

The Psychosocial Effects of Physical Activity on Military Veterans That Are Wounded, Injured, and/or Sick: A Narrative Synthesis Systematic Review of Quantitative Evidence

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Military Behavioral Health

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ABSTRACT

Physical activity (PA) for military veterans that are wounded, injured and/or sick (WIS) is becoming increasingly recognized as an advantageous method of increasing wellbeing. A narrative synthesis approach was used to systematically review current quantitative evidence exploring the psychological effects of PA on veterans that are WIS. Key databases were searched resulting in the inclusion of 19 studies. PA was shown to have a positive effect on post-traumatic stress, depression, anxiety, stress, quality of life, social wellbeing, sleep quality, perceived functional impairment, participant mindfulness, and positive/negative affect; with improvements in stress, social well-being, and positive/negative effect being greater among veterans that are WIS with lower health statuses. After comparing PA types, outdoor recreation appeared to more consistently reduce PTSD symptoms post-intervention; whereas, yoga and horse riding were more effective in reducing anxiety and stress. Furthermore, where significant others were included in PA interventions/programs for veterans that are WIS, longer-lasting benefits have been reported. However, in line with other reviews in this area, the methodological weaknesses of current research and non-standardized delivery of PA interventions limits the generalisability of the findings of this review.

Keywords: Exercise ; mental health ; programs ; psychology ; intervention

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Introduction

Since the end of World War One, United Kingdom Armed Forces (UKAF) have consistently deployed to war and operational theaters in many places around the world. In fact, media sources would suggest that the year 2015 would be the first time of peace for Britain in 100 years, following the withdrawal of soldiers from Afghanistan in 2014 (Cobain et al., 2014). Sadly, this history of conflict has left many soldiers injured, both physically and psychologically. A recent analysis of UKAF and veteran statistics suggests that as many as 67,515 veterans are likely to have suffered from mental and/or physical health problems between 2001 and 2014, as a result of their service (Williamson et al., 2019). While the definition of what qualifies someone as a veteran differs between cultures and countries, the British Government defines a veteran as "anyone who has served for at least one day in Her Majesty's Armed Forces (Regular or Reserve) or Merchant Mariners who have seen duty on legally defined military operations" (Ministry of

Defence, 2017). This definition allows a wide variety of ex-service personnel to be included within the term veteran, as it does not require any operational or combat experience, which is particularly important considering the recent decline in UKAF combat operations.

Despite this relative time of peace of UKAF, it is estimated that as many as 21,903 or 60% of military discharges are due to musculoskeletal injuries (Williamson et al., 2019), many of which occur as a result of training (Sharma et al., 2015). This high level of physical injury, combined with a history of operational deployments, has led to a large number of military veterans that are either wounded, injured, and/or sick (WIS) living within the UK. Not only may veterans that are WIS experience significant life-changing impairment following injury (Carless, 2014), veterans who have been deployed on combat operations may be at further risk of developing mental health conditions, such as post-traumatic stress disorder (PTSD) (Fulton et al., 2015), which increases the likelihood of developing other disorders, such as depression and anxiety disorders, by 80% (American Psychiatric Association, 2013). In addition to the physical and psychological challenges, many veterans may face difficulties transitioning into civilian life. One study found that 25% of a Canadian Armed Forces' veteran sample experienced a difficult transition (MacLean et al., 2014), which may be higher among veterans with a lower health status (Thompson et al., 2011). The cause of this may be a result of the assimilation and immersion in military culture, which may differ from civilian culture in aspects including the environment, social capital, and unquestioned beliefs (Cooper et al., 2017), potentially leading to feelings of alienation and a crisis of identity among military personnel following discharge (Demers, 2011). The result of these physical and psychosocial challenges may, in part, explain the high levels of depression and suicide reported within the veteran population (Gutierrez et al., 2016). For this reason, and for the purpose of this review, the term 'veteran that is WIS' is used to describe veterans with either a physical and/or mental health condition(s).

In an international context, growing evidence is emerging to demonstrate that physical activity (PA) can improve the physical and psychosocial wellbeing of veterans who are WIS (Shirazipour et al., 2019; Greer & Vin-Raviv, 2019; Caddick & Smith, 2014; Brittain & Green, 2012). Moreover, PA has shown to be associated with lower levels of somatic symptoms of trauma among military veterans (Hoerster et al., 2012), and reduce the various somatic symptoms, such as hypertension, associated with trauma (Gupta, 2013). This review aims to build upon three existing reviews that have been published in this area which explored the efficacy of existing research linked to PA and wellbeing of veterans that are WIS (Shirazipour et al., 2019; Greer & Vin-Raviv, 2019; Caddick & Smith, 2014). While all three of these reviews provide insightful evidence into the impact of PA on veterans that are WIS, Shirazipour et al. (2019) identified a gap in the current knowledge of the psychological effects of diverse types of PA, such as outdoor recreation and indoor-based group fitness. To overcome this gap in existing knowledge, this review aims to utilize the World Health Organization's (WHO) broad definition of PA of "any bodily movement produced by skeletal muscles that requires energy expenditure" (WHO., 2019), which will allow many different types of PA to be included in this review. Furthermore, while all three of the reviews included qualitative and quantitative research, this review aims to solely include quantitative research, as this will have been subject to statistical analysis on a likely larger sample, in order to compare different modes of PA and their psychological effects on veterans that are WIS.

Specific objectives

This review had three objectives: 1) to identify and collate the previous and current research surrounding PA and veterans that are WIS; 2) to analyze and report the psychological effects of PA interventions on veterans that are WIS using a narrative synthesis approach; and 3) where possible, compare and contrast outcomes between different PA types.

Methods

Search strategy for relevant literature

Key databases were searched including Google Scholar, PubMed, SPORTDiscus, psycINFO, psycARTICLES, Scopus, Medline, and Summon. These databases are similar to those used in other systematic reviews within this area (Greer & Vin-Raviv, 2019; Caddick & Smith, 2014). This ensured that prominent databases that focus upon psychology, sport, exercise and medicine-related research were considered within the review process. The primary search strategy was conducted using the following search strings:

- String 1: ‘Wounded OR Injured OR Sick OR Ill AND Veteran* OR Military OR Soldier*’
- String 2: AND Physical Activity OR Exercise OR Sport OR Outward Bound
- String 3: AND Intervention OR Program*

String one was used to identify research relating to the population which this review is aimed at - military veterans who have either a physical or psychological wound, injury or sickness. String two ensured that research was within the context of PA. String three narrowed the search to articles in the field of PA interventional studies.

Depending on the database, these terms were searched in full or reduced if the database did not have a sufficiently large number of articles in the area being reviewed. This primary search was supplemented by hand searching, citation searching, and contacting lead authors in the field to identify studies that may not have been published at the time of this systematic review.

Inclusion/exclusion criteria

Inclusion criteria included:

- Studies whose sample included veterans that are physically and/or psychologically WIS, as defined above;
- Studies that focused their analysis upon the psychological effects of PA, as defined by the WHO, interventions/programs;
- Studies where clear pre/post intervention comparisons were considered and reported;
- Studies that were conducted on western military participants, *e.g.*, Australia, America; UK, in order to avoid cross-cultural factors impacting analysis; and
- Studies that utilized a quantitative approach to data collection.

Exclusion criteria included:

- Studies that focused upon veterans with serious mental illness, as defined by the research team’s local health authority as a “diagnoses which typically involve psychosis (losing touch with reality or experiencing delusions) or high levels of care, and which may require hospital treatment” (Mental Health Wales, 2019);
- Studies that included non-military/veteran personnel in their sample, and;
- Studies that were not published in English.

Data extraction/synthesis

Data from the studies, which met the inclusion criteria of the review, were extracted and tabulated according to the following characteristics: 1) Author and date; 2) Country of origin; 3) Study design; 4) Study sample; 5) Type of PA intervention; 6) Types of measures; 7) Measurement tools utilized; and 8) Outcomes. Summary details for all publications included within this systematic review are provided in [Table 1](#).

Table 1. Descriptions of studies included within the systematic review.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
1	Bennett et al. (2014)	USA	5-day pre/post quasiexperimental	34 veterans with PTSD or injury and their significant others.	5-day outdoor recreation and sport combined with couples' therapy for veterans and their significant others.	Relationship with significant other, PTSD, PTG	Revised dyadic adjustment scale (RDAS), Post-traumatic stress checklist - civilian/military (PCL - C/M), Post-traumatic growth inventory (PTGI)	Significant post-intervention decrease in PTSD symptom in both experimental groups. Significant increase in dyadic relationship scores in experimental group B. PTG did not significantly differ in either of the experimental groups following the intervention.
2	Bennett et al. (2017)	USA	13-week longitudinal among participants	40 veterans with combat related disabilities	4-day therapeutic fly-fishing program	PTSD, depression, perceived stress, functional impairment, self-determination, and leisure satisfaction	the Posttraumatic Stress Disorder Checklist Military (PCLM), Patient Health Questionnaire-9 (PHQ-9), Perceived Stress Scale (PSS), Walter Reed Functional Impairment Scale (WRFIS), Basic Needs Satisfaction in Life Scale (BNSLS), the Leisure Satisfaction Scale (LSS)	Significant post-intervention improvements in PTSD, depression, perceived stress, and functional impairment. However, none of these measures were statistically significant at a 3-month follow up. Conversely, leisure satisfaction was found to be significantly greater at a 3 month follow up compared to baseline, but not significantly greater post-intervention. Basic needs satisfaction did not differ at any of the three time points.
3	Cushing et al. (2018)	USA	6-week pre/post among participants	18 veterans with PTSD	1-hour weekly yoga sessions for 6 weeks.	PTSD, sleep quality, mindfulness, anxiety; depression	PTSD Checklist-Military version (PCL-M), Patient Health Questionnaire (PHQ-8), Beck Anxiety Inventory (BAI), Pittsburgh Sleep Quality Index (PSQI), Mindful Attention Awareness Scale (MAAS)	Large significant post-intervention improvements in PTSD, sleep quality, depression, anxiety, and mindfulness.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
4	Duvall and Kaplan (2014)	USA	4-week longitudinal among participant	98 veterans with mental health and/or substance abuse disorder	4-7-day residential outdoor activity intervention.	Perceived stress, attentional functioning, positive and negative affect, tranquility, social functioning, life outlook.	4-item version of the Perceived Stress Scale, modified version of the Attentional Functioning Index, adapted items from the Positive and Negative Affect Schedule, a 3-item modified version of the UCLA Loneliness Scale, 3-item modified version of the Social Connectedness Scale, 9-item measure of life outlook adapted from the State Hope Scale and the Seeking of Noetic Goals Test	Significant post-intervention improvements in attentional functioning, positive affect, negative affect, tranquility, social functioning, and life outlook, but perceived stress did not significantly differ. Significant improvements at 1-month follow up measures compared to post-intervention scores in positive affect, but not for any of the other measures. Further analysis revealed participants with more frequent everyday health issues benefited from the intervention to a greater extent than those with less frequent everyday health issue in all of the measures.
5	Gehrke et al. (2018)	USA	8-week pre/post among participant	17 veterans with PTSD	8 weekly 3 hour equine therapy sessions. The program focused on PTSD specific issues and building connection and trust with their horses while increasing self-confidence.	positive and negative affect	Positive and Negative Affect Scale (PANAS)	Significant post-intervention improvement in positive/negative affect.
6	Goldstein et al. (2018)	USA	12-week pre/post RCT	47 veterans with PTSD	12-week 3 × 1 hour per week exercise sessions, including aerobic exercise, strength training, and yoga, integrated with principles of Mindfulness Based Stress Reduction (MBSR).	PTSD symptoms, QoL, leisure time, feasibility and acceptability.	Clinician-Administered PTSD Scale (CAPS), World Health Organization Quality of Life (WHOQOL-BREF), Feasibility and Acceptability Questionnaire, Godin Leisure-Time Exercise Questionnaire	Significant post-intervention improvements in PTSD, mental components of QoL, and leisure time in the experimental group compared to a waitlist control. Yet, no significant difference in physical components of QoL.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
7	Johnston et al. (2015)	USA	10-week pre/post among participant with benchmarked control comparison	12 active duty and veterans with PTSD	90-minute twice weekly for 10 weeks yoga intervention	PTSD, resilience, mindfulness	The Clinician Administered PTSD Scale (CAPS) for the DSM-IV, Resilience Scale (RS), Five-Facet Mindfulness Questionnaire (FFMQ)	Significant post-intervention reduction in PTSD scores, but not for resilience and mindfulness. Following benchmarking results, the treatment effect of the intervention was lower than the benchmarked treatment effect but significantly higher than the benchmarked control condition.
8	Lanning et al. (2017)	USA	4-month longitudinal among participants with additional qualitative analysis	51 veterans and active duty service members	90-minute therapeutic horse-riding sessions once per week for 8 weeks designed specifically for veterans. The participants learned basic horse care and riding skills along with communication skill	PTSD, QoL, Self-reported physical and psychological functioning	Post-traumatic Stress Disorder Checklist Military (PCL-M); PCL-5; SF-36v2 Quality of Life Assessment; World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0)	Large to medium decreases in PTSD symptoms at mid, post, and 2 months following the intervention. Small differences in physical components of QoL at mid, post, and 2-months post intervention; whereas, medium to large improvements in mental components of QoL were observed at all three time points. Small increase of physical functioning at mid-intervention, but was not sustained post and 2-months post-intervention.
9	Lanning et al. (2018)	USA	4-month longitudinal quasiexperimental with among participant follow-up measure	89 veterans with PTSD	8-week therapeutic riding intervention	PTSD, depression, QoL, physical functioning	PTSD Checklist Military (PCLM-M), PTSD Checklist-5 (PCL-5), Short Form-36 question version 2 Quality of Life Assessment (SF36v2), World Health Organization Disability Assessment Schedule 2.0 (WHODAS- 2.0), Major Depression Inventory (MDI)	Small differences in PTSD, depression, QoL, and physical functioning between experimental group and non-randomized control group mid-intervention. Medium post-intervention improvements in mental components of QoL, PTSD, and depression in comparison to the control group, but small differences in all other measures. Small differences among participants in all measures between post-intervention and a 2-month follow up.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
10	Lundberg et al. (2011)	USA	5-day pre/post among participant	18 WIS veterans	5 day adapted sport and recreation retreat for veterans and their significant others	QoL, Mood-state, and perceived competence	World Health Organization's Quality of Life Assessment (WHOQOL), Profile of Mood States-Brief (POMS-B), a four-item modified version of the Perceived Competence Scale (PCS).	Significant post-intervention effect on QoL, with only the mental components subscale being significant, mood state, and perceived competence.
11	McCarthy et al. (2017)	Australia	8-week pre/post among participant	30 veterans with PTSD	8 weekly 90 minute yoga intervention	PTSD, Depression, anxiety, stress, sleep quality, sensory profile, QoL.	PTSD checklist (PCL), the Depression, Anxiety and Stress Scale (DASS), the Pittsburgh Sleep Quality Index (PSQI), the Adult/Adolescent Sensory Profile, the SF36 Quality of Life assessment	Significant post-intervention improvements in PTSD, depression, anxiety, stress, sleep quality, and QoL. Significant post-intervention decreases in all sensory profile subscales bar sensation seeking.
12	Mehling et al. (2018)	USA	12-week pre/post RCT	47 veterans with PTSD	12-week 3 × 1 hour per week exercise sessions, including aerobic exercise, strength training, and yoga, integrated with principles of Mindfulness Based Stress Reduction (MBSR).	Mindfulness, interoceptive awareness, positive state of mind	39-item Five Facet Mindfulness Questionnaire (FFMQ), Multidimensional Assessment of Interoceptive Awareness (MAIA), Positive States of Mind Scale (PSOM),	Elements of mindfulness, interoceptive awareness and positive state of mind significantly improved in the experimental group compared to a waitlist control group.
13	Morgan et al. (2019)	UK	10-14-day pre/post among participant, with additional qualitative analysis	10 WIS veterans	10-14 day scuba diving intervention offering WIS veterans the opportunity to progress through accredited diving qualifications.	Psychological components of ill-health	General Health Questionnaire-28 (GHQ-28)	No significant post-intervention difference in GHQ-28 scores.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
14	Reinhardt et al., (2018 ⁷)	USA	10-week pre/post RCT	51 veterans with PTSD	10 week 90 minutes twice weekly yoga intervention	PTSD	Clinician-Administered PTSD Scale (CAPS), Post traumatic stress checklist - military/civilian (PCL-M/C), Impact of Events Scale-Revised (IES-R)	Large non-significant post-intervention difference between experimental group and waitlist control in PCL-M and IES-R scores. However, only a significant CAPS Reexperiencing subscale time interaction was observed following ANOVA.
15	Rogers et al. (2014)	USA	5-week pre/post among participants	14 veterans with PTSD	5 weekly 4 hour surf sessions. Each session focused on specific themes such as role identity, leadership and trust, community building, problem solving, and transitioning.	PTSD, depression	Post-traumatic Stress Checklist-Military (PCL-M), Major Depression Inventory (MDI)	Both PTSD and depression scores significantly decreased among participants between baseline and post-intervention measures.
16	Romanuk et al. (2018)	Australia	13-week longitudinal quasi-experimental	47 WIS veterans and their partners (Individual, n = 25; Couples, n = 22)	5-day residential equine assisted therapy program for individual veterans or veterans and their significant other	PTSD, Depression and Anxiety, Happiness, QoL.	Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5), Depression Anxiety Stress Scale- 21 (DASS-21), The Oxford Happiness Questionnaire (OHQ), Quality of Life, Enjoyment and Satisfaction Questionnaire- Short Form (Q-LES-Q-SF)	Significant post-intervention improvements in PTSD, Depression, Happiness, and QoL in both individual and couple group post intervention, with anxiety only significantly improving in the individual program. However, all measures were maintained to a greater extent among participants of the couples' program compared with the individual program.
17	Staples et al. (2013)	USA	6-week pre/post among participant	12 veterans with PTSD	1-hour twice weekly yoga sessions for 6 weeks.	PTSD, Sleep quality, Anger, QoL	PTSD checklist military version (PCL-M), The Pittsburgh Sleep Quality Index (PSQI), The State-Trait Anger Expression Inventory-2 (STAXI-2) Outcome Questionnaire 45.2 (OQ-45.2).	No significant post-intervention difference in PTSD symptoms, anger, and QoL total scores. However, the Hyperarousal subscale of the PCL-M significantly decreased. Sleep quality significantly improved post-intervention.

	Author and date	Country of origin	Study length and design	Sample	Physical activity intervention	Measures	Measurement tools	Outcomes
18	Townsend et al. (2018)	USA	13-week longitudinal among participant	127 injured service members and veterans	5-day retreat-style seasonal outdoor activity (e.g. snowmobiling, rafting, equine activities, fishing, hiking) for veterans and their significant others. Marriage counseling and education related to veteran reintegration used in conjunction to recreational activities.	PTSD, anxiety and depression, self-reported physical and mental health functioning	Post-traumatic Stress Disorder Checklist Military (PCL-M), Depression, Anxiety, and Stress scale (DASS), Veterans RAND Health Survey (VR-12)	Significant decrease in PTSD symptoms at baseline, post-intervention, 3-months post-intervention, and 6-months post intervention. Depression, anxiety, stress, physical functioning did not significantly decrease at all time points. Mental health functioning significantly increased post-intervention, but returned to baseline levels at 3 and 6-months post-intervention.
19	Vella et al. (2013)	USA	8-week longitudinal among participant	74 veterans with PTSD	Residential 2 day, 3-night, fly-fishing intervention.	PTSD, depression, anxiety, stress, positive/negative affect, perceived stress, sleep quality	Post-traumatic Stress Disorder Checklist Military (PCL-M), Brief Symptom Inventory-18 (BSI), Positive and Negative Affect Scale (PANAS), Perceived Stress Scale (PSS), Pittsburgh Sleep Quality Inventory (PSQI)	Significant post-intervention improvements in positive affect, negative affect, anxiety, depression, and somatic symptoms of stress. Comparisons with no post-intervention measure revealed significant improvements in sleep quality, perceived stress and PTSD symptoms at a 6-week follow-up.

Due to the various types of interventions, measures, and measurement tools, statistical analysis was deemed inappropriate for this review. Therefore, data was considered and synthesized through a narrative lens. Following tabulation, data was categorized into types of outcome measures, such as post-traumatic stress disorder (PTSD) and quality of life (QoL), and then compared with other interventions. Textual descriptions of these comparisons can be found under the relevant subheading in the results section.

Risk of bias

Each study included in this review was assessed using the QualSyst tool for quantitative studies (Kmet et al., 2004). QualSyst uses 14 questions, each of which is answered with either a 'yes' (2 points), 'partial' (1 point), or 'no' (0 points). The total score is then divided by the total possible score of 28 for a quality score. For example, a study which scored 14 points would be given a score of 0.5 ($14/28 = 0.5$). However, as the use of summary scores, such as this, has been widely criticized (Colle, Rannou, Revel, Fermanian, & Poiraudau, 2002; Jüni et al., 1999) and is not recommended by the Cochrane Handbook (Higgins & Green, 2011), the 14 questions are reported as standalone scores and summary scores were not calculated and compared, instead the individual question scores have been color coded to make interpretation easier.

The QualSyst tool was selected due to its ability to assess quantitative studies of various design, including randomized controlled trial (RCT) and quasi-experimental designs. The QualSyst tool has been applied to systematic reviews in many areas of research including medical research (Dhooira et al., 2016) and psychology (Chastin, et al., 2015). Results of the QualSyst analysis are presented in Table 2.



Table 2. QualSyst analysis results for studies included within the systematic review.

	Bennett et al. (2014)	Bennett et al. (2017)	Cushing et al. (2018)	Du-vall and Kaplan (2014)	Gehrke et al. (2018)	Goldstein et al. (2018)	Johnston et al. (2015)	Lanning et al. (2017)	Lanning et al. (2018)	Lundberg et al. (2011)	McCarthy et al. (2017)	Mehling et al. (2018)	Morgan et al. (2019)	Reinhardt et al., (2017)	Rogers et al. (2014)	Roman-iuk et al. (2018)	Staples et al. (2013)	T...	
Q1. Question or objective sufficiently described?																			
Q2. Study design evident and appropriate to answer study question?																			
Q3, Method of subject selection described and appropriate?																			

	Bennett et al. (2014)	Bennett et al. (2017)	Cushing et al. (2018)	Duval and Kaplan (2014)	Gehrke et al. (2018)	Goldstein et al. (2018)	Johnston et al. (2015)	Lanning et al. (2017)	Lanning et al. (2018)	Lundberg et al. (2011)	McCarthy et al. (2017)	Mehling et al. (2018)	Morgan et al. (2019)	Reinhardt et al., (2017)	Rogers et al. (2014)	Romanuk et al. (2018)	Staples et al. (2013)
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Q4. Subject characteristics or input variables/ information sufficiently described?

Q5. If random allocation to treatment group was possible, is it described?

Q6. If interventional and blinding of investigators to intervention was possible, is it reported?

	Bennett et al. (2014)	Bennett et al. (2017)	Cushing et al. (2018)	Duvall and Kaplan (2014)	Gehrke et al. (2018)	Goldstein et al. (2018)	Johnston et al. (2015)	Lanning et al. (2017)	Lanning et al. (2018)	Lundberg et al. (2011)	McCarthy et al. (2017)	Mehling et al. (2018)	Morgan et al. (2019)	Reinhardt et al., (2017)	Rogers et al. (2014)	Romanuk et al. (2018)	Staples et al. (2013)	To... s... e...
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Q7. If interventional and blinding of subjects to intervention was possible, is it reported?

Q8. Outcome measure(s) well defined and robust to measurement/misclassification bias?

Q9. Sample size appropriate?

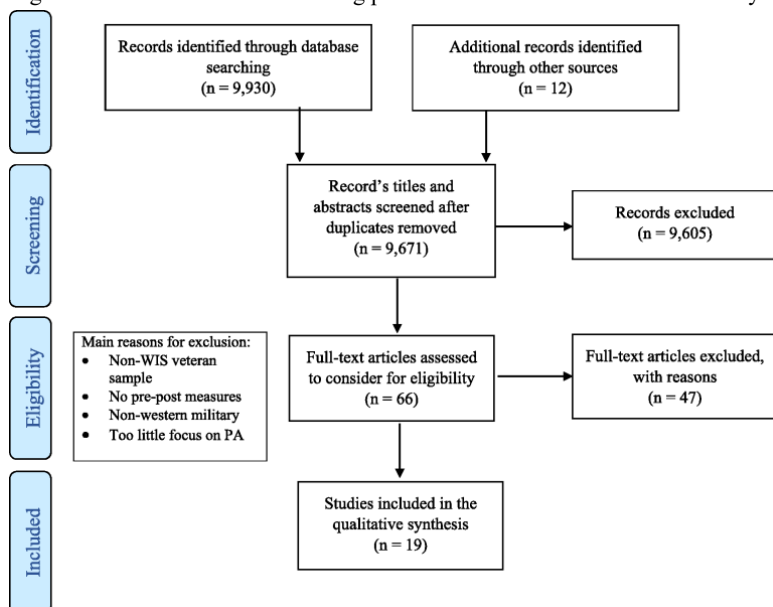
	Bennett et al. (2014)	Bennett et al. (2017)	Cushing et al. (2018)	Duval and Kaplan (2014)	Gehrke et al. (2018)	Goldstein et al. (2018)	Johnston et al. (2015)	Lanning et al. (2017)	Lanning et al. (2018)	Lundberg et al. (2011)	McCarthy et al. (2017)	Mehling et al. (2018)	Morgan et al. (2019)	Reinhardt et al., (2017 ⁸)	Rogers et al. (2014)	Romanuk et al. (2018)	Staples et al. (2013)
Q10. Analysis described and appropriate?																	
Q11. Some estimate of variance is reported for the main results/outcomes?																	
Q12. Controlled for confounding																	
Q13. Results reported in sufficient detail?																	
Q14. Do the results support the conclusion?																	

Note. = Yes = Partial = No.

Results

Following a rigorous screening process (see Figure 1), 19 studies were eventually included within this systematic review. Studies originated from three countries, 16 from the USA, two from Australia, and one from the UK. The 19 studies used a mixture of quantitative methodologies, including three randomized controlled trials, three quasi-experimental non-randomized designs, and 13 among participant analyses. Sample sizes ranged from 10 to 127 participants. PA intervention/program length varied from two days to 12 weeks, and for the purpose of this review, studies which adopted only pre/post measures are referred to as ‘pre/post’ studies; while those with post-intervention follow up measures are referred to as ‘longitudinal’. All 19 studies included pre/post-intervention measures, however, only seven included longitudinal measures which ranged from one to six months post-intervention. Forty-one unique measurement tools were utilized, predominantly self-report questionnaires, apart from the Clinician-Administered PTSD Scale (CAPS) which was implemented in three studies. These measurement tools measured a variety of outcomes, with 14 post-traumatic stress, nine depression, anxiety, and/or stress, eight quality of life, four sleep quality, four positive/negative affect, three perceived functional impairment, three mindfulness, two social wellbeing, one perceived mood, one competence, one happiness, one tranquility, one attentional functioning, one life-outlook, one leisure time, one interoceptive awareness, one psychiatric disorders, one anger, one post-traumatic growth, one resilience, one self-determined motivation, and one leisure satisfaction measurements. Descriptions of all studies and their respective outcomes can be found in Table 1.

Figure 1. Flow chart of the screening process of studies included within the systematic review.



Narrative synthesis of results

Post-traumatic stress disorder

Fourteen studies met the inclusion criteria for this section of the review, with five yoga (Reinhardt et al., 2018; Cushing et al., 2018; McCarthy et al., 2017; Johnston et al., 2015; Staples et al., 2013), five outdoor recreation (Townsend et al., 2018; Bennett et al., 2017; Rogers et al., 2014; Bennett et al., 2014; Vella et al., 2013), three horse-riding (Lanning et al., 2018; Romaniuk et al., 2018; Lanning et al., 2017), and one a multi-exercise intervention, combined with mindfulness-based stress reduction (MBSR) (Goldstein et al., 2018).

Despite an RCT by Reinhardt et al. (2018) finding no significant difference in PTSD scores post-intervention, the majority of yoga intervention studies included in this review suggested that yoga did have a positive, post-intervention impact on PTSD (Cushing et al., 2018; McCarthy et al., 2017; Johnston et al., 2015; Staples et al., 2013). Specifically, where the three subscales of hyperarousal, reexperiencing, and avoidance were included in the analysis, yoga appeared to have the greatest impact on the hyperarousal subscale (Cushing et al., 2018; McCarthy et al., 2017).

While not specifically a yoga intervention, the study by Goldstein et al. (2018) employed a multi-exercise intervention, which included a yoga component and was combined with MBSR. Participants in the experimental group observed a large, significant decrease in PTSD symptoms, compared to a control group.

Outdoor recreation appeared to reduce PTSD symptoms immediately following participation (Townsend et al., 2018; Bennett et al., 2017; Rogers et al., 2014; Bennett et al., 2014; Vella et al., 2013). However, among the three studies where follow-up measures were reported (Townsend et al., 2018; Bennett et al., 2017; Vella et al., 2013), two studies observed a significant longitudinal improvement. One at 6-weeks post-intervention (Vella et al., 2013) and one at 6-months post-intervention in participants of the only of the three interventions to include veterans' significant others (Townsend et al., 2018).

Two horse-riding studies used the same sample and intervention but employed different methodologies (Lanning et al., 2018; Lanning et al., 2017). Both noted moderate-to-large, significant improvements within participants (Lanning et al., 2017) compared to a control group (Lanning et al., 2018) and benefits had been maintained in both studies 2-month beyond the end of the intervention. Furthermore, Romaniuk et al. (2018) found significant improvements immediately following their horse-riding intervention. However, positive effects were maintained in a "couples' programme" at 3 months follow-up, but benefits were not observed at this time for participants whom completed an "individual programme".

Depression, anxiety, and stress

Nine studies met the inclusion criteria for this section of the review, consisting of five outdoor recreation (Townsend et al., 2018; Bennett et al., 2017; Rogers et al., 2014; Vella et al., 2013; Lundberg et al., 2011), two yoga (Cushing et al., 2018; McCarthy et al., 2017), and two horse-riding interventions (Romaniuk et al., 2018; Lanning et al., 2017).

Outdoor recreation had a positive, post-intervention effect on depression (Townsend et al., 2018; Bennett et al., 2017; Rogers et al., 2014; Vella et al., 2013; Lundberg et al., 2011). However, neither of the three studies with longitudinal measures found a positive effect at 6 weeks (Vella et al., 2013) or 3 months (Bennett et al., 2017), or 6 months (Townsend et al., 2018) after the respective interventions had finished, even with inclusion of veterans' significant others (Townsend, et al., 2018).

Two outdoor recreation studies observed mixed findings regarding their effect on anxiety. One study reported a moderate, but significant post-intervention reduction in anxiety scores, however, it was not maintained at a 6 weeks follow-up (Vella et al., 2013). In contrast Townsend et al. (2018) observed no differences in anxiety levels between any time points from baseline to 6-months post-intervention.

The influence of outdoor recreation on stress was also mixed, with three studies observing a positive, post-intervention effect on stress (Townsend et al., 2018; Bennett et al., 2017; Vella et al., 2013), however, this effect was not maintained at any of the follow-up measures (Townsend et al., 2018; Bennett et al., 2017; Vella et al., 2013). One other study reported no significant differences in stress scores at any time points, including a 4-week follow-up (Duvall & Kaplan, 2014). However, among participants with frequent, everyday health issues, Duvall and Kaplan (2014) observed significant decreases in stress scores between baseline and the 4-week follow-up.

Yoga was found to have a positive, post-intervention effect on the symptoms of depression (Cushing et al., 2018; McCarthy et al., 2017), anxiety (Cushing et al., 2018; McCarthy et al., 2017), and stress (McCarthy et al., 2017).

Horse-riding interventions were found to have a positive impact on the symptoms of depression (Romaniuk et al., 2018; Lanning et al., 2017), anxiety (Romaniuk et al., 2018), and stress (Romaniuk et al., 2018). While Lanning et al. (2017) reported only a small difference (significance not calculated) between post-intervention and a 3 months follow-up, Romaniuk et al. (2018) found that reductions in depression, anxiety, and stress were maintained to a much greater extent in a "couples" version of the intervention, compared to the individuals' version. In direct contrast, moderate-to-large increases in depression, anxiety, and stress were reported for participants completing an "individual programme" between post-intervention and 3 months follow-up.

Quality of life

Eight studies met the inclusion criteria of this section, with three focused upon horse-riding (Lanning et al., 2018; Romaniuk et al., 2018; Lanning et al., 2017), two on yoga (McCarthy et al., 2017; Staples et al., 2013), two employed

outdoor recreation (Townsend et al., 2018; Lundberg et al., 2011), and one multi-activity intervention combined with MBSR (Goldstein et al., 2018).

Horse-riding had a positive post-intervention effect on QoL among participants (Romaniuk et al., 2018; Lanning et al., 2017) and in comparison to a control group (Lanning et al., 2018). However, this was not sustained 2 months after the end of the intervention (Lanning et al., 2018; Lanning et al., 2017) or at the point of 3 months follow-up (Romaniuk et al., 2018), even when significant others were included in the intervention (Romaniuk et al., 2018).

The post-intervention effects of yoga on QoL was mixed, with one study reporting significant improvements (McCarthy et al., 2017), but another reporting no difference between pre- and post-intervention evaluations (Staples et al., 2013).

Two outdoor recreation interventions initially had a positive effect on the mental components of QoL immediately post-intervention (Townsend et al., 2018; Lundberg et al., 2011), however, this beneficial effect was not maintained after either 3- or 6-months follow-up (Townsend et al., 2018). It is also noteworthy that outdoor recreation had no significant effect on the physical components of QoL (Townsend et al., 2018; Lundberg et al., 2011).

Multi-activity exercise classes with components of MBSR led to a medium significant post-intervention improvement within the mental components of QoL, compared to a group of waitlist control participants, but no significant difference was observed within the physical components of QoL (Goldstein et al., 2018).

Sleep quality

Four studies met the inclusion criteria of this section of the review and included three yoga (Cushing et al., 2018; McCarthy et al., 2017; Staples et al., 2013) and one outdoor recreation intervention (Vella et al., 2013).

All three yoga interventions reported positive post-intervention effects on sleep quality (Cushing et al., 2018; McCarthy et al., 2017; Staples et al., 2013). Similarly, one outdoor recreation intervention reported a significant, positive improvement in sleep quality up to 6-weeks post-intervention (Vella et al., 2013).

Positive/negative affect

Four studies met the criteria to be included in this section of the review, including two outdoor recreation (Duvall & Kaplan, 2014; Vella et al., 2013), one horse-riding (Gehrke et al., 2018), and one multi-exercise activity intervention combined with MBSR (Mehling et al., 2018).

Outdoor recreation had a significant post-intervention effect on positive affect (Duvall & Kaplan, 2014; Vella et al., 2013), which was maintained after 1-month (Duvall & Kaplan, 2014) and 6 weeks post-intervention (Vella et al., 2013). This effect was particularly prominent among participants whom experienced frequent everyday health issues, who Duvall and Kaplan (2014) suggest may generally have a lower positive affect. Similarly, outdoor recreation reduced negative affect post-intervention (Duvall & Kaplan, 2014; Vella et al., 2013), and this beneficial change was maintained 1-month (Duvall & Kaplan, 2014) and 6-weeks after the respective interventions finished (Vella et al., 2013). This effect was found to be more prominent among participants with frequent, everyday health issues (Duvall & Kaplan, 2014).

One horse-riding intervention study (Gehrke et al., 2018) and a multi-exercise activity combined with MBSR intervention study (Mehling et al., 2018) observed positive post-intervention effects.

Perceived functional impairment

Three studies met the inclusion criteria for this section of the review, with two horse-riding (Lanning et al., 2018; Lanning et al., 2017) and one outdoor recreation intervention (Bennett et al., 2017). Horse-riding led to a small improvement in perceived functioning at mid- and post-intervention, compared to a control group (Lanning et al., 2018). However, in the study by Lanning et al. (2017), perceived functioning scores only slightly improved mid-intervention, but returned to near baseline post-intervention. Using the same analysis, both studies noted a further decrease at 2-months follow-up (Lanning et al., 2018; Lanning et al., 2017). Outdoor recreation had a positive, post-intervention effect on perceived functional impairment, however, this was not sustained at 3 months follow-up (Bennett et al., 2017).

Mindfulness

Three studies met this section's inclusion criteria, with two yoga interventions (Cushing et al., 2018; Johnston et al., 2015) and one multi-exercise combined with MBSR (Mehling et al., 2018). The post-intervention effect of Yoga on mindfulness was mixed; one study reported the positive impact of yoga on participant mindfulness in comparison to a control group (Cushing et al., 2018), but another study reported no change in mindfulness scores (Johnston et al., 2015). In contrast, one multi-exercise combined with MBSR intervention resulted in a significant post-intervention improvement in mindfulness, compared to a control group (Mehling et al., 2018).

Social wellbeing

Two studies met the inclusion criteria of this section of the systematic review, both of which were outdoor recreation interventions (Duvall & Kaplan, 2014; Bennett et al., 2014). Using a three-arm design with two similar experimental groups and one control condition, Bennett et al. (2014) reported a significant, post-intervention difference in dyadic relationship scores in experimental group B in comparison to the control group; whereas, experimental group A's scores did not statistically differ to the control condition. However, another study reported that their conceptualization of social functioning, calculated using the Loneliness Scale and Social Connectedness Scale (SCS), significantly increased post-intervention, particularly among participants whom reported frequent everyday health issues (Duvall & Kaplan, 2014).

Other effects

Other positive effects of PA interventions included improvements in perceived mood (Lundberg et al., 2011), competence (Lundberg et al., 2011), happiness (of which the couples' program maintained their scores to a greater extent at a 3-month follow up compared to the individual program) (Romaniuk et al., 2018), tranquility (Duvall & Kaplan, 2014), attentional functioning (Duvall & Kaplan, 2014), life-outlook (Duvall & Kaplan, 2014), leisure time (Goldstein et al., 2018), and some aspects of interoceptive awareness (Mehling et al., 2018). The latter concept is concerned with encouraging an individual to consider and integrate bodily sensations with cognitive processes, allowing one to either explore his/her emotional state.

Although, PA interventions were not shown to have a significant effect on psychiatric disorders (Morgan et al., 2019), anger (Staples et al., 2013), post-traumatic growth (Bennett et al., 2014), resilience (Johnston et al., 2015), self-determined motivation (Bennett et al., 2017), and leisure satisfaction (Bennett et al., 2017).

Discussion

This review has collated and considered current quantitative evidence surrounding the psychological effects of physical activity (PA) interventions on veterans that are wounded, injured, and/or sick (WIS) using a narrative synthesis approach.

Post-traumatic stress disorder (PTSD) has been noted as being particularly prominent among military veterans, with as many as 23% of Operation Enduring Freedom/Iraqi Freedom veterans suffering from the disorder (Fulton et al., 2015). Corresponding with the results of previous reviews surrounding PA for veterans that are WIS (Greer & Vin-Raviv, 2019; Caddick & Smith, 2014) and non-military/veteran specific meta-analyses (Rosenbaum et al., 2015), the various modes of PA interventions that met the inclusion criteria of this review had a positive, post-intervention effect on PTSD, particularly in symptoms of hyperarousal. Furthermore, some studies highlighted the short-term positive intervention effects of less than 2-months in some participants (Lanning et al., 2018; Romaniuk et al., 2018; Townsend et al., 2018; Lanning et al., 2017; Vella et al., 2013). However, while many of these studies had increases in PTSD scores between post-intervention and a relatively short-term follow-up, studies which included veterans' significant others appeared to maintain reductions in PTSD scores to a greater extent, with one study observing a significant reduction at 6-months compared to baseline (Townsend et al., 2018) and 3-months post-intervention compared to participants undertaking an individual version of their intervention (Romaniuk et al., 2018). Contrary to qualitative findings published in the review by Shirazipour et al. (2019), which suggested that PA may be impacted by and improve family relationships but does not necessarily require the inclusion of a family member, the general trend identified in this review suggests that the inclusion of significant others may lengthen the positive effects of an intervention. However, as only a small number of studies included in this review incorporated significant others, more research is required to add strength to this preliminary finding.

Overall, outdoor recreation appeared to be the most consistent type of PA that effectively reduced PTSD symptoms post-intervention. However, to what degree this effect is likely to be sustained remains unclear. This aligns with

findings of previous reviews that advocate the therapeutic effect of veterans interacting with nature (Shirazipour et al., 2019; Greer & Vin-Raviv, 2019; Caddick & Smith, 2014).

With the increased likelihood of mental health conditions such as depression, anxiety, and stress disorders among veterans that are WIS, reducing symptoms of these may positively impact upon their wellbeing. Generally, a positive, post-intervention effect on symptoms of depression, anxiety, and stress was observed following participation in the various types of PA, despite the effects of outdoor recreation on anxiety and stress being mixed. However, whether a positive improvement can be maintained post-intervention is unclear, with conflicting results stemming from horse-riding and outdoor recreation interventions. A recent systematic review that considered the psychological wellbeing of veterans that are WIS identified that outdoor recreation can have a beneficial impact on the psychological wellbeing of veterans with PTSD, especially in the context of reductions in perceived levels of depression and stress (Greer & Vin-Raviv, 2019), and building upon this, this review suggests that positive reductions in depression, anxiety, and stress may be greater among participants with ongoing and frequent everyday health issues (Duvall & Kaplan, 2014) and maintained for a longer duration when significant others are included within the intervention (Romaniuk et al., 2018).

Comparing PA types, all studies included in this systematic review, with the exception of one outdoor recreation study, observed a reduction in depression scores. Whereas, horse riding and yoga appeared to be more effective in decreasing levels of stress and anxiety. Perhaps the absence of mindfulness in outdoor recreation that can be found within yoga (Salmon et al., 2009) and animal therapy (Schramm et al., 2015) which has been linked to reductions in anxiety (Vøllestad et al., 2012) can explain this finding.

In comparison to the general population, veterans may have a lower health-related QoL (Opezzo et al., 2016; Kazis et al., 1998). Despite previous reviews suggesting that sport or PA can improve veterans' QoL (Greer & Vin-Raviv, 2019; Shirazipour et al., 2019; Caddick & Smith, 2014), the evidence presented in this review shows mixed findings for the impact of PA on overall QoL. Total QoL scores increased in several studies post-intervention, however, this finding was not maintained at follow-up measures, even when significant others were included (Townsend et al., 2018; Romaniuk et al., 2018). While all three types of PA, horse-riding, outdoor recreation, and yoga, observed positive effects on QoL post-intervention, among studies where physical and mental aspects of QoL were separated (Goldstein et al., 2018; Lundberg et al., 2011), greater improvements were reported for mental components. This may suggest that short-term PA participation for veterans that are WIS has a greater immediate effect on the mental components of QoL, rather than the physical.

Both yoga and outdoor recreation types of PA were found to have a positive post-intervention effect on sleep quality. While there is little current evidence on the effect of PA on veterans that are WIS's sleep quality, research within other populations, such as older adults (Reid et al., 2010) and obese adolescents (Mendelson et al., 2016), has reported improved sleep quality. Therefore, these studies may strongly hint at the fact that a similar benefit can be experienced by veterans that are WIS undertaking PA, however, which mode of PA is more effective remains unclear.

Positive and negative affect significantly improved post-intervention among horse-riding, outdoor recreation, and multi-exercise PA interventions, with larger effects observed for individuals with ongoing, frequent health issues (Duvall & Kaplan, 2014). Although this finding is limited by the small number of studies, it aligns with the finding of other reviews in this area (Shirazipour et al., 2019; Caddick & Smith, 2014). All outdoor recreation, horse-riding, and multi-activity exercise with mindfulness components which measured positive/negative affect observed significant improvements, yet more research is needed in this area before meaningful and robust comparisons of PA types can be made.

An immediate positive, post-intervention effect on perceived functional impairment was observed following both outdoor recreation and horse-riding, however, this was not maintained at the point of follow-up in any of the studies. While neither outdoor recreation nor horse-riding appeared to be more effective than the other, due to the nature of perceived functional impairment, consistent participation in PA may be required to further improve or maintain physical functioning post-intervention. The lack of significant findings could therefore be caused by a lack of continued engagement in PA following the intervention.

PA interventions can improve participants' mindfulness. Two out of three studies which analyzed participant mindfulness observed a significant improvement. However, each of these interventions contained a potentially con-

founding component of mindfulness training. Therefore, it is unclear to what extent the PA and/or mindfulness training is responsible for the increases in mindfulness, making any comparison between PA modes difficult.

PA may provide a medium whereby veterans can increase their social interaction and associated wellbeing (Greer & Vin-Raviv, 2019; Shirazipour et al., 2019; Caddick & Smith, 2014). While this review is limited in the small number of studies which analyzed social wellbeing, PA may increase social wellbeing, particularly among those with frequent everyday health issues (Duvall & Kaplan, 2014). As only outdoor recreation studies in this review evaluated social wellbeing, comparisons of different types of PA cannot be made. However, the group-based design of the outdoor recreation activities could help explain the increase in social wellbeing.

Limitations

This review contains one conceptual and three methodological limitations. Conceptually, this review utilized a very broad definition of PA, resulting in many different types of activities being considered and included. This may be considered a limitation, as comparing indoor yoga to outdoor recreation may be challenging due to large differences in modes and execution of interventions, which may impact on various other aspects of the intervention, such as the opportunity for social interaction. Indeed, Shirazipour et al. (2019) noted that a lack of understanding related to how PA interventions are implemented and how this subsequently impacts upon experiences and outcomes, represents a clear knowledge gap within the current literature. Even within PA with similar modes of delivery, this difference in implementation style may impact on outcomes. This limitation is particularly prominent among PA interventions which include additional and complementary, non-PA components, such as marriage counseling and mindfulness-based stress reduction. However, as the aim of this review was to collate and compare the effects of various PA interventions on veterans that are WIS, a narrative synthesis gives an understanding of how each intervention has the potential to positively influence veterans that are WIS, without the various types of PA interventions impacting the results. Nevertheless, the nonstandardized modality and delivery of PA interventions may lead to unreliable comparisons and outcomes, therefore, findings presented herein should be interpreted with caution.

From a methodological perspective, however, a narrative synthesis approach in itself may be viewed as a limitation. While such an approach was deemed as an effective tool to explore and synthesize the varied interventions, measures, and measurement tools, the absence of statistical analysis in a narrative synthesis renders cause and effect relationships indeterminate. Despite this, the approach used in this review allows the reader to gain a good understanding of the current state of research relating to the effects of PA on veterans that are WIS.

In addition, the various designs of studies which met the inclusion criteria of this review may be considered a limitation. Few studies in this review adopted an RCT design, with many of the studies adopting a within participant and/or quasi-experimental design. The result of this research approach may have led to bias and the occurrence of a type 1 statistical error within respective studies. Furthermore, many studies included within this review typically employed small samples of veterans that are WIS and many lacked longitudinal follow-up measures, both of which prevent the complete understanding of the effect of any PA intervention. Findings from such studies should, therefore, be interpreted with caution.

Implication/future recommendations

The results of this review lead to three recommendations for the development of future PA interventions. Firstly, designing interventions in a manner which facilitates the inclusion of significant others may serve to lengthen the beneficial psychological effects gained from an intervention. Secondly, interventions may have a greater impact on veterans that are WIS with a lower health status. Ensuring that programs are accessible and inclusive for such individuals will ensure that those likely to benefit most are able to participate. Thirdly, practitioners may benefit from implementing outdoor recreation interventions/programs when aiming to reduce PTSD symptoms, and yoga or horse-riding interventions/programs for reducing levels of perceived anxiety and stress.

Corresponding to findings of related systematic reviews (Greer & Vin-Raviv, 2019; Shirazipour et al., 2019), this review has identified an overall weak methodology in the current literature. In order to increase the quality and understanding of research relating to the effects of PA on veterans that are WIS, future research may benefit from adopting an RCT design. Such an approach will reduce the bias that may be present within previously published studies and allow the identification and understanding of the effect of PA on veterans that are WIS. In addition, future research may benefit from standardizing the measurement tools used to analyze the various psychological outcomes of

PA interventions, as the studies which met the inclusion criteria of this review used a wide variety of different, clinically-administered and/or self-administered measures (See Table 1). In doing so, an accumulation of RCT research with a standardized measure will permit a future meta-analysis to be conducted, further increasing the accuracy of the knowledge relating to PA intervention effects on veterans that are WIS. Moreover, future research should ensure that multiple, follow-up measures are considered post-intervention. In doing this, longitudinal effects of PA interventions on veterans that are WIS will become more apparent, allowing practitioners to adopt PA interventions that optimize health-related outcomes.

Summary

PA, as defined by the World Health Organization (WHO), encompasses many forms of activities. When implemented as interventions, these activities may have positive psychological effects on veterans that are WIS. The studies synthesized in this review suggest that PA interventions can have a positive, post-intervention impact on PTSD, depression, anxiety, stress, QoL, social wellbeing, sleep quality, perceived functional impairment, mindfulness, positive affect, and negative affect, with some of these beneficial effects being complementary and possibly more prominent in veterans that are WIS with ongoing, frequent health issues. Furthermore, outdoor recreation appeared to more consistently reduce PTSD symptoms than other PA types post-intervention; whereas, yoga and horse riding was more effective in reducing anxiety and stress. While benefits gained from PA are prominent post-intervention, they may decrease over time. However, with the inclusion of a significant other, these beneficial effects may well become lengthened. However, the differences in modality and delivery of PA interventions and an overall weak methodology of the current literature in this area makes comparisons difficult. More rigorous, RCT studies are warranted and will be necessary to confirm findings presented within this systematic review.

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AUTHOR QUERIES

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