recommendations are conservative, but this is based on expert consensus and requires investigation.
- Psychosocial distress is common and psychosocial support is recommended.
- Risk factors are common, including hypertension, dyslipidaemia, and overweight/obesity.
- There is an urgent need to develop and test interventions for recovery from SCAD.

Introduction

Spontaneous coronary artery dissection (SCAD) is increasingly recognized as an important cause of myocardial infarction (MI), particularly among women.[1] Women make up 87–95% of SCAD events. Spontaneous coronary artery dissection is a frequent cause of MI in younger women, with reported mean age of 44–53 years age.[1] The exact mechanism of SCAD is not fully understood, but it is an acute coronary event resulting from development of haematoma within the tunica media which leads to compression of the true lumen.[1] It has been associated with fibromuscular dysplasia (FMD), a condition that causes arterial walls to become more rigid and subject to stenosis, aneurysm, and dissection.[2] Prevalence is difficult to estimate as there is no International Classification of Diseases (ICD-10) code specifically for SCAD, therefore insufficient data, and low awareness of SCAD hamper our understanding of the condition. However, global estimates suggest SCAD is the underlying cause of MI in 22–43% of women <50 years.[3]

As well as affecting younger women, SCAD is thought to occur in the absence of traditional risk factors associated with MI. Additionally, participating in strenuous physical activity has been associated with incidence of SCAD events in up to 30% of women.[4] This can lead to psychological distress, fear, and anxiety, which can have devastating and debilitating consequences for SCAD survivors. Consequently, recognizing the burden of psychological distress and providing support and ongoing management is highly recommended by leading experts in SCAD.[3] This support may include access to physical activity and psychosocial support programmes, such as cardiac rehabilitation (CR), as fear and hesitancy after a SCAD event are common and may lead to avoidance of all physical activity.[5]

Cardiac rehabilitation is a multicomponent intervention recommended after cardiac events.[6] Typically, CR includes supervised physical activity sessions, and interventions to reduce risk factors, improve psychosocial wellbeing, and increase medication adherence.[6] There is strong evidence from randomized controlled trials that CR reduces cardiac events and decreases mortality in people who have survived an MI, but this evidence is largely generated in a population with atherosclerotic disease.[7] Furthermore, most trials of CR include mostly male participants, typically aged in their mid-60s.[7] Only small studies have explored the feasibility of SCAD survivors' participation in CR.[8,9] These studies managed exercise recommendations through conservative guidance that prevented participants from exercising at pre-morbid levels. This highlights the challenges that SCAD survivors have in knowing what physical activity is safe and the psychosocial burden of living with a SCAD diagnosis.

Therefore, the aim of this review was to determine the evidence regarding physical activity, cardiovascular risk factors, or associated factors, and the psychosocial impact of SCAD for SCAD survivors after discharge from hospital.

Methods

This systematic review was completed in accordance with PRISMA reporting guidelines.[10]

Eligibility criteria

Outcomes of interest were physical activity participation levels, cardiovascular risk factors and associated risk factors, and psychosocial recovery from SCAD. We included any study (qualitative or quantitative) that reported data pertinent to understanding the impact of SCAD on physical activity and psychosocial aspects of recovery. We also included papers that reported cardiovascular risk or associated risk factors where studies reported outcomes of SCAD survivors. We excluded papers that only provided information on in-hospital management. Any reports that were non-empirical were excluded.

Information sources

We searched MEDLINE, Embase, CinAHL, PsychINFO, and Google Scholar until November 2021. No limits were applied to study design, methodology, or language. We also hand searched the reference lists of included papers. This systematic review used a pre-defined protocol registered on PROSPERO (identification number CRD42021254798).

Search strategy

We applied broad search criteria to ensure we captured all relevant literature. Search terms included SCAD OR Spontaneous Coronary Artery Dissection OR Coronary Vessel Anomalies AND Psychosocial OR Recovery OR Cardiac rehabilitation OR Psychological Distress OR Quality of life OR Activities of daily living OR Physical activity OR Post hospitalisation OR Anxiety OR Depression OR Post traumatic stress disorder. We also searched for cardiovascular risk factors, including hypertension, blood pressure, and other associated risks. Searches are detailed in Supplementary material online, *File S1*. We downloaded all references into Endnote X20 (Clarivate Analytics, Philadelphia, USA) and duplicates were removed. Two reviewers (S.M. and S.M.c.H.) screened all titles and abstracts excluding those that clearly did not meet inclusion criteria. In the case of uncertainty, records were retained. Three reviewers (L.N., S.M.c.H., and C.H.) then independently screened all titles and abstracts following the prespecified inclusion and exclusion criteria. The full texts of all retained references were then retrieved and subjected to further scrutiny. Any full texts that were subsequently excluded were listed, and a reason for their exclusion was provided.

Quality assessment

We used Joanna Briggs Institute tools to assess methodological quality of the included quantitative studies.[11] For the included qualitative studies, we ensured that COREQ checklists were available.[12]

Strategy for data extraction and synthesis

We extracted data about study and participant characteristics (location, study design, number of participants, sex, age at time of index event, age at time of study, and time elapsed between index event and study), physical activity, psychosocial outcomes, and cardiovascular and associated risk factors into customized Microsoft Excel spreadsheets (Microsoft Corporation, Bellevue, Washington DC, USA). We calculated weighted mean for age at time of index event. Given the heterogeneous nature of the included study types and study outcomes and purpose, we completed a narrative synthesis for these elements. We used a customized spreadsheet to check accuracy between number of participants with a risk factor and percentage reported. Where discrepancies of more than 1% were found ($n = 3$ studies), we emailed authors to ask for clarification. We included updated figures from author responses ($n = 3$). We reported all risk factors that were included in at least three studies and pooled data to demonstrate the overall prevalence of risk factors in SCAD survivors. For qualitative data, we undertook a thematic analysis.[13]

Results

The initial search identified 1076 titles (*Figure 1*). Forty-one papers were retrieved in full. Following detailed examination of the full reports, 1 was an editorial, 1 was an unpublished thesis, and 10 were conference abstracts with incomplete data. Therefore, 28 studies were included in the final review (Supplementary material online, *File S1*). There were 20 cross-sectional studies,[14–33] 2 case–control studies,[34,35] 4 quasi-experimental studies,[8,9,36,37] and 2 qualitative studies.[38,39] Participants in one study were healthcare professionals,[39] while the remainder were SCAD survivors. In total, there were 4167 SCAD patient participants although some were sourced from the same SCAD registries so it is possible that these are not unique participants, and in two studies, it was clear that participants were the same.[18,34] The majority of patient participants were female ($n = 3897$ 93.5%, range = 57.7–100%), mean age 48.0 ± 9.8 years at index event. Participants mostly came from the USA, Canada, or The Netherlands.

Quality assessment was conducted using three quality assessment tools[11] because of the heterogeneous nature of the studies (Supplementary material online, *File S2*). For the two qualitative studies, full COREQ[12] checklists were available. Overall, the quality of the studies was moderate. For the cross-sectional studies, recruitment was either through registries or patient forums and social media, potentially leading to selection bias. This may be evident in the low overall age of the participants. Where level of education was reported (eight studies), the majority of participants had a high level of education.[14,16–18,20,34,37,38] Indeed, in one study that compared SCAD to

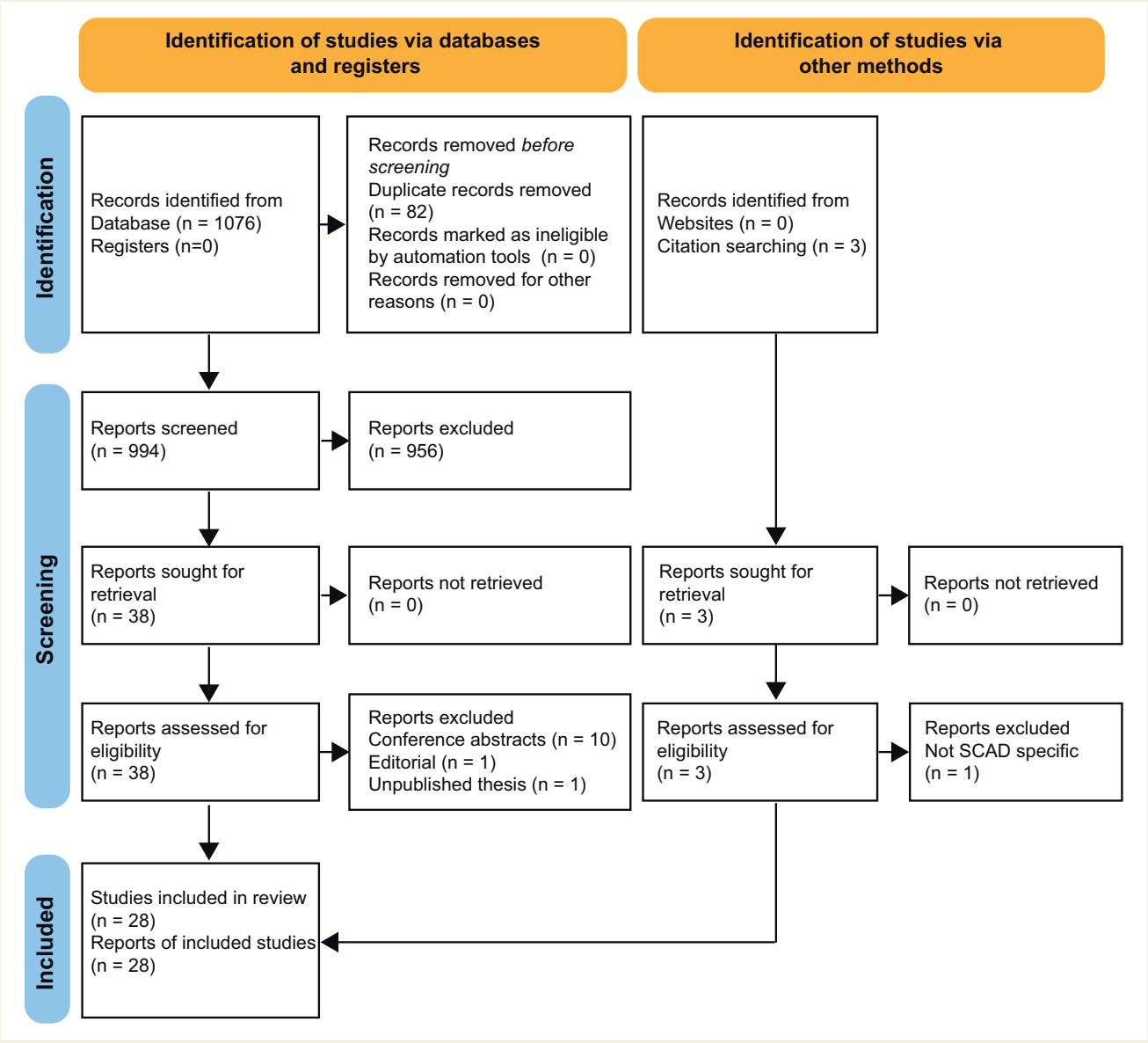


Figure 1 Prisma flow diagram. SCAD, Spontaneous coronary artery dissection.

acute coronary syndrome (ACS) patients, 56% had completed university, compared to 22% of ACS survivors.[34] Furthermore, in the 14 studies that reported ethnicity, the majority of participants were described as of White/Caucasian/European origin (median = 86.9%, range 43–98%).[8,9,14–21,28,30,31,35,37,38]

Physical activity outcomes

Nine studies provided data for physical activity outcomes (*Table 1*).[8,9,16,18–20,36,38,39] Only one study examined levels of self-reported physical activity pre- and post-SCAD. This retrospective study reported that only 44.5% ($n = 133/299$) of SCAD survivors were active prior to SCAD (the study authors defined active as undertaking at least three exercise sessions per week for ≤31 min), and 2.5 ± 3.7 years after SCAD this decreased to 36.8% ($n = 110/299$).[20] There is very limited evidence for improvements in cardiorespiratory fitness following CR. Participants in a 6-month dedicated SCAD CR programme ($n = 70$) had high cardiorespiratory fitness[40] at baseline (10.1 ± 3.3 metabolic equivalents) (METs), which increased to 11.5 ± 3.5 METS at follow-up ($P < 0.001$).[8] The same study also demonstrated a significant reduction in major adverse cardiovascular events (MACE) in the group that participated in CR compared with those who did not. Another study demonstrated increased $\dot{V}O_2$peak by 4.4 mL·kg·min^{-1}, but this study was very small ($n = 9$) so these findings should be interpreted with caution.[9] Another small study ($n = 11$) did not observe an increase in METS but did show an increase in aerobic exercise duration in minutes (26.6 vs. 40.2, $P = 0.0002$).[36] Patients expressed that CR was not tailored to their specific needs, that levels of exercise during CR were insufficient, and that they did not have clear guidance about appropriate physical activity.[14]

Table 1 **Physical activity findings**

Cross-sectional studies					
Chacin-Suarez *et al.*, 2021[20]	Self-reported activity	≥3×/week aerobic activity	≥3×/week ≥31 min/session	No aerobic activity	Strength building activities
	Pre-SCAD (retrospective)	461/950 (48.5%)	379/950 (39.9%)	158/950 (16.6%)	303/950 (32.0%)
	Post-SCAD	153/299 (51.2%)	110/299 (36.8%)	52/299 (17.4%)	59/299 (19.7%)
	PA counselling at CR	279/299 (93.3%) received PA counselling and reported non-specific advice such as 'do what feels okay within reason'.			
	Sub-analysis of participants who reported exercising ≥3×/week ≥31 min/session in pre-SCAD ($n = 133$)				
	Self-reported activity	≥3×/week aerobic activity		≥3×/week ≥31 min/session	No aerobic activity
	Post-SCAD	86/133 (64.7%)		69/133 (51.9%)	10/133 (7.5%)
Krittanawong *et al.*, 2016[16]	Self-reported activity	≥3×/week aerobic activity	<30 min/session	≥30 min/session	No aerobic activity
	Overall	171/336 (50.9%)	120/336 (35.7%)	171/336 (50.9%)	45/336 (13.4%)
	Attended CR	140/259 (54.1%)	93/259 (35.9%)	140/259 (54.1%)	26/259 (10.0%)
	No CR	31/77 (40.3%)	27/77 (35.1%)	31/77 (40.3%)	19/77 (24.7%)
	Compared with non-participants, SCAD CR participants reported higher overall duration ($P = 0.01$) and frequency ($P = 0.002$) of aerobic exercise. Of the 269 patients who participated in CR, 82% perceived physical health benefits.				
Smaardijk *et al.*, 2020[18]	Self-reported physically inactivity (<30 min of moderately intensive exercise per day) at the time of the study (mean 2.4 years after index event).				29/172 (16.8%)
Wagers *et al.*, 2018[19]		*n* (%)	Perceived programme helpfulness[a] (mean ± SD)		
	CR (including exercise)	265/367 (72.2%)	6.84 ± 3.06		
	Exercise programmes other than CR	25/367 (6.8%)	7.00 ± 3.06		
	[a]Based on 1–10 Likert scales (minimally-maximally helpful)				
Quasi-experimental studies					
Chou *et al.*, 2016[8]		Baseline	6-month follow-up	*P*	
	Functional status METS (mean ± SD)	10.1 ± 3.3	11.5 ± 3.5	<0.001	
	Chest pain *n* (%)	44/70 (62.9%)	26/70 (37.9%)	<0.001	
Imran *et al.*, 2018[36]		Baseline	Follow-up	Change	*P*
	Functional status METS ($n = 8/10$)	11.0	11.8	+0.8 ± 0.4	0.05
	Aerobic exercise duration (min) ($n = 10/10$)	26.6	40.2	+13.6 ± 2.2	0.0002
	Resistance exercise	$n = 7$ increased no. of resistance exercise modalities, $n = 1$ increased no. of repetitions, $n = 2$ increased both			
Silber *et al.*, 2015[9]	Sessions attended: mean 28 (range 5–39)	Baseline (mean ± SD)	Follow-up (mean ± SD)	Change (mean ± SD)	
	VO_{2peak} mL/kg/min ($n = 4/11$)	25.4 ± 4.1	28.2 ± 3.0	4.4 ± 3.8	
	6-min walk test (m) ($n = 5/11$)	553.3 ± 161.5	625.8.3 ± 121.4	114.3 ± 66.3	
Qualitative studies					
Bouchard *et al.*, 2020[39]	CR participation was overwhelming recommended by healthcare providers. Advice about physical activity thresholds after SCAD in CR were very conservative due to a lack of guidelines. Respondents noted that many patients had been dissatisfied with exercise regimes that were too restrictive. There were concerns about how to integrate SCAD patients into established CR since the needs of patients are different, but numbers are too small for SCAD-specific programmes.				
Bouchard *et al.*, 2021[38]	Participants suggested that pre-SCAD activity levels should be considered when developing exercise programmes to optimize CR experience. CR guidelines were considered too restrictive and did not factor in SCAD survivors' lifestyles, especially for young mothers.				

ACS, acute coronary syndrome; CR, cardiac rehabilitation; MET, metabolic equivalent; SCAD, spontaneous coronary artery dissection; SD, standard deviation; VO_2peak, peak oxygen uptake.

Table 2 **Psychosocial findings**

Cross-sectional studies

Chacin-Suarez *et al.*, 2021[20]	Worried about SCAD recurrence					418/950 (44.8%)
	Concerned about sudden cardiac death					300/950 (32.2%)
Edwards *et al.*, 2019[14]		Anxiety (STAI)	Depression (PHQ-9)	Health-related quality of life (SF-12)	Insomnia severity index (ISI)	Perceived stress (PSS)	PTSD (IES-R)
	Mean ± SD	47.8 ± 17.8	8.6 ± 5.0	43.8 ± 12.5 (MCS) 45.1 ± 6.6 (PCS)	12.1 ± 48.2	32.3 ± 3.0	27.1 ± 16.5
	Clinically significant scores	10/14 (71.4%)	5/14 (35.7%)	Not reported	8/14 (57.1%)	13/14 (92.9%)	6/14 (42.9%)
	11/14 (78.6%) had a history of mental health treatment and 8/11 (72.7%) reported diagnoses and treatment were related to SCAD. 4/11 (28.6%) had PTSD.						
Johnson *et al.*, 2020[15]	Anxiety (GAD-7 ≥ 10 = moderate/severe)		Anxiety sensitivity (ASI mean ± SD)	Depression (PHQ-9 ≥ 10 = moderate/severe)		Probable PTSD (PDS-5 > 27)	Resilience (CD-RISC)
	82/435 (16.0%)		16 ± 3	77/447 (15.0%)		40/512 (7.8%)	Median 78 IQR 67–86
	In regression analysis, younger age at time of SCAD ($P = 0.025$) and lower resilience as assessed by the SD-RISC score ($P < 0.0001$) were associated with higher PDS-5 score for measures of trauma, anxiety, and depression.						
Krittanawong *et al.*, 2016[16]		Anxiety (GAD-7)	Depression (PHQ-9)		Physical functioning (SF-36 subscale)	Role functioning-physical (SF-36 subscale)	Bodily pain (SF-36 subscale)
	Overall ($n = 354$) mean ± SD	4.7 ± 4.8	3.9 ± 3.6		80.5 ± 19.9	63.8 ± 41.1	55.5 ± 7.8
	CR ($n = 269$) mean ± SD	4.9 ± 4.7	4.0 ± 3.5		81.1 ± 18.7	63.0 ± 41.5	55.2 ± 7.5
	No CR ($n = 85$) mean ± SD	3.9 ± 4.9	4.0 ± 3.8		78.4 ± 23.4	66.5 ± 39.6	56.5 ± 8.9
		General health (SF-36 subscale)	Vitality (SF-36 subscale)		Social functioning (SF-36 subscale)	Role functioning-emotional (SF-36 subscale)	Mental health (SF-36 subscale)
	Overall ($n = 354$) mean ± SD	65.6 ± 20.9	51.9 ± 22.5		78.9 ± 24.3	78.2 ± 35.8	73.7 ± 15.7
	CR ($n = 269$) mean ± SD	65.3 ± 20.8	52.4 ± 22.5		78.8 ± 24.5	78.2 ± 36.0	72.9 ± 16.0
	No CR ($n = 85$) mean ± SD	66.2 ± 21.2	50.6 ± 22.7		79.4 ± 23.8	78.0 ± 35.5	76.3 ± 14.4
	Of the 269 patients who participated in CR, 75% perceived emotional benefits.						
Liang *et al.*, 2014[17]		Anxiety (GAD-7) ($n = 155$)			Depression (PHQ-9) ($n = 158$)		
	Mean ± SD	4.7 ± 5.1			4.1 ± 3.9		
	Since their SCAD event, 51/158 (33%) reported receiving treatment for depression and 57/158 (37%) for anxiety. In univariate analysis, younger age ($P = 0.02$) and peripartum SCAD ($P < 0.005$) were associated with higher PHQ-9 ($P = 0.04$) and GAD-7 scores.						
Smaardijk *et al.*, 2020[18]		Anxiety (GAD-7)	Depression (PHQ-9)	Perceived stress (PSS-10)		Fatigue (FAS-10)	Positive mental well-being (MHC-SF)
	Mean ± SD	4.9 ± 4.2	4.9 ± 3.9	14.7 ± 6.8		23.4 ± 6.7	3.2 ± 0.8
	25% ($n = 43/172$) of participants reported a frequent history of burnout.						

Continued

Table 2 *Continued*

Cross-sectional studies						
Wagers *et al.*, 2018[19]		*n* (%)				Mean ± SD
	Heart health continued to be stressor in daily life-based on 1–10 Likert scales (minimally-maximally stressful)				—	6.81 ± 2.42
	Offered counselling post-SCAD			91/367 (24.8%)		—
	Offered stress management post-SCAD			36/367 (9.8%)		—
	Interested in online psychosocial education/support.			168/367 (45.7%)		—
Case–control studies						
Smaardijk *et al.*, 2021[34]		Anxiety (GAD-7 ≥ 10 = moderate/severe)	Depression (PHQ-9 ≥ 10 = moderate/severe)	Perceived stress (PSS-10 ≥ 14 = moderate/high)	Fatigue (FAS-10 ≥ 22–substantial/extreme)	Positive mental well-being (MHC-SF, mean ± SD)	Body vigilance (BVS-3, mean ± SD)
	SCAD group	21/172 (12.2%)	16/172 (9.3%)	85/172 (49.4%)	96/172 (55.8%)	3.2 ± 0.8	14.3 ± 6.3
	ACS group	10/76 (13.2%)	12/76 (15.8%)	34/76 (44.7%)	40/76 (52.6%)	3.1 ± 0.9	15.7 ± 7.3
	No significant differences for any measure between groups.						
Quasi-experimental studies						
Chou *et al.*, 2016[8]			Baseline (mean ± SD)			Follow-up (mean ± SD)	*P*
	STOP-D		13.0 ± 1.4			8.0 ± 1.7	0.046
Imran *et al.*, 2018[36]			Baseline	Follow-up		Change (mean ± SD)	*P*
	Anxiety (GAD-7) (*n* = 10)		7.2	2.8		–4.4 ± 3.3	.03
	SF-36 MCS (*n* = 9)		43.6	53.1		9.5 ± 0.4	.04
	SF-36 PCS (*n* = 9)		42.2	51.1		8.9 ± 3.5	.01
	Depression (PHQ-9)		4.6	2.5		Not reported	Not significant
Silber *et al.*, 2015[9]	Depression: PHQ-9 scores (*n* = 7) reduced by mean of 2.3 points. Baseline and follow-up scores not reported.						
Vaca *et al.*, 2021[37]	Completed all measures (*n* = 5)			Anxiety (STAI) mean ± SD		Depression (PHQ-9) mean ± SD	
	Baseline			50.8 ± 10.3		8.3 ± 3.0	
	Post-treatment (8 weeks)			51.7 ± 8.6		9.4 ± 4.3	
	3-month follow-up			42.6 ± 8.3		6.3 ± 4.8	
	6 participants (86%) reported baseline anxiety scores above the clinical threshold						
Qualitative studies						
Bouchard *et al.*, 2020[39]	Participants considered it essential to address psychological needs and stressors and increase available access to psychological support. Healthcare providers noted that it was difficult to provide reassurance to patients, while simultaneously navigating the uncertainties associated with SCAD. Informational and peer support were viewed as important, as was the need to acknowledge the uniqueness of SCAD. Staff had additional training needs to support people with SCAD.						
Bouchard *et al.*, 2021[38]	Participants experienced anxiety about SCAD recurrence and confusion about their event due to a lack of knowledge about SCAD triggers. This affected identity, recovery, and led to isolation and restrictions in daily life (e.g. limiting working hours). Participants perceived a lack of control over health and were dismayed and frustrated with a lack of tailored CR. They suggested a need for increased/extended access to psychological, informational, and peer support (co-led by patients and healthcare professionals and delivered in-person or online). Families were considered important and must be factored into CR models.						

ACS, acute coronary syndrome; CD-RISC, Connor–Davidson Resilience Scale; CR, cardiac rehabilitation; FAS-10, Fatigue Assessment Scale-10 item; GAD-7, Generalized Anxiety Disorder-7 item; MCS, mental component summary; MHC-SF, mental health continuum short-form; PCS, physical component summary; PDS-5, post-traumatic diagnostic scale-5 item; PHQ-9, patient health questionnaire-9 item; PSS-10, perceived stress scale-10 item; PTSD, post-traumatic stress disorder; SCAD, spontaneous coronary artery dissection; SD, standard deviation; SF-12, short form-12 item; SF-36, short form-36 item; STOP-D, screening tool for psychological distress.

Table 3 Cardiovascular risk and other factors associated with spontaneous coronary artery dissection

		Traditional cardiovascular risk factors							Associated factors			
	No.	Any smoking[a] *n* (%)	Diabetes mellitus *n* (%)	Dyslipidaemia *n* (%)	Hyper-tension *n* (%)	Post-menopause[b] *n* (%)	Family history *n* (%)	Obesity *n* (%)	CTD *n* (%)	FMD *n* (%)	Migraines *n* (%)	Hypothyroidism *n* (%)
Alfonso *et al.*, 2012[22]	45	28 (62.2)	5 (11.1)	17 (37.8)	15 (33.3)							3 (6.7)
Bouchard *et al.*, 2021[38]	15		1 (6.7)			5 (38.5)				1 (6.7)		
Buja *et al.*, 2013[23]	38	14 (36.8)	2 (5.3)		20 (52.6)							
Chacin-Suarez *et al.*, 2021[20]	950	270 (28.4)	27 (2.8)	311 (32.7)	304 (32.0)			173 (18.2)	37 (3.9)	339 (35.7)		
Chou *et al.*, 2016[8]	70	7 (10.0)	2 (2.9)	13 (18.6)	27 (38.6)	14 (20.0)	27 (38.6)			57 (81.4)		7 (10.0)
Clare *et al.*, 2019[35]	208		17 (8.2)	58 (27.9)	64 (30.8)			39 (18.8)				15 (7.2)
Hassan *et al.*, 2019[21]	156	19 (12.2)	8 (5.1)	40 (25.6)	70 (44.9)		55 (35.3)					
Imran *et al.*, 2018[36]	11	4 (36.4)										
Johnson *et al.*, 2020[15]	512		14 (2.7)	165 (32.2)	159 (31.1)					186 (36.3)	164 (32.0)	65 (12.7)
Krittanawong *et al.*, 2016[16]	354	96 (27.1)	9 (2.5)	92 (26.0)	90 (25.4)				13 (3.7)	49 (13.8)	88 (24.9)[c]	
Lettieri *et al.*, 2015[24]	134	46 (34.3)	3 (2.2)	44 (32.8)	69 (51.5)		33 (24.6)					
Liang *et al.*, 2014[17]	158	42 (26.6)	2 (1.3)	37 (23.4)	44 (27.8)						49 (31.0)	
McGrath-Cadell *et al.*, 2016[25]	40	3 (7.5)	2 (5.0)	4 (10.0)	7 (17.5)		11 (27.5)			7 (30.4)[d]	17 (42.5)	
Mortenson *et al.*, 2009[26]	22	14 (73.7)	0 (0.0)	4 (18.2)	9 (42.9)							
Nakashima *et al.*, 2016[27]	63	20 (31.7)	0 (0.0)	14 (22.2)	21 (33.3)		5 (7.9)			5 (20.8)[d]		
Prasad *et al.*, 2015[28]	115	36 (31.3)	2 (1.7)	36 (31.3)	32 (27.8)				1 (0.9)	52 (45.2)	53 (46.1)	
Rogowski *et al.*, 2017[29]	64	18 (28.1)	0 (0.0)	33 (51.6)	29 (45.3)		12 (18.8)		1 (1.6)	5 (12.5)[d]		2 (3.1)
Saw *et al.*, 2017[30]	327	32 (9.8)	15 (4.6)	84 (25.7)	119 (36.4)	169 (56.9)	109 (33.3)				119 (36.4)	43 (13.1)
Silber *et al.*, 2015[9]	9	4 (44.,4)		6 (66.7)	5 (55.6)			3 (33.3)	1 (11.1)	2 (22.2)		
Smaardijk *et al.*, 2020[18]	172	31 (18.0)	2 (1.2)	15 (8.7)	54 (31.4)	63 (36.6)	80 (46.5)		5 (2.9)	38 (22.1)	89 (51.7)	
Tweet *et al.*, 2012[32]	87	9 (10.3)	2 (2.3)	12 (13.8)	16 (18.4)				7 (8.0)	10 (11.5)		
Tweet *et al.*, 2014[31]	189	15 (7.9)	2 (1.1)	31 (16.4)	22 (11.6)					61 (54.0)[d]		
Vanzetto *et al.*, 2009[33]	17	10 (58.8)	3 (17.6)	9 (52.9)	6 (35.3)		3 (17.6)	2 (11.8)	1 (5.9)			
Total no. with risk factor		718	118	1025	1182	251	335	217	66	812	579	135
Total no. examined		3019	3736	3692	3729	552	1723	1184	2518	3240	2312	1976
		23.8%	3.2%	27.8%	31.8%	45.5%	18.7%	18.3%	2.6%	25.1%	25.0%	6.8%

CTD, connective tissue disorder; FMD, fibromuscular dysplasia.
[a]Includes current and previous smokers.
[b]Percentages based on females only.
[c]Only reported for 238/354 participants.
[d]Percentages based on number of screened for FMD.

Psychosocial outcomes

Fourteen studies reported psychosocial outcomes[8,9,14–20,34,36–39] using a range of validated tools, which made comparisons difficult (*Table 2*). Even when the same tool was used it was reported differently, or at different time points, therefore, we could not pool data. Only one study reported a significant reduction in depression after completion of CR,[8] one reported that CR had emotional benefits,[16] and the two qualitative studies suggested the need for psychosocial support during CR.[38,39] One study recruited participants to a cognitive behavioural therapy programme. Of 21 invited participants, only eight participated, and one participant dropped out due to increased PTSD symptoms. Two further participants did not complete follow-up. Therefore, although results show reduced anxiety and depression levels this is only in five participants.[37] The majority of studies involved cross-sectional surveys that were completed between 2.4 and 4.3 years after SCAD events meaning that the psychosocial outcomes reported related to longer-term levels of anxiety and depression. These studies were of limited usefulness in assessing requirements for psychosocial support immediately after SCAD but highlighted that some SCAD survivors suffer from longer-term post-traumatic stress disorder,[15] or continue to have high levels of perceived stress,[18,19] fatigue,[18] and depression.[14,34] However, overall mean scores for depression as assessed by the Patient Health Questionnaire 9-item scale tended to be within the normal range (3.9–4.9).[16–18] A similar pattern was observed for anxiety as assessed by the Generalized Anxiety Disorder 7-item scale.[16–18] The two qualitative papers highlighted the importance of increasing access to psychological support and acknowledging the uniqueness of SCAD.[38,39] Spontaneous coronary artery dissection survivors valued programmes that incorporate the family system in patients' recovery, including extending CR programme offerings to family members (*Table 2*).

Cardiovascular risk factors and associated factors

Twenty-three studies reported participant risk factors, both cardiovascular and associated with SCAD (*Table 3*). The most common risk factors were FMD (812/3240, 25.1%; range 6.7–81.4%),[8,9,15,16,18,20,25,27–29,31,32,38] migraines (579/2666; 25%; range 24.9–51.7%),[5,15–18,25,28] and hypertension (1182/3729; 31.8%; range 11.6–55.6%).[8,9,15–18,20–26,29–33,35] Only four studies reported categories of overweight and obesity, with the largest study ($n = 950$) reporting 27% were overweight and 18% were obese,[20] and another which had only nine participants reporting 22.2% overweight and 33.3% obese.[9] The other two studies only reported obesity and not overweight with 11.8% obese in one,[33] and 18.8% obese in the other.[35] Only one small study reported any risk factor reduction after completion of CR.[9] This was a reduction of 1.1 kg in body mass (71.5 ± 11.5 kg at baseline vs.70.4 ± 11.0 kg at follow-up).

Chest pain

Five studies reported chest pain following SCAD. In one study, over half ($n = 495$, 53.0%) recalled having recurrent symptoms of chest pain after SCAD, or chest discomfort/shortness of breath ($n = 537$, 56.8%) following physical activity (PA).[20] In another study, 5/19 (26%) of participants were readmitted to hospital with chest pain.[26] In one study, 13/31 (42%) had repeat angiography due to ongoing chest pain,[32] and in another study, 9/94 (10%) experience recurrent chest pain.[31] In a study, in which pre- and post-CR measures were recorded chest pain was reduced from 44 (62.9%) to 26 (37.1%) ($P < 0.001$) following CR participation.[8]

Discussion

This is the first systematic review of recovery from SCAD (*Figure 2*). SCAD survivors may have a high burden of psychosocial issues, including PTSD, which suggests the importance of psychosocial support in recovery programmes; however, the data were mainly collected a substantial time after the acute event, limiting understanding of early recovery.

Spontaneous coronary artery dissection survivors were younger than ACS survivors and cumulatively have a higher level of traditional risk factors than previously supposed, indicating a need to focus on risk factor reduction amongst these patients. Hypertension, dyslipidaemia, and smoking history were common, as well as the associated risks including high levels of FMD and migraines. In contrast, there were lower rates of diabetes than in the general population.[41] Data on obesity were limited, but in the four studies that did report this, around quarter of the participants were obese.

In five studies that reported chest pain following a SCAD, chest pain was common, affecting up to half of all participants. Chest pain was reduced following CR; however, this was reported in a study that was not randomized therefore it is not possible to determine if this was due to CR or to the passage of time.

In terms of recovery following a SCAD, overall, we found extremely limited evidence of benefit of CR for people to address both physical and psychosocial recovery and there were no randomized controlled trials. Participants who were included in CR found that the programmes were not suitable for their needs. Some SCAD survivors had previously high levels of physical fitness, and they found the nature of permitted exercise in CR to be restrictive. Despite this, SCAD survivors are frequently advised to exercise at a lower level than typically promoted to ACS survivors in CR, with international guidelines recommending that an individualized and conservative approach be used.[42]

The restrictions applied to SCAD survivors are somewhat reminiscent of restrictions applied to ACS survivors in the early days of coronary care. Over time, a wealth of evidence has developed demonstrating the benefits of physical activity to promote recovery from ACS.[43] This evidence base now needs to be built for SCAD survivors, with robust prospective studies that explore the effects of aerobic and resistance exercise on recovery.

Spontaneous coronary artery dissection survivors are predominantly female and this is a known barrier to CR uptake. While the benefits of CR for ACS survivors are comparable between sexes, women are 36% less likely to participate[44] in part attributable to the older age of onset, but also due to competing priorities such as caring responsibilities.[45] Although the SCAD population identified in this review is younger than the female ACS population, the qualitative studies indicate that caring responsibilities are still an important influence on CR participation. When CR is predominantly attended by men, women are less likely to participate.[45] Cardiac rehabilitation is

Figure 2 Main findings.

typically provided in a circuit-based format with gym equipment including exercise bikes, etc. We have previously demonstrated that when men and women attend leisure centres, they choose different types of exercise modalities, with men preferring to use the gym, and women typically preferring exercise classes.[46] It is possible that the circuit style class of CR further impacts decisions for women not to attend CR.

Due to the comparatively small numbers of people experiencing SCAD, it is unlikely that each centre will be able to develop dedicated SCAD recovery programmes. This indicates that alternative models of CR could be suitable, such as digital tools that enable participants to access individualized resources at a time convenient to them. There is a wealth of evidence that digital tools are successful when compared with traditional CR at promoting risk factor reduction, improved quality of life, increased physical activity, and reduction of morbidity.[31] One study included in this review recommended that online tools may be suitable to support SCAD survivors.[38] To date we are only aware of one digital tool the SCAD warrior app-developed after consultation with SCAD survivors for people with SCAD, but there is no published data on efficacy of this app to improve physical or psychosocial health following a SCAD event.[38]

This review has several limitations. Many of the studies were small and there were no randomized controlled trials. There is a potential for selection bias in recruitment when social media and patient groups are used to recruit participants. The heterogeneous nature of the studies meant that data could not be pooled, and so a narrative synthesis was undertaken.

There is an urgent need to develop and evaluate recovery programmes for SCAD survivors. CR programmes are suitable for recovery from ACS but need to be tailored to encompass psychosocial support given the high burden of psychosocial issues and robustly evaluated. Due to lower global incidence of SCAD, it is possible digital tools may offer a solution to provide tailored support, but prospective randomized controlled trials of CR and digital health are required before this can be recommended.

Supplementary material

Supplementary material is available at *European Journal of Cardiovascular Nursing* online.

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Data availability

Data will be made available on request.

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