Evidence Compass

Technical Report

What are the physical and mental wellbeing benefits veterans achieve through participating in sporting activities?

A Rapid Evidence Assessment

August 2018

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Please address any comments or queries about this report to

EvidenceCompass@dva.gov.au

Acknowledgements

This project was funded by the Department of Veterans' Affairs (DVA). We acknowledge the valuable guidance and enthusiastic contribution of our Expert Reference Group for this project, which comprised senior personnel from the University of South Australia and included Professor Roger Eston, Professor Gaynor Parfitt, Alison Bell and Suzana Freegard.

We acknowledge the work of staff members from the International Centre for Allied Health Evidence who were responsible for conducting this project and preparing this report. These individuals include: Associate Professor Steve Milanese, Matthew Crocker, Matt Ransom and Emile Sach.

For citation:

Milanese, S, Crocker, M, Ransom, M and Sach, E (2018). What are the physical and mental wellbeing benefits veterans achieve through participating in sporting activities? A Rapid Evidence Assessment. Technical Report prepared for the Australian Government Department of Veterans' Affairs. International Centre for Allied Health Evidence.

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List of Abbreviations

ABS	Australian Bureau of Statistics
ASAAT	Adapted Sport and Adventurous Training
ASIQ	Adult Suicide Ideation Questionnaire
BDI-II	Beck Depression Inventory-II
BRFSS	Behavioural Risk Factor Surveillance System
BPI	Brief Pain Inventory
CAM	Complementary and Alternative Medicine
CAPS	Clinician Administered PTSD Scale
CBT	Cognitive Behavioural Therapy
CES-D	Center for Epidemiological Studies Depression Scale
CHART	Craig Handicap Assessment Reporting Technique
CI	Confidence Interval
CMI	Chronic Multisymptom Illness
CMP	Chronic Musculoskeletal Pain
CPG	Clinical Practice Guideline
DSM	Diagnostic and Statistical Manual of Mental Disorders
DVA	Department of Veterans' Affairs (Australia)
EAP	Equine Assisted Psychotherapy
ECG	Electrocardiogram
GLTEQ	Godin Leisure-Time Exercise Questionnaire
GV	Gulf War Veteran
iCAHE	International Centre for Allied Health Evidence
IE	Integrative Exercise
IM	Integrative Medicine
IPAQ	International Physical Activity Questionnaire
MAST	Michigan Alcohol Screening Test

MVPA	Moderate-to-vigorous-physical activity
NVWG	National Veterans Wheelchair Games
PA	Physical Activity
PCL	PTSD Checklist
PCL-M	Posttraumatic Stress Checklist-Military
PHQ	Patient Health Questionnaire
PICO	Population Intervention Comparison Outcome
PSQI	Pittsburg Sleep Quality Index
PTSD	Posttraumatic Stress Disorder
QOL	Quality of Life
RCT	Randomised Controlled Trial
REA	Rapid Evidence Assessment
RSA	Respiratory Sinus Arrhythmia
SUD	Substance Use Disorder
THR	Therapeutic Horse Riding
UK	United Kingdom
US	United States
USA	United States of America
VA	Veterans Affairs (USA)
WHO	World Health Organisation
WSC	Winter Sports Clinic

Executive Summary

- Health is a multifaceted concept that describes a person's state of wellbeing (ABS 2001). The objective of this review is to synthesise the published research literature on the physical and mental wellbeing benefits veterans achieve through participating in sporting activities.
- **Physical wellbeing benefit** is any benefit that improves the functional capacity of the individual (ABS 2001). This benefit may be perceived by the individual or objectively measured.
- **Mental wellbeing benefit** is any benefit that improves the individual's emotions, thoughts or behaviours (ABS 2001). This benefit can almost only be perceived by the individual, but in specific situations, change may be objectively measured.
- **Sporting activity** has been defined in this report as any coordinated or organised activity that requires some degree of physical exertion. This working definition is deliberately broad in its scope to capture the continuum of physical activity.
- Reflecting the broad definition used in this review, the sporting activity interventions featured in this review fell into six categories: structured competitive sport; supervised aerobic exercise; supervised mind body exercise; supervised combined aerobic and anaerobic exercise; unmonitored unsupervised physical activity and structured recreational physical activity.
- Wellbeing outcomes were measured subjectively via participant, self-report surveys and when appropriate, supplemented by objective physical measures.
- Results were not pooled as the number of outcome measures used were too great to give confidence in homogeneity. Instead, aggregate scores of outcome measures were used to decide whether the intervention had a positive effect on veteran wellbeing.
- A comprehensive literature review, not restricted by publication date, returned twenty-seven (27) papers in all, comprising twenty-five (25) primary studies and two (2) systematic reviews (SRs). One (1) guideline met the inclusion criteria but upon closer review was deemed irrelevant.
- A publication date was not enforced onto the search strategy, as DVA wished to capture studies (e.g. case control, qualitative studies etc.) not covered by systematic reviews.

The authors of this REA appreciate that this amendment reduces the quality of evidence within the REA and DVA acknowledges this reality.

- The following number of studies were found for each category of sporting activity: structured competitive sport (n=3); supervised aerobic exercise (n=3); supervised mind body exercise (n=5); supervised combined aerobic and anaerobic exercise (n=2); unmonitored unsupervised physical activity (n=5) and structured recreational physical activity (n=7).

- The twenty-five primary studies were made up of the following study designs: randomised controlled trials (RCTs) (n=2); cohort studies (n=20); case control studies (n=2); qualitative studies (n=1) and case study (n=1).

- The evidence for each intervention was ranked via the following categories: 'Supported' – clear, consistent evidence of beneficial effect; 'Promising' – evidence suggestive of beneficial effect but further research required; 'Unknown' – insufficient evidence of beneficial effect; 'Not supported' – Clear, consistent evidence of no effect or negative/harmful effect.

- Based on the findings of this REA, sporting activity was overall categorised as 'promising' as a means to benefit veteran mental wellbeing but received a ranking of 'unknown' for its effect on veteran physical wellbeing. The rankings of evidence for each intervention are listed below:

    - Structured competitive sport: *'promising'* for mental; *'unknown'* for physical.
    - Supervised aerobic exercise: *'promising'* for mental; *'promising'* for physical.
    - Supervised mind body: *'promising'* for mental; *'unknown'* for physical.
    - Supervised combined aerobic and anaerobic exercise: *'unknown'* for both.
    - Unmonitored unsupervised physical activity: *'promising'* for mental; *'promising'* for physical.
    - Structured recreational physical activity: *'promising'* for mental; *'unknown'* for physical.

- The evidence base of this REA is at a relatively low level, due to a reliance on cohort studies and the small number of higher level of evidence studies (2 SRs, 2 RCTs). Therefore, the findings of this REA need to be interpreted in this context and future,

more rigorous studies are required to investigate the relationship between sporting activity and veteran mental and physical wellbeing.

- Based on the evidence contained in this REA, and the small number of reported adverse events, any form of sporting activity could be considered as a supplement to any veteran, mental wellbeing program.

Introduction

The objective of this review was to synthesise the published academic literature on the physical and mental wellbeing benefits veterans achieve through participating in sporting activities. This review aims to answer the following research questions:

Primary research question:

1. What are the physical and mental wellbeing benefits veterans achieve through participating in sporting activities?

Secondary research questions:

2. Are there any economic or social benefits to the community from veterans participating in sporting activities?

3. Are any physical or mental wellbeing benefits veterans achieve through participating in sporting activities linked to the type of activity (i.e. recreational, competitive, team based etc.)?

This Rapid Evidence Assessment (REA) was tasked with identifying the physical and mental wellbeing benefits veterans achieve through participation in sporting activities. As of December 2017, there were 87,238 Australian veterans receiving a disability pension (DVA 2017). This figure reflects a large population who could potentially benefit from the findings of this REA. This review has been approached in a systematic manner and describes the best available research evidence.

Health is a multifaceted concept that describes a person's state of wellbeing (ABS 2001). The two major dimensions of wellbeing are physical health and mental health, with the third aspect, the social environment, affecting wellbeing to a lesser extent. A person's state of wellbeing is a particularly subjective notion as an ailment or disease does not necessarily suggest a poor state of being, but rather it is the person's perception of their state of health and the influence that their issue has on their quality of life which determines their wellbeing (ABS 2001). Given the aim of this REA, three working definitions have been provided below for physical and mental health benefits, as well as sporting activities:

Physical wellbeing benefit is any benefit that improves the functional capacity of the individual (ABS 2001). This benefit may be perceived by the individual or objectively measured.

Mental wellbeing benefit is any benefit that improves the individual's emotions, thoughts or behaviours (ABS 2001). This benefit can almost only be perceived by the individual, but in specific situations, change may be objectively measured.

Sporting activity has been defined in this report as any coordinated or organised activity that requires some degree of physical exertion. This working definition is deliberately broad in its scope so as to capture the continuum of physical activity.

Sporting activity interventions

Given the breadth of possible activities and the various means by which veterans can participate in an activity, the sporting activity interventions that feature in this REA have been differentiated into six categories. These categories are provided below as well as examples of what constituted each intervention.

Structured competitive sport

Veterans participated in a competitive sporting match (e.g. wheelchair rugby).

Supervised aerobic exercise

This exercise group involved veterans participating in an aerobic activity under supervision with measures taken either immediately following a single episode (acute effects) or following a program of aerobic exercise.

Acute effects: A single, short burst of aerobic exercise (e.g. veteran cycled on a stationary bike and measures were taken pre and post intervention).

Program effects: Veterans were supervised on multiple occasions whilst performing aerobic exercise (e.g. treadmill running program under supervision of a physiotherapist).

Supervised mind body exercise

Veterans participated in exercise that deliberately incorporated a mindful aspect to the physical movement (e.g. yoga under the supervision of a yoga instructor).

Supervised combined aerobic and anaerobic exercise

Veterans were supervised whilst performing aerobic and anaerobic exercise (e.g. a supervised gym class that involved cycling as well as the lifting of weights).

Unmonitored unsupervised physical activity

Veterans completed their physical activity in an unsupervised environment and their exercise levels were not monitored (e.g. veterans were asked to swim regularly. There was no supervision or monitoring of activity during the duration of the trial. Pre-intervention measures were compared with a single post-intervention measure).

Structured recreational physical activity

Veterans participated in physical activity that was not constrained by rules but was guided by instructors (e.g. attendance at a fly-fishing camp).

Measuring physical and mental wellbeing

Given wellbeing is subjectively determined, it is very difficult for researchers to establish the validity of a mental or physical wellbeing outcome measure (Muldoon et al. 1998). Instead of comparing the validity of the self-reported measure with a validated, objective measure, researchers may instead compare the results of one self-report measure with the results of a similar measure that assesses the same outcome of interest (Muldoon et al. 1998*).* In the absence of a gold-standard self-report measure, researchers favour the use of multiple, similarly designed surveys to measure the physical and mental wellbeing of an individual (ABS 2001).

Each study in this REA, reported multiple outcome measures and where appropriate, supplemented the self-reported scores with objective physical measures (e.g. grip strength, blood pressure and heart-rate). The self-reported wellbeing measures covered the following aspects of health: psychosocial (e.g. depression inventory, PTSD checklist, general self-efficacy score); physiological (e.g. sleep quality, rate of perceived exertion); social (e.g. quality of life screening) and pain (e.g. brief pain inventory). In studies that did not pool their survey results, an aggregate effect on mental and physical wellbeing was assessed by the iCAHE review team to establish the effectiveness of each intervention. Some studies did pool the findings of multiple outcome scores and in these instances p-values and effect sizes were formulated to establish the significance of the intervention's effect.

Summary

Numerous studies have shown that exercise and sporting activities are associated with improved wellbeing (Rutter et al. 2013; Smith-Marek et al. 2016 and Martin et al. 2015), but to date there has been limited synthesis of the evidence pertaining to the benefits experienced by veterans. Research indicates that both sport and physical activity have the potential to influence wellbeing among individuals diagnosed with mental illness (Caddick & Smith 2014) and with many returned service personnel victim to mental health issues, research into the possible benefits experienced by veterans is warranted. The wide scope of this REA aims to fill a gap in the literature and help identify interventions which will improve the wellbeing of veterans. In addition, any economic or social benefit to the community created by the sporting activity will be addressed, as well as discussion of factors of sporting activity design that impact the effectiveness of the intervention.

Method

To answer the question of what the physical and mental wellbeing benefits veterans achieve through participating in sporting activities, this review utilised a Rapid Evidence Assessment (REA) methodology developed for the Department of Veterans' Affairs (DVA) by the Australian Centre for Posttraumatic Mental Health (Varker et al. 2014). An REA is a research methodology which uses similar methods and principles to a SR but makes concessions to the breadth and depth of the process, in order to suit a shorter timeframe. The advantage of an REA is that it utilises rigorous methods for locating, appraising and synthesising the evidence related to a specific topic of enquiry. To make an REA rapid, however, the methodology places a number of limitations in the search criteria and in how the evidence is assessed. For example, REAs often limit the selection of studies to a specific time frame (e.g. last 10 years), and limit selection of studies to peer-reviewed published, English studies (therefore not including unpublished pilot studies, difficult-to-obtain material and/or non-English language studies). Also, while the strength of the evidence is assessed in a rigorous and defensible way, it is not necessarily as exhaustive as a well-constructed SR and/or meta-analysis. A major strength however, is that an REA can inform policy and decision makers more efficiently by synthesising and ranking the evidence in a particular area within a relatively short time frame.

Defining the research question

The components of the question were defined using terms of the Population Intervention Comparison Outcome (PICO) framework (refer to Appendix 1). Operational definitions were established for key concepts related to the question, and from this, specific inclusion and exclusion criteria were defined for screening studies into this REA. As part of this operational definition, the population of interest was defined as ex-serving air force, navy or army veterans. The intervention was defined as any sport, physical activity, exercise or fitness intervention targeting the physical and mental wellbeing of veterans. The outcome was defined as any measure of physical or mental wellbeing (e.g. quality of life, rehabilitation assessment, mental health diagnosis, change in mood, change in activities of daily living, impact on progress to rehabilitation, functional outcomes, length of stay (hospital) and associated medical expenses).

Search strategy

To identify the relevant literature, systematic bibliographic searches were performed to find relevant trials from the following databases: the Cochrane Library, Ovid Databases (Medline,

EMBASE, PsychInfo), National Institute for Health and Clinical Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), Guideline International Network (G-I-N), National Guidelines Clearinghouse (NGC) and Clinical Guidelines Portal (CGP). An example of the search strategy conducted using the Medline database appears in Appendix 2. This proposed search strategy was developed in consultation between the academic librarian, the expert reference group and DVA.

Search terms

Search terms using the Title/s, Abstract/s, MeSH terms and Keyword lists included:

Veterans/ OR Veterans Health/ OR Veterans Disability Claims/ OR "United States Department of Veterans Affairs"/ OR veteran* OR militar* OR armed service* OR air force OR airforce OR navy OR army OR exmilitary OR ex-military OR ex-service* OR exservice* OR combat disorders/ OR combat disorder? OR combat experience? AND Sports/ OR exercise/ OR circuit-based exercise/ OR Athletic Performance/ OR sports for persons with disabilities/ OR warm up exercise/ OR cool-down exercise/ OR physical conditioning, human/ OR plyometric exercise/ OR resistance training/ OR running/ OR water Sports/ OR swimming/ OR walking/ OR exp Physical Fitness/ OR Baseball/ OR Basketball/ OR Bicycling/ OR Boxing/ OR Football/ OR Soccer/ OR Golf/ OR Gymnastics/ OR Hockey/ OR Racquet Sports/ OR Tennis/ OR Martial Arts/ OR Tai Ji/ OR Return to Sport/ OR Jogging/ OR Skating/ OR Snow Sports/ OR Skiing/ OR Diving/ OR Volleyball/ OR Weight Lifting/ OR Wrestling/ OR Mountaineering/ OR "Track and Field"/ OR sport* OR athletic* OR physical exercise* OR physical activit* OR physical fitness OR baseball OR basketball OR netball OR bicycling OR cycling OR cricket OR archery OR boxing OR football OR soccer OR rugby OR golf OR gymnastic* OR hockey OR tennis OR racquet sport* OR lacrosse OR martial art* OR tai ji OR tai chi OR running OR runs OR jogging OR jogs OR skating OR snow sport* OR skiing OR snow-boarding OR ice skating OR swimming OR diving OR volleyball OR walking OR weight lifting OR weightlifting OR wrestling OR horse riding OR riding OR sailing OR surfing OR wind-surfing OR aerobics OR rowing OR mountaineering OR climbing OR canoeing OR kayaking OR rafting OR wood-chopping OR ballgame? OR ball game? OR polo OR hurling OR races OR racing OR shot put OR shotput OR discus OR power lifting OR sailing OR wheelchair sport* OR wheelchair basketball OR wheelchair rugby OR aerobic exercise* OR athletic participation OR judo OR movement therap OR lawn bowl* OR petanq OR petanque OR boccia OR bocci OR bocce OR boules OR bowling OR fishing OR sled hockey OR biathlon OR bi-athlon OR snowmobiling OR equestrian OR triathlon OR shooting OR snowboarding OR badminton OR fencing OR squash OR ice hockey OR waterboarding OR sprinting OR hurdling OR judoku OR karate OR curling OR relay

OR murder ball OR murderball Combat sport* OR Cue sport* OR Ice sports OR Kite sport* OR Orienteering OR Aquatic sport* OR Team sport* OR Aikido OR jiu jitsu OR jiujitsu OR ju jitsu OR jujitsu OR judo OR karate OR kung fu OR kungfu OR qigong OR taekwondo OR tikwondo OR wushu OR kick boxing OR kickboxing OR billiard? OR snooker?

Paper selection

After conducting searches, identified studies were evaluated according to the following inclusion and exclusion criteria:

Included:

1. Published, peer-reviewed research studies: Guidelines which scored highly on the AGREE II Critical Appraisal tool and have been developed using best evidence reviews, and systematic reviews with meta-analyses; systematic reviews with or without meta-analysis and primary research designs randomised controlled trials (RCTs) and cohort studies (prospective or retrospective that are not previously included in the high-quality guidelines.
2. Studies which assessed the effect of any sport, physical activity, exercise or fitness intervention targeting the physical and mental wellbeing of veterans.
3. Human adults (i.e. ≥ 18 years of age)
4. Population: veterans
5. English language

Excluded:

1. Non-English Papers
2. Grey literature (e.g. media: websites, newspapers, magazines, television, conference abstracts, theses)
3. Opinion pieces or editorials
4. Papers where the study focus was not relevant to veterans participating in sport or physical activity
5. Studies only available in abstract form e.g. conference presentations, dissertations and papers where a full-text version is not readily available
6. Animal studies

Information management

A screening process was adopted to code the eligibility of papers acquired through the search strategy. Papers were directly imported into the bibliographic tool Endnote X8© and then processed using Covidence© software. All records that were identified using the search strategy were screened for relevance against the inclusion criteria. Screening for inclusion was performed independently by two reviewers and was based on the information contained in the title and abstract. Full text versions of all studies which satisfied this initial screening were obtained.

In screening the full-text papers, the reviewers made the decision on whether the paper should be included or excluded, based on criteria for the specific question. If the paper met the criteria for inclusion, then it was subject to data abstraction. At this stage in the information management process, 20% of the articles being processed were randomly selected and checked by one independent reviewer. It was found that there was 100% inter-rater agreement between the reviewers.

Data extraction

The following information was extracted from the identified publications using a data extraction tool which was specifically developed for this review. The following information was extracted from individual studies:

- Evidence source (author, date, country)
- Population (participant characteristics)
- Study design
- Intervention
- Outcome measures
- Data analysis
- Level of evidence (Quality ranking)
- Main findings
- Statistical findings

Evaluation of the evidence

There were five key components that contributed to the overall evaluation of the evidence: (Varker et al. 2015)

1. The **strength of the evidence base** in terms of the quality and risk of bias, quantity of evidence, and level of evidence (study design)
2. The **direction** of the study results in terms of positive, negative or null findings
3. The **consistency** of the study results
4. The **generalisability** of the body of evidence to the target population (i.e. adults/military personnel)
5. The **applicability** of the body of the evidence to the Australian context

The first three components provided a gauge of the internal validity of the study data in support of efficacy for an intervention. The last two components considered the external factors that may influence effectiveness, in terms of the generalisability of study results to the intended target population, and applicability to the Australian context.

Strength of the evidence base

The strength of the evidence base was assessed in terms of the (a) quality and risk of bias, (b) quantity of evidence and (c) level of evidence.

a) **Quality and risk of bias** reflected how well the studies were conducted, including how participants were selected, allocated to groups, managed and followed-up; and how the study outcomes were defined, measured, analysed and reported. An assessment was conducted for each individual study with regard to the quality and risk of bias criteria utilising a modified version of the Chalmers Checklist for appraising the quality of studies of interventions (see Appendix 3). Three independent raters rated each study according to these criteria, and together a consensus agreement was reached as to an overall rating of ‘Good’, ‘Fair’, or ‘Poor’.

b) **Quantity** of evidence reflected the number of studies that were included as the evidence base for each ranking. The quantity assessment also took into account the number of participants in relation to the frequency of the outcomes measured (i.e. the statistical power of the studies). Small underpowered studies that were otherwise sound may have been included in the evidence base if their findings were generally similar- but at least some of the studies cited as evidence must have been large enough to detect the size and direction of any effect.

c) **Level of evidence** reflected the study design. Details of the study designs included in this REA were assessed against a hierarchy of evidence commonly used in Australia: (Merlin et al. 2009)

- Level I: SR of randomised controlled trials (RCTs)
- Level II: RCT
- Level III-1: Pseudo-RCT (i.e. a trial where a pseudo-random method of allocation is utilised, such as alternate allocation).
- Level III-2: Comparative study with concurrent controls. This can be any one of the following:
    - Non-randomised experimental trial [this includes controlled before-and-after (pre-test/post-test) studies, as well as adjusted indirect comparisons (i.e. utilise A vs B and B vs C to determine A vs C with statistical adjustment for B)]
    - Cohort study
    - Case-control study
    - Interrupted time series with a control group
- Level III-3: A comparative study without concurrent controls. This can be any one of the following:
    - Historical control study
    - Two or more single arm study [case series from two studies. This would include indirect comparisons utilise (i.e. A vs B and B vs C to determine A vs C where there is no statistical adjustment for B)]
    - Interrupted time series without a parallel control group.
- Level IV: Case series with either post-test or pre-test/post-test outcomes

Overall strength

A judgement was made about the strength of the evidence base, taking into account quality and risk of bias, quantity of evidence and level of evidence. Agreement was sought between three independent raters and consensus about the strength of the evidence base was obtained according to the following categories.

High strength
One or more level I studies with a low risk of bias OR three or more level II studies with a low risk of bias

Moderate strength
One or two level II studies with a low risk of bias OR two or more level III studies with a low risk of bias

Low strength
One or more level I to level IV study with a high risk of bias

Direction

The direction component of the ranking system makes a judgement as to whether the results are in a positive or negative direction. In cases where there are studies which show findings in different directions, preference is given to the direction of the study findings with the highest level and best quality.

Positive direction
The weight of the evidence indicates positive results

Unclear direction
The evidence does not show significant effects OR the results are mixed

Negative direction
The weight of the evidence indicates negative results

Consistency

The consistency component of the ranking system of the body of the evidence assesses whether the findings are consistent across the included studies (including across a range of study populations and study designs). It was important to determine whether study results are consistent to ensure that the results are likely to be replicable or only likely to occur under certain conditions.

High consistency
All studies are consistent reflecting that results are highly likely to be replicable

Most studies are consistent and inconsistency may be explained, reflecting that results are moderately- highly likely to be replicable

Some inconsistency reflecting that results are somewhat unlikely to be replicable

High inconsistency
All studies are inconsistent reflecting that results are highly unlikely to be replicable

Generalisability

This component covers how well the participants and settings of the included studies could be generalised to the target population. Population issues that might influence this component included gender, age or ethnicity, or level of care (e.g. community or hospital).

High generalisability
The population/s examined in the evidence are the same as the target population

The population/s examined in the evidence are similar to the target population

The population/s examined in the evidence are different to the target population, but it is clinically sensible to apply this evidence to the target population

Low generalisability
The population/s examined in the evidence are not the same as the target population

Applicability

This component addresses whether the evidence base is relevant to the Australian context, or to specific local settings (such as rural areas or cities). Factors that may reduce the direct application of study findings to the Australian context or specific local settings include organisational factors (e.g. availability of trained staff) and cultural factors (e.g. attitudes to health issues, including those that may affect compliance).

Ranking the evidence

On balance, this next step takes into account the considerations of the strength of the evidence (quantity and risk of bias, quantity of evidence and level of evidence), consistency, generalisability and applicability. The total body of the evidence is then ranked into one of four categories: 'Supported', 'Promising', 'Unknown' and 'Not Supported' (see Figure 1). Agreement on ranking is sought between all three independent raters.

Figure 1: Categories within the intervention ranking system

SUPPORTED	PROMISING	UNKNOWN	NOT SUPPORTED
Clear, consistent evidence of beneficial effect	Evidence suggestive of beneficial effect but further research required	Insufficient evidence of beneficial effect and further research is required	Clear, consistent evidence of no effect or negative / harmful effect

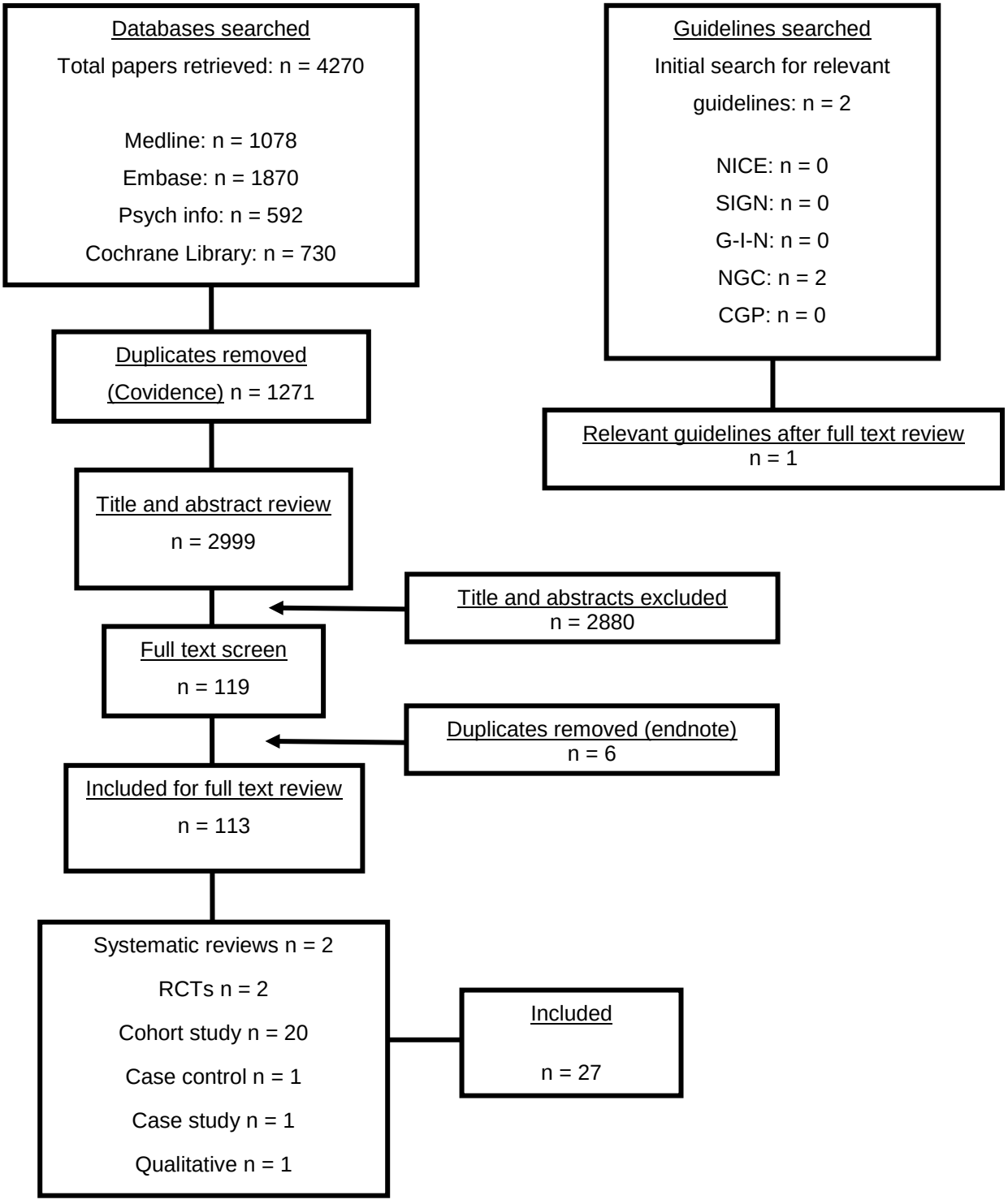
Results

The following section presents the flowchart relating to the number of records identified at each stage of the REA (refer to Figure 2). The subsequent databases were searched: Medline©, Embase©, PsychInfo© and Cochrane© Library. Following the removal of duplicates (n = 1,271), 4,720 articles were transferred to Covidence© software where two reviewers independently scanned the title and abstract to identify relevant studies for full text screening. After a further exclusion of 6 articles using Endnote© duplicate screening software, one hundred and nineteen (119) articles were included for full text screening. From the database searches, 27 original publications met the full inclusion criteria and were included in the results of this REA. The majority of studies excluded from the review was due to a minimal or non-existent connection with sporting or physical activities, but there was also a significant portion that were either dissertations, abstracts or not published in English.

Five guideline databases were searched: National Institute for Health and Clinical Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), Guideline International Network (G-I-N), National Guidelines Clearinghouse (NGC) and Clinical Guidelines Portal (CGP). Two potentially relevant guidelines were found, but following full text review only one was deemed relevant.

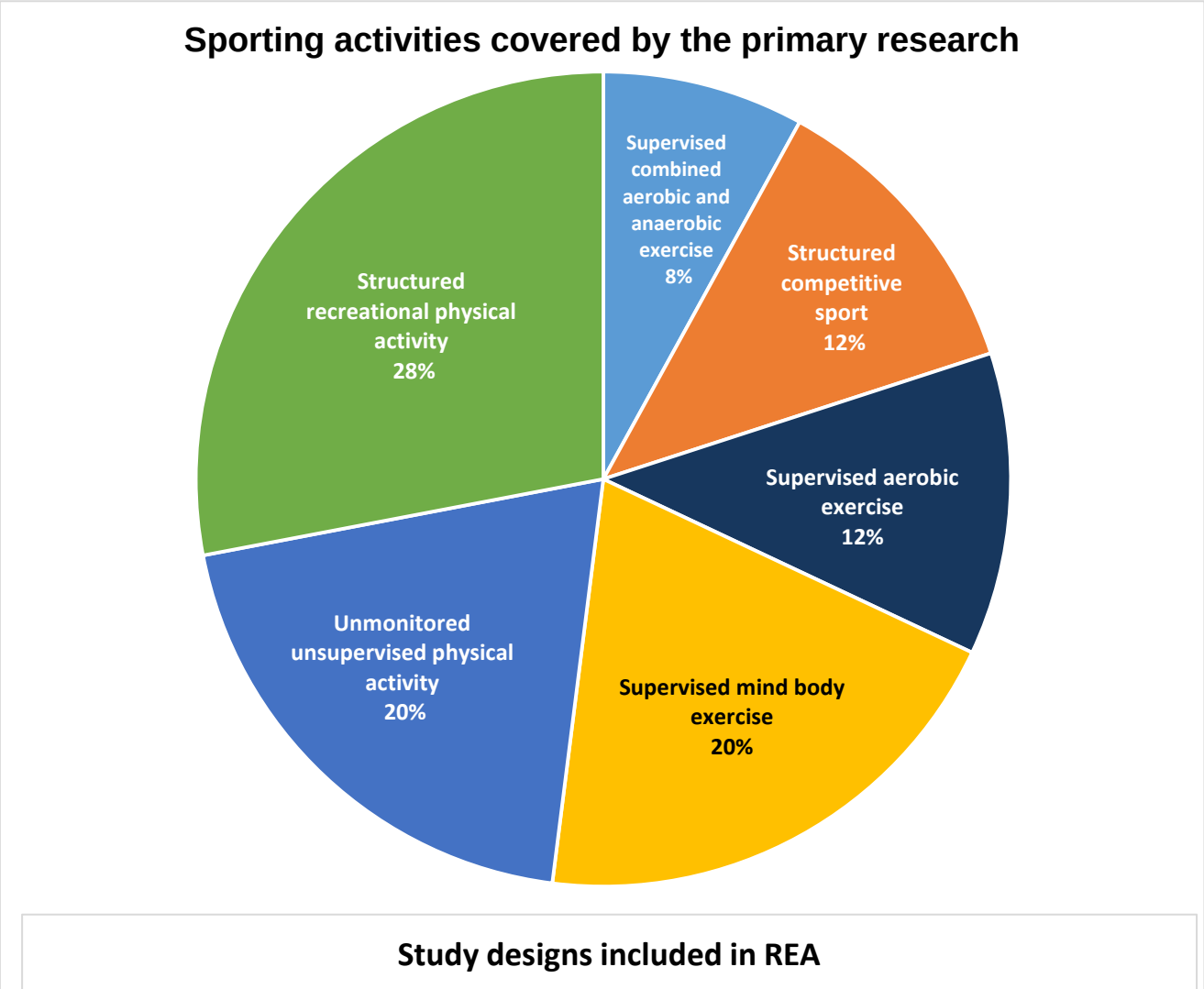
The 27 studies originated from a range of international locations. Seventy-five percent of the studies were from the USA, with three studies originating from the UK and singular studies from Australia and China. The included studies year of publication ranged from 1992 to 2018, with 25 of the studies (90%) published in the last 10 years.

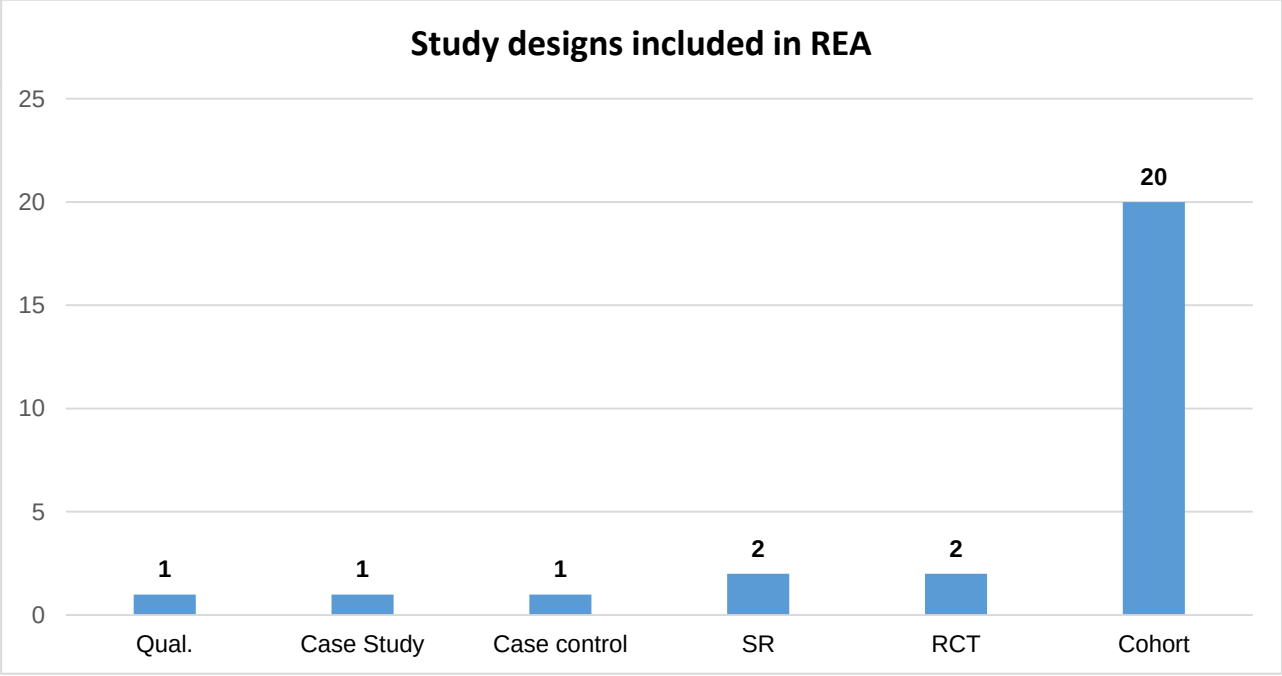
Figure 2: Flowchart representing the number (n) of records retrieved at each stage of the rapid evidence assessment



Summary of the Evidence

A total of 25 primary research articles and 2 secondary research articles were included in this REA.





Highest level of evidence for each sporting activity

Sporting activity	Highest level of evidence
Structured competitive sport	*Cohort study (Level III-2)*
Supervised aerobic exercise	*Case control (Level III-2)*
Supervised mind body exercise	*RCT (Level II)*
Supervised combined aerobic and anaerobic exercise	*Cohort study (Level III-2)*
Unmonitored unsupervised physical activity	*Cohort study (Level III-2)*
Structured recreational physical activity	*RCT (Level II)*

All studies featured limitations in their design but the most common was a lack of follow up or a short intervention period; reflective of a potential timing bias. Similarly, most studies investigated veterans with multiple co-morbidities: Posttraumatic Stress Disorder (PTSD), depression, Substance Use Disorder (SUD) (alcohol and illicit substances) and obesity, which affects the generalisability of the results to all veterans. However, all but two studies were conducted in English language, Western countries (USA, UK and Australia) which enhances the applicability of the findings to the Australian veteran population. Although differences in veteran culture exist, (particularly between Australian and USA veterans), it is expected that the actual experiences of Australian veterans would be more similar to those of Western countries, than of countries with vastly different cultures.

Each of the following sections deal with a separate sporting activity, with studies of higher quality discussed first.

Secondary Research Studies

Systematic Reviews (SR)

Caddick and Smith (2014) – Level 1 Systematic Review: Fair quality

Caddick and Smith (2014) examined the potential impact of sport and physical activity on the subjective and psychological wellbeing of combat veterans in the aftermath of physical or psychological combat trauma. Eleven studies were identified by the review, which included seven qualitative and four quantitative papers. The type of sport and physical activity studied within the individual papers varied significantly and included structured competitive sport, structured recreational physical activity and supervised combined aerobic and anaerobic exercise. Four of the studies investigated interventions with structured competitive sport components. The study by Sporner et al. (2009a) utilised a cross-sectional study design to investigate 132 veterans with a disability of mean age 47.4 years at the National Veterans Wheelchair Games (NVWG) and Winter Sports Clinic (WSC). The main findings indicated that participants rated overall improvements in self-esteem and quality of life (QOL), interaction with other veterans, acceptance of disability, and mobility skills as important outcomes of participation. Cordova et al. (1998) investigated 44 male disabled veterans aged 19-70 during a National Disabled Veterans WSC. Questionnaires addressing self-concept and leisure satisfaction administered one month prior to, during, and one month after the sports clinic identified that total leisure satisfaction and self-satisfaction scores improved across the collection points.

Brittain and Green (2012) conducted a qualitative study on veterans with an injury or veterans with a disability, who were undertaking an elite sport within the Paralympics. The main findings suggested that participation in elite sport provided a source of inspiration and achievement, fostered self-actualisation and direction in life, and facilitated re-integration and acceptance of disability. Hawkins, Cory and Crowe (2011) utilised a qualitative approach to investigate the effects of participation in a three-day U.S. Paralympic Military Sport Camp on nine male and four female injured service members, aged 20-40 years old. The findings suggested that participation provided a source of motivation, sense of competence, autonomy, relatedness, connection with previous interests, general perceived health and fitness benefits, and normalisation of disability.

Six of the studies in Caddick and Smith (2014) investigated structured, recreational physical activity interventions. Burke and Utley (2013) studied the effects of a 9-day climbing challenge on Mt. Kilimanjaro for 4 injured male veterans aged 22-44 years. The authors reported that there was a strong sense of social support amongst the group and that the veterans

experienced the trek as a form of active coping. Carless et al. (2013) recruited 11 male veterans aged 20-43 years with physical disability, chronic illness or mental health problems and investigated the effect of a 5-day inclusive adapted sports and adventurous training course. Following the intervention, the cohort reported a 'rekindling' of motivation to become more active and they described a reconnection with their previous military service identity which enhanced their current perception of self-worth. The participants also experienced a sense of being valued, respected and cared for, and being inspired by others. Dustin et al. (2011) recruited 10 male and 3 female veterans diagnosed with PTSD and explored the effects of a 4 day 'river running' trip. The main findings suggested that the trip reduced PTSD symptomatology, enhanced perceived coping skills, confidence and self-efficacy. Additionally, the authors felt that the 'ecotherapeutic' impact of exercising in nature, contributed to the positive wellbeing effects. Mowatt and Bennett (2011) conducted a narrative analysis of letters written by 67 veterans diagnosed with PTSD following a 2-day therapeutic fly-fishing program. Findings from the letters suggested that fishing provided a context and location for veterans to experience camaraderie, enjoyment and relaxation, an opportunity for reflection, and positive experience of the outdoors. Although, all recreational physical activity interventions reported positive outcomes, their findings should be viewed in the context of generally small sample sizes and lower levels of study design.

Lundberg, Bennett and Smith (2011) recruited 18 male veterans aged 30-34 years with an acquired disability and/or PTSD diagnosis, to study the effects of a 5-day adaptive sports and recreation program. Questionnaires which addressed mood, QOL and perceived competence were used to identify changes in veteran wellbeing. The findings reported that the program improved perceived competence, increased vigour and lessened mood disturbance, however, did not impact upon self-reported QOL. Hyer et al. (1996) employed a mixed methods design to study the impact of a 5 day 'Outward Bound Experience' outdoor adventure pursuit. The study recruited 219 male veterans diagnosed with PTSD with a mean age of 41 years. The outcomes measured included, symptoms of PTSD, depression, locus of control and anxiety. The findings found no apparent impact on measures of PTSD symptomatology, however, self-reported data highlighted the benefits of improved self-esteem, enjoyment of the outdoors, overcoming negative emotions, being more in control, and enhanced relationships. The final study within this SR investigated a supervised combined aerobic and anaerobic exercise intervention (Otter & Currie 2004). Fourteen male veterans diagnosed with PTSD with a mean age of 55 years participated in a 40-week community exercise rehabilitation program. Focus groups were conducted at weeks 10, 25, and 40 with participants reporting positive impact on work and lifestyle habits, motivation, daily habits and energy levels, social support, and reduced anger.

Caddick and Smith (2014) - Summary

Caddick and Smith (2014) reported that the findings from the eleven studies revealed that participation in these various activities can have a positive influence on both the subjective and psychological wellbeing of combat veterans. Partaking in sport and physical activity was reported to enhance subjective wellbeing in veterans through active coping and greater physical activity. Other positive findings attributed to participation in sporting activities were found in PTSD symptom reduction, the presence of positive affective experiences, enjoyment from exercising in nature, and enhanced quality of life. It was reported that psychological wellbeing was impacted by improving determination and inner strength, focussing on ability and broadening perceptions of ability, enhancing identity and self-concept, creating a sense of achievement, and refining social wellbeing. The value of participation in sport and physical activity was further emphasised due to its ability to enhance motivation for living.

The authors also highlighted that the majority of researchers who selected veterans with PTSD as their participants, chose various 'non-competitive' activities, with potential 'therapeutic' qualities. Contrastingly, research that involved veterans with an injury or a disability, chose competitive-like sporting activities as a means to improve veteran wellbeing. Caddick and Smith (2014) suggested that this was a deliberate choice and proposed that certain qualities of a sporting activity (e.g. relaxing qualities vs. achievement oriented) dictated their inclusion in a PTSD focussed investigation, or an injured or disabled veteran cohort. However, these findings are underpinned by lower levels of study design (e.g. cohort studies), small sample sizes and should be viewed in this light.

Whitworth and Ciccolo (2016) – Level 1 Systematic Review: Poor quality

Whitworth and Ciccolo (2016) conducted a SR to examine the relationship between exercise and PTSD in military veterans. Twelve relevant studies were identified which included eight observational studies, two experimental, and two qualitative. Five cross sectional studies investigated unmonitored unsupervised physical activity (Arnson et al. 2007; Kozaric-Kovacic et al. 2009; Chwastiak, Rosenheck & Kazis 2011; Smith et al. 2016 and Davidson et al. 2013).

Arnson et al. (2007) examined the relationship between PTSD, exercise, health-related QOL, and fibromyalgia in 55 male Israeli veterans diagnosed with PTSD using DSM-IV criteria. Significant differences were found in the total Short-Form Health Survey score, with veterans who reported regular exercise scoring more favorably on the scale. Greater physical function and reduced sensitivity to pressure (as measured by a rheumatologist pressing their thumb

into the body of the participant and gauging subjective response to the non-noxious stimulation) was also found to be greater in regular exercisers than non-exercisers.

Kozaric-Kovacic et al. (2009) recruited 478 Croatian veterans to examine the relationship between Body Mass Index (BMI) and lifestyle behaviors of male military veterans with and without PTSD. Reported results showed that significantly more veterans without PTSD (48.8%) reported engaging in weekly exercise than those with PTSD (27.9%). Chwastiak, Rosenheck and Kazis (2011) examined the relationship among mental illness, exercise, cigarette smoking, and BMI using data collected from 501,161 US veteran's responses in the 1999 Large Health Survey of Veteran Enrollees. The results indicated that 6.2% of the sample had PTSD and that those diagnosed were significantly more likely not to do any weekly exercise, smoke cigarettes, and be obese. Smith et al. (2016) investigated risk factors of obesity in 735 US veterans with and without PTSD. Participation in exercise (frequency and intensity not described) reduced the likelihood of obesity in veterans with current and lifetime PTSD. Davidson et al. (2013) recruited 346 US military veterans admitted to a veteran affairs 90-day residential rehabilitation program to investigate the relationship between exercise, PTSD symptoms, depressive symptoms and sleep quality, and how this relationship translates to suicide risk. Outcomes were measured using questionnaires, interviews and the military version of the PTSD Checklist. Exercise was found to reduce depressive symptoms and improve sleep quality, which in turn was associated with a decreased suicide risk. The duration, intensity and frequency of exercise to positively affect each outcome was not highlighted by the authors. For the last outcome of interest, exercise did not affect PTSD symptomatology and hence did not affect suicide risk.

A longitudinal study by Talbot et al. (2014) examined the relationship between PTSD, exercise and sleep quality data from 736 US veterans. The results suggested that veterans with PTSD reported significantly less exercise and worse sleep quality at baseline. Baseline exercise and sleep quality were also found to be significant predictors of exercise at follow up, however, baseline PTSD status was not. Two of the studies examined interventions with supervised combined aerobic and anaerobic exercise components. LeardMann et al. (2011) investigated the association between exercise and PTSD in 38,883 US veterans using a prospective cohort study design from 2001 to 2006. Exercise was categorised into aerobic exercise and strength training, with aerobic exercise further divided into intensities of light, moderate and vigorous. At follow-up, vigorous exercise was found to reduce the risk of developing new or persistent symptoms of PTSD. The qualitative study by Otter and Currie (2004) was also identified by the Whitworth and Ciccolo (2016) SR with the results previously reported in Caddick and Smith (2014).

Hamner and Hitri (1992) investigated the effects of acute aerobic exercise on plasma beta-endorphin levels in veterans with and without PTSD by recruiting 18 US veterans to participate in a maximal exercise test. Post-test results showed that veterans with PTSD produced significantly more beta-endorphins than those without PTSD. Keller-Ross et al. (2014) examined the effects of a cognitive stress test on muscle fatigue and handgrip steadiness in males with PTSD. The results showed that veterans with PTSD fatigued faster and were more unstable during a handgrip task than those without PTSD, however, the outcome was not affected by the acute cognitive stressor.

One study investigated the effect of a structured recreational physical activity by examining the effect of a recreational surfing camp on PTSD in 15 British veterans (Caddick, Smith & Phoenix 2015). The surfing camp lasted 3-weeks and was composed of surfing, yoga, meditation and coastal walks. Interviews and direct participant observation was used to collect data. Participants reported improved wellbeing, positive changes in affective state, and that recreational surfing served as a distraction from PTSD symptoms. Babson et al. (2015) conducted a prospective cohort study which examined the effects of a supervised aerobic exercise intervention on PTSD symptoms. The study recruited 217 US veterans who were participants in a veteran affairs residential PTSD treatment program. Participants within the program all had the chance to participate in organised bicycling outings. The findings suggested that exercise improved hyper-arousal symptoms for veterans who had poor baseline sleep quality. However, the total miles cycled were not correlated with any PTSD symptom or sleep quality.

Whitworth and Ciccolo (2016) - Summary

Whitworth and Ciccolo (2016) reported on findings from thirteen studies, of which twelve were relevant to the aims of this REA. The authors found that in veterans, regular exercise is negatively correlated with PTSD and its symptoms. However, the longitudinal effect of exercise on PTSD remained unclear. The authors reported that exercise might have unique effects in veterans with PTSD, which could be directly related to the physiological changes that typically occur with the disorder. Also, the studies suggested that veterans perceive sport and exercise to be helpful for coping with the symptoms of PTSD.

Clinical Practice Guideline

Only one clinical practice guideline (CPG) was found to have any relevance to the aims of this REA. Published by the U.S. Department of Veterans Affairs (2014), this CPG found that physical activity should be included in the management of veterans with chronic multi-symptom illness (CMI). Veterans are often diagnosed with CMI which is an umbrella term that can affect mood, cognition, energy levels and give the sufferer pain. Details of the duration of the exercise, intensity, frequency and type of physical activity was not described and as such this guideline's value to the review's overall findings is minimal.

Primary Research Studies

Structured competitive sport

Level of evidence: 'promising' for mental wellbeing; *'unknown'* for physical wellbeing.

Cohort studies:

Three cohort studies investigated the physical and mental wellbeing benefits of structured competitive sport for veterans (Burling et al. 1992; Laferrier, Teodorski & Cooper 2015 and Sporner et al. 2009b). Burling et al. (1992) followed a cohort of 34 veterans of a residential rehabilitation program and investigated the impact participation in a community-based softball team had on their wellbeing. The rehabilitation program primarily treated veterans with an alcohol or drug dependence (over 95%) and the cohort was on average 38 years old and entirely male. The option to participate in softball training and games was an adjunct to their rehabilitation treatment. It was found that those veterans who participated in the softball program were more likely to complete their inpatient rehabilitation program ($p<0.01$) as well as more likely to find housing, employment and be abstinent from substance abuse at 3-months following the softball intervention ($p<0.05$). The authors concluded that participation in softball appeared to enhance outcomes by providing opportunities for practicing coping skills and developing supportive relationships.

Laferrier, Teodorski and Cooper (2015) conducted a cross sectional study to investigate the effect participation in sport had on the self-esteem and QOL of 220 veterans with disabilities. The participants were recruited in 2009 and 2010 from registered athletes at the NVWG, the United States Olympic Committee Warrior Games, and the National Veterans Summer Sports Clinic. Statistically significant differences were found between pre-event and post-event self-esteem scores ($p<0.05$) which suggested that participation in sporting activity positively affected this outcome. Both QOL ($p<0.01$) and self-esteem ($p<0.001$) scores were statistically significantly higher among veterans with more years of participation in sports, exercise and recreation since the onset of their disability. Interestingly, athletes who participated in team events ($p=0.037$) or a combination of events that included team play ($p=0.036$) had statistically significantly higher self-esteem scores than those who participated in individual events. Laferrier, Teodorski and Cooper (2015) suggested that the environment created by being surrounded by a group of peers or a team may foster positive self-esteem by providing an internal support system. In summary, the authors found that structured competitive sport improved mental wellbeing in this population of veterans with a disability.

Sporner et al. (2009b) recruited 38 military veterans to assess the role competitive sport had on physical wellbeing. Participants were recruited from the wheelchair basketball and rugby tournaments of the 2007 and 2008 NVWG. A miniaturised data logger was used to collect manual wheelchair activity during gameplay such as distance travelled, activity time and number of starts/stops. The results of the study identified that greater than 75% of the athletes reached the Centre for Disease Control and Prevention (CDC) recommended 20 minutes of daily strenuous activity during the game. The authors concluded that promoting participation in wheelchair basketball and rugby improved the physical wellbeing of veterans in this cohort.

The highest level of evidence for structured competitive sport was Level III-2, cohort studies.

Supervised aerobic exercise

Level of evidence: 'promising' for mental wellbeing; *'promising'* for physical wellbeing.

Acute effects of aerobic exercise

Case control study:

Cook, Stegner and Ellingson (2010) recruited 32 Gulf War veterans (GVs), in order to appraise the effect of acute exercise on pain levels in GVs with chronic musculoskeletal pain (CMP). Each participant completed a maximal effort test on a cycle ergometer and then seven days later completed a sub-maximal bout of exercise (70% of calculated maximal effort) for 30 minutes on the same ergometer. Heat and pressure pain thresholds were calculated for each participant prior to and after the sub-maximal effort and rates of perceived exertion were recorded during the testing. Eleven GVs with CMP and 16 healthy GVs (control) completed both days of testing. Perceived rates of exertion were greater in GVs with CMP whilst exercising (13.5 vs 12.0) and their average level of pain whilst exercising was also greater (4.7 vs 4.1); both measures were statistically significant ($p<0.05$). Pain thresholds post-exercise were also more sensitive in the GVs with CMP group than compared with the control, but this difference was not statistically significant ($p>0.05$). The authors concluded that acute, aerobic exercise decreased the pain thresholds of GVs with CMP making them more likely to experience greater pain during and following exercise. However, these findings are underpinned by a small sample size and only one incident of testing.

Effects of a supervised aerobic program

Cohort studies:

Two cohort studies looked at the role of supervised exercise in improving veteran's physical and mental wellbeing. Kerr, Leicht and Spinks (2008) examined the effect of aerobic and resistance exercise on cardiovascular disease risk factors. The study included 164 Australian male, Vietnam War veterans in an exercise program over a 12-month period. The program consisted of 15-20 minutes of aerobic exercises at 55-75% recommended capacity and 7-9 resistance training exercises. The results illustrated that regular aerobic and resistance training, at least 2 days per week over a 12-month period, significantly improved both anthropometric and cardio-respiratory characteristics of the given sample. The authors concluded that this form of supervised exercise improved veteran physical wellbeing.

Shivakumar et al. (2017) looked at the efficacy of a 12-week exercise program, to help target PTSD in female veterans. The study included 31 participants over a 12-week period. Participants completed 4 exercise sessions per week (30-40 minutes of brisk walking), with 2 of the weekly sessions supervised by one of the researchers. This study demonstrated that the 12-week exercise program was feasible, safe, and well tolerated by female veterans. Both posttraumatic and depressive symptoms, measured using clinician administered PTSD scale (CAPS) and PTSD checklist (PCL), decreased significantly from the start to the end of the intervention, along with improvement in quality of life and decreased pain severity.

The highest level of evidence for supervised aerobic exercise was Level III-2, cohort and case control studies.

Supervised mind body exercise

Level of evidence: 'promising' for mental wellbeing; *'unknown'* for physical wellbeing.

RCTs:

One RCT investigated the effect of mindful exercise on the wellness of veterans. Mehling et al. (2016) recruited 47 veterans with diagnosed PTSD and randomly assigned them to a waiting list or integrative exercise (IE) group. The IE intervention lasted 12 consecutive weeks and consisted of a weekly 50-minute session that focused on body-mind centering, mindful breathing coordinated with slow movement and a brief discussion of the mindfulness principle of the week. Participants attended the session once a week and had wellness measures taken at baseline, 4, 8 and 12 weeks. Large effects for the intervention group were observed in the outcomes of non-reactivity (Cohen's effect d=0.85), self-regulation (d=1.05) and body listening

(d=0.80). The authors concluded that a 12-week IE program for war veterans with PTSD significantly improved the mindfulness, interoceptive bodily awareness, and positive states of mind compared to a wait list.

Cohort studies:

The first of four prospective cohort studies that appraised the effects of mindful exercise on wellness, investigated the effect of an integrative medicine (IM) program on a cohort of 42 veterans. Gaddy (2017) recruited war veterans with at least one of the following medical issues; mood disorder, PTSD, substance use disorder (SUD), chronic pain, anxiety, personality disorder or psychotic disorder. Forty-one participants (98%) exhibited more than one of these mental health issues. The IM program consisted of eight different groups and participants were encouraged to attend all eight sessions each week for the duration of 4 weeks. The groups were:

1) Hatha yoga (led by a recreational therapist)
2) Healing foods (led by a nutritionist)
3) Brain-boosting lifestyle choices (led by a psychologist)
4) Guided imagery (led by a psychologist)
5) Tai Chi (led by a recreational therapist)
6) Creativity in recovery (led by an art therapist)
7) Sensory exploration and breathing techniques (led by an occupational therapist)
8) Holistic pain management techniques (led by a psychologist trainee)

Wellness measures were taken at the beginning of the trial and again at the end of the four-week intervention period. Significant increases in participants' physical competency scores (d=0.76) and moderate increases in mental competency scores (d=0.58) were noted at program completion. Improvements were also seen in participants' self-perception of feeling calm (d=0.86), feeling energised (d=0.69), extent to which pain interfered with daily activities (d=0.67) and extent to which physical or mental health issues interfered with social activities (d=0.74).

Hull et al. (2015) included 226 veterans with a pain or mental health related issue, to assess the effectiveness of a complementary and alternative medicine (CAM) program. The CAM program offered services such as yoga nidra, individual acupuncture, group auricular

acupuncture, gentle yoga, qigong and integrative health education. Qigong and gentle yoga were only added for the last month of the trial. During the yearlong trial, 165 veterans participated in more than one CAM service and the range of individual sessions attended varied from 1 to 55 within the study duration. No significant relationship existed between attendance to CAM service and improvement in veteran wellness.

Seventeen veterans with PTSD were included in the study by Niles et al. (2016) that measured the effect of Tai Chi on self-reported wellness. Seventy-five percent of participants attended three of the four prescribed Tai Chi sessions and all found the classes to be helpful for managing distressing symptoms (i.e. intrusive thoughts, concentration difficulties and physiological arousal). The sessions were conducted by two, experienced Tai Chi instructors and each class lasted for 60 minutes.

Lastly, twelve female veterans with an active diagnosis of PTSD due to military sexual trauma, were recruited to take part in a group intervention (David, Simpson & Cotton 2006). The intervention ran for 12 consecutive weeks and each weekly session (3 hours) was divided into three parts:

(a) 1 hour of psycho-education on facts about sexual assault and role play practice exercises on assertive communication and boundary setting

(b) 1 hour of physical self-defence training with two self-defence specialists

(c) 1 hour of group debriefing

Three experienced female psychologists were present throughout each session, and the two martial artists (one female, one male) were present for the first 2 hours of each group session. Measures of self-efficacy, risk perception and psychiatric indicators were taken at baseline, post-test (12-weeks), 3-months post intervention and 6-month follow-up. There were no significant changes in general self-efficacy at any point of measure but there was statistically significant improvement in interpersonal self-efficacy at each follow-up. PTSD severity was not significantly reduced at post-test but had significantly improved at 3 and 6-month follow-up. However, the participant's perception of the general risk of assault did not change throughout the intervention and at all follow-up points.

The highest level of evidence for supervised mind body exercise was Level II, a randomised controlled trial.

Supervised combined aerobic and anaerobic exercise

Level of evidence: 'unknown' for mental wellbeing; *'unknown'* for physical wellbeing.

Cohort studies:

Morey et al. (2018) conducted a prospective study to assess the implementation and outcomes of a structured wellness and health program (Gero-fit), with exercise as the primary therapeutic focus. The study aimed to determine if structured exercise should be promoted as a model of care. Six hundred and ninety-one (691) participants from six Veteran Affairs Medical Centers with a mean age 75 years were studied over one year. The program targeted individuals over the age of 65 who were at risk of premature functional decline due to deconditioning, chronic disease, or use of assistive devices. Participants partook in a 3-day-per-week facility-based exercise program (aerobic and strength training, Tai Chi or dancing) that offered structured exercise customised to individual health status and underlying impairments. Clinically and statistically significant ($p<0.05$) changes from baseline in gait speed, 8-foot 'up and go' (timed measure of mobility), number of sit to stands in 30 seconds, and 6-minute walk distance were found at 3, 6 and 12-month follow-ups. Self-reported levels of satisfaction indicated that most program participants were highly satisfied with the program, with 93% of participants reporting high satisfaction at 3 months, 88% at 6 months, and 94% at 12 months. The authors concluded that implementing a Gero-fit-like program improved the physical wellbeing of older veterans and potentially improved their mental wellbeing.

Sealey (2010) recruited 32 Vietnam War veterans, of which 63% had a diagnosis of PTSD. For the 24 months prior to the study, all participants reported a sedentary lifestyle. The veterans completed one of the following exercise interventions:

1. Lower-body vibration, upper-body resistance and stretching (20-30 minutes)
2. Lower-body vibration, upper-body resistance, aerobic exercise and stretching (40-60 minutes)
3. Full-body resistance, aerobic exercise and stretching (40-60 minutes).

Immediately prior to the single bout of exercise and within five minutes of completion, each participant completed the Subjective Exercise Experience Scale. Regardless of the intervention, each veteran reported increased feelings of positivity and increased wellbeing, but the improvements were not statistically significant ($p>0.05$). The number 1) and 3) exercise interventions on average scored more positively, but these findings are based on a lower quality study design and should be considered in that light.

The highest level of evidence for supervised combined aerobic and anaerobic exercise was Level III-2, cohort studies.

Unmonitored unsupervised physical activity

Level of evidence: 'promising' for mental wellbeing; *'promising'* for physical wellbeing.

Cohort studies:

Five cohort studies investigated the impact of unmonitored, unsupervised physical activity for veterans. Bosch et al. (2017) assessed the effectiveness of engagement in exercise for sleep quality, using a longitudinal study design that included 195 participants with PTSD. Data was collected at baseline and at 1-year follow-up. Engagement in vigorous and moderate exercise and its correlation with sleep was assessed using self-reporting methods, along with the number of days of exercise completed per week. Other measures included PCL-M for measuring PTSD symptoms, Pittsburg Sleep Quality Index (PSQI) and Michigan Alcohol Screening Test (MAST) for alcohol usage within the past month. Multiple regression analyses demonstrated that engagement in exercise at baseline was statistically significantly associated with better sleep quality at one-year follow-up while controlling for age, gender, alcohol use, baseline PTSD symptoms, and baseline sleep quality ($p<0.05$). Multiple regression analyses examined the relationship between engagement in exercise at baseline and PTSD symptoms at one-year follow-up (controlling for age, gender, alcohol use, baseline PTSD symptoms, and baseline sleep quality), of which there was no significant difference ($p=0.57$). The authors concluded that engagement in exercise (frequency and intensity not identified) was correlated with improved sleep quality, but did not affect PTSD symptomatology in veterans.

Bourn et al. (2016) investigated whether physical activity can moderate the association between pain and PTSD. Data was collected from 239 veterans who were actively seeking treatment. CAPS was administered to evaluate PTSD symptoms in relation to trauma, the Brief Pain Inventory (BPI) was administered to assess the intensity of pain and pain interference in daily life, and the Godin Leisure-time Exercise Questionnaire (GLTEQ) was used to examine levels of physical activity during a normal week. The results of the study indicated that pain severity and interference were generally associated with more severe PTSD symptoms. Physical activity did not influence PTSD severity, however, it did moderate the relationship between PTSD and pain. Those who were active, experienced less PTSD symptoms irrespective of pain.

Du et al. (2015) conducted a cohort study that aimed to identify whether physical activity can act as a protective factor against depressive symptoms in older Chinese veterans. Depressive symptoms were assessed using the Center for Epidemiological Studies Depression Scale (CES-D) and these measures were recorded upon completion of the study. Physical activity was measured using self-reported questions about exercise participation and frequency in their daily lives. Responses were generated on how regularly they participated in any sport or exercised for 30 minutes, 3 days a week, within the last year. The results of the study illustrated that an inverse relationship between physical activity and depressive symptoms existed within this sample. The independent protective effect of physical activity, on depressive symptoms was far more beneficial than other lifestyle indicators, such as social participation, not smoking and abstaining from alcohol. Additionally, even with confounding factors (age, sex, variations in lifestyle, negative life events, chronic disease and level of cognitive function) controlled, the relationship between physical activity and depressive symptoms remained significant ($p=0.0001$). Du et al. (2015) concluded that veterans who were more active, had less depressive symptoms, irrespective of confounding variables.

Gutierrez et al. (2016) conducted a cross-sectional, observational study of 103 US veterans and assessed the association between physical activity and suicidal ideation. During a single session, the participants completed the Adult Suicide Ideation Questionnaire (ASIQ), the Beck Depression Inventory-II (BDI-II), the International Physical Activity Questionnaire (IPAQ), the PSQI and had a 5-minute electrocardiogram (ECG) to record any respiratory sinus arrhythmias (RSA). The mean number of minutes of exercise per week was 1,241 (standard deviation=835), however, the authors believed this number was overstated and acknowledged that the intensity of exercise was not recorded which limited the value of this measure. There was no statistically significant relationship between suicidal ideation and level of exercise ($p=0.74$), nor was there any connection between RSA, veteran activity level and suicidal ideation ($p=0.81$).

Hoerster et al. (2012) looked at the relationship between level of physical activity and the prevalence of depression or somatic symptoms (e.g. back pain, headaches, sleep disturbance, fatigue). Two-hundred and sixty-six (266) US Veterans who had returned from deployment to Iraq or Afghanistan were enrolled in this cross-sectional study. At the time of the study, veterans were recommended to complete a total of 150 minutes of moderate-to-vigorous physical activity (MVPA) per week. Of the sample, 59% of veterans met the weekly requirement with a median of 180 weekly MVPA minutes. Use of a multivariate regression analysis demonstrated that those who did not meet the recommendation (41%) had statistically significantly higher levels of depression ($p=0.042$) and increased prevalence of somatic symptoms ($p=0.018$).

The highest level of evidence for unmonitored unsupervised physical activity was Level III-2, cohort studies.

Structured recreational physical activity

Level of evidence: 'promising' for mental wellbeing; *'unknown'* for physical wellbeing.

RCT:

Johnson et al. (2018) employed a randomised wait list-controlled trial to look at recreational physical activity and wellbeing. Twenty-nine veterans were recruited and randomised into a 6-week therapeutic horse riding (THR) intervention (n=15) or a control wait list (n=14). Measures of PTSD symptoms, self-efficacy, emotional regulation and loneliness were recorded at baseline, 3 weeks and at the end of the intervention (6-weeks) for both the THR group and the wait list. Measures were then compared. Each weekly THR class lasted for 1 hour and included a welcome to the barn (5 to 10-minute orientation of the stables), grooming of the horse and a horse riding lesson. The horse was led by a trained instructor and 2 volunteers escorted the rider on foot as a safety measure. Participants of the THR group had a 66.7% likelihood of having lower PTSD scores at 3 weeks and an 87.5% likelihood of reduced PTSD at 6 weeks ($p<0.01$). Self-efficacy also improved at each point of measure in the THR group, however, the changes were not statistically significant.

Cohort studies:

Four cohort studies looked at the influence of structured, recreational physical activity on the physical and mental wellbeing of veterans. Lanning and Krenek (2013) conducted a prospective study to assess the effectiveness of a new THR program on veteran wellbeing. Over a 24-week period, 13 veterans participated in a THR program that included aspects of riding, grooming and activities of interaction between the horse and veteran. The program was accredited by the Professional Association of Therapeutic Horsemanship and each session was conducted once a week for 1-2 hours. Veterans who completed 12 THR sessions showed some reduction in depressive symptoms but this effect was larger in veterans who completed all 24 sessions. Given there was no control group, the authors were reluctant to draw a causal inference between THR and depression, and the findings should be considered in respect to the low level of study design.

A 4-day therapeutic fly-fishing program was conducted for a cohort of 40 veterans (Bennett, Piatt & Van Puymbroeck 2017). Eighty percent of participants had a diagnosis of PTSD and

an unspecified number were still active members of the US military. Outcomes measured included symptoms of PTSD, depression, perceived stress, functional impairment, self-efficacy and leisure satisfaction. For the first 2 days of the program, the veterans received training on how to fly-fish from an experienced trainer and then spent the subsequent 2 days fishing and socialising with other participants. This therapeutic fly-fishing program improved self-reported measures in all 6 outcome measures ($p<0.005$) at the end of the camp. Although there was still some improvement from baseline at 3-month follow-up, the differences were not significant ($p=0.08$). A shorter but similar fly-fishing program was conducted over 3 nights (2 days) and was completed by 74 veterans with PTSD over 19 separate camps (Vella, Milligan & Bennett 2013). This prospective cohort study took repeated measures of mood, anxiety, depression and somatic measures of stress two weeks before the fly-fishing camp, on the last day of the camp and at a 6 week follow-up. Participants fished for a total of 16 hours and all measures of psychological distress improved at post intervention ($p<0.001$) and were maintained at 6-week follow-up ($p<0.05$).

Rogers, Mallinson and Peppers (2014) investigated the effect of an ocean surfing program on the symptoms of veterans with diagnosed PTSD. Eleven veterans completed the five, 4-hour surfing sessions over 5 consecutive weeks. Each session included 10-15 veterans, 10-15 surfing instructors and an occupational therapist. The 4-hour classes included a group lesson on surfing, a land based warm up and a 45-minute one-on-one lesson with a surf instructor. Each week previously learnt skills were built on and developed with the intent of getting the veterans to successfully stand on the surfboard and catch a wave. All participants self-reported improved PTSD symptom severity ($d=0.77$) and reduced depressive symptoms ($d=0.61$) at post intervention measures. At the completion of the study, 73% (8 of 11) of participants recorded PTSD symptoms at a clinically sub-threshold level for PTSD diagnosis.

Case study:

One case study explored structured, recreational physical activity and veteran wellbeing. Asselin et al. (2012) featured a 44-year-old, non-ambulatory, male veteran with an incomplete spinal cord injury who underwent a THR program. After several weeks of riding (frequency of riding and duration not included), the veteran was able to squeeze the horse with his legs and after 2 years of the program, the veteran was experiencing less muscle spasms and had increased whole body strength. Additionally, the veteran expressed emotional benefits such as increased confidence and a greater motivation to continue with his rehabilitation.

Qualitative study:

One qualitative study assessed the narratives and more intimate experiences encountered by veterans who participated in some form of structured, recreational physical activity. Peacock, Carless and McKenna (2018) interviewed veterans who had participated in an adapted sport and adventurous training (ASAAT) program to develop a narrative that would inform the public of their journey with PTSD. Each ASAAT lasted five days and veterans were coached by experienced personnel through a variety of appropriate, physical activities. The researchers attended 35 of these 5-day courses over a period of 18 months and conducted an unspecified number of interviews. The final product was the story of one veteran's journey which was then shared with twenty members of the public. The veteran reflected that the exercise program had been very helpful in his healing as he was comforted knowing that there were others like him who faced the same struggles.

The highest level of evidence for structured recreational physical activity was Level II, a randomised controlled trial.

Discussion

The primary aim of this REA was to identify the physical and mental wellbeing benefits veterans experience through participation in a sporting activity. Overall, the evidence showed that veterans who participated in any form of physical activity reported improved mental wellbeing, however, the evidence base was insufficiently strong to conclusively support the findings and as such it was deemed to be 'promising'. Given that the majority of studies only focussed on mental wellbeing outcomes, the evidence base for physical activity as a promoter of physical wellbeing in veterans remains 'unknown'. However, this area of research has previously received much attention in the general civilian population where it is generally accepted that physical activity will improve physical wellbeing (Rutter et al, 2013; Smith-Marek et al. 2016 and Martin et al. 2015).

The degree to which improvements were made was in large dependent on the duration of the intervention. It was observed in multiple studies that the longer the veteran participated in any sporting activity, the greater the improvement in mental wellbeing (Caddick & Smith 2014; Mehling et al. 2016 and Johnson et al. 2018). The link between exercise and improvement in mental wellbeing had previously been confirmed in the non-veteran population (Rutter et al. 2013; Smith-Marek et al. 2016 and Martin et al. 2015), but this REA provides preliminary evidence to suggest that similar benefits occur in the veteran community.

Nonetheless, the majority of studies focussed on veterans with an existing mental health issue (e.g. PTSD, depression etc.) and therefore, the generalisability of the results to the asymptomatic veteran population is limited. Likewise, the literature predominantly focussed on the mental wellbeing benefits of sporting activity and recorded changes via self-reported outcome measures. This focus on mental wellbeing is likely a reflection of the general trend towards mental health awareness and the challenging nature that surrounds its diagnosis and treatment. The findings of this REA, provides 'promising' support for the prescription of sporting activity (in any form) for the supplementary treatment of mental health issues in veterans, but there is inadequate evidence pertaining to the wellbeing effects it has on the asymptomatic, veteran population.

Of all the types of sporting activity, structured recreational activity has received the most attention (7 of 25 included primary studies). The link between recreational activity and PTSD is discussed at greater length in the proceeding text, but it is worth adding that all assessed recreational sporting activities were conducted in the 'wild' environment, and that all reviewed studies reported positive mental wellbeing benefits. Although widely researched, only one of the included studies (Johnson et al. 2018) was of a higher level of evidence (RCT) and therefore, the strength of the findings is affected due to the reliance on cohort and case studies. Therapeutic horse riding received consistently strong support for reducing PTSD symptoms (Johnson et al. 2018 and Lanning & Krenek 2013) but this finding should be taken with caution given the low number of studies as well as the presence of only one higher level of evidence study; Johnson et al. (2018). Similarly, THR only received 'promising' support for improving veteran self-efficacy. Therapeutic horse riding interventions may need to be longer in duration and include larger samples to clarify the wellbeing benefits experienced by veterans.

Likewise, therapeutic fly-fishing was a popular intervention (Bennett, Piatt & Van Puymbroeck 2017 and Vella, Milligan & Bennett 2013) and it too received 'promising' support for its effectiveness in benefitting veteran wellbeing; but this was only demonstrated to occur in the short term. All fly-fishing programs were conducted as 3 to 5-day camps and future studies should ensure that participant wellbeing is followed up to six months post intervention to assess for sustained improvement. Likewise, the two studies that involved fly-fishing were both of a lower level of evidence (cohort studies), and as such these findings should be tested against more rigorous research methods. Nonetheless, one factor that all recreational activities shared in common was that the longer the duration of the intervention, the greater the improvement in mental wellbeing.

As all structured, recreational sporting activities occurred in the 'wild' environment, it is unknown whether the presence of being in the wild, or the break from routine (most recreational

studies involved camps of greater than 2 days) were driving factors in the improvement of veteran wellbeing as no study controlled these variables. Further research in this area is required to shed more light on the benefits of recreational sporting activity. Overall, the evidence base for structured recreational physical activity is 'promising' for short term mental wellbeing benefits and 'unknown' for physical wellbeing improvements.

Supervised, mind body exercise such as Tai Chi and yoga, showed positive effects on veteran mental wellbeing but again there was no emphasis on physical wellbeing and follow up was inadequate to judge the lasting benefits of this sporting activity (Gaddy 2017; Mehling et al. 2016 and Niles et al. 2016). Four consecutive weeks of a single session of mindful exercise was adequate to improve veteran mental wellbeing and this improvement increased up to 12 weeks (Mehling et al. 2016; Niles et al. 2016 and David, Simpson & Cotton 2006). Yoga, Tai Chi and martial arts are appropriate sporting activities to ground mindfulness. None of the studies adequately followed up with their cohort and as such the evidence base for mindful exercise was ranked as 'promising' for improving veteran mental wellbeing. Again, the evidence base for mindful exercise as a promoter of physical wellbeing is 'unknown'.

Only two studies investigated supervised, combined aerobic and anaerobic exercise (Morey et al. 2018 and Sealey 2010) and none were of high methodological quality. The evidence for this intervention was ranked as 'unknown' for improving physical and mental wellbeing in veterans even though both studies showed that a combined aerobic and anaerobic exercise program can improve veteran wellbeing. The short-term nature of non-statistically significant improvements in mental wellbeing (Sealey 2010), the studied populations (e.g. >65 years old, community-based veterans) and small sample sizes were insufficient to confidently support this intervention. Higher quality studies such as RCTs with larger sample sizes are needed to appraise the effects of combined anaerobic and aerobic exercise.

The wellbeing effects of supervised aerobic exercise were investigated as an acute episode of exercise or as an effect in response to a program. A single episode of intense exercise increased the pain sensitivity of a cohort of veterans with chronic musculoskeletal pain (Cook, Stegner & Ellingson 2010) but this study was limited by a small sample and the findings were not statistically significant. It should be noted that this was the only occasion of a negative outcome on veteran wellbeing following participation in a sporting activity. Based on this study, the evidence base for an acute period of aerobic exercise to improve veteran wellbeing is 'unknown' and further studies are needed to explore any potential relationship. Conversely, a program of cycling improved depression levels and lowered hyperarousal symptoms in a cohort of veterans (Babson et al. 2015 in Whitworth & Ciccolo 2016). The evidence for supervised aerobic exercise showed that a regular program was more effective in improving

mental and physical wellbeing than a single episode of exercise (Kerr, Leicht & Spinks 2008 and Shivakumar et al. 2017). However, the evidence base was only determined to be 'promising' for both wellbeing types as the studies suffered from small sample sizes and poor methodological quality.

Structured competitive sport as an intervention to improve veteran wellbeing was a surprisingly limited research area despite the presence of the Invictus Games and the American Warrior Games. Only three studies (Burling et al. 1992; Laferrier, Teodorski & Cooper 2015 and Sporner et al. 2009b) investigated this sporting activity intervention and all were of lower study quality (cohort studies). The studies demonstrated that team sports significantly improved the self-esteem of veteran participants (Burling et al. 1992; Laferrier, Teodorski & Cooper 2015 and Sporner et al. 2009b) in comparison to those who only partook in individual sports. Moreover, the greater the number of years a veteran had been involved in a sport, the greater their QOL and self-esteem (Laferrier, Teodorski & Cooper 2015). The evidence base for competitive sport as an intervention to improve mental wellbeing is 'promising' but higher quality studies are needed to confirm the evidence base. Again, little attention was given to physical wellbeing benefits from competitive sport and based on the evidence of the three studies, the evidence base is 'unknown'.

Sporting activity that was unmonitored and unsupervised was investigated within this REA (Bosch et al. 2017; Bourn et al. 2016; Du et al. 2015; Gutierrez et al. 2016 and Hoerster et al. 2012). Twenty percent (5 out of 25) of included primary studies assessed the link between this method of activity and veteran wellbeing. Physical activity, regardless of monitoring or supervision, was found to be more beneficial in reducing depressive symptoms in veterans than other lifestyle changes (Du et al. 2015 and Hoerster et al. 2012). Similarly, any form of physical activity improved sleep quality in a population of veterans with PTSD (Bosch et al. 2017). None of the reviewed studies were of a high evidence level (5 cohort studies), and as such the evidence base for unsupervised, unmonitored physical activity as an intervention to improve mental wellbeing was found to be 'promising' and 'promising' in terms of resulting in physical wellbeing benefits.

Social and economic benefits to the community

No study specifically analysed the economic or social benefits realised by veteran participation in a sporting activity. No study identified the economic savings through earlier treatment of mental health issues, but the reduction in suicide risk as discussed by Davidson et al. (2013) in Whitworth and Ciccolo (2016) would likely be amenable to this kind of analysis. Simple sporting activities (e.g. walking, gym-based exercises) were identified as an effective and low-

cost alternative to medical intervention in the treatment of depression and PTSD in veterans (Du et al. 2015 and Shivakumar et al. 2017), but clearly more work is needed to identify the cost-effectiveness of sporting activity over other interventions.

Relationship between structure of sporting activity and benefit in wellbeing

The structure of sporting activities were classified as supervised, unsupervised, team based, competitive, group based or recreational. A secondary research aim of this REA was to establish if a link between sporting activity structure and wellbeing benefits existed.

Although no study deliberately sought to evaluate the effect of the structure of the exercise on veteran wellbeing outcomes, there was low level evidence to suggest that researchers deliberately chose certain sporting activities in respect to their cohort. Interestingly, researchers who investigated the impact of sport on the wellbeing of veterans diagnosed with PTSD were more likely to select non-competitive activities such as fly-fishing, river rafting, horse riding and aerobic exercise, whereas the inverse was true for veterans with a disability or injury (Caddick & Smith 2014). Another trait shared by these non-competitive activities was that most were conducted in the 'wild' environment. Caddick and Smith (2014) specifically identified that further exploration of the selection of sporting activity in respect to population is needed to help determine the factors of activity which affect veteran wellbeing (i.e. Is it the non-competitiveness of the sport which is important or is there a 'mysterious power' associated with activity performed in the 'wild'?). The high number of primary studies (7) in this REA with a recreational focus also attests to the notion that certain sporting activities are selected for certain populations and again, further exploration may help identify the influential factors. Although a pattern did emerge, it should be noted that these studies were of a lower level of evidence and these findings should encourage future, more rigorous research methods to explore this relationship.

All recreational based sporting activities returned positive mental wellbeing benefits and those studies that conducted a follow-up demonstrated retention in some of the benefits (Dustin et al. 2011 in Caddick & Smith 2014; Bennett, Piatt & Van Puymbroeck 2017 and Vella, Milligan & Bennett 2013). Although the activities of fly-fishing, river rafting and horseback riding were popular amongst veterans with PTSD, more physically demanding activities, namely surfing, were also popular and equally beneficial amongst the same cohort (Caddick, Smith & Phoenix 2015 in Whitworth & Ciccolo 2016 and Rogers, Mallinson & Peppers 2014). Veterans with PTSD who participated in surfing identified that they enjoyed the physicality of the exercise and found that the unpredictability of the environment worked well to distract them from their

PTSD symptoms (Caddick, Smith & Phoenix 2015 in Whitworth & Ciccolo 2016 and Rogers, Mallinson & Peppers 2014), yet these findings should be taken as preliminary given the lower quality of the evidence and few studies. Further research is needed to clarify if the differences in activity preference are personality based or if there is some other underlying driver of behaviour.

Additionally, veterans who participated in team sports and competitive sport had higher levels of self-esteem and the greater number of years of participation, correlated with a higher perceived QOL (Caddick & Smith 2014).

There was no distinction in wellbeing benefits whether the activity was supervised or monitored.

Implications

The positive, preliminary findings of this REA should encourage government and veterans alike to prioritise sporting activity as a means to promote veteran wellbeing. Likewise, the effect of certain characteristics of sporting activity interventions on veteran wellbeing also warrants further consideration as in some studies, researchers selected specific activities (e.g. competitive, nature based recreational activity etc.) based on the group of veterans the intervention was directed towards (Caddick & Smith 2014). It is most likely that the specific qualities of these sporting activities appealed to researchers in relation to their participants, but this REA was not able to determine what factors were causal in affecting veteran wellbeing. Only three studies (Burling et al. 1992; Laferrier, Teodorski & Cooper 2015; Sporner et al. 2009b) in this investigation were found to address the benefits to disabled veterans of structured, competitive sport and it would seem prudent that further research is directed at this area given the popularity of the Warrior Games and the Invictus Games.

Further research is also required to identify the aspects of sporting activity which lead to improved wellbeing as the current research base has not controlled these variables. Mindful exercise and recreational exercise in the ‘wild’ environment have shown promise, but the lack of robust study design again reduces the power of these studies’ findings. Similarly, greater attention should be paid to the diversity of the veteran population as to date the majority of research has focussed on Caucasian males (Whitworth & Ciccolo 2016). Likewise, asymptomatic veterans are needed in future investigations as the power of sporting activity as a preventative treatment against mental and physical issues is yet to be extensively explored. This area of research has the potential to have the greatest economic and social effect, as a

positive correlation between sporting activity and wellbeing benefits may open up new welfare management programs within the military.

Moreover, the way in which studies assess for mental and wellbeing benefits could be revisited. No study appraised the effects of their intervention based on the International Classification of Functioning framework and given the wide range of self-reported outcome measures used, the research base could potentially be strengthened through the streamlining of outcome assessment. The WHO Disability Assessment Schedule 2.0 (WHODAS) has been shown to cover six domains of functioning (Cognition, Mobility, Self-care, Socialising, Life activities and Participation) and has been validated across different cultures and all adult populations (WHO 2010). The standardisation of wellbeing assessment would open up opportunities to pool data through meta-analyses and ultimately elevate the strength of the evidence base.

Limitations of the rapid evidence assessment

The findings from this REA should be considered alongside its limitations. The first set of limitations relates to the methodology that underpinned this REA. The final search strategy was expanded to include weaker study designs (e.g. cohort studies, case series) to increase the possibility of capturing more sporting activity interventions, but this has reduced the overall quality of evidence.

However, some restrictions on our methodology were necessary. These limitations included: the omission of potentially relevant papers that could not be obtained in full text (the timeliness of an REA prevents extensive means, i.e. contacting publication authors, to obtain potentially relevant papers); the omission of non-English language papers, and reference lists of included papers were not hand-searched to find other relevant studies (again timeliness issues prevented the hand searching of reference lists). Similarly, although we did evaluate the evidence in terms of its strength, consistency, and generalisability, these evaluations were not as exhaustive as in a SR.

Moreover, the outcome measures used to evaluate changes in mental and physical wellbeing were not universally used. Due to their self-reported nature and variability, a meta-analysis of the results was not undertaken as consistency could not be guaranteed and as such, the overall effect of individual sporting activities on wellbeing remains ambiguous. Similarly, the categorisation of the sporting activities was based on qualitative judgement and was not based on any validated method to differentiate types of exercise. This has affected conclusions made about the link between design of sporting activity and effect on wellbeing. Although not a

limitation, the broad definition of sporting activity is in contrast to what many would perceive as 'sport'. Readers of this REA should be aware of this broad definition when disseminating results as consumers may be unaware of the low threshold of physical activity which was classified as a sport. Future research may be better directed at different aspects of physical activity, and specifically around the competitive or structured nature of the exercise, to help clarify the key aspects of physical activity which improve mental wellbeing.

The findings of the review indicate that many of the recreational activities studied were organised by a body external to the individual and specifically for veterans (as opposed to programs where veterans accessed and engaged with 'usual' activities that exist in the community). The benefits a veteran may experience from participation in a readily available, community activity remain unclear and further research is needed in this area. There is also a lack of clarity whether the effects from sporting activity were associated with physical activity or other co-existing elements; such as socialisation. With socialisation in particular, it is unclear whether the effect would be the same if socialisation was contained to being amongst other veterans, as opposed to being amongst other social groups within the community. There are possible implications for veterans who are isolated from other veterans by virtue of distance, as well as potential implications when veterans choose to engage with activity in the community (where other participants are not veterans).

Furthermore, the quality of the reviewed studies was low in the hierarchy of evidence and there were some recurring limitations. Of the common methodological limitations, small sample sizes, a lack of follow-up to assess sustained effect and short periods of intervention, were the most troublesome (Whitworth & Ciccolo 2016; Johnson et al. 2018 and Cook, Stegner & Ellingson 2010).

Finally, the information presented in this REA is a summary of information presented in available papers. We recommend that readers source the original papers if they would like to know more about a particular area.

Conclusion

Overall, 'promising', low level evidence supported sporting activity as a means to improve the mental wellbeing of veterans with mental health issues. The amount of improvement was correlated to the amount of time in which a veteran participated in the sporting activity, but the evidence for sustained mental wellbeing benefits from participation are less well known. The evidence that underpins this REA is of a lower level (2 SRs, 2 RCTs, 20 cohort studies, 1

qualitative study, 1 case control study and 1 case study) but nonetheless findings can be made. With consideration of the low evidence base, this REA provides promising support for sporting activity as a means to improve mental wellbeing in veterans, but acknowledges that the physical wellbeing benefits are under researched. Further studies that investigate the effects of sporting activity on asymptomatic veterans are needed, as too are studies with larger sample sizes and more consistent follow-up assessments. The type of sporting activity (e.g. competitive, supervised etc.) should also be investigated further, as low level evidence suggests that veterans with comorbidities (e.g. PTSD, physical disability etc.) may benefit from certain styles of activity compared to others. Based on the evidence contained in this REA (Caddick & Smith 2014; Whitworth & Ciccolo 2016) and the minimal risk of adverse events (Cook, Stegner & Ellingson 2010), any form of sporting activity could be considered as a supplement to any veteran, mental wellbeing program.

References

1. American Psychiatric Association 1987, Diagnostic and Statistical Manual of Mental Disorders, 3rd ed., rev. Washington, DC.

2. Asselin, G, Penning, J, Ramanujam, S, Neri, R & Ward, C 2012, 'Therapeutic horseback riding of a spinal cord injured veteran: a case study', *Rehabilitation Nursing*, vol. 37, no. 6, pp. 270-276.

3. Australian Bureau of Statistics, 2001, *Measuring Wellbeing: Frameworks for Australian Social Statistics*, cat. no. 4160.0, viewed 22 May 2018, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/2f762f95845417aeca25706c00834efa/BCDF2C64DD5B539CCA2571B90011998C?opendocument>.

4. Arnson, Y, Amital, D, Fostick, L, Silberman, A, Polliack, ML, Zohar, J, Rubinow, A & Amital, H 2007, 'Physical activity protects male patients with post-traumatic stress disorder from developing severe fibromyalgia', *Clinical and experimental rheumatology*, vol. 25, no. 4, pp. 529.

5. Babson, K, Heinz, A, Ramirez, G, Puckett, M, Irons, J, Bonn-Miller, M & Woodward S 2015, 'The interactive role of exercise and sleep on veteran recovery from symptoms of PTSD', *Mental Health and Physical Activity*, vol. 8, pp. 15-20.

6. Bair, M, Matthias, M, Nyland, K, Huffman, M, Stubbs, D, Kroenke, K & Damush, T 2009, 'Barriers and facilitators to chronic pain self-management: A qualitative study of primary care patients with comorbid musculoskeletal pain and depression', *Pain Medicine*, vol. 10, no. 7, pp. 1280-1290.

7. Bennett, J, Piatt, J & Van Puymbroeck, M 2017, 'Outcomes of a therapeutic Fly-Fishing program for veterans with Combat-Related Disabilities: A community-based rehabilitation initiative', *Community Mental Health Journal*, vol. 53, no. 7, pp. 756-765.

8. Bosch, J, Weaver, T, Neylan, T, Herbt, E & McCaslin, S 2017, 'Impact of engagement in exercise on sleep quality among veterans with Posttraumatic Stress Disorder Symptoms', *Military Medicine*, vol. 182, no. 9, pp. 1745-1750.

9. Bourn, L, Sexton, M, Porter, K & Rauch, M 2016, 'Physical activity moderates the association between pain and PTSD in treatment-seeking veterans', *Pain Medicine*, vol. 17, no. 11, pp. 2134-2141.

10. Brittain, I & Green, S 2012, ‘Disability sport is going back to its roots: Rehabilitation of military personnel receiving sudden traumatic disabilities in the twenty-first century’, *Qualitative Research in Sport, Exercise and Health*, vol. 4, no. 2, pp. 244-264.

11. Burling, T, Seidner, A, Robbins-Sisco, D, Krinsky, A & Hanser, S 1992, ‘Batter up! Relapse prevention for homeless veteran substance abusers via softball team participation’, *Journal of Substance Abuse*, vol. 4, no. 4, pp. 407-413.

12. Burke, S & Utley, A 2013, ‘Climbing towards recovery: investigating physically injured combat veterans’ psychosocial response to scaling Mt. Kilimanjaro’, *Disability and Rehabilitation,* vol. 35, no. 9, pp. 732-739.

13. Caddick, N & Smith, B 2014, 'The impact of sport and physical activity on the well-being of combat veterans: A systematic review', *Psychology of Sport and Exercise*, vol. 15, no. 1, pp. 9-18.

14. Caddick, N, Smith, B & Phoenix, C 2015, ‘The effects of surfing and the natural environment on the well-being of combat veterans’, *Qualitative Health Research*, vol. 25, no. 1, pp. 76-86.

15. Carless, D, Peacock, S, McKenna, J & Cooke, C 2013, ‘Psychosocial outcomes of an inclusive adapted sport and adventurous training course for military personnel’, *Disability and Rehabilitation*, vol. 35, no. 24, pp. 2081-2088.

16. Chwastiak, LA, Rosenheck, RA & Kazis, LE 2011, ‘Association of psychiatric illness and obesity, physical inactivity, and smoking among a national sample of veterans’, *Psychosomatics*, vol. 52, no. 3, pp. 230-236.

17. Cook, D, Stegner, A & Ellingson, L 2010, ‘Exercise alters pain sensitivity in Gulf War veterans with chronic musculoskeletal pain’, *The Journal of Pain*, vol. 11, no. 8, pp. 764-772.

18. Cordova, J, Miller, J, Leadbetter, G, Trombetta, S, Parks, S & O'Hara, R 1998, ‘Influence of the National Disabled Veterans' Winter Sports Clinic on self-concept and leisure satisfaction of adult veterans with Disabilities. *Palaestra-Macomb Illinois*, vol. 14, pp. 40-43.

19. Cowper, P, Morey, M, Bearon, L, Sullivan, R, DiPasquale, R, Crowley, G, Monger, M & Feussner, J 1991, ‘The impact of supervised exercise on the psychological well-being and health status of older veterans’, *Journal of Applied Gerontology,* vol. 10, no. 4, pp. 469-485.

20. David, W, Simpson, T & Cotton, A 2006, 'Taking charge: A pilot curriculum of self-defense and personal safety training for female veterans with PTSD because of military sexual trauma', *Journal of Interpersonal Violence*, vol. 21, no. 4), pp. 555-565.

21. Davidson, L, Babson, A, Bonn-Miller, O, Souter, T & Vannoy, S 2013, 'The impact of exercise on suicide risk: examining pathways through depression, PTSD, and sleep in an inpatient sample of veterans', *Suicide & Life-Threatening Behaviour*, vol. 43, no. 3, pp. 279-289.

22. Department of Veterans' Affairs, Australian Government, 2017, *DVA Pensioner Summary*, viewed 22 May 2018, <https://www.dva.gov.au/sites/default/files/files/about%20dva/stat/PenSumm_Dec2017.pdf>.

23. Du, W, Tan J, Yi, F, Zou, Y, Zhao, Y & Wang, L 2015, 'Physical activity as a protective factor against depressive symptoms in older Chinese veterans in the community: result from a national cross-sectional study', *Neuropsychiatric Disease & Treatment*, vol. 11, pp. 803-813.

24. Dustin, D, Bricker, N, Arave, J, Wall, W & West, G 2011, 'The promise of river running as a therapeutic medium for veterans coping with post-traumatic stress disorder', *Therapeutic Recreation Journal*, vol. 45, no. 4, pp. 326.

25. Gaddy, M 2017, 'Implementation of an integrative medicine treatment program at a veteran's health administration residential mental health facility, *Psychological Services*, vol. 12, no. 1, pp. 12.

26. Gutierrez, P, Davidson, C, Friese, A & Forester, J 2016, 'Physical activity, suicide risk factors, and suicidal ideation in a veteran sample', *Suicide & Life-Threatening Behaviour*, vol. 46, no. 3, pp. 284-292.

27. Hall, K, Beckham, J, Bosworth, H, Sloane, R, Pieper, C & Morey, M 2014, 'PTSD is negatively associated with physical performance and physical function in older overweight military veterans', *Journal of Rehabilitation Research & Development*, vol. 51, no. 2, pp. 285-295.

28. Hamner, MB & Hitri, A 1992, 'Plasma beta-endorphin levels in post-traumatic stress disorder: a preliminary report on response to exercise-induced stress', *The Journal of neuropsychiatry and clinical neurosciences*, vol. 4, no. 1, pp. 59-63.

29. Hawkins, B, Cory, A & Crowe, B 2011, 'Effects of participation in a Paralympic military sports camp on injured service members: Implications for therapeutic recreation', *Therapeutic Recreation Journal*, vol. 45, no. 4, pp. 309.

30. Hoerster, K, Jakupcak, M, McFall, M, Unutzer, J & Nelson, K 2012, 'Mental health and somatic symptom severity are associated with reduced physical activity among US Iraq and Afghanistan veterans', *Preventive Medicine*, vol. 55, no. 5, pp. 450-452.

31. Hull, A, Holiday, S, Eickhoff, C, Rose-Boyce, M & Sullivan, P 2015, 'The integrative health and wellness program: Development and use of a complementary and alternative medicine clinic for veterans', *Alternative Therapies in Health and Medicine*, vol. 21, no. 6, pp.12.

32. Hyer, L, Boyd, S, Scurfield, R, Smith, D & Burke, J 1996, 'Effects of outward bound experience as an adjunct to inpatient PTSD treatment of war veterans', *Journal of Clinical Psychology,* vol. 52, no. 3, pp. 263-278.

33. Johnson, R, Albright, D, Marzolf, J, Bibbo, J, Yaglom, H, Crowder, S, Carlisle, G, Willard, A, Russell, C, Grindler, K & Osterlind, S 2018, 'Effects of therapeutic horseback riding on post-traumatic stress disorder in military veterans', *Military Medical Research*, vol. 5, no. 1, pp. 3.

34. Kerr, R, Leicht, A & Spinks, W 2008, 'Effects of a 12-month exercise program on cardiorespiratory health indicators of Vietnam War Veterans resident in the tropics', *Australian Journal of Rural Health*, vol. 16, no. 3, pp. 132-136.

35. Keller-Ross, ML, Schlinder-Delap, B, Doyel, R, Larson, G & Hunter, SK 2014, 'Muscle fatigability and control of force in men with posttraumatic stress disorder', *Medicine & Science in Sports & Exercise*, vol. 46, no. 7, pp. 1302-1313.

36. Kozaric-Kovacic, D, Ilic, MG, Romic, Z, Vidovic, A, Jendricko, T & Pivac, N 2009, 'Body mass index in male Caucasian veterans with or without posttraumatic stress disorder', *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, vol. 33, no. 8, pp. 1447-1450.

37. Laferrier, J, Teodorski, E & Cooper, R 2015, 'Investigation of the impact of sports, exercise, and recreation participation on psychosocial outcomes in a population of veterans with disabilities: a cross-sectional study', *American Journal of Physical Medicine & Rehabilitation*, Vol. 94, no. 12, pp. 1026-1034.

38. Lanning, B & Krenek, N 2013, ‘Examining effects of equine-assisted activities to help combat veterans improve quality of life’, *Journal of Rehabilitation Research and Development*, vol. 50, no. 8, p. vii-xiii.

39. LeardMann, CA, Kelton, ML, Smith, B, Littman, AJ, Boyko, EJ, Wells, TS, Smith, TC & Millennium Cohort Study Team, 2011, ‘Prospectively assessed posttraumatic stress disorder and associated physical activity’, *Public Health Reports*, vol. 126, no. 3, pp. 371-383.

40. Lundberg, N, Bennett, J & Smith, S 2011, ‘Outcomes of adaptive sports and recreation participation among veterans returning from combat with acquired disability’, *Therapeutic Recreation Journal*, vol. 45, no. 2, p. 105.

41. Martin, E, Dick, A, Scioli-Salter, E & Mitchell, K 2015, 'Impact of a yoga intervention on physical activity, self-efficacy, and motivation in women with PTSD symptoms', *The Journal of Alternative and Complementary Medicine*, vol. 21, no. 6, pp. 327-332.

42. Mehling, W, Chesney, M, Metzler, T, Goldstein, L, Maguen, S, Geronimo, C, Agcaoili, G, Barnes, D, Hlavin, J & Neylan, T 2016, ‘Integrative exercise reduces posttraumatic stress symptoms in war veterans: The VGX study’*, Journal of Clinical Psychology*, vol. 22, no. 6, pp. 20.

43. Merlin, T, Weston, A & Tooher, R 2009, ‘Extending an evidence hierarchy to include topics other than treatment: revising the Australian 'levels of evidence'', *BMC Medical Research Methodology*, vol. 9, no. 34, pp. 34.

44. Morey, M, Lee, C, Castle, S, Valencia, W, Katzel, L, Giffuni, J, Kopp, T, Cammarata, H, McDonald, M, Oursler, K & Wamsley, T 2018, ‘Should structured exercise be promoted as a model of care? Dissemination of the Department of Veterans Affairs Gerofit program’, *Journal of the American Geriatrics Society*, pp. 1-8.

45. Mowatt, R & Bennett, J 2011, ‘War narratives: veteran stories, PTSD effects, and therapeutic fly-fishing’, *Therapeutic Recreation Journal*, vol. 45, no. 4, p. 286.

46. Muldoon, MF, Barger, SD, Flory, JD & Manuck, SB 1998, ‘What are quality of life measurements measuring?’, *BMJ: British Medical Journal*, vol. *316, p*p. 545-548.

47. NHRMC. How to review the evidence: systematic identification and review of the scientific literature. Canberra: Biotext; 1999.

48. Niles, B, Mori, D, Polizzi, C, Kaiser, A, Ledoux, A & Wang, C 2016, 'Feasibility, qualitative findings and satisfaction of a brief Tai Chi mind–body programme for veterans with post-traumatic stress symptoms', *BMJ open*, vol. 6, no. 11, pp. e012464.

49. Otter, L & Currie, J 2004, 'A long time getting home: Vietnam Veterans' experiences in a community exercise rehabilitation programme', *Disability and Rehabilitation*, vol. 26, no. 1, pp. 27-34.

50. Peacock, S, Carless, D & McKenna, J 2018, 'Inclusive adapted sport and adventure training programme in the PTSD recovery of military personnel: A creative non-fiction', *Psychology of Sport and Exercise*, vol. 35, pp.151-159.

51. Rogers, C, Mallinson, T & Peppers, D 2014, 'High-intensity sports for posttraumatic stress disorder and depression: Feasibility study of Ocean Therapy with veterans of Operation Enduring Freedom and Operation Iraqi Freedom', *American Journal of Occupational Therapy*, vol. 68, no. 4, pp. 395-404.

52. Rutter, L, Weatherill, R, Krill, S, Orazem, R, Taft, C & Gold, S 2013, 'Posttraumatic Stress Disorder symptoms, depressive symptoms, exercise, and health in college students', *Psychological Trauma: Theory, Research, Practice, and Policy*, vol. 5, no. 1, pp. 56-61.

53. Sealey, R 2010, 'Acute exercise in Vietnam Veterans is associated with positive subjective experiences', *International Journal of Exercise Science*, vol. 3, no. 1, p.36.

54. Shirazipour, C, Aiken, A & Latimer-Cheung, A 2017, 'Exploring strategies used to deliver physical activity experiences to Veterans with a physical disability', *Disability and Rehabilitation*, vol. 182, no. 11, pp. 1-8.

55. Shivakumar, G, Anderson, E, Suris, A & North, C 2017, 'Exercise for PTSD in Women Veterans: A Proof-of-Concept Study', *Military Medicine*, vol. 182, no. 11, pp. 1809-1814.

56. Smith-Marek, E, Durtschi, J, Brown, C & Dharnidharka, P 2016, 'Exercise and diet as potential moderators between trauma, posttraumatic stress, depression, and relationship quality among emerging adults', *The American Journal of Family Therapy*, vol. 44, no. 2, pp. 53-66.

57. Sporner, M, Fitzgerald, S, Dicianno, B, Collins, D, Teodorski, E, Pasquina, P & Cooper, R 2009a, 'Psychosocial impact of participation in the national veterans wheelchair games and winter sports clinic', *Disability and Rehabilitation*, vol. 31, no. 5, pp. 410-418.

58. Sporner, M, Grindle, G, Kelleher, A, Teodorski, E, Cooper, R & Cooper, R 2009b, 'Quantification of activity during wheelchair basketball and rugby at the National Veterans Wheelchair Games: A pilot study', *Prosthetics and Orthotics International*, vol. 33, no. 3, pp. 210-217.

59. Talbot, LS, Neylan, TC, Metzler, TJ & Cohen, BE, 2014 'The mediating effect of sleep quality on the relationship between PTSD and physical activity', *Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine*, vol. 10, no. 7, pp. 795.

60. US Department of Health and Human Services, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion 1996, Physical Activity and Health: A Report to the Surgeon General, Atlanta, GA.

61. Vella, E, Milligan, B & Bennett, J 2013, 'Participation in outdoor recreation program predicts improved psychosocial well-being among veterans with post-traumatic stress disorder: A pilot study', *Military Medicine*, vol. 178, no. 3, pp. 254-260.

62. Varker, T, Forbes, D, Dell, L, Weston, A, Merlin, T, Hodson, S & O'Donnell, M 2014, A Developer's Guide to Undertaking Rapid Evidence Assessments (REAs). Guide prepared for the Department of Veterans Affairs. Australian Centre for Posttraumatic Mental Health.

63. Varker, T, Forbes, D & Dell, L 2015, 'Rapid evidence assessment: increasing the transparency of an emerging methodology', *Journal of Evaluation in Clinical Practice,* vol. 21, no. 6, pp. 1199-1204.

64. Veterans Affairs 2014, Clinical practice guideline for the management of chronic multisymptom illness, *Department of Defense*, USA, <file:///C:/Users/crockemj/Downloads/ngc-10612.pdf>.

65. Whitworth, J & Ciccolo, J 2016, 'Exercise and post-traumatic stress disorder in military veterans: a systematic review', *Military Medicine*, vol. 181, no. 9, pp. 953-960.

66. World Health Organization 2010, Measuring Health and Disability Manual for WHO Disability Assessment Schedule WHODAS 2.0, edited by Üstün, TB, Kostanjesk, N, Chatterji, S and Rehm, J, <http://apps.who.int/iris/bitstream/handle/10665/43974/9789241547598_eng.pdf;jsessionid=9ADCC11A42E664D04899072BF66BD791?sequence=1>.

Appendix 1

Population Intervention Comparison Outcome (PICO) framework

This question was formulated within a Population Intervention Comparison Outcome (PICO) framework. Application of a PICO framework helps to structure, contain and set the scope for the research question. Inclusion of intervention and comparison components is dependent on the question asked, and may not be appropriate for all question types.

- **What are the benefits of veterans participating in sporting activities?**
  - **PICO format:** In ex-serving air force, navy or army veterans, what are the physical and mental wellbeing benefits of participating in sport, physical exercise, physical activity or physical fitness?

P Patient, Problem, Population	**I** Intervention	**C** Comparison (*optional*)	**O** Outcome (*"more effective" is not acceptable unless it describes **how** the intervention is more effective)*
Veterans; ex-serving air force or navy or army	Sport; physical exercise; physical activity; physical fitness		Quality of life, rehabilitation assessment, mental health diagnosis, change in mood, change in activities of daily living, impact on progress to rehab, functional outcomes, length of stay (hospital) and associated medical expenses

Appendix 2

Example search strategy

The following is an example of the search strategy conducted in the Medline database:

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1 Veterans/ (13764)
2 Veterans Health/ (902)
3 Veterans Disability Claims/ (283)
4 "United States Department of Veterans Affairs"/ (6835)
5 (veteran* or (former adj10 (militar* or armed service* or air force or airforce or navy or army))).ti,ab,kw. (30615)
6 (exmilitary or ex-military or ex-service* or exservice*).ti,ab,kw. (129)
7 ((past or return* or ex-) adj10 (service* or military or airforce or air force or navy or army or marine? or soldier? or sailor? or seaman or seamen or airman or airmen)).ti,ab,kw. (5889)
8 combat disorders/ (2945)
9 (combat disorder? or combat experience?).ti,ab,kw. (304)
10 or/1-9 (41196)
11 Sports/ (27717)
12 exercise/ (89863)
13 circuit-based exercise/ (28)
14 Athletic Performance/ (8217)
15 sports for persons with disabilities/ (98)
16 warm up exercise/ (153)
17 cool-down exercise/ (8)
18 physical conditioning, human/ (1293)
19 plyometric exercise/ (372)
20 resistance training/ (6262)
21 running/ (17166)
22 Water Sports/ (32)
23 swimming/ (16165)
24 walking/ (27832)
25 exp Physical Fitness/ (25763)
26 Baseball/ (2053)
27 Basketball/ (1844)
28 Bicycling/ (9900)
29 Boxing/ (1044)
30 Football/ (5182)
31 Soccer/ (6174)
32 Golf/ (1001)
33 Gymnastics/ (2105)
34 Hockey/ (1401)
35 Racquet Sports/ (459)
36 Tennis/ (1378)
37 Martial Arts/ (1163)
38 Tai Ji/ (869)
39 Return to Sport/ (601)
40 Jogging/ (778)
41 Skating/ (827)
42 Snow Sports/ (147)
43 Skiing/ (3134)
44 Diving/ (6527)

45 Volleyball/ (493)
46 Weight Lifting/ (4293)
47 Wrestling/ (773)
48 Mountaineering/ (2512)
49 "Track and Field"/ (858)
50 (sport* or athletic* or physical exercise* or physical activit* or physical fitness or baseball or basketball or netball or bicycling or cycling or cricket or archery or boxing or football or soccer or rugby or golf or gymnastic* or hockey or tennis or racquet sport* or lacrosse or martial art* or tai ji or tai chi or running or runs or jogging or jogs or skating or snow sport* or skiing or snow-boarding or ice skating or swimming or diving or volleyball or walking
or weight lifting or weightlifting or wrestling or horse riding or riding or sailing or surfing or wind-surfing or aerobics or rowing or mountaineering or climbing or canoeing or kayaking or rafting or wood-chopping or ballgame? or ball game? or polo or hurling or (return adj2 sport) or ((driving or car or motor or automobile*) and (races or racing)) or shot put or shotput or discus or power lifting or sailing or wheelchair sport* or wheelchair basketball or wheelchair rugby or aerobic exercise* or athletic participation or judo or movement therap*).ti,ab,kw. (405032)
51 (lawn bowl* or petanq or petanque or boccia or bocci or bocce or boules or bowling or fishing or sled hockey or biathlon or bi-athlon or snowmobiling or equestrian or triathlon or shooting or snowboarding or badminton or fencing or squash or ice hockey or waterboarding or sprinting or hurdling or judoku or karate or curling or relay or murder ball or murderball).ti,ab,kw. (27249)
52 (Combat sport* or Cue sport* or Ice sports or Kite sport* or Orienteering or Aquatic sport* or Team sport* or Aikido or jiu jitsu or jiujitsu or ju jitsu or jujitsu or judo or karate or kung fu or kungfu or qigong or taekwondo or tikwondo or wushu or kick boxing or kickboxing or billiard? or snooker?).ti,ab,kw. (4564)
53 or/11-52 (524032)
54 and/10,53 (1078)

Appendix 3

Quality and bias checklists

Chalmers Checklist for appraising the quality of studies of interventions (NHMRC 1999)

Completed		
Yes	No	
		1. **Method of treatment assignment**
		• Correct, blinded randomisation method described OR randomised, double-blind method stated AND group similarity documented
		• Blinding and randomisation stated but method not described OR suspect technique (eg allocation by drawing from an envelope)
		• Randomisation claimed but not described and investigator not blinded
		• Randomisation not mentioned
		2. **Control of selection bias after treatment assignment**
		• Intention to treat analysis AND full follow-up
		• Intention to treat analysis AND <25% loss to follow-up
		• Analysis by treatment received only OR no mention of withdrawals
		• Analysis by treatment received AND no mention of withdrawals OR more than 25% withdrawals/loss-to-follow-up/post-randomisation exclusions
		3. **Blinding**
		• Blinding of outcome assessor AND patient and care giver (where relevant)
		• Blinding of outcome assessor OR patient and care giver (where relevant)
		• Blinding not done
		• Blinding not applicable
		4. **Outcome assessment (if blinding was not possible)**
		• All patients had standardised assessment
		• No standardised assessment OR not mentioned
		5. Additional Notes
		• Any factors that may impact upon study quality or generalisability

Checklist for considering the Quality of Descriptive, Observational Prevalence Studies:

Modified from Giannakopolous, Rammelsberg, Eberhard, Schmitter (2012)

Completed		
Yes	**No**	
		Target Population
		Target population clearly defined, including: age, sex, employment, ethnicity, religion AND Relevant data from health questionnaire of sampled persons, *if appropriate*
		Target population not clearly defined: limited data available on: age, sex, employment, ethnicity, religion AND Relevant data from health questionnaire of sampled persons, *if appropriate*
		Target population poorly defined: little or no information on age, sex, employment, ethnicity, religion OR little or no information from relevant data from health questionnaire of sampled persons, *if appropriate*
		Sampling method (Representativeness)
		Sophisticated probability sampling used (e.g. stratified sampling; cluster sampling; multistage sampling; multiphase sampling)
		Simple probability sampling used: (e.g. simple random sampling)
		No probability sampling used
		Measurement (Reliability)
		Standardised data-collection methods (e.g. validated clinical interview or diagnostic instrument/criteria) OR Reliable survey instruments (e.g. validated self-report measure / validated screening instrument)

		Non-standardized data collection OR Non-validated interview or non-validated self-report measure
		Information About Non- responders
		Analysis of differences conducted on non-responders
		No analysis of differences information provided on non-responders OR Only proportion (e.g. %) of non-respondents supplied without any other information
		Additional Information
		Information that may affect the overall rating (e.g. were special features accounted for? Were there satisfactory/appropriate statistical analyses, confidence intervals, etc.?)

Quality and Bias Assessments for Meta-Analysis and Systematic Review (NHMRC 2000)

Study Type					Error Categories
Citation:					
Y	N	NR	NA	Quality Criteria	
				A. Was an adequate search strategy used?	
				Was a systematic search strategy reported?	I
				Were the databases search reported?	III
				Was more than one database searched?	III
				Were search terms reported?	IV
				Did the literature search include hand searching?	IV
				B. Were the inclusion criteria appropriate and applied in an unbiased way?	
				Were inclusion/exclusion criteria reported?	II
					III

				Was the inclusion criteria applied in an unbiased way?	
				Was only level II evidence included?	I=IV
				C. Was a quality assessment of included studies undertaken?	
				Was the quality of the studies reported?	III
				Was a clear, pre-determined strategy used to assess study quality?	IV
				D. Were the characteristics and results of the individual studies appropriately summarised?	
				Were the characteristics of the individual studies reported?	III
				Were baseline demographic and clinical characteristics reported for patients in the individual studies?	IV
				Were the results of the individual studies reported?	III
				E. Were the methods for pooling the data appropriate?	
				If appropriate, was a meta-analysis conducted?	III-IV

				F. Were the sources of heterogeneity explored?	
				Was a test for heterogeneity applied?	III-IV
				If there was heterogeneity, was this discussed or the reasons explored?	III-IV
Comments					
Quality rating: [Good/Fair/Poor]				Systematic review:	