Does being psychologically resilient assist in optimising physical outcomes from a spinal cord injury? Findings from a systematic scoping review

Does Being Psychologically Resilient Assist in Optimising Physical Outcomes from a Spinal Cord Injury? Findings from a Systematic Scoping Review

Purpose

To systematically search for current research on the role of resilience in physical rehabilitation of SCI and describe the research to date.

Materials and Methods

The PRISMA approach was used. Five databases were searched for papers published up to March 2020. Sample included adults who have sustained a SCI; outcomes included a physical rehabilitation outcome and a measure of psychological or personal resilience/resilience training.

Results

The initial search found 2074 studies. 12 studies were included. Six suggest positive effects of resilience on physical functioning/recovery, Six report resilience as not affecting physical functioning/recovery.

Conclusion

Resilience may positively affect physical outcomes; however, the relationship is under researched and contrasting findings may be due to measurements and methods employed by research. Future research may distinguish between two sources of resilience following an SCI: prior resilient experiences, and resilience as a product of the injury. Individuals' past events that triggered resilient behaviour may be able to promote a resilient response to an SCI. Focussing on emotional coping may result in poorer outcomes than building a sense of control. Resilience training may affect psychosocial rehabilitation; it is difficult to establish if it would affect physical outcomes. A negative approach to injury can have negative effects on functioning; when identifying patients for psychoeducational training, those with the presence of negative appraisals of their injury are most in need.

Keywords: Resilience, Psychological; Spinal cord injuries; Rehabilitation**;** Systematic scoping review

Abbreviations

SCI = Spinal Cord Injury

CD-RISC = Connor-Davidson resilience scale short form

CD-RISC 10 = Connor-Davidson resilience scale short form

PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

FIM = Functional Independence Measure

CHART = Craig handicap assessment and reporting technique

Spinal cord injury (SCI) is a disability resulting in enduring physical and mental adversity, increased risk of early mortality [1, 2], and huge economic costs at a personal and societal level [3]. Spinal cord injuries (SCI) are most commonly incomplete, rather than complete, meaning the spinal cord is still able to convey messages to and from the brain to some degree [4], which offers hope for some recovery of physical function. In addition to the actual injury sustained, individual differences that effect rehabilitation abound, for example, social support [5], education level [6], age at time of injury [7], and pre-injury stress events [8]. An individual's personal resilience is another factor that may help with recovery from an SCI; recovery of psychological and social functioning are associated with higher levels of resilience [9, 10]. However, the degree to which resilience may affect physical outcomes, such as mobility and motor function, has not yet been established.

Resilience and SCI

Resilience is multi-faceted in its definitions and heterogenous in its use across research [11, 12]. A recent review concluded there was no unanimous way of defining or measuring resilience [13]. Terms such as "hardiness" and "grit" are often used interchangeably resulting in resilience being defined and measured in indirect ways or by concepts closely aligned with resilience [14]. This heterogeneity in defining resilience is present in SCI research [9].

Broadly, however, resilience can be defined as an adaptive and coping response to adversity [15, 16]. An individual's level of resilience is determined by many modifiable factors and may be influenced by both state and trait like characteristics. For example, research identifies environmental and personal sources of resilience such as social support or optimism [17]. Therefore, levels of resilience are fluid and changeable [14, 18] and can be increased by intervention at any stage of life [19] even after severe trauma [20].

Resilience in response to an SCI affects rehabilitation outcomes [21, 22]. In general, an individual's degree of resilient response is contingent on the scale of the experienced trauma, set against the availability of psychological resources [23]. An SCI then, requires a huge amount of psychological resources to facilitate a resilient response. Resilience following an SCI may have a specific psychological profile. For example, the process of resilience following an SCI is associated

with self-efficacy, internal locus of control, coping skills, and spirituality [8, 10, 22, 24-28], however the process of resilience following an SCI has been identified as an area needing more research [9]. Resilience in SCI patients is associated with outcomes such as improved wellbeing, better quality of life, satisfaction with social roles, improved pain management, and lower anxiety and depression [10, 29-31]. Further, those who have high levels of resilience at the start of rehabilitation from an SCI will have better psychosocial outcomes; those that have lower levels are more likely to become depressed [10, 32]. Despite these findings, predicting the outcome of an SCI is largely based on injury-related factors [33].

Clearly, modifying an individual's resilience after an SCI is desirable, and interventions that promote resilience among people with SCI have been recommended [see 22, 34]. However, research directly measuring resilience training as part of SCI rehabilitation has not been completed [35]. This research could have important benefits; for example, negative coping strategies in early rehabilitation contribute to premature mortality [36], so resilient coping in early stages is vital for long-term health in SCI patients. However, outcomes measured are commonly psychosocial [35, 37, 38]. It has been suggested there may be limited evidence for resilience affecting physical outcomes in disability [35], however, the effect of resilience or resilience training on physical outcomes, specifically in SCI, has not been widely explored [35, 40] or reviewed. To the knowledge of the authors, only two reviews have been completed around SCI and personal resilience in general [9, 22].

A qualitative systematic review [22] which included six studies aimed to identify how people with an SCI experienced resilience in their recovery. The overarching theme was 'roads to resilience' with sub-themes of 'uncertainty and regaining independence', 'prior experiences of resilience', 'adopting resilient thinking', and 'strengthening resilience through social support'. Kornhaber et al. [22] conclude that there are a variety of ways to build resilience and that resilience is not binary in nature. Resilience is influenced by life experiences prior to the SCI and can be harnessed by health professionals following an SCI. They suggest nurses can play an important role in fostering resilience in SCI patients.

The most recent review [9] aimed to establish the extent of studies focusing on resilience and SCI. Of the 40 studies included, one intervention study was identified, 45% were correlational, and 15% were longitudinal. The remaining studies were interested in measurement development and analysis. McDonald et al. [9] describe the definitions of resilience these SCI studies use, finding most define resilience as a personal quality or resource; therefore, as a predictor of other outcomes, rather than as an outcome itself. These studies measure resilience predominantly with the Connor-Davidson resilience scale or its short form (CD-RISC/CD-RISC 10). The authors make several important conclusions. They state that research cannot tell us how resilience is fostered and sustained after an SCI, partly down to the volume of correlational designs. They also conclude that research on resilience in SCI can result in better psychosocial outcomes. However, not found among the studies in this substantial review are the effects of resilience on physical recovery and mobility, suggesting limited research in the area.

Battalio et al. [35] could not find any research that has investigated the use of training programs targeting resilience in people with any chronic physical disabilities. Given the positive psychosocial outcomes associated with resilience during an SCI it is likely this training would have positive outcomes. Currently, the impact of resilience training on physical function is unknown. In the context of research recommending resilience training for people with an SCI [34, 41] and the lack of research investigating the physical outcomes of resilience during an SCI [40], this review aims to synthesise the current research in the effect of resilience on physical rehabilitation outcomes following an SCI. Specifically, it aims to systematically search for and describe the current research investigating how resilience affects physical outcomes in adult SCI patients. Due to the broad, exploratory nature of this research, a scoping review is an appropriate approach [71]. Therefore, this review asks the question does being psychologically resilient assist in optimising physical outcomes from a spinal cord injury?

Method

This systematic scoping review was guided by the PRISMA and PRISMA-ScR approaches [42;72], and the guide for conducting systematic scoping reviews [73, 74].

The review was also informed by a lived experience from one of the co-authors. In 2014, one of the authors, XX, sustained a traumatic SCI that paralysed him from the neck down. As a rehabilitation inpatient, he noted that current interventions in SCI rehabilitation centres did not conduct specific resilience training; a finding mirrored by a lack of research into resilience training for chronic disability [35]. He identifies prior stressful and traumatic events in his life that contributed to him feeling resilient in the event of his SCI [43]. From the personal perspective of XX, in the context of the contribution of resilience to his recovery, but the lack of inclusion of resilience in the rehabilitation services XX received, this review aims to discover what research shows about the effects of resilience on physical mobility recovery following a SCI.

Search Strategy

Five databases (MEDLINE, CINAHL, Web of Science, PsychInfo and EMBASE) were searched in abstract and title on 5th October 2018. The search string was split into two domains, (i) Spinal Cord Injury and (ii) resilience. The following is an example search string (MEDLINE) which was adapted for use in all databases, changes were made to meet individual search databases requirements or Mesh headings:

SCI OR spina* OR spinal injur* OR incomplete SCI OR spinal cord injur* OR tetraplegia OR quadriplegia OR paraplegia AND resilien* OR hardiness OR coping behaviour* OR coping behavior* AND MESH TERMS Spinal Cord Injuries+ OR Spinal injuries+ OR Paraplegia+ OR Quadriplegia AND resilience, psychological

An updated search was conducted in April 2021 targeting articles for the years 2018 – April 2021 finding 346 articles. Five were identified as found in the previous search (which also included some articles from 2018). Eventually, one article was added to the paper.

Eligibility Criteria

Peer-reviewed and English language studies with any publication date were included. Furthermore, they must have met the following criteria:

- Sample of adults who have sustained any type of SCI
- Must include a physical rehabilitation outcome. This may be a direct, explicit measure, or physical outcomes which are surmisable from the article.
- Must include a measure of resilience or resilience training (as in McDonald et al. [9] resilience must refer to psychological or personal resilience, not environmental resilience such as social support). This includes alternative words for resilience or individual characteristics of resilience.

Screening and Study Selection

Articles were screened through, (a) removal of duplicates using the software-based reference management system Endnote© [44], (b) eligibility exclusions on title check, (c) exclusions on abstract, and (d) exclusions on full text. A single reviewer completed title and abstract checks (XX), then, two researchers (XX and XX) reviewed the full-text. Existing discrepancies regarding final inclusion were resolved on agreement from all authors. The screening process is represented in Fig. 1.

Studies often used the Functional Independence Measure (FIM). Studies that did not offer outcomes from the physical independence sub-scale of the FIM individually were not included as an overall score on the FIM includes several scales such as social independence.

Data Extraction

Data was extracted on the following categories from each study: (i) citation, (ii) study aim, (iii) population, (iv) methodology, (v) data collection and analysis, (vi) findings, (vii) findings specific to resilience and physical function, and (viii) key outcomes.

Quality Appraisal

Methodological quality was rated using the Qualitative [45] and Quantitative versions [46] of the McMasters methodological rating tool. The McMasters Critical Review Form is frequently used within systematic reviews synthesising quantitative and qualitative studies [see 47-50]. This tool assesses the characteristics of studies to establish methodological quality (e.g. methods of sampling, data collection, appropriateness of conclusions).

Results

Characteristic of Studies

Twelve studies were included in the final review. The screening process can be seen in figure 1. Eight studies were based in the US [31, 34, 35, 40, 41, 51-53], two were multi-country studies including UK, Switzerland, Germany and Ireland [54, 55], one was in Norway [56], one was in the UK [57]. There were two qualitative studies [53, 56] and the rest were quantitative [31, 34, 35, 40, 41, 51, 52, 54-57]. The MQA for quantitative and qualitative studies can be found in appendices 1 and 2.

As clarified in table 1, the studies included describe a mixture of independent and dependent variables and use a variety of methods. Therefore, direct comparison and meta-analysis is not possible. Results will be presented in terms of those that support, or suggest, resilience as having a positive effect on physical functioning/recovery (N = 6) and those that show resilience as not affecting physical functioning/recovery (N = 6). Studies are described in the next section. Information on the sample for each study is presented in table 2. Information on the methods for each study is presented in table 1.

Positive Relationship Between Resilience and Physical Outcomes

Edwards et al. [41] wanted to determine if resilience was stable across time and if any changes to resilience over one year were associated with changes in other factors including physical function. They administered a survey twice, one year apart to adults with physical disabilities (N = 893; 162 SCI). They found resilience was stable over the course of the year and that changes in resilience correlated with physical functioning as well as depression, fatigue and sleep quality. Although statistically significant, resilience only accounted for 0.3% of variability. Based on these findings, the authors state resilience as a viable target for treatment. Given the SCI cohort were on average 17 years post injury, it would be interesting to complete this study in the first few years post injury where most physical recovery is gained. The authors also point to the correlational nature of this study and encourage research which can investigate the cause and effect of resilience and physical functioning.

Geard et al. [56] report a qualitative study exploring health, resilience and wellbeing over time in people with severe physical injuries. They conducted interviews asking people (N = 7) with

SCI to reflect upon how they maintain resilience and wellbeing overtime. Through thematic analysis, they found two overarching themes with subthemes. These were (1) Marshalling personal resources to handle challenges over time, including subthemes of (1a) maintaining a positive attitude, (1b) allowing oneself to be self-protective, (1c) staying active and flexible to maintain health and wellbeing; (2) Staying connected and accepting help when needed, (2a) harnessing relational sources when needed, (2b) balancing dependence and autonomy to stay part of ordinary life, and (2c) handling the lack of accessibility in society. In the subtheme "maintaining a positive attitude" stubbornness or constructive self-talk is important for recovery with some participants alluding to a fighting spirit or long-term resilience. Although the effect of resilience on physical recovery is not quantifiable here, the importance of resilience to some SCI patients, and the way it is displayed or perceived by them is demonstrated in this paper, and physical outcomes are evident. For example, one participant describes regaining physical function through a "fighting spirit" or stubbornness and avoiding negative talk.

Heinemann et al. [52] wanted to evaluate the effects of psychological interventions on various rehabilitation outcomes. They compared the usual rehabilitative care in 6 facilities (N = 1032) and took measures at discharge from the centre and 1-year post injury. They found that more time in psychoeducational interventions, focussing on goals, along with longer stay in rehabilitation, was associated with better functioning including higher motor function. However, more psychotherapeutic sessions focusing on processing emotions and/or locus of control were associated with poorer functioning at discharge and one year later. They also found that services aiming to remediate deficits resulted in negative outcomes, but positive outcomes were more likely from services aiming to foster adjustment and growth. Resilient patients received more educational interventions and were more empowered to achieve high levels of independence.

Kennedy et al. [54] investigated the contribution pre-rehabilitation appraisals of SCI and coping strategies had on functional independence post-discharge. 127 patients across four European countries completed questionnaires at the start of rehabilitation (12 weeks post-injury) and one year later. Higher scores on the motor subscale were significantly associated with challenge appraisals but were significantly lower with threat and loss appraisals. FIM was also significantly lower with social

reliance but higher with fighting spirit. They conclude that people with passive and avoidant coping strategies are less likely to engage with rehab (although they did not measure engagement with rehab). Although they did not study resilience directly, cognitive appraisals have been predictive of resilience [58, 59]. They conclude that early assessment of appraisals can identify those that need psychological intervention which may affect FIM outcomes.

Kennedy et al. [55] aimed to explore changes in cognitive appraisals over the course of two years of SCI injury and how these changes were related to various outcomes including FIM. 232 patients completed surveys at three time points, (i) 12 weeks post injury, (ii) 1-year post-injury, and (iii) two years post-injury. Although the authors did not relate findings directly to resilience, they reported higher levels of physical functioning were associated with coping strategies such as positive reinterpretation which is seen as a resilient trait.

Machida et al. [53] examined the resilience process of sports participants with an SCI and the role sport played on the resilience process. Interviews were conducted with 12 male quadriplegic wheelchair rugby players. They found seven general themes regarding process of overcoming adversity and developing resilient qualities. These categories include the following: (a) pre-existing factors and experiences, (b) disturbance/disturbing emotions, (c) multiple sources and types of support, (d) special opportunities and experiences, (e) various behavioural and cognitive coping strategies, (f) motivation to adapt, and (g) gains from the resilience process. They concluded that pre-injury resilience building experiences, and support from others who had been injured, were helpful to build resilience. Resilience process that occurred after injury did not come in an orderly fashion but was complex, interactive and an unpredictable process. However, apart from the fact all are now playing competitive sport there is not much mention on how the resilience process affected physical outcomes.

No Relationship Between Resilience and Physical Outcomes

Barone and Waters [51] aimed to determine how much sociodemographic characteristics and hardiness in people with (N = 243) an SCI explained coping. They used the Roy Adaptation Model

[60] as a framework which describes a person or group as adaptable and with methods for managing change. Employing a descriptive explanatory design, they found that less educated, less hardy and recently injured participants more commonly used escape-avoidance coping over social support, problem solving, and positive reappraisal. Although they did find the sub-scale control partially predicted psychosocial adaptation, they found the overall scale measuring hardiness was not associated with any outcomes including physical.

Battalio et al. [31] explored if resilience was uniquely associated with functional outcomes in people with physical disabilities. Functional outcomes were defined as satisfaction with social roles, physical functioning and quality of life. They delivered surveys to people (N = 1949; response rate of 1476) with a variety of physical disabilities including 24% SCI. They found resilience was associated with satisfaction of social roles and quality of life but not with physical function. They found that the relationship between physical function and resilience may be mediated by psychological health and symptom severity, or conversely, physical function may not be as responsive to changes in resilience as other domains of function.

Battalio et al. [35] used cross-lagged panel designs to test temporal associations between resilience and four function domains (anxiety, depression, social role satisfaction, and physical function). Questionnaires were sent to participants (N = 1574; SCI 24%) at three time-points approximately one year apart. They found reciprocal relationships between resilience and each domain apart from physical functioning. The authors conclude that resilience predicts psychological and social function over time in individuals with chronic physical disabilities, including those with SCI.

Kennedy et al. [57] assessed the relationship between different cognitive appraisals used by patients with an SCI to see how they affect socialising, life satisfaction and functional outcomes. 81 adult participants from three different centres 3-8 months following discharge received a postal survey. They found that the cognitive appraisal of “negative perception of disability” had the strongest negative effect on mobility and physical independence, possibly due to resigned and emotion-oriented, rather than task-oriented behaviour. Strong negative correlations were also shown between

the cognitive appraisals of fearful despondency and overwhelming disbelief with the functional independence measure. Cognitive appraisals of determined resolve contributed to positive functional independence outcomes, but growth and resilience did not. However, in this analysis the FIM was not divided between physical and cognitive outcomes. Dividing these may have resulted in more specific information as to which cognitive appraisals effected physical outcomes and which affected cognitive outcomes. Further, although the growth and resilience sub-scale did not contribute to positive CHART or FIM outcomes, positive cognitive appraisals did. Positive cognitive appraisals are predictive of resilience [58, 59]. An alternative interpretation is that there is some support for resilience positively affecting physical recovery in SCI in this study; it is possible an alternative measurement of resilience would produce different outcomes.

Silverman et al. [40] examined the relationship between resilience and symptoms of depression, social functioning and physical functioning in ageing people with a disability. They also wanted to investigate the effect of resilience on change in functional outcomes over time. A postal survey was mailed to participants (N = 1594; SCI 414) at four time points over three years. They found greater resilience at baseline predicted a decrease in depressive symptoms and an increase in social functioning. Although higher resilience at baseline was associated with higher physical functioning at baseline it did not correlate with a change in physical functioning by T4. They conclude that resilience did not predict change in physical functioning over three years although they were positively correlated at baseline.

White et al. [34] wanted to investigate the relationship between changes in resilience and adjustment outcomes to SCI in an inpatient rehabilitation clinic. Questionnaires were completed at three times during the rehabilitation program (N = 42). Results indicated that participants' resilience did not change although there were significant changes in each of the adjustment outcomes. Results also indicate relationships between higher resilience was associated with lower depressive symptoms, higher satisfaction with life, and higher spirituality at all three timepoints. Change in FIM was not associated with any of the variables including resilience. However, resilience scores may not have

changed because no part of the rehabilitation process targeted resilience. They recommend resilience interventions and provide some guidance on how these may work.

Discussion

This review aimed to systematically gather research around resilience and physical recovery from a SCI. One of the main findings from this search may be the lack of findings; the efficacy of resilience to promote physical outcomes is under researched. It is far more likely that resilience has been studied in terms of its effects on functioning in general, or psychosocial adaptation to an injury. Even in the included papers physical functioning is not often the primary variables of interest. The main outcome from this paper may be a call for future papers to explore this relationship.

There is a mix of outcomes amongst included studies; overall, they suggest the possibility that resilience will positively affect physical outcomes, however the strength of these findings is not conclusive. This is for a variety of reasons. First, apart from three studies [49, 50, 54] this relationship was not a primary goal, or the study included participants with other physical impairments. Therefore, the findings of no relationship between resilience and physical outcomes must be taken with caution. Furthermore, included papers suggest contextual factors will change the chance of resilience positively affecting physical recovery. Factors affecting resilience and recovery include educational background, level of injury [51], social support, and pre-injury resilience building experiences [22, 53]. Targeted research considering these contextual factors will assist in answering the question of if resilience can positively affect physical outcomes.

Interestingly, four of the six studies reporting no link between resilience and physical recovery used the CD-RISC-10. However, of the seven reporting a link between resilience and physical recovery only 1 used CD-RISC 10; the others used alternative measures or were qualitative. The CD-RISC 10 only uses the hardiness scale of the original CD-RISC. Using a one factor measurement of resilience may not fully reflect resilience as shown or experienced by SCI patients. The 25 item CD-RISC includes a sub-scale on control, and items on past success and tolerance of negative affect [66, 67]; building a sense of control is important in recovery [51, 68] and past

resilience building experiences were identified as important for rehabilitation from an SCI [22, 55]. Therefore, these items may be relevant for the SCI population and may result in different findings.

Our findings suggest past, resilience building experiences may contribute to coping following an SCI [22, 53]. This is in the context of other findings that suggest chronic stress prior to injury has a negative effect on recovery due to physical effects of that stress [8], and that resilience and resilient resources reduce the association between traumatic childhood experiences and later health problems [61, 62]. These findings complement each other; perhaps past chronic stress or stressful experiences that did not promote resilience will have a negative effect on rehabilitation, through physical changes, but a traumatic or stressful experience that an individual overcame is helpful through psychological changes. Indeed, conditions where adversity will facilitate a poor response in future hardship, and those which will promote resilience, are under researched [63]. To assist in promoting resilience, clinicians need to look not for past trauma or stress, but past experiences of resilience, no matter the context of the event that triggered it. Bouchard and Hook [8] recommend collaboration between health care providers for better treatment. They give the example of a psychologist and psychiatrist working together to identify past traumatic events prior to injury. These events may indicate the need for complex psychological therapy to lessen the negative effects of SCI-related stress [8]. To extend on this, health care workers, along with the patient and family, should distinguish between the traumatic experiences that may have had a negative physical impact due to stress, from the traumatic experiences that may have built resilience or resulted in a resilient response. Health care workers, such as psychologists and physios, may be able to use the prior resilient response to promote a resilient response to the SCI, resulting in greater effects of rehabilitation both psychologically, and, potentially, physically.

Resilience training may be an effective psychoeducational, strength-based addition to SCI rehabilitation promoting psychosocial outcomes. Researchers have recommended resilience training be a part of the rehabilitation process [34, 41]. This recommendation is supported by the finding that psychoeducational interventions resulted in better functional outcomes as compared to psychotherapeutic approaches; essentially, strength-based approaches were more effective than

approaches looking at deficits [52]. Similarly, negative appraisals of disability and injury resulted in poorer functioning [54]. Due to the limited research in the area, it is difficult to establish if resilience training can result in better physical outcomes for SCI patients. However, resilience is associated with focussing on strengths and positive action [64], an approach which may contribute to better physical outcomes [52, 56].

Further, this review finds that a focus on emotional coping over control taking may result in poorer outcomes, but that building a sense of control can result in better outcomes [51, 57]. It has been suggested cognitive appraisals are causal in the generation of emotional responses [65], so taking control of these appraisals should affect the subsequent emotional response. Whether this will lead to physical outcomes is unknown. Control is a characteristic of hardiness [51]. If so, can we promote a resilient approach, and better physical recovery, by installing a sense of control in the physical rehabilitation process?

Of the studies that do not find a positive relationship between resilience and physical recovery there are still some useful findings for this research question. For example, some suggest that a negative approach to injury can have negative effects on functioning [57]. The presence of threat and loss appraisals and the negative perception of one's disability resulted in negative outcomes across several domains [51, 54, 57]. Therefore, not only is it important to look for the presence or absence of resilience, it is important to look for the presence of the antitheses to resilience; i.e. when identifying patients in most need of psychoeducational or resilience training, it is not those with absence of resilience that are most in need but those with the presence of negative appraisals of their injury.

Limitations and Future Research

The primary finding is that future research needs to establish if resilient characteristics can contribute to greater physical recovery, or engagement in physical rehabilitation, following an SCI. Limitations of this review, and the included studies, provide additional guidance for future research.

Battalio et al. [35] advises experimental research be conducted to explore a causal relationship between resilience and different domains; we repeat this recommendation in the context of physical recovery. Experimental research is needed to explore the possibility of increased physical

recovery following an SCI in the face of higher resilience and, therefore, if resilience training could improve physical outcomes. However, it is recognised that experimental research is challenging in a field where injury severity and other individual differences differ so vastly.

Detection bias was avoided by using broad search and inclusion terms; this suited the purpose of this review, which was to gauge the current state of knowledge of how resilience affects physical outcomes in an SCI. As the first review in this area it was deemed appropriate to cast a wide net given 89% of the time resilience in research is measured indirectly or through similar concepts [23, 66]. Broad search terms have been used previously [17] and decrease the odds of a "type I" bias where relevant papers are missed or rejected. Previous reviews have used narrower search terms but describe this as a limitation [9]. However, it is possible the broad search approach increased the chance of a "type II" bias in that studies have been included that should not have been. Resilience is multi-faceted and there is a risk closely related concepts may have been included in this review. Future research, and potentially future reviews on the subject, should attempt to standardise terms, and be more precise and thoughtful on how they measure resilience.

Whilst conducting the quantitative MCQ form there were two main biases in the included studies – sample and measurement bias. Samples were mainly white and relatively well educated. Generalisability of these findings is not possible and research with additional samples is needed to confirm any findings in the included studies applies to different demographics. In addition, most samples are male in majority. This reflects the fact most SCI patients are male. However, differences in resilient responses between male and female SCI patients may be present and may reflect different resilient process and approaches required.

Many studies finding no link between resilience and physical outcomes used the CD-RISC 10 to measure resilience, introducing a measurement bias. Furthermore, Battalio et al. [35] state other measures, such as observational methodologies, are needed. They also state that the factor validity and measurement invariance of the CD-RISC 10 has not been studied in people with chronic physical disabilities and call for future research to study this. Although one study concluded the 5-factor

structure was reasonable for an SCI population [69], the relevance of the unidimensional CD-RISC 10 has not been established. The findings from this review support the need for this line of research.

Future research may attempt to distinguish between two sources of resilience following an SCI: prior resilient experiences, and resilience as a product of an SCI. For example, past resilient experiences may contribute to resilience following an SCI [22, 42, 53], however, if there is no indication of prior resilience, does, or can, an SCI be used to promote resilience. This thought process results in two different research questions:

- How do pre-injury levels of resilience effect physical rehabilitation outcomes of adult SCI patients?
- How do post injury changes in resilient thinking effect physical rehabilitation outcomes of adult SCI patients?

The next step would be to ask how we can use this knowledge to promote resilient approaches to rehabilitation through trainings and therapy.

Conclusion

This review identified the current literature exploring the effects of psychological resilience on physical function. There were limited papers in this area, and within these papers the results were split. However, some promising lines of research are apparent. Bouchard and Hook [8] propose that individuals' past and present stress exposure may significantly affect the course of patients' SCI recovery. Building on this, we propose that individuals' past events that triggered resilient behaviour may be used by health professionals to promote a resilient response to an SCI, which can positively affect the course of patients' SCI recovery.

There is evidence resilience is associated with positive outcomes in social and psychological domains in people with SCI. However, this review finds a gap in the evidence for resilience and its effects on physical recovery. Resilience is a concept better described as a changeable state [14] that can be acquired at any stage of life [19] even after intense trauma [20] and is worth teaching to SCI patients due to established psychological effects [70]. However, research also needs to address if it

can contribute to physical recovery, and therefore should be integrated into physical recovery programmes and rehabilitation too.

Acknowledgments

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Table 1. Characteristics of study: methods

Citation	Design and Setting	Measures	Procedure	Data Collection/ Analysis	Increased or high resilience associated with better physical recovery?
Barone, S. & Waters, K. (2012)	Cross- sectional - Descriptive explanatory design – mailed surveys	Health related hardiness scale (HRHS); Revised ways of coping checklist; Derogatis's Psychosocial adjustment to medical illness scale; modified Functional Independence Measure (FIM)	Questionnaires mailed to 1000 participants on US spine injury register. 29% response rate.	Canonical correlational analyses, hierarchical multiple regression.	N
Battalio et al. (2017)	Cross-sectional – mailed surveys	Connor-Davidson resilience scale short form (CD-RISC 10); Patient-reported outcomes measurement system (PROMIS); WHO's brief Older Peoples Quality of Life Questionnaire (OPQOL-brief).	Questionnaires mailed to 1949 participants recruited through internet or print ads; registry of previous research participants word of mouth; other sources	Linear regression analysis	N
Battalio et al. (2019)	Prospective cohort design – mailed surveys	CD-RISC 10; PROMIS short-form	Questionnaires mailed to people participating in a large US wide longitudinal survey study; 3 time-points approx 1 years apart each	Cross-lagged panel designs	N

Edwards et al. (2017)	Prospective cohort design – mailed surveys	CD-RISC 10; Patient Health Questionnaire (PHQ-9); PROMIS	Questionnaires mailed to 2041 participants at two time points, one year apart, recruited through internet or print ads, registry of previous research participants, word of mouth and other sources	Pearson correlations and linear regressions	Y
Geard et al. (2018)	Exploratory qualitative study - phone interviews	Interviews	Invitation mailed to 59 former patients; 13 responded positively.	Thematic analysis	Y
Heinemann et al. (2012)	Prospective observational cohort study at 6 inpatient rehab facilities in the US	FIM; Craig handicap assessment and reporting technique (CHART); Diener satisfaction with life scale; PHQ-9	Data collected at 2 time points 1 year apart either by telephone or face to face interview	Linear regression and logistic regression	Y
Kennedy et al. (2010)	Single cohort – mailed survey	FIM; CHART; APAPSS scale; life satisfaction questionnaire; secondary complication screening unit	Questionnaires mailed to 255 people with response rate of 31.8%. All participants were from one of three spinal injury centres.	Correlations and hierarchical regressions	N. Although the cognitive appraisal "negative perception of disability", which may indicate a lack of resilience, was associated with negative outcomes.

Kennedy et al. (2011)	Prospective cohort study	Hospital Anxiety and Depression Scale (HADS); FIM (motor score subscale); Appraisal of Life Events; Spinal cord lesion-related coping strategies questionnaire; COPE (subscales of positive reinterpretation, behavioural disengagement and planning)	Questionnaires administered in rehab after 12 weeks and by post after 1 year.	ANOVA and t-tests. Correlations. Regressions.	Y. Although not directly: fighting spirit associated with higher FIM, but also threat and loss appraisals were associated with lower FIM scores
Kennedy et al. (2012)	Prospective cohort multi wave design	FIM; HADS; WHOQoL-BREF; Spinal cord injury quality of life questionnaire; Stress related growth scale; Perceived manageability scale; Appraisal of life events scale; Spinal cord lesion-related coping strategies questionnaire; COPE (subscales positive reinterpretation, behavioural disengagement and planning); Sense of coherence scale; Short form social support questionnaire	Questionnaires administered in rehab after 12 weeks and by post after 1 year and 2 years.	t-tests, correlations and stepwise regressions	Y
Machida et al. (2013)	Qualitative - Phenomenological study.	semi-structured interviews; questions around three main topics: (a)	Recruited participants at a competitive wheelchair rugby	Modern form of analytic induction whilst considering	Unclear – but as participants were able to play

		the adversity experience (traumatic accident which resulted in SCI), including affect, behaviors, and cognitions experienced at the time of injury; (b) a description of the resilience process, including coping strategies and social interactions; and (c) factors perceived to be important or debilitating in coping with the accident and losing physical functions.	tournament and interviewed at hotel or tournament site. Interviews lasted between 40 and 90 minutes and data saturation was reached after 12 interviews.	data for relation to the Resiliency Model.	competitive sport, marked as "Y"
Silverman et al. (2015)	Single Cohort - mailed survey	PHQ-9; Patient Reported outcomes Measurement Information System which included CDRSC-10 and the PROMIS physical functioning items.	Survey mailed to a community sample of individuals at t1 and 3 years later.	Linear regression and regression	N
White et al. (2010)	Repeated measures at inpatient rehabilitation centre	CD-RISC 10; Satisfaction with life scale; Intrinsic spirituality scale; PHQ-9; FIM	3 time points (admission, 3 weeks later and discharge)	Repeated measures multivariate analysis of covariance (MANCOVA)	N

Table 2. Sample characteristics

Reference and location	Demographics	Injury type	Other injuries/disabilities included in research	Cause	Time since injury	Education	Hospitalisation	Functioning at time of study	Household Income
Barone, S. & Waters, K. (2012) - USA	243 adults (42 years mean age, SD 15 years) on U.S. National Spinal Cord Injury Association, 66.3% caucasian males, 33.7% female.	Partial or complete quadriplegic (47%) or paraplegic (53%).	No	86.5% trauma, 11.9% nontraumatic	4 weeks post injury minimum, mean 13 years (SD 11.5 years)	47% completed bachelors degree	Mean length of hospitalisation 25 weeks	Unable to functionally ambulate independently more than 150 feet	Mean of $46,650
Battalio et al. (2017) - USA	1476 responses, 61 years ±12, 64% women, 89% white	SCI 24%	Muscular dystrophy (MD) 19%; Multiple Sclerosis (MS) 32%; Postpoliomyelitis syndrome (PPS) 25%	n/a	20±11 years since diagnosis	27% graduate degree; 57% graduated college	n/a	PROMIS physical functioning score of 37 (US average is 50) - 1.3SD's below general population (US) so significantly impaired	n/a

Battalio et al. (2019) - USA	2041 eligible (64% female 90 white); 1,574 final inclusion, with one of four chronic physical disabilities	SCI (24%)	MD - 19%; MS - 31%; PPS - 26%	n/a	n/a	30% completed college; 27% completing graduate or professional school.	n/a	n/a	n/a
Edwards et al. (2017) - USA	893 responses, 162 SCI; 55.3 ±5.7, 64% women, 90% white	SCI 18%	MD 18%; MS 40%; PPS 24%	n/a	15.3±9.9 whole sample; 17.9±11.3 SCI	26% whole sample, 20% SCI graduate/professional school; 31% whole sample, 30% SCI college graduate	n/a	n/a	< 25,000USD 21%; 25 - 55 27%; 56-85 18%; >86,000 30% whole sample; <25,000 30%; 25-55 31%; 56-85 15%; >86,000 21%

Geard et al. (2018) - Norway	Former SCI patients from large rehab hospital. N = 7 men took part in individual interviews. 35-75 years	SCI	No	n/a	2 to 32 years since injury	n/a	n/a	3 permanent wheelchair users, 1 partial user, 3 could walk without walking aids but with some difficulties	n/a
Heinemann et al. (2012) - USA	N = 1032, age 38 years (SD17) 81% male, 71% white 22% black, 38% married	SCI	No	approx 85% trauma (49% vehicle crash, 25% falls)	First year of injury	ranged from high school education (19%) high school diploma (48%)	31 days average from injury to rehab admission; 55 days in rehab	Mean FIM score at admission = 23.5	n/a
Kennedy et al. (2010) - UK	n = 81, age 50.37 (range 18-81) 75% male	8 complete tetraplegia, 23 incomplete tetraplegia, 17 complete paraplegia, 23 incomplete paraplegia, 9 not indicated.	No	n/a	3-18 months after discharge	n/a	n/a	n/a	n/a

Kennedy et al. (2011) - UK - Swiss - German and Irish	n = 127, age 39.3 (17.5 - 64.5); 79% male	48 paraplegia complete lesion, 33 incomplete tetraplegia, 24 incomplete paraplegia, 22 complete tetraplegia	No	92.1% traumatic injury (43% road traffic accident, 39% fall, 29% sports, 1 assault)	Newly acquired (first questionnaire 12 weeks postinjury)	n/a	n/a	n/a	n/a
Kennedy et al. (2012) - UK - Swiss - German and Irish	n = 232, age 40 (18-74); 79% male	32% complete paraplegia, 27.4% incomplete tetraplegia, 19.8% complete tetraplegia	No	n/a	Newly acquired (first questionnaire 12 weeks postinjury)	n/a	n/a	n/a	n/a
Machida et al. (2013) - USA	n = 12; 21-41 years old who participate in competitive wheelchair rugby	SCI (quadriplegia, C5 to C7, complete and incomplete injuries)	No	Trauma	n/a	n/a	n/a	Require a wheelchair	n/a

Silverman et al. (2015) - USA	n = 1594 (SCI = 414). 20 - 94 years old. 64% women and 92% white	SCI	MS - 509, MD - 282, PPS - 389	n/a	mean injury time of 15.30±10.46 years	86% beyond high school education	n/a	37.2±10.2 measured by y physical functioning part of PROMIS	<$25,000 - 340 (22%); $25,000-$40,000 - 259 (17%); $41,000-$55,000 - 208 (14%); $56,000-$70,000 - 184 (12%); $71,000-$85,000 142 (9%); $86,000-$100,000 149 (10%); >$100,000 - 240 (16%)
White et al. (2010) - USA	n = 42 (33 men) mean age 37.5	SCI	No	n/a	At time of injury	n/a	Mean length of stay was 51 days (range of 29 to 107).	Predicted to be non-ambulatory at time of discharge	n/a

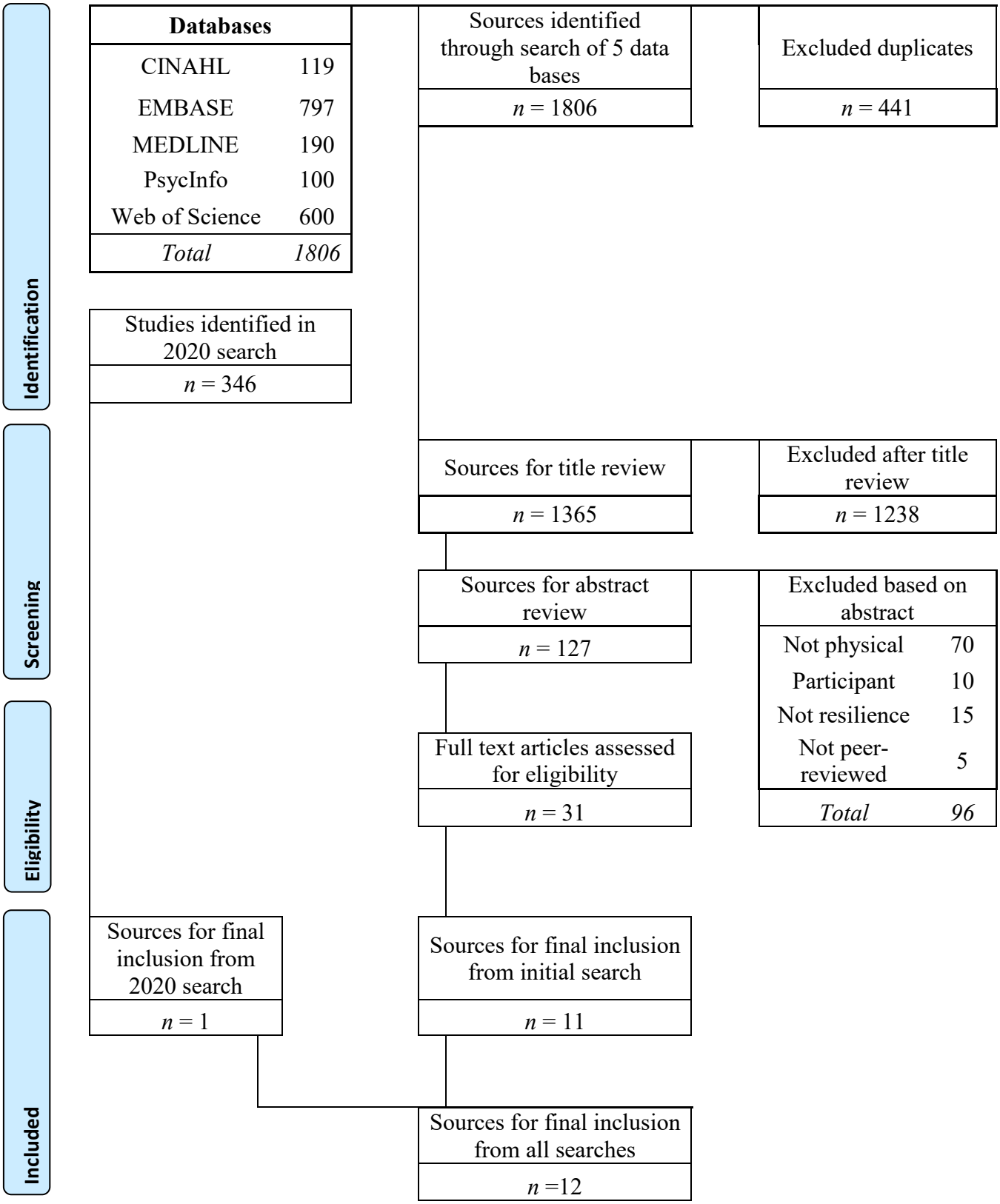

Figure 1. Screening and study selection process.