Adaptive Sports for Disabled Veterans

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted healthcare topics of importance to clinicians, managers, and policymakers as they work to improve the health and healthcare of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program is comprised of four ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program and Cochrane Collaboration. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, and interface with stakeholders. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee comprised of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, Deputy Director, ESP Coordinating Center at Nicole.Floyd@va.gov.

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This report is based on research conducted by the Evidence Synthesis Program (ESP) Center located at the **Minneapolis VA Medical Center, Minneapolis, MN**, funded by the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development. The findings and conclusions in this document are those of the author(s) who are responsible for its contents; the findings and conclusions do not necessarily represent the views of the Department of Veterans Affairs or the United States government. Therefore, no statement in this article should be construed as an official position of the Department of Veterans Affairs. No investigators have any affiliations or financial involvement (*eg*, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties) that conflict with material presented in the report.

ACKNOWLEDGMENTS

This topic was developed in response to a nomination by Lucille Beck, PhD and Joel Scholten, MD for the purpose of determining the benefits and harms associations with participation in adaptive sports for Veterans with disabilities as well as to identify facilitators and barriers to participation. The scope was further developed with input from the topic nominators (*ie*, Operational Partners), the ESP Coordinating Center, the review team, and the technical expert panel (TEP).

In designing the study questions and methodology at the outset of this report, the ESP consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

The authors gratefully acknowledge the following individuals for their contributions to this project:

Operational Partners

Operational partners are system-level stakeholders who have requested the report to inform decision-making. They recommend Technical Expert Panel (TEP) participants; assure VA relevance; help develop and approve final project scope and timeframe for completion; provide feedback on draft report; and provide consultation on strategies for dissemination of the report to field and relevant groups.

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Technical Expert Panel (TEP)

To ensure robust, scientifically relevant work, the TEP guides topic refinement; provides input on key questions and eligibility criteria, advising on substantive issues or possibly overlooked areas of research; assures VA relevance; and provides feedback on work in progress. TEP members are listed below:

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Peer Reviewers

The Coordinating Center sought input from external peer reviewers to review the draft report and provide feedback on the objectives, scope, methods used, perception of bias, and omitted evidence. Peer reviewers must disclose any relevant financial or non-financial conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The Coordinating Center and the ESP Center work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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INTRODUCTION

The term "adaptive sports" is used to describe a sport that has either been adapted specifically for persons with a disability or created specifically for persons with a disability.[1] For persons with physical disabilities, organized sports can be traced back to the early 1900s. However, opportunities expanded greatly in the post-World War II era when adaptive sports began to be used for rehabilitation of Veterans.[2] Many of the early programs were in downhill skiing but the range of available sports and opportunities for participation at all levels, from recreational to competitive, has broadened greatly.

Within the Department of Veterans Affairs (VA), the vision of the National Veteran Sports Programs and Special Events (NVSP&SE) office (http://www.va.gov/adaptivesports) is "to be leaders in the provision of adaptive sports and therapeutic arts programs that complement VA's rehabilitation system of care for Veterans and members of the Armed Forces with disabilities." The national rehabilitation events are intended to "provide opportunities for Veterans to improve their independence, well-being, and quality of life through adaptive sports and therapeutic arts programs." The programs offered include the National Veterans Wheelchair Games, the National Veterans Golden Age Games, the National Disabled Veterans Winter Sports Clinic, the National Veterans Summer Sports Clinic, the National Disabled Veterans T.E.E. (Training, Exposure, Experience) Tournament, and the National Veterans Creative Arts Competition and Festival. Partners in the programs include the Paralyzed Veterans of America, the Disabled American Veterans, and the American Legion Auxiliary, along with Veterans Service Organizations, corporate sponsors, individual donors, and community organizations. Veterans training for Paralympic and Olympic sports may qualify for a monthly assistance allowance and the NVSP&SE provides grants to support national or community-based adaptive sports programs with the goal of increasing the availability of adaptive sports activities for Veterans and Service Members.

The purpose of this report is to systematically review the available evidence on the benefits and harms of adaptive sports participation and the barriers to and facilitators of participation. With input from our Operational Partners and Technical Expert Panel members, the scope of the project was limited to the following medical conditions: amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), cerebrovascular accident/stroke (CVA), traumatic brain injury (TBI), or visual impairment or blindness. Further, the scope was limited to the adaptive sports listed in Table 1. The report was intended to guide the VHA in developing, making available, and evaluating regional and national adaptive sports programs for Veterans that go beyond general recommendations to participate in sports.

Table 1. Adaptive Sports Eligible for Inclusion in Evidence Review

Alpine skiing	Golf	Surfing
Archery	Hand-cycling	Swimming
Athletics/ Track & field	Kayaking/Canoeing	Table Tennis
Billiards	Nordic Skiing	Tennis (including Wheelchair Tennis)
Boccia (Bocci, Bocce)	Para-Triathlon	Weightlifting-Power Lifting
Climbing	Sailing	Wheelchair Basketball
Curling	Shooting	Wheelchair Fencing
Cycling	Sitting Volleyball	Wheelchair Lacrosse
Equine Assisted Activities and Therapies (EAAT)	Sled Hockey	Wheelchair Rugby
Fishing (any type)	Snowboarding	
Goalball	Soccer	

The key questions for the review were:

Key Question 1. What is the effectiveness of participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

Key Question 1a. Does the effectiveness vary by frequency/duration of adaptive sport program participation?

Key Question 1b. Do particular patient groups (*ie*, age range, gender, race, time since injury, time involved in adaptive sports, type and/or severity of disability) benefit more than others from adaptive sports participation?

Key Question 2. What are the potential harms of participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

Key Question 3. What are the known facilitators of and barriers to the participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

This review will be used by the Veterans Health Administration (VHA) national program offices for Physical Medicine and Rehabilitation Services, Prosthetic and Sensory Aids Services, Recreation Therapy, and NVSP&SE, as well as the offices under Rehabilitation and Prosthetic Services. The review will inform implementation efforts and enhance efforts to integrate all of

the VHA's rehabilitation programs that incorporate adaptive sports within their treatment plan and the national programs hosted by the NVSP&SE with the goal of advancing Veteran's access to and the utilization of adaptive sports as part of their ongoing rehabilitation.

METHODS

TOPIC DEVELOPMENT

The key questions and scope of this review were developed with input from the Operational Partners, Technical Expert Panel, and content experts from the Minneapolis VA Health Care System serving on our project team.

SEARCH STRATEGY

We searched MEDLINE from 1995 to July 2018 using Medical Subject Headings (MeSH) and key words for the adaptive sports and medical conditions of interest (Appendix A). We searched EMBASE, SPORTDiscus, and Rehabilitation and Sports Medicine Source using search strategies based on the MEDLINE strategy.

STUDY SELECTION

Citations were entered into Distiller SR (Evidence Partners). Titles were reviewed by a single investigator or research associate. Abstracts of titles identified as potentially eligible were reviewed independently by 2 reviewers with a citation moving to full-text review if either reviewer considered the citation eligible. At the full-text review, agreement of 2 reviewers was needed for study inclusion or exclusion. Disputes were resolved by discussion with input from a third reviewer, if needed.

Due to the large number of citations, we also used the DistillerAI (Artificial Intelligence) feature to complete an AI Audit review of titles. This features screens titles and produces a confidence score from 0 (not confident reference should be included) to 1 (very confident reference should be included) to predict the inclusion/exclusion status of a reference. This prediction is based on a variable test set of included and excluded references identified by a human reviewer. The 850 references identified by Distiller AI were reviewed at the abstract level by a review investigator.

For Key Question 1 and 2 we included intervention studies comparing participation in an adaptive sports program to usual care, no intervention, or other intervention among individuals with a medical condition of interest. We label these as “sports program studies”. To expand the number of potentially eligible studies and provide possible information for the development of future programs, we also included studies of individuals participating in organized adaptive sports activities although the activity wasn’t specifically implemented for the purpose of determining whether participation provided benefits or harms. We label these as “sports activity participation studies” – typically cross-sectional observational studies.

For Key Question 3 we included studies assessing facilitators of and barriers to participation in adaptive sports among individuals with a medical condition of interest.

At all levels of review, the inclusion and exclusion criteria were as follows.

Inclusion:

- Age 18 and older with 1 or more medical conditions of interest (ALS, limb amputation, hearing loss or deafness, MS, PTSD, spinal cord disorder, SCI, CVA, TBI, or visual impairment or blindness);
- Participation in 1 or more adaptive sports of interest (Table 1) at the community level or higher (to include adaptive sports programs that begin during inpatient rehabilitation and continue to an outpatient/community-based phase);
- Reporting an outcome of interest; *primary outcomes* of interest were a) clinically important changes in health and wellness, daily functioning, self-esteem, perceived competence, community reintegration, participation in social activities, participation in employment, mood//quality of life, and health care utilization; b) harms related to participation in adaptive sports; and c) barriers and facilitators related to adaptive sports participation; *secondary outcomes* were: a) participation in adaptive sports programs and b) improvement in physical health or PTSD scale scores.

Exclusion:

- Sports programs with modifications of equipment or environment/culture exclusively based on participant age;
- Individual fitness programs or other activities done outside of a program led by a coach or program director (exception – athlete training for competition);
- Study of a sport activity other than pre-defined sports of interest or where >75% of participants are involved in sport not of interest;
- Study of a group of individuals with condition not pre-defined as condition of interest or where >75% do not have a condition of interest;
- Rehabilitation programs with no “sport” component
- Study of “physical activity” levels where physical activity includes items like household work, gardening, volunteering outside the home (*ie*, studies of physical activity must have included a “sport” component);
- Engineering/modeling studies;
- Human performance laboratory studies.

DATA ABSTRACTION

We abstracted study design and demographic data from eligible studies including medical condition(s), age, gender, and time since injury/diagnosis; adaptive sport; and US Veteran status. We also abstracted primary and secondary outcomes of interest (see Inclusion, above).

QUALITY ASSESSMENT

We did not formally assess risk of bias of individual studies due to the many study design variants in the included literature. For each included study, we reviewed critical elements of either observational and experimental studies or qualitative studies based on checklists developed by the Joanna Briggs Institute (http://joannabriggs.org/) (Appendix B).

DATA SYNTHESIS

For Key Question 1, tables were developed by outcome and stratified by whether the study reported on an adaptive sport program ("sports program study") or provided a cross-sectional view of adaptive sport participants ("sports activity participation study"). Subgroups of interest included: time since injury or diagnosis, frequency/duration of participation, age, gender, race, and type and/or severity of disability.

For Key Question 2, we also report outcomes from adaptive sports program and sports activity participation studies.

For Key Question 3, the International Classification of Functioning, Disability, and Health (ICF) model was used to summarize motivators to participation in adaptive sports, facilitators of participation, and barriers to participation.

For all Key Questions, findings were narratively synthesized.

RATING THE BODY OF EVIDENCE

We did not formally rate the overall quality of the evidence due to heterogeneity of participants, adaptive sports, study designs, and outcomes assessed.

PEER REVIEW

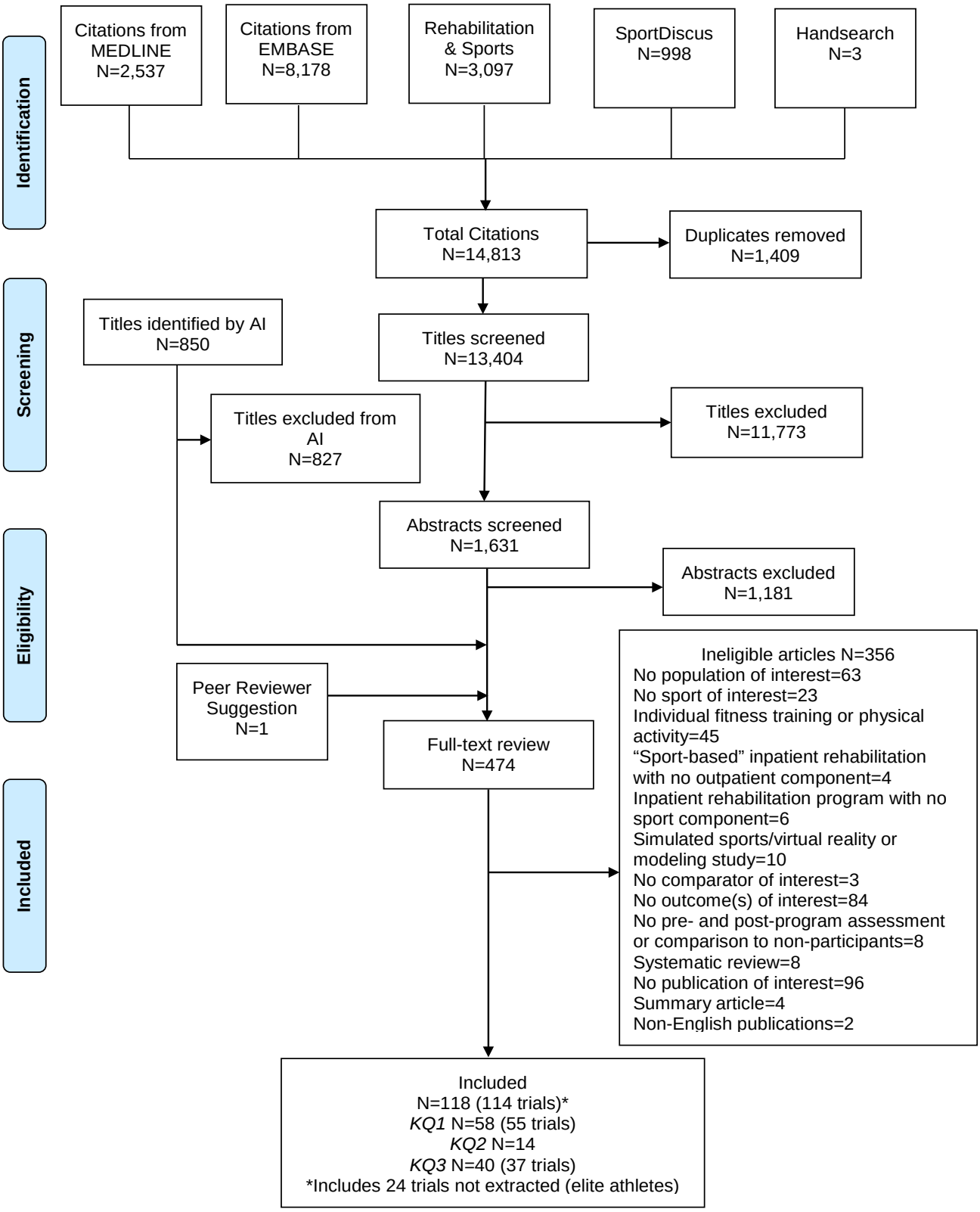
A draft version of this report was reviewed by content experts as well as clinical leadership. Reviewer comments and our responses are presented in Appendix C and the report was modified.

RESULTS

LITERATURE FLOW

Searching multiple bibliographic databases (1995-July 2018) and removing duplicate citations yielded a total of 13,404 citations (Figure 1). Review at the title level excluded nearly 12,000 citations, leaving 1,631 for abstract review. Over 1,100 abstracts were excluded resulting in 450 articles for full-text review with an additional 23 from DistillerAI. Following full-text review, there were 118 articles[3-120] eligible representing 114 studies. Twenty-four of the articles provided data on elite athletes (*eg*, Paralympians or World Championship participants). These articles were not included in our analyses as findings would be of limited applicability to the Veteran population.[5,6,17,24,27,28,36,39-41,47,48,51,56,62,71-74,84,88,91,98,111]

Figure 1. Literature Flow Chart



KEY QUESTION 1. What is the effectiveness of participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

KEY QUESTION 1A. Does the effectiveness vary by frequency/duration of adaptive sport program participation?

KEY QUESTION 1B. Do particular patient groups (*ie*, age range, gender, race, time since injury, time involved in adaptive sports, type and/or severity of disability) benefit more than others from adaptive sports participation?

Fifty-five studies reported an objective measure of at least 1 effectiveness outcome of interest. We grouped outcomes into 7 categories: Health and Wellness, Daily Functioning, Self Esteem/Perceived Competence, Mental Health (including mood, depression, and PTSD), Quality of Life, Community Reintegration/Social Participation, Employment, and Health Care Utilization. No studies reported a Health Care Utilization outcome. We also grouped studies into 2 groups: sports program studies and sports activity participation studies. Program studies described an adaptive sports program with multiple sessions over a period of a few days, a few weeks, or longer. Outcomes were often assessed both before and after participation in the program. Sports activity participation studies were typically cross-sectional, providing a one-time assessment of individuals who participate in organized adaptive sports activities although the activity wasn't specifically implemented for the purpose of determining whether participation provided benefits or harms. In both types of studies, there may or may not have been a comparator group.

Program Studies

Of the 25 program studies, 8 enrolled participants with PTSD including 6 studies with US Veterans.[13,14,38,58,64,75,93,113] There were 8 studies in participants with MS,[25,37,49,59,67,80,99,112,114] 5 studies of participants who had experienced a CVA,[11,12,96,97,119] 3 studies with SCI,[9,54,115] and 1 study of US Veterans with acquired disabilities associated with combat deployment.[70] The SCI studies included 1 study of participants with paraplegia or quadriplegia, another reporting injury level (cervical, thoracic, or lumbar), and 1 including both traumatic and non-traumatic SCI.

Adaptive sports included EAAT (11 studies, 3 with Veterans),[11,12,38,49,58,64,67,75,80,99,114] hiking or climbing (3 studies),[25,37,59,112] golf (3 studies),[96,97,119] fly-fishing (2 studies, both with US Veterans),[14,113] ski/snowboard (2 studies, 1 with US Veterans),[9,13] curling (1 study),[54] surfing (1 study with US Veterans),[93] and multiple sports (2 studies, 1 with US Veterans).[70,115] Medical conditions by adaptive sports included in the 25 program studies are shown in Table 2. Summary demographics are reported in Table 3 with detailed information in Appendix D, Table 1.

Table 2. Medical Conditions and Adaptive Sports – Number of Sports Program Studies Reporting Objective Effectiveness Outcomes

Adaptive Sport (number of studies)	Medical Condition (number of studies)					
	PTSD (8)	MS (8)	CVA (5)	SCI (3)	Multiple (1)	ALS, Limb Amputation, Hearing Loss, TBI, or Vision Loss (0)
EAAT (11)	4	5	2			
Hiking/ Climbing (3)		3				
Golf (3)			3			
Fishing (2)	2					
Ski/Snow-board (2)	1			1		
Curling (1)				1		
Surfing (1)	1					
Multiple (2)				1	1	

ALS=amyotrophic lateral sclerosis; CVA=cerebrovascular accident/stroke; EAAT=equine-assisted activities and therapies; MS=multiple sclerosis; PTSD=Post-traumatic stress disorder; SCI=spinal cord injury; TBI=traumatic brain injury

Table 3. Summary Demographics – Sports Program Studies (k=25)

Characteristics	Categories	Number of Studies[a]
Age (mean or median)	>50 years	12
	25-49 years	12
	<25 years	0
Gender	100% Male	0
	75-99% Male	6
	50-74% Male	8
	25-49% Male	6
	<25% Male	3
Time from Injury or Diagnosis (mean or median)	>10 years	3
	5-10 years	8
	<5 years	3

[a]Studies reporting mean or median values for characteristic

Programs ranged from 2 days to 45 weeks. The 45-week study involved 6 months of training for a hiking trip with 4 months follow-up after the trip.[25,37] Six studies, each lasting less than 1 week, were structured with all-day activities (fly-fishing, skiing, snowboarding, kayaking, or various wheelchair sports).[9,13,14,70,113,115] One study described a 5-day, one hour per day program of EAAT.[75] The remaining studies described programs of EAAT, golf, climbing, or curling, ranging

from 4 to 24 weeks, most occurring once per week for between 30 minutes and 2 hours. Program details are provided in Appendix D, Table 2.

Study designs varied and included 6 randomized controlled trials[11,54,58,97,112,114] and 4 nonrandomized controlled trials.[12,13,96,99] The remaining studies were pre-post designs. Sample sizes were small with 5 studies of 10 or fewer participants, 12 studies of 11 to 20 participants, 6 studies of 21 to 50 participants, and 2 studies with more than 50 participants. Thirteen studies were done in the US,[13,14,38,58,64,67,70,75,93,99,113,115,119] 1 in Canada,[97] 2 in South America,[11,12] and 9 in Europe.[9,25,37,49,54,59,80,96,112,114] Of the US studies, 8 specifically enrolled Veterans.[13,14,58,64,70,75,93,113]

Effectiveness Outcomes by Sport

Table 4 provides a summary of effectiveness outcomes from program studies organized by sport. Outcomes data are reported in Appendix D, Tables 3 to 9. Some studies may have reported more than 1 outcome in a particular cell (*eg*, more than 1 quality of life measure). Red symbols represent studies with a control group and indicate similar (↔) or statistically significantly different (↑) outcomes between groups following the intervention period. All differences favored the intervention group. Black symbols are from studies with no comparator group and indicate a significant or non-significant change from baseline. Some studies did not report results in a way that allowed a determination of significance (*eg*, 3 of 8 participants reported improvement); those studies are counted in the number of studies reporting a particular outcome category but denoted as “no outcomes data”.

Equine Assisted Activities and Therapies (EAAT)

Outcomes from EAAT programs were reported for individuals with PTSD, MS, or a history of CVA. Various forms of EAAT for individuals with PTSD were consistently associated with improved mental health outcomes (including overall mental health, depression, PTSD, and anxiety symptoms).[11,38,58,64,75] Three of the 4 studies of EAAT for individuals with PTSD enrolled exclusively US Veterans.[58,64,75]

EAAT may be associated with improved balance[80,99] and decreased fatigue[114] in those with a history of MS.

Program participation was not associated with changes in pain or overall health for individuals with PTSD,[38] MS,[114] or history of CVA.[11]

Other outcomes associated with EAAT programs in individuals with PTSD, MS, or history of CVA were infrequently reported. There were no reports of worsening of any outcomes associated with program participation.

Hiking/Climbing

Findings from 3 studies of hiking and/or climbing programs for individuals with MS suggest that program participation was not associated with changes in different aspects of health and wellness including balance,[59] fatigue,[37] and cognitive function.[112] Daily functioning,[37] self-esteem,[37] and depression[112] outcomes were reported by 1 study with no apparent association.

Golf

Golf programs for individuals with a history of CVA may be associated with improved balance[97,119] although 1 study found no significant difference in balance between golf training and social communication training.[96] There is little reporting of other outcomes including a measures of cognitive function,[96] daily functioning (walking task),[119] depression symptoms,[96] or impact of sickness on quality of life.[97]

Fly-fishing

Two fly-fishing programs for Veterans with PTSD symptoms were associated with improvements in PTSD symptoms and other mental health outcomes.[14,113] There was limited reporting of association with improved sleep quality[113] and improved daily functioning.[14]

Ski/Snowboard, Curling, Surfing, Multiple Sport Program

There was limited reporting of outcomes for these activities with studies including individuals primarily with PTSD or SCI. Available studies suggest that ski/snowboard,[13] surfing,[93] and multiple sports[70] programs may be associated with improved mental health symptoms including PTSD symptoms, depression, and mood. There was limited reporting of other outcomes. No studies report an association between program participation and a worsening of outcomes.

Effectiveness Outcomes by Population

Outcomes organized by population are summarized in Table 5. Detailed outcome data is reported in Appendix D, Tables 3 to 9.

PTSD

Among 8 studies of individuals with PTSD (7 of which enrolled exclusively Veterans), EAAT,[38,58,64,75] fly-fishing,[14,113] ski/snowboard,[13] and surfing[93] programs were associated with improved mental health outcomes. Two studies had a comparator group. A non-randomized trial of a ski/snowboard program for 17 Veterans and their significant others reported significant reductions in PTSD symptoms in the program participants compared to baseline.[13] The ski/snowboard group had a change in symptoms that was significantly greater than individuals who did not participate in the program. A randomized trial of a therapeutic horseback riding program for 29 US Veterans with PTSD found significant reductions in mean PCL-M scores at 3 weeks compared to baseline and at 6 weeks compared to 3 weeks for Veterans in the intervention group.[58] There were no significant changes in the wait list group and mean scores at all time points were above 50.

Few studies reported other outcomes of interest. No study reported that program participation was associated with worse outcomes.

Multiple Sclerosis

For individuals with MS, EAAT programs were generally associated with improved balance.[80,99,114] There was little reporting of other outcomes. Similarly, there was little reporting of outcomes associated with hiking/climbing programs. No study reported that program participation was associated with worse outcomes.

CVA

For individuals with a history of CVA, golf therapy programs were associated with improved balance in 1 study[97] while 2 studies reported no association.[96,119] Both EAAT[11] and golf therapy[97] programs may be associated with improved quality of life but overall few studies reported outcomes of interest.

Spinal Cord Injury

For individuals with SCI, few outcomes were reported to allow assessment of effectiveness of ski/snowboard programs,[9] wheelchair curling,[54] or multi-sport programs.[115] None of the studies enrolled exclusively US Veterans with SCI.

Multiple Conditions

A single pre-post study of a multisport program (water sports, fly-fishing, or winter sports) for 18 US Veterans with a variety of post-combat disabilities reported that program participation was associated with improved self-esteem, mood, and quality of life.[70]

Table 4. Summary of Sports Program Studies that Reported Patient-Centered Effectiveness Outcomes by Sport[a]

Sport (k=number of studies)[b] Population/ Condition	Health and Wellness (k=17)	Daily Functioning (k=10)	Self-Esteem/ Perceived Competence (k=5)	Mental Health (Mood, Depression, PTSD) (k=13)	Quality of Life (k=7)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=0)
EAAT (k=11)[a] PTSD k=4 MS k=5 CVA k=2	***PTSD k=2 (****1 with no outcomes data)* PHQ-9 Somatic ↔ AUDIT-C ↑ ***MS k=5*** *(2 with no outcomes data* POMA ↑↔ BBS ↑↑ VAS (pain) ↔ FSS ↑ ***CVA k=2*** SF-36 General Health ↔ SF-36 Pain ↔ BBS ↔	***PTSD k=1*** SF-36 Function ↔ ***MS k=3*** *(2 with no outcomes data)* BI ↔ ***CVA k=2*** SF-36 Function ↑ FAC ↔	***PTSD*** *k=1* GPSES ↔	***PTSD k=4*** *(1 with no outcomes data)* PCL-S ↑ PCL-M ↑ PCL-5 ↑ BSI ↑ PHQ-9 ↑ GAD ↑ ***MS k=1*** *(no outcomes data)* ***CVA k=1*** SF-36 Mental Health ↑	***PTSD k=1*** SWLS ↔ ***MS k=1*** MSQoL-54 ↑ ***CVA k=1*** SF-36 ↑	***PTSD k=2*** *(1 with no outcomes data)* SELSA ↔ ***MS k=1*** *(no outcomes data)* ***CVA k=1*** SF-36 Social ↔	
Hiking/Climbing (k=3) MS k=3	k=3 Postural sway ↔ FSMC ↔ MFIS ↑ Cognitive executive function ↔	k=1 MSWS ↔	k=1 ESES ↔	k=1 CES-D ↔			
Golf (k=3) CVA k=3	k=3 BBS/BBT ↔↑ CMPCI ↑ BTT ↑	k=1 FFB ↔		k=1 CES-D ↔	k=1 SIP ↑		

Sport (k=number of studies)[b] **Population/ Condition**	**Health and Wellness (k=17)**	**Daily Functioning (k=10)**	**Self-Esteem/ Perceived Competence (k=5)**	**Mental Health (Mood, Depression, PTSD) (k=13)**	**Quality of Life (k=7)**	**Community Integration/ Participation in Social Activities (k=5)**	**Employment (k=0)**
Fly-fishing (k=2) PTSD k=2	k=1 PSQI ↑	k=1 WRFIS ↑	k=1 BNSLS ↔	k=2 PHQ-9 ↑ PCL-M ↑↑ BSI-18 ↑ PANAS ↑	K=1 LSS ↔		
Ski/Snowboard (k=2) PTSD k=1 SCI k=1			***SCI k=1*** PSI-6 ↑	***PTSD k=1*** PCL-M & C ↑	***PTSD k=1*** RDAS ↔		
Curling (k=1) SCI k=1	k=1 MFRT ↔	k=1 SCIM-III ↔					
Surfing (k=1) PTSD k=1				k=1 PCL-M ↑ MDI ↑			
Multiple sports (k=2) SCI k=1 Multiple k=1			***Multiple k=1*** PCS ↑	***Multiple k=1*** POMS-Brief ↑	***Multiple k=1*** WHOQoL ↑	***SCI k=1*** LMS Social ↔ Stimulus avoidance ↑	

[a]Each arrow represents one study reporting that outcome; some studies may have reported more than one outcome per category
[b]Some studies reported patient counts of change without outcomes data; significance of findings could not be determined and those studies are not included in counts; some studies reported a between group difference for some outcomes and a pre-post difference for other outcomes
↔ No significant difference between intervention and comparator groups
↔ No significant change from pre- to post-intervention (no comparator group)
↑ significant improvement for intervention group vs comparator group
↑ significant improvement from pre- to post-intervention (no comparator group)

ADL=activities of daily living; AIMS=Athletic Identity Measurement Scale; AUDIT-C=Alcohol Use Disorders Identification Test; BBS/BBT=Berg Balance Scale/Test; BI=Bartel Index; BDI=Beck Depression Inventory; BNSLS=Basic Needs Satisfaction in Life Scale; BSI=Brief symptom Inventory; BTT=Block-Tapping task; CES-D=Center for Epidemiologic Studies Depression Scale; CHART=Craig Handicap Assessment Reporting Technique; CIQ=Community Integration Questionnaire; CMPCI=Chedoke-McMaster Postural Control Inventory; CSES=Coping Self Efficacy Scale; CVA=cerebrovascular accident or stroke; DERS=Difficulties in Emotion Regulation Scale; EAAT=equine assisted activities and therapies; EDSS=Expanded Disability Status Scale; EMG=Electromyography; ES=effect size; ESES=Exercise Self-Efficacy Scale; FAC=Functional Ambulation Category Scale; FES-I=Falls Efficacy Scale – International; FFB=Functional Fitness Battery; smoking cessation, alcohol control); FGA=Functional Gait Assessment; FSMC=Fatigue Scale for Motor and Cognition; FSS=Fatigue Severity Scale; GAD=Generalized Anxiety Disorder Scale; GPSES=General Perceived Self-Efficacy Scale; HADS=Hospital Anxiety and Depression Scale; IMF=Index of Muscle Function; IPAQ = International Physical Activity Questionnaire; LAM=Leisure Attitude Measurement; LiSat-9= Life Satisfaction Questionnaire-9 item; LMS=Leisure Motivation Scale; LSS=Leisure Satisfaction Scale; MAS=Modified Ashworth Scale; MDI=Major Depression Inventory; MRT=Mental Rotation Test; MFISt=Modified Fatigue Impact Scale (total); MFRT=Modified Functional Reach Test; MS=multiple sclerosis; MSQoL-54=Multiple Sclerosis Quality of Life-54; MSWS=Multiple Sclerosis Walking Ability Scale; NAB=Mazes subtest of Executive module from the Neuropsychosocial assessment battery; NR=not reported; NS=not statistically significant; NVWG=National Veterans Wheelchair Games; OR=odds ratio; PANAS=Positive Affect and Negative Affect Schedule; PCL-C=PTSD Checklist-Civilian; PCL-M=PTSD Checklist-Military; PCL-S=PTSD Checklist-Specific; PCL-5=PTSD checklist for Diagnostic and Statistical Manual of Mental Disorders (DSM-5); PCI=Proactive Coping Inventory; PCS=Perceived Competence Scale; PHQ=Patient Health Questionnaire; POMA=Performance Oriented Mobility Assessment; POMS(-B)=Profile of Mood States (-Brief); PS=Participation Scale; PSDQ=Physical Self-Description Questionnaire; PSFS=Patient-Specific Functional Scale; PSI-6=Physical Self Inventory; PSQI=Pittsburgh Sleep Quality Inventory; PSS=Perceived Stress Scale; PTGI=Posttraumatic Growth Inventory; PTSD=post-traumatic stress disorder; QLI=Quality of Life Index; RDAS=Revised Dyadic Adjustment Scale; RNL=Reintegration to Normal Living Index; RSES=Rosenberg Self-Esteem; SCI=spinal cord injury; SCIM=Spinal Cord Independence Measure; SCL-90-R=Symptom Checklist 90; SDS=self-rating depression scale; SEADL=Self-Efficacy for Activities of Daily Living; SELSA=Social and Emotional Loneliness Scale for Adults – short version; SF-36=Medical Outcomes Study Short Form; SIP=Sickness Impact Profile; SOQ=Sport Orientation Questionnaire; SOT=Sensory Organization Test; STAI=State-Trait Anxiety Inventory; SWLS-Satisfaction with Life Scale; TEOSQ=Task and Ego Orientation in Sport Questionnaire; TOLnm=Tower of London Test (number of moves);TOLtt=Tower of London Test (total time); TUG=timed up and go; WRFIS=Walter Reed Functional Impairment Scale; WSC=Winter Sports Clinic (Veterans); VAS=Visual Analog Scale; WHOQoL-BREF=World Health Organization Quality of Life-Brief; WUSPI=Wheelchair User's Shoulder Pain Index

Table 5. Summary of Sports Program Studies that Reported Patient-Centered Effectiveness Outcomes by Population[a]

Population (k=number of studies)[b] Sport	Health and Wellness (k=17)	Daily Functioning (k=10)	Self-Esteem/ Perceived Competence (k=5)	Mental Health (Mood, Depression, PTSD) (k=13)	Quality of Life (k=7)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=0)
PTSD (k=8) EAAT k=4 Fly-fishing k=2 Ski/snowboard k=1 Surfing k=1	***EAAT k=2*** *(1 with no outcomes data)* PHQ-9 ↔ AUDIT-C ↑ ***Fly-fishing k=2*** PSQI ↑	***EAAT k=1*** SF=36 Function ↔ ***Fly-fishing k=2*** WRFIS ↑	***EAAT k=1*** GPSES ↔ ***Fly-fishing k=1*** BNSLS ↔	***EAAT k=4*** *(1 with no outcomes data)* PCL-M ↑ PCL-S ↑ PCL-5 ↑ GAD ↑ PHQ-9 ↑ BSI ↑ ***Fly-fishing k=2*** PCL-M ↑↑ PHQ-9 ↑ BSI ↑ PANAS ↑ ***Ski/snowboard k=1*** PCL-M ↑ ***Surfing k=1*** PCL-M ↑ MDI ↑	***EAAT k=1*** SWLS ↔ ***Fly-fishing k=1*** LSS ↔ ***Ski/snowboard k=1*** RDAS ↔	***EAAT k=1*** SELSA ↔	

Population (k=number of studies)[b] **Sport**	**Health and Wellness (k=17)**	**Daily Functioning (k=10)**	**Self-Esteem/ Perceived Competence (k=5)**	**Mental Health (Mood, Depression, PTSD) (k=13)**	**Quality of Life (k=7)**	**Community Integration/ Participation in Social Activities (k=5)**	**Employment (k=0)**
Multiple Sclerosis (k=8) EAAT k=5 Hiking/ climbing k=3	***EAAT k=5*** *(2 with no outcomes data)* BBS ↑↑ POMA ↑↔ FSS ↑ VAS (pain) ↔ ***Hiking/ climbing k=3*** Postural sway ↔ MFIS ↑ FSMC ↔ Cognitive executive function ↔	***EAAT k=1*** BI ↔ ***Hiking/ climbing k=1*** MSWS ↔	***Hiking/ climbing k=1*** ESES ↔	***EAAT k=1*** *(no outcomes data)* ***Hiking/ climbing k=1*** CES-D ↔	***EAAT k=1*** MSQoL-54 ↑	***EAAT k=1*** *(no outcomes data)*	
CVA (k=5) EAAT k=2 Golf k=3	***EAAT k=2*** SF-36 General Health ↔ BBS ↔ SF-36 Pain ↔ ***Golf k=3*** BBS ↔↑↔ CMPCI ↑ BTT ↑	***EAAT k=2*** SF-36 Functional Capacity ↑ FAC ↔ ***Golf k=1*** FFB ↔		***EAAT k=1*** SF-36 Mental Health ↑ ***Golf k=1*** CES-D ↔	***EAAT k=1*** SF-36 ↑ ***Golf k=1*** SIP ↑	***EAAT k=1*** SF-36 Social ↔	
Spinal Cord Injury (k=3) Ski/snowboard k=1 Curling k=1 Multiple k=1	***Curling k=1*** MFRT ↔	***Curling k=1*** SCIM III ↔	***Ski/snowboard k=1*** PSI-6 ↑			***Multiple k=1*** LMS Social ↔ Stimulus avoidance ↑	

Population (k=number of studies)[b] Sport	Health and Wellness (k=17)	Daily Functioning (k=10)	Self-Esteem/ Perceived Competence (k=5)	Mental Health (Mood, Depression, PTSD) (k=13)	Quality of Life (k=7)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=0)
Multiple (k=1) Multiple k=1			k=1 PCS ↑	k=1 POMS-B ↑	k=1 WHOQoL ↑		

[a]Each arrow represents one study reporting that outcome; some studies may have reported more than one outcome per category
[b]Some studies reported patient counts of change without outcomes data; significance of findings could not be determined and those studies are not included in counts; some studies reported a between group difference for some outcomes and a pre-post difference for other outcomes
↔ No significant difference between intervention and comparator groups
↔ No significant change from pre- to post-intervention (no comparator group)
↑ significant improvement for intervention group vs comparator group
↑ significant improvement from pre- to post-intervention (no comparator group)
Abbreviations – See Table 4

Sports Activity Participation Studies

The sports activity participation studies enrolled primarily SCI (20 studies)[3,10,16,43,45,50,61,66,76,77,81,86,87,95,100-102,105-107,110,120] or mixed conditions (5 studies)[33,42,63,103,117] populations. Participants were typically involved in multiple sports (20 studies).[16,33,35,43,45,50,61,63,66,76,81,86,87,95,101-103,105-107,110,117] Table 6 displays the distribution of medical conditions by adaptive sports in the 30 sports activity participation studies. Table 7 summarizes demographic characteristics. Additional study information is reported in Appendix D, Table 1.

Table 6. Medical Conditions and Adaptive Sports – Number of Sports Activity Participation Studies Reporting Objective Effectiveness Outcomes

Adaptive Sport (number of studies)	Medical Condition (number of studies)				
	SCI (20)	Vision Impairment (4)	Multiple (5)	Limb amputation (1)	ALS, Hearing Loss, MS, PTSD, CVA, TBI (0)
Multiple (20)	15 (1 quadriplegia or paraplegia, 7 tetraplegia or paraplegia, 1 paraplegia, 5 not specified)	1	4 (SCI, limb amputation, TBI, PTSD, vision impairment, MS)[a]		
Wheelchair Rugby (4)	4 (1 quadriplegia, 2 (tetraplegia, 1 not specified)				
Wheelchair Basketball (2)	1 (not specified)		1 (SCI or limb amputation)		
Soccer (2)		1		1	
Goalball (1)		1			
Cycling (1)		1			

[a]multiple conditions in each study
ALS=amyotrophic lateral sclerosis; CVA=cerebrovascular accident/stroke; PTSD=post-traumatic stress disorder; MS=multiple sclerosis; SCI=spinal cord injury; TBI=traumatic brain injury

Table 7. Summary Demographics – Sports Activity Participation Studies (k=30)

Characteristics	Categories	Number of Studies[a]
Age (mean or median)	>50 years	2
	25-49 years	23
	<25 years	0
Gender	100% Male	9
	75-99% Male	13
	50-74% Male	6
	25-49% Male	0
	<25% Male	1
Time from Injury or Diagnosis (mean or median)	>10 years	12
	5-10 years	2
	<5 years	1

[a]Studies reporting mean or median values for characteristic

Most sports activity participation studies were cross-sectional in design. Some studies included a comparator group – typically non-sport participants with the same physical condition or athletes from the same sport without the physical condition.

The number of participants enrolled ranged from 11[8] to 1034.[105] There were 11 studies with fewer than 50 enrolled, 4 studies with 50 to 100 enrolled, 13 studies with 101 to 500 enrolled, and 2 studies with more than 500 enrolled.

Eight studies were done in the US,[16,45,49,61,63,66,100,103] 3 in Canada,[33,76,86,87] 2 in Australia/New Zealand,[3,43] 2 in Japan,[77,81] 1 in South America,[35] and the remaining 14 in Europe. Of the 8 US studies, 4 specifically enrolled US Veterans.[18,61,63,103]

Effectiveness Outcomes by Sport

Table 8 provides a summary of effectiveness outcomes from sport activity participation studies organized by sport. Outcomes data are reported in Appendix D, Tables 3 to 9. As noted above, some studies may have reported more than 1 outcome in a particular cell and some studies did not report results in a way that allowed a determination of significance (denoted as "no outcomes data").

Wheelchair Basketball, Wheelchair Rugby, Goalball, Cycling, Soccer

With few studies focused exclusively on any of these sports, there is little information on outcomes among participants in the sports. No outcome was reported by more than 1 study. There was no evidence that adaptive sports participation was associated with worsening of any outcome.

Table 8. Summary of Sports Activity Participation Studies that Reported Patient-Centered Effectiveness Outcomes by Sport[a]

Sport (k=number of studies)[b] Population/ Condition	Health and Wellness (k=7)	Daily Functioning (k=4)	Self-Esteem/ Perceived Competence (k=9)	Mental Health (Mood, Depression, PTSD) (k=7)	Quality of Life (k=10)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=3)
Wheelchair basketball (k=2) SCI k=1 Multiple k=1		***SCI k=1*** (no outcomes data)		***Multiple k=1*** SCL-90-R ↑		***Multiple k=1*** PS ↑	
Wheelchair rugby (k=4) SCI k=4			k=1 SEADL ↑ (transferring items only)	k=2 (no outcomes data)	k=1 LiSat-9 ↔		
Goal ball (k=1) Visual impairment k=1	k=1 Stability ↔						
Cycling (k=1) Visual impairment k=1			k=1 AIMS ↑				
Soccer (k=2) Limb amputation k=1 Visual impairment k=1	***Limb amputation k=1*** (no outcomes data) ***Visual impairment k=1*** Center of pressure displacement ↔				***Limb amputation k=1*** (no outcomes data)		

Sport (k=number of studies)[b] Population/ Condition	Health and Wellness (k=7)	Daily Functioning (k=4)	Self-Esteem/ Perceived Competence (k=9)	Mental Health (Mood, Depression, PTSD) (k=7)	Quality of Life (k=10)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=3)
Multiple (k=20) SCI k=15 Visual impairment k=1 Multiple k=4	***SCI k=2*** Dyspnea ↑ Chronic disease risk ↔ ***Visual impairment k=1*** FES-I ↑ Static balance ↑ ***Multiple k=1*** QLI Health ↔	***SCI k=1*** CHART Physical independence ↑ ***Visual impairment k=1*** Gait speed ↔	***SCI k=5*** (2 with no outcomes data) AIMS ↑ TEOSQ self-efficacy Task ↑ Barrier ↑ PSDQ Global Esteem ↑ Physical ↑ ***Multiple k=3*** (2 with no outcomes data) RSES ↑	***SCI k=4*** (1 with no outcomes data) CES-D ↔ SDS ↑ HADS ↑ STAI State ↔ STAI Trait ↑↑ POMS ↑	***SCI k=4*** (1 with no outcomes data) LiSat-9 ↑ SWLS ↑ RNL ↑ ***Multiple k=4*** (1 with no outcomes data) QLI Total ↔ SWLS ↑ WHOQoL ↑↑	***SCI k=3*** CHART Social Integration ↑ CIQ ↑↔ ***Multiple k=1*** (no outcomes data)	***SCI k=2*** Study-determined measures ↑↔ ***Multiple k=1*** Study-determined measure ↑

[a]Each arrow represents one study reporting that outcome; some studies may have reported more than one outcome per category
[b]Some studies reported patient counts of change without outcomes data; significance of findings could not be determined and those studies are not included in counts; some studies reported a between group difference for some outcomes and a pre-post difference for other outcomes
↔ No significant difference between intervention and comparator groups
↔ No significant change from pre- to post-intervention (no comparator group)
↑ significant improvement for intervention group vs comparator group
↑ significant improvement from pre- to post-intervention (no comparator group)
Abbreviations – See Table 4

Multiple Sports

Among studies enrolling participants from a variety of sports, the most commonly studied population was individuals with SCI. Participation in adaptive sports for individuals with SCI was consistently associated with greater self-esteem,[95] athletic identity,[106,107] and self-efficacy,[86,87] and higher quality of life.[45,76,105] Results were less consistent for mental health, community integration, and employment outcomes. Sports participation was associated with better balance outcomes for individuals with visual impairment.[35] Two of 3 studies assessing quality of life reported sports participation by individuals with various medical conditions was associated with higher quality of life.[63,117]

Effectiveness Outcomes by Population

Outcomes organized by population are summarized in Table 9.

Spinal Cord Injury

Fifteen of 20 studies enrolling individuals with SCI included participants from a variety of sports. As noted above, participation in adaptive sports was consistently associated with greater self-esteem[95] and self-efficacy[86,87] and better quality of life.[45,76,105] Results were less consistent for mental health and community integration outcomes and there was little reporting for health and wellness or daily functioning. Two studies reported employment outcomes. A survey of 302 US Veterans, diagnosed with paraplegia or tetraplegia, asked about working or volunteering status before and after participation in the NVWG.[61] Veterans working after the Games were more likely to report that participation in the Games had a positive influence on employment compared to those not working (RR 1.52 [95%CI 1.21, 1.92]). Another study enrolled 149 adults with chronic SCI; 47% were US Veterans.[16] Participation in organized sports (including basketball, tennis, snow skiing, water sports, bowling, hand cycling, fishing, and others) was positively associated with employment defined as either full- or part-time paid work or regular volunteer work (OR 2.04 [95%CI 0.98, 4.69]). Results were not reported for the Veteran group alone. Few outcomes were reported for individuals with SCI participating in wheelchair basketball or wheelchair rugby.

Visual Impairment

Among individuals with visual impairment, sports participation (either goalball or soccer) was associated with improved balance[35] although separate studies of these sports reported no difference in balance measures between blind goalball players and blind sedentary individuals[7] or blind soccer players and sighted soccer players.[26] There were few reports of other outcomes.

Limb Amputation

A single study of 11 soccer players with limb amputations reported a balance score and a quality of life measure but without a comparison (either pre-participation or another group).[8]

Multiple Conditions

In studies of individuals with multiple medical conditions, participation in adaptive sports was associated with higher quality of life in 2 of 3 studies reporting.[63,117] Other outcomes were reported by a single study.

Table 9. Summary of Sports Activity Participation Studies that Reported Patient-Centered Effectiveness Outcomes by Population[a]

Population (k=number of studies)[b] Sport	Health and Wellness (k=7)	Daily Functioning (k=4)	Self-Esteem/ Perceived Competence (k=9)	Mental Health (Mood, Depression, PTSD) (k=7)	Quality of Life (k=10)	Community Integration/ Participation in Social Activities (k=5)	Employment (k=3)
SCI (k=20) (includes tetraplegia, quadriplegia, and paraplegia) Wheelchair rugby k=4 Wheelchair basketball k=1 Multiple k=15	***Multiple k=2*** Dyspnea ↑ Chronic disease risk ↔	***Wheelchair basketball k=1*** (no outcomes data) ***Multiple k=1*** CHART Physical Independence ↑	***Wheelchair rugby k=1*** SEADL ↑ (transferring items only) ***Multiple k=2*** (2 with no outcomes data TEOSQ self-efficacy Task ↑ Barrier ↑ PSDQ Global Esteem ↑ Physical ↑	***Wheelchair rugby k=2*** (no outcomes data) ***Multiple k=6*** (3 with no outcomes data) CES-D ↔ SDS ↑ STAI Trait ↑↑ STAI State ↔ POMS ↑	***Wheelchair rugby k=1*** LiSat-9 ↔ ***Multiple k=4*** (1 with no outcomes data) LiSat-9 ↑ RNL ↑ SWLS ↑	***Multiple k=3*** CIQ ↔↑ CHART Social Integration ↑	***Multiple k=2*** Study-determined measures ↑↔
Visual impairment (k=4) Goalball k=1 Tandem cycling k=1 Soccer k=1 Multiple k=1	***Goalball k=1*** Stability ↔ ***Soccer k=1*** Center of pressure displacement ↔ ***Multiple k=1*** FES-I ↑ Static balance ↑	***Multiple k=1*** Gait speed ↔	***Tandem cycling k=1*** AIMS ↑				

Population (k=number of studies)[b] **Sport**	**Health and Wellness (k=7)**	**Daily Functioning (k=4)**	**Self-Esteem/ Perceived Competence (k=9)**	**Mental Health (Mood, Depression, PTSD) (k=7)**	**Quality of Life (k=10)**	**Community Integration/ Participation in Social Activities (k=5)**	**Employment (k=3)**
Limb amputation (k=1) Soccer (k=1)	k=1 (no outcomes data)				k=1 (no outcomes data)		
Multiple (k=5) Wheelchair basketball k=1 Multiple k=4	***Multiple k=1*** QLI ↔	***Multiple k=1*** (no outcomes data)	***Multiple k=3*** (2 with no outcomes data) RSES ↑	***Wheelchair basketball k=1*** SCL-90-R ↑	***Multiple k=4*** (1 with no outcomes data) QLI ↔ SWLS ↑ WHOQoL ↑↑	***Wheelchair basketball k=1*** PS ↑ ***Multiple k=1*** (no outcomes data)	***Multiple k=1*** Study-determined measure ↑

[a]Each arrow represents one study reporting that outcome; some studies may have reported more than one outcome per category
[b]Some studies reported patient counts of change without outcomes data; significance of findings could not be determined and those studies are not included in counts; some studies reported a between group difference for some outcomes and a pre-post difference for other outcomes
↔ No significant difference between intervention and comparator groups
↔ No significant change from pre- to post-intervention (no comparator group)
↑ significant improvement for intervention group vs comparator group
↑ significant improvement from pre- to post-intervention (no comparator group)
Abbreviations – See Table 4

KEY QUESTION 1A. Does the effectiveness vary by frequency/duration of adaptive sport program participation?

Few studies (and no sports activity participation studies) reported information to address Key Question 1a. Two studies of individuals with SCI reported that athletic identity scores were higher for those who participated in sports more hours per week.[102,106,107] No specific sports were noted. Another study of 1,034 athletes with SCI reported that more hours per week of participation was a significant predictor of higher athletic identity.[105] Those who were able to participate in their "favorite" sport also had higher athletic identity scores. Scores did not differ for team and individual sport athletes.

One study reported measures of depression, anxiety, and mood in adaptive sports participants and non-participants.[81] The study enrolled individuals diagnosed with tetraplegia, paraplegia, or quadriplegia with multiple sports represented. Scores on the Self-rating Depression Scale (SDS) were significantly lower in "high active" individuals compared to inactive or "low active" individuals. State Trait Anxiety Inventory (STAI) state anxiety scores did not differ between "high active" and inactive individuals but STAI trait anxiety scores were significantly lower in the "high active" group. There were lower Profile of Mood States (POMS) Depression subscale scores for the "high active" group compared to the inactive and "low active" groups. A similar pattern was observed for the POMS Vigor subscale. In a study of tetraplegic wheelchair rugby players, CES-D scores were higher in those who practiced no more than once per week but did not differ significantly from those who practiced 2 or more time per week.[100]

KEY QUESTION 1B. Do particular patient groups (*ie*, age range, gender, race, time since injury, time involved in adaptive sports, type and/or severity of disability) benefit more than others from adaptive sports participation?

Similarly, few studies (and sports activity participation studies) reported information to address Key Question 1b. A sports activity participation study enrolling 221 US Veterans participating in the NVWGs, the US Olympic Committee Warrior Games, or the National Veterans Summer Sport Clinic reported that self-esteem scores were significantly higher for Veterans who participated in sport, exercise, or recreation for 5 to 10 years compared to those participating for 1 to 5 years or less than 1 year. Scores were also higher for Veterans who participated in individual sports compared to team sports.[63]

A sports activity participation study enrolling 50 visually impaired or "able-bodied" tandem cycling participants reported that, among the visually impaired group, scores were similar regardless of time when vision failed (from birth vs later in life) or hours per week training (9-12 vs 13-16).[108]

The studies cited for Key Question 1a enrolling individuals with SCI reported that athletic identity scores were significantly higher for male athletes.[102,106,107] No specific sports were noted. In the third study, male gender was a significant predictor of higher athletic identity.[105]

A study of 234 wheelchair athletes (marathon or basketball) reported that ego orientation scores from the Task and Ego Orientation in Sport Questionnaire (TEOSQ) were higher in wheelchair marathoners, but both ego and task orientation were similar for male and female athletes.[100]

There was no correlation between level of activity, time from injury, level of injury, or age and CIQ scores in a study of 30 individuals with SCI participating in team (wheelchair rugby, wheelchair basketball, boccia, and unihockey) or individual (wheelchair racing, power lifting, swimming, wheelchair fencing, and alpine skiing) sports.[110]

A study from the US enrolling wheelchair rugby and wheelchair basketball players, 81% with SCI, reported that each additional year of participation in adaptive sports was significantly associated (P=.03) with an increase in employment rate through the first 10 years of participation.[66] The association weakened with participation beyond 10 years. The study included Veterans but did not report separate results for the Veteran group.

KEY QUESTION 2. What are the potential harms of participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

Fourteen research articles were eligible for our analysis of harms associated with adaptive sports participation: 4 RCTs, 1 cohort study, 7 cross-sectional studies, and 2 case series. There were 6 program studies[37,54,58,59,80,114] and 8 sports activity participation studies.[4,10,19,34,44,53,57,118] In all studies enrolling individuals with MS,[37,59,80,114] participants in the treatment and comparator groups (if present) had exacerbations and neurological worsening during study participation; these events were excluded from our analysis as they could not be attributed solely to adaptive sports participation.

Sports Program Studies

The 6 program studies reporting harms are summarized in Table 10. Additional information about the studies is reported in Appendix D, Table 1. The 4 eligible RCTs/CCTs were studies of specific sport programs, with 3 of the 4 involving EAAT[58,80,114] and the fourth a study of wheelchair curling.[54]

Two studies of EAAT for individuals with MS[80] or US Veterans with PTSD/TBI[58] reported no adverse events during the programs. Program durations were 5[58] and 10[80] weeks. A 12-week RCT of EAAT for individuals with MS reported that 44% of the EEAT and 27% of the standard care group experienced an adverse event or serious adverse event. This study included extensive monitoring and used a broad definition of adverse events. The “accidence” incidence when comparing the groups was 13% (4/30 experiencing 5 events) in the intervention group and 3% (1/37) in the control group.[114] The RCT of 4 weeks of wheelchair curling for individuals with SCI reported no adverse events.[54]

The 2 other program studies involved mountain climbing (total of 10 months of training and hiking)[37] or indoor climbing (5-week program)[59] for individuals with MS. The mountain climbing program reported 3 minor medical events[37] while the indoor climbing study reported on fatigue noting no excessive fatigue.[59]

Table 10. Injuries Reported in Sports Program Studies

Author, Year, Study Type	Disability	Sport Duration of Participation	Injured n/N (%)	Comparator	Comparator Injured n/N (%)	Injury Type
D'hooghe 2014[37] Cohort	Multiple Sclerosis	Mountain Climbing Duration NR	3/9 (33%)	N/A	N/A	Medical event (minor)
Herzog 2018[54] RCT	SCI	Wheelchair Curling Duration NR	0/6 (0%)	No curling	0/7 (0%)	Adverse event
Johnson 2018[58] RCT	PTSD, TBI	Therapeutic Horseback Riding Duration NR	0/15 (0%)	Wait List	0/14 (0%)	Injuries
Jolk 2015[59] Case Series	Multiple Sclerosis	Indoor Climbing Duration 0 (no prior experience)	0/6 (0%)	N/A	N/A	Fatigue
Muñoz-Lasa 2011[80] CCT	Multiple Sclerosis	Therapeutic Horseback Riding Duration 0 (no prior experience)	0/12 (0%)	Physiotherapy	0/15 (0%)	Adverse event
Vermöhlen 2018[114] RCT	Multiple Sclerosis	Hippo-therapy Duration NR	14/32 (44%) Total=16 events[a]	Standard Care	10/37 (27%) Total=16 events[b]	Adverse event or Serious adverse event

[a]Infection (6), Psychological condition (1), Orthopedic condition (3), Accidence (5), Metabolic condition (1)
[b]Infection requiring hospitalization (1), Other infection (12), Psychological condition (2), Accidence (1)
N/A=not applicable; PTSD=post-traumatic stress disorder; RCT=randomized controlled trial; SCI=spinal cord injury; TBI=traumatic brain injury

Sports Activity Participation Studies

Three of the 8 sports activity participation studies (Table 11) compared injury or adverse event rates between groups.[4,44,118] Akbar et al calculated the relative risk of injury comparing sport participants (predominantly wheelchair basketball) to those that denied playing sports. The relative risk for developing rotator cuff injury was 2.09 (95%CI 1.68-2.59) for SCI wheelchair users that played overhead sports compared to those not playing sports.[4]

An earlier study compared shoulder pain among individuals with SCI participating in multiple sports (51% basketball, 26% tennis, 23% rugby, 19% racing, 5% skiing, 5% handcycling, *etc*).[44] Individuals who trained at least 3 hours/week, were involved in at least 3 competitions each year, and used a sport-modified wheelchair were considered athletes. The athlete group was more likely to experience shoulder pain (OR 2.15 [95%CI 1.11, 4.18]).

You et al looked at rotator cuff injuries in table tennis (n=19) and archery (n=16) participants with SCI.[118] The mean numbers of rotator cuff related diseases were similar in the 2 groups.

There were differences in the pattern of injury for the different sports and for the playing/non-playing arm (table tennis) or the bow or draw arm (archery).

Several studies reported injuries during training. Bauerfeind et al reported injuries among 14 male wheelchair rugby players during 9 months of training camps and tournaments.[10] There were 102 injuries that did not require medical consultation (muscle strains, muscle overloads, abrasions, subluxations, and bruises). Four injuries did require physician consultation including a multi-joint spinal overload, a supraspinatus muscle strain, bruised ribs, and olecranon bursitis. Two of these 4 injuries were a result of a fall during play and 2 were degenerative.

Table 11. Injuries Reported in Sports Activity Participation Studies

Author, Year, Study Type	Disability	Sport Duration of Participation	Injured n/N (%)	Comparator Duration of Participation	Comparator Injured n/N (%)	Injury Type
Akbar 2015[4] Cross-sectional	SCI	Wheelchair Overhead Sports Duration NR	78/103 (76%)	No sports	70/193 (36%)	Rotator cuff tear
Bauerfeind 2015[10] Case series	SCI	Wheelchair Rugby 7 years (mean)	4/14 (29%)	N/A	N/A	Injury requiring physician consult
Boninger 1996[19] Cross-sectional	SCI and limb amputation	Wheelchair Racing 12.6 years (mean)	8/12 (67%) 4 bilateral 4 unilateral	N/A	N/A	Carpal tunnel syndrome physical examination
Curtis 1999[34] Cross-sectional	SCI and others	Wheelchair Basketball Duration NR	33/46 (72%)	N/A	N/A	Shoulder pain
Fullerton 2003[44] Cross-sectional	SCI	Any Wheelchair Sport 10 years (mean)	67/172 (39%)	Non-athletes	56/85 (66%)	Shoulder pain
Haykowsky 1999[53] Cross-sectional	Visual Impairment	Powerlifting 5 years (mean)	4/11 (36%)	N/A	N/A	Powerlifting-related injury
Jackson 1996[57] Cross-sectional	SCI	Wheelchair Basketball Duration NR	17/33 (52%)	N/A	N/A	Carpal or median neuropathy
You 2016[118] Cross-sectional	SCI	Wheelchair Table Tennis 17 years (mean)	RC diseases (mean) Playing arm: 2.2 Non-playing arm: 2.3	Wheelchair Archery 12 years (mean)	RC diseases (mean) Bow arm: 2.3 Draw arm: 2.5	Shoulder tendinopathy

N/A=not applicable; NR=not reported; RC=rotator cuff; SCI=spinal cord injury

Another study described injuries among 11 visually impaired athletes (9 males) training for a powerlifting competition.[53] During a 12-month period, 4 of 11 (36%) reported a powerlifting-related injury requiring medical intervention and discontinuation of training for more than 1 day. The injury rate corresponded to 0.11 injuries per 100 hours of training.

A study of shoulder pain in 46 female wheelchair basketball players found that 72% (33/46) experienced shoulder pain since wheelchair use.[34] Although 52% had shoulder pain at the time of the survey, only 11 % reported that it limited their activities in the past week. Medical conditions included SCI (39%), limb amputation (9%), lower extremity musculoskeletal and neuromuscular disabilities (28%), polio (13%), and spina bifida (11%) and average years of wheelchair use was 13. Scores on the Wheelchair User's Shoulder Pain Index (WUSPI) were higher (indicating greater pain) for ambulatory athletes (mean score 20.0) compared to nonambulatory athletes (mean score 12.8) and, among medical conditions, highest among athletes with limb amputations (mean score 35.7). It was not possible to determine whether wheelchair basketball was a significant factor.

Upper limb nerve entrapment was the focus of a study of 12 wheelchair racers.[19] The sample included 11 males (92%), mean age was 33 years, and 75% participants had experienced a SCI. On physical exam, 67% (8/12) had signs of carpal tunnel syndrome – 4 bilateral and 4 unilateral. Five (42%) had signs of ulnar nerve entrapment – 4 bilateral and 1 unilateral.

A final study assessed the prevalence of carpal tunnel syndrome in 33 male wheelchair basketball players (58% paraplegia, 18% limb amputation).[57] Ten (30%) met criteria for clinical carpal tunnel syndrome. With electrodiagnostic testing, carpal tunnel syndrome was confirmed in 70% (7/10). Based on the electrodiagnostic results, median neuropathy was identified in 52% (17/33).

Summary of Findings

Harms associated with the limited number of adaptive sports programs reporting were infrequent and generally not serious. Four of 6 sports program studies reported there were no injuries among participants. The other 2 studies involved a total of 41 selected individuals with MS participating in either rock climbing or hippotherapy. All but 1 of the sports activity participation studies enrolled wheelchair athletes (predominantly SCI); reported harms were shoulder and wrist pain. Overall, few adaptive sports or populations of interest were represented in the literature and few studies were designed to determine specific harms associated with an adaptive sports program.

KEY QUESTION 3. What are the known facilitators of and barriers to the participation in adaptive sports programs among individuals with amyotrophic lateral sclerosis (ALS), limb amputation, hearing loss or deafness, multiple sclerosis (MS), post-traumatic stress disorder (PTSD), spinal cord disorder, spinal cord injury (SCI), stroke/cerebrovascular accident (CVA), traumatic brain injury (TBI), or visual impairment or blindness?

We used a modified version of the International Classification of Functioning and Disability Health framework (ICF) to conceptualize the reported barriers, facilitators, and motivators associated with participation in adapted sports.[121,122] The ICF is the World Health Organization framework for measuring interrelated factors of health and disability at individual and population levels. The model was designed to be a classification system of health and health-related domains used to describe changes to an individual's capacity in daily life. The framework includes the following domains: health conditions, body functions and structure, activity, participation, environmental factors, and personal factors (Table 12).

Table 12. ICF Domains

Domain	Definition
Health conditions	disease, disorder, injury, or trauma
Body functions	physiological functions of body systems
Body structures	anatomical parts of the body
Activity	execution of a task or action by individual
Participation	involvement in adaptive sports
Environmental factors	physical, social factors external to individuals with positive or negative influence on performance in society, capacity to execute actions or tasks, or on bodily functions or structure
Personal factors	background features of an individual's life that comprise features that are not a part of a health condition or health state

https://www.icf-research-branch.org/icf-training/icf-e-learning-tool

The ICF model attempts to explain a person's ability to function as a result of a health condition or disability. Disabilities exist in the context of environmental and personal factors outside of the person. An individual's functioning in life and the extent to which they are disabled are a result of an interaction between health conditions and both personal and environmental factors, which can interact with body function, activities, and participation in a continuous manner.

Previous reviews have utilized the ICF model to explain the factors affecting sports participation for people with disabilities.[121,123] For the purposes of this review, facilitators were factors or components that contributed to initial participation in adapted sports, while motivators contributed to continued participation. Barriers were factors or aspects of living with a disability that prevented or limited regular sports participation.

Thirty-seven studies, represented in 40 papers, reported on barriers (n=25), facilitators (n=15), and motivators (n=24) to participation in adaptive sports. Thirty-six of these were observational and 1 was of an experimental design (RCT).[54] Among the observational studies, 15 were surveys

or questionnaires,[21,22,55,60,78,82,83,85,89,92,94,102,105-107,116] 3 were conducted in focus groups,[15,25,37,65] 10 were interviews,[23,29-32,52,68,69,90,104,109] 1 was a narrative analysis,[79] 1 reviewed registration forms and participation logs,[18] and 6 were of mixed methods.[20,33,46,64,76,103] The questionnaires and surveys were either completed via mail or administered in person. Six studies reported exclusively on barriers,[18,22,76,83,89,105] 3 on facilitators,[25,37,79,103] 4 on motivators,[54,64,68,78] and 23 on a mix of factors related to participation.

Barriers to Participation in Adaptive Sports (Figure 2)

Health Conditions and Participation

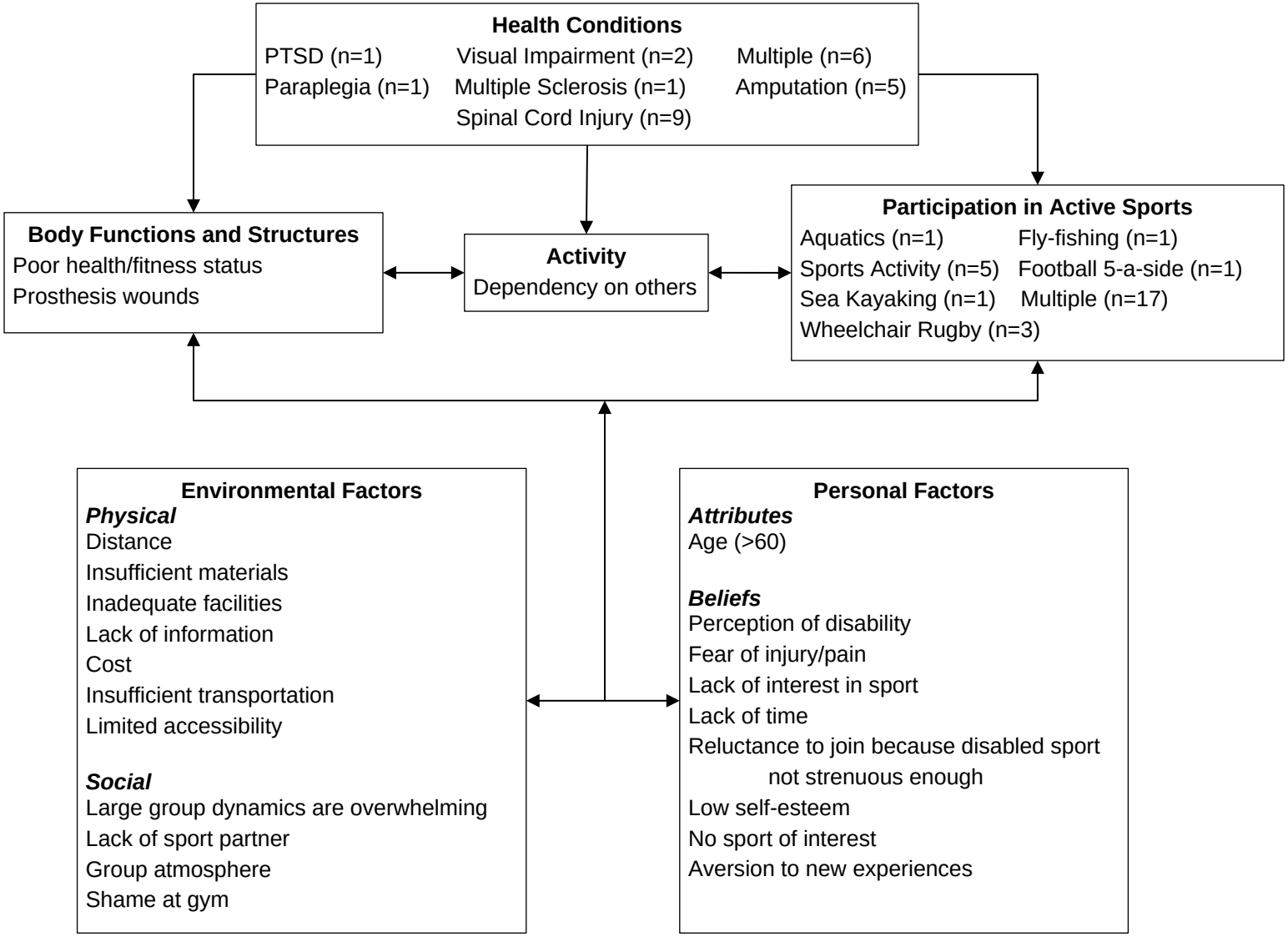
Nine of the 25 studies reporting on barriers exclusively recruited participants with SCI (N=3029),[76,82,92,102,104-107,109,116] 1 enrolled participants with SCI or Guillain-Barré disease (n=33),[85] 5 enrolled individuals with limb amputations (N=1113),[21-23,60,69] 2 enrolled participants with visual impairment (N=738),[55,76] and a further 6 enrolled participants across a range of diagnoses (N=329).[18,20,33,65,83,89] Other diagnoses, with a single study each, included MS (n=45),[32] PTSD (n=27),[15] and paraplegia (n=24).[94]

Sports investigated in the reports included aquatics,[32] fly-fishing,[15] sea kayaking,[109] 5-a-side football,[76] and wheelchair rugby.[20] Twenty studies enrolled participants from a variety of sports.[18,21-23,33,55,60,65,69,82,83,85,89,92,94,102,104-107,116]

Body Structure or Function

Twelve of the 25 articles reported that impaired body structure or function was a barrier to sports participation. Ten studies that focused mainly on individuals with limb amputations, SCI, or multiple diagnoses reported that poor physical health was a barrier to participation in sports.[21,23,60,69,83,89,94,102,104,105] Other impairments that prevented participation in sports included poor health/fitness status, muscle tone dysfunction, fatigue, difficulty sleeping, unmet medical needs, poor health from being a smoker, and physical pain from stump wounds. One study that investigated sports participation among individuals with limb amputations who participated in a range of sports reported that wounds from prosthesis use caused players to stop playing.[60]

Figure 2. Barriers to Adaptive Sports Participation



Activity

Six studies reported that limitations due to activity factors prevented participation in sports.[23,55,83,85,89,106,107] Bragaru et al reported that many feared becoming a burden to others.[23] Participants also reported that dependency on others to complete basic activities of daily living (ADLs) was a key factor that also limited their sports participation. In some cases, the dependent participant needed help with ADLs but lacked a personal care assistant so participation in sports was challenging.[83,85]

Environmental Factors

Physical

Twenty-three of the 25 studies reported physical environmental barriers. Of these, 11 studies reported that a lack of information about the availability of adapted sports opportunities prevented participation.[21,32,55,65,69,82,83,85,89,104,109] Cost was another prohibitive factor cited by 12 studies enrolling participants with a wide range of diagnoses.[21,33,55,60,65,82,83,89,94,102,104,106,107] Other physical barriers to participation included the travel distance required to practice sports, insufficient transportation, insufficient materials, inadequate facilities, and accessibility limitations such as limited team numbers or limited facilities. Bragança et al reported that often the clothing available for adaptive sports is insufficient and can be a barrier to participation.[20]

Social

Eleven studies reported social barriers to participation.[15,22,23,55,69,82,83,94,102,104,109] The lack of a sporting partner and feeling shame from others were common themes mentioned by sports participants. Other social barriers reported included issues with a group atmosphere ranging from difficulties with inclusion, frustration with team sports, and issues with a highly competitive environment. Bragaru et al reported that some participants disliked participating in sports with only other disabled team members.[23]

Personal Factors

Eighteen studies reported personal factors that prevented participation in sports. Personal factors were subdivided into attributes and beliefs.

Attributes

Three studies, 2 focused on individuals with limb amputations and 1 on multiple diagnoses, reported that advanced age (>60 years) prevented participants from engaging in sports.[22,60,83]

Beliefs

Fifteen studies reported that personal beliefs interfered with regular sports participation. The fear of pain or further injury was supported by 7 studies.[23,55,60,65,76,83,94] A lack of time to participate regularly in sports was the most frequently reported barrier and was mentioned in 8 studies across a variety of disabilities.[23,55,65,83,85,102,104,106,107] Four studies reported that participants believed their disability, which included visual impairment, SCI, or multiple diagnoses, made them unable to engage in sport.[55,65,76,92] One study, in participants with SCI, stated that they did not participate in sports before their injury and therefore the experience was completely novel to them post-injury.[116] This caused many of them to be unaccustomed to the rigors associated with

training. Other beliefs reported include no sport of interest available and a lack of interest in sporting in general. One study reported that some participants with MS felt a reluctance to join MS-specific aquatics classes because of the belief that disabled sport is not strenuous enough.[32]

Facilitators and Motivators of Participation in Adaptive Sports (Figure 3 and Appendix Figure 1)

Health Conditions and Participation

Thirty-one studies (N=5873), in 34 papers, reported on facilitators and motivators influencing participation in adaptive sports, whether this was in a formalized program or through individual or group participation in "non-programmatic" sporting activity. Health conditions varied across studies. Eight enrolled participants with SCI (N=1918),[54,82,92,102,104,106,107,109,116] 5 with limb amputations (N=338),[21,23,29,60,69] 2 with PTSD (N=95),[15,79] 2 with visual impairment (N=807),[55,90] 2 with MS (N=54),[25,32,37] and 9 with multiple conditions (N=337).[20,30,31,33,46,52,64,65,85,103] In addition to those previously listed, other health conditions included PTSD, TBI, tetraplegia, quadriplegia, CVA, and paralysis. No studies indicated that health condition influenced participation in adaptive sports. Adaptive sports represented also varied across studies, including fly-fishing, aquatics, hiking, wheelchair rugby and basketball, curling, and EAAT, among others.

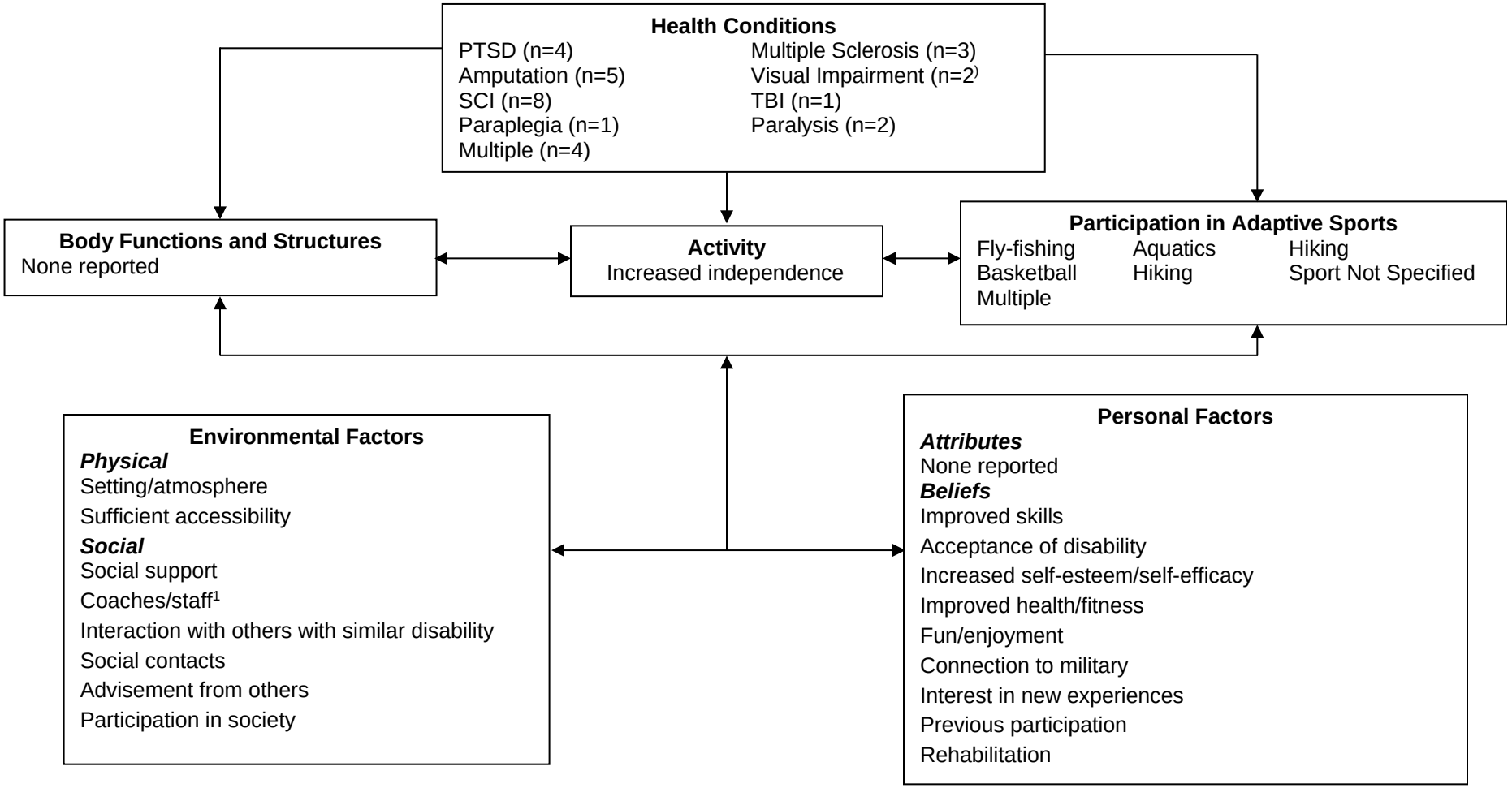
Body Functions and Structures

No studies reported on body function and structures as a facilitator or motivator to adaptive sports participation.

Activity

Independence was identified as both a facilitator and motivator to participation in adaptive sports. Seven studies, 1 conducted after a hiking expedition to Machu Picchu,[25,37] found re-gaining and experiencing independence was a factor reported for initiating and maintaining participation among participants with multiple conditions, including visual impairment, SCI, and MS.[29,52,55,78,103,109] The ability to maintain ADLs was also reported by multiple studies as a motivator for continued participation in adaptive sports.[23,33,46,60,65,68,94,103]

Figure 3. Facilitators of Adaptive Sports Participation



Environmental Factors

Physical

In comparison to the study by Kars et al[60] that found that problems with the prosthesis and prosthesis costs limited participation in sports, individuals with lower limb amputations in the study by Bragaru et al identified their prosthetic device to be a facilitating factor for participation.[23] The participants considered sports an opportunity to make the best use of their prosthetic devices. There were no factors related to body function and structures reported as motivators.

Nine studies identified the physical setting or atmosphere and accessibility to be factors influencing the initiation and continuation of adaptive sports.[15,25,30-32,37,46,65,79,92,109] A supportive and stress-free environment with safety measures in place was also identified as an important factor in 2 studies, 1 in hikers with MS and the other in sea kayakers with SCI.[25,37,109]

One study cited access to an active sports club membership as a facilitating factor to participation among persons with SCI.[92] Two other studies, 1 on aquatics for people with MS and 1 in persons with SCI across multiple sports, reported safety, specifically a minimal risk of falls and overheating, as motiving factors for continued involvement.[32,82] Participants in the study by Chard attributed continued participation to a welcoming environment that created a sense of belonging.[32] Nam et al reported transportation as both motivator and barrier, as most participants used owner-driven cars to attend sports club.[82]

Social

Identified by 18 studies, meeting people and/or maintaining social contacts was the most reported facilitator and motivator for participation in adaptive sports.[20,21,23,29,32,46,55,60,64,65,68,78,85,94,102,103,106,107,116] Twelve studies,[15,23,30-32,46,52,68,69,90,103,104,109] including 1 in Veterans with PTSD and 1 in Veterans with a limb amputation, identified interacting with others with similar disabilities as a facilitating and motivating factor,[15,69] while 11 studies cited participation in society.[25,30-33,37,55,64,69,85,94,103,109]

Advisement from others such as therapists and doctors (11 studies),[21,23,32,46,60,68,69,82,94,102,116] and social support from friends, family, and adaptive sports groups (12 studies)[15,23,25,32,37,55,65,69,78,79,82,104,109] were also commonly reported as being facilitators and motivators to adaptive sports participation. At the same time, a lack of information from healthcare providers was also reported as a barrier in number of studies.

Group atmosphere, including the use of exercise partners,[29,68,69,78] as well as improved relationships,[30,31,33,52,103] were identified solely as motivators to participation in 4 studies each. The use of a buddy system was also identified as encouraging continued participation among scuba divers with SCI or limb amputation.[29] In addition, 3 studies reported the opportunity to be a part of a team as a motivator for multiple sports, including wheelchair rugby, wheelchair basketball, and boccia, among tetraplegics and individuals with limb amputations.[68,69,78]

Sporner et al surveyed Veterans with various health conditions at the NVWG and the WSC and found 77% reported improved personal relationships and 73% reported increased communication skills with friends and family following participation.[103] Two studies also found that the presence

of coaches and/or staff with some physical therapy or sports training was a motivator, helping to ensure safety among adaptive sports participants.[32,65]

Personal Factors

Attributes

No studies reported on attributes as a facilitator or motivator to adaptive sports participation.

Beliefs

Increasing self-esteem and self-efficacy[15,23,29-31,33,46,55,64,65,68,69,78,85,102-104,106,107,109,116] and improving and/or maintaining health and fitness [21,23,25,32,33,37,46,52,54,55,60,65,68,69,79,85,94,102-104,106,107,109,116] were the most-identified beliefs associated with participation in adaptive sports. Sports represented in these studies included fly-fishing, aquatics, sea kayaking, scuba diving, wheelchair rugby, curling, hiking, EAAT, and others; health conditions included MS, SCI, PTSD, limb amputation, and visual impairment, among others.

Fun and enjoyment,[15,21,23,29-32,46,55,78,94,102,106,107,109,116] as well as an interest in new experiences,[30,31,52,55,65,68,69,78,79,102,103,106,107,109] were the most-reported reasons for taking part in various adapted sports among participants with limb amputations, PTSD, TBI, SCI, and visual impairment.

Participants in 8 studies reported acceptance of disability contributed to the initiation and/or continuation of adaptive sports.[15,23,29,52,55,69,94,109] Four of these studies were among Veterans with various health conditions, including PTSD and limb amputation, participating in fly-fishing or other adaptive sports.[15,52,69,103] Carin-Levy reported the freedom from impairment and feeling of freedom among scuba divers with SCI or a limb amputation.[29] Improving sports skills was also reported as a facilitator and motivator to participation.[15,33,52,78,90,103,109]

Attitude toward adaptive sports was an important motivating factor reported in 2 studies enrolling individuals with TBI, SCI, paraplegia, tetraplegia, or limb amputation.[33,52] Participants in these studies reported feeling a sense of belonging and an expansion on what they valued in life through adaptive sports. In addition, being a role model to others was reported as a motivating factor in 1 study.[65]

Five studies in SCI, paraplegic, and visually impaired populations, among others, reported rehabilitation as the reason for adaptive sports initiation or continuation.[20,55,85,94,116] Previous participation in sports, including connection to a recreation center and the ability to perform sports enjoyed before disability, were identified as facilitators and motivators to adaptive sports in participants with a limb amputation, SCI, or visual impairment.

Findings Focused on Veterans

Barriers

Health Conditions and Participation

Two studies reported barriers to participation focused on US Veterans (N=55).[15,69] Bennett et al studied 28 Veterans with PTSD participating in a fly-fishing expedition.[15] Littman et al

completed semi-structured interviews with 27 Veterans with lower limb amputation asking about factors influencing their participation in sports.[69]

Environmental Factors

Physical. The study enrolling Veterans with limb amputations noted a lack of information about sporting opportunities and insufficient transportation as physical barriers to participation.[69]

Social. Bennett reported that a large group size was a barrier for Veterans with PTSD so fly-fishing groups were intentionally limited to 2 or 3 people.[15] Littman et al identified the lack of a sporting partner and feelings of shame, brought on by others, as social barriers to participation in sports after limb amputation.[69] These factors were supported by other studies of civilian populations.

Body Functions and Structures

No studies in US Veterans reported on body function and structures as a barrier to adaptive sports participation.

Activity

No studies in US Veterans reported on activity level factors as a barrier to adaptive sports participation.

Personal

Attributes. No studies in US Veterans reported on physical attributes as a barrier to adaptive sports participation.

Beliefs. Littman et al reported that a fear of further injury and/or pain and having low self-esteem were beliefs that prevented Veterans with limb amputation from participating in sports.[69]

Facilitators and Motivators

Health Conditions and Participation

Six studies focused on disabled US Veterans, with 2 reporting on both facilitators and motivators.[52,69] Health conditions represented in these studies included PTSD, TBI, lower limb amputation, visual impairment, MS, and SCI. Studies varied by sport with 3 studies assessing participation in multiple sports. Two studies were conducted at a fly-fishing retreat for Veterans with PTSD[15,79] and 1 looked at EAAT for Veterans with multiple health conditions.[64]

Body Function and Structures

No studies in US Veterans reported on body functions and structure as a facilitator or motivator to adaptive sports participation

Activity

Increased independence was a factor reported for initiating and maintaining participation among Veterans in 3 studies.[52,79,103] Sporner also identified the ability to maintain activities of daily living as a motivator to participation in various adaptive sports.[103]

Environmental Factors

Physical. Two studies among Veterans with PTSD, conducted at a fly-fishing retreat, considered the natural environment and peaceful setting of the outdoors as contributors to Veteran participation.[15,79]

Social. Among Veterans with SCI, limb amputation, visual impairment, and MS, 79% reported "increased friends" as a motivating factor to continue involvement in adaptive sports.[103] Two studies, 1 in Veterans with PTSD and 1 in Veterans with limb amputation, identified interacting with others with similar disabilities as a facilitating and motivating factor.[15,69]

Littman et al reported the opportunity to be a part of a team as a motivator for multiple sports, including wheelchair rugby, wheelchair basketball, and boccia, among tetraplegics and individuals with limb amputations.[69] In addition, Sporner et al found 77% of Veterans at the NVWG or WSC reported improved personal relationships and 73% reported increased communication skills with friends and family.[103]

Personal Factors

Attributes. No studies in US Veterans reported on physical attributes as a facilitator or motivator to adaptive sports participation.

Beliefs. In US Veterans, 4 studies identified increasing self-esteem and self-efficacy[15,64,69,103] and 3 studies identified improving and/or maintaining health and fitness[52,69,103] to be beliefs associated with participation in adaptive sports. New experiences, acceptance of disability, and improving skills also contributed to the initiation and/or continuation of adaptive sports in Veterans.[15,52,69,79,103] Sports represented in these studies included fly-fishing and EAAT; health conditions included TBI, PTSD, and limb amputations. Fun and enjoyment was also reported as a facilitator in Veterans with PTSD at a fly-fishing retreat.[15]

Attitude toward adaptive sports was an important motivating factor reported in 1 study.[52] Participants reported feeling a sense of belonging and an expansion on what they valued in life through adaptive sports. New experiences, such as the opportunity to travel and/or learn a new sport, was also reported as an important factor by 4 studies in Veterans.[52,69,79,103]

One study, in Veterans with PTSD, cited a reconnection to military culture as a facilitator for participating in a fly-fishing retreat. In addition, activities focused on Veteran's experiences and issues was reported to be an important characteristic of the retreat.[15]

Summary of Findings

Barriers to adaptive sports participation were similar across studies reporting on different medical conditions and different sports. Reported barriers were mainly due to physical environmental factors such as a lack of information, cost, accessibility, or transportation concerns. Personal barriers included fear of injury/pain, lack of time, and low self-esteem.

Reasons for either initiating participation or continuing participation in adaptive sports were similar. Commonly reported reasons for participation included social factors (social contacts, participation in society, interaction with others with similar disabilities) and personal beliefs

(improved health/fitness, increased self-esteem/self-efficacy, improved skill, interest in new experiences).

The majority of studies used a cross-sectional approach and collected data either through questionnaires or interviews.

SUMMARY AND DISCUSSION

SUMMARY OF EVIDENCE

Key Questions 1-3

Evidence for the effectiveness of adaptive sports ***programs*** is limited in quantity, quality, and applicability. Findings come largely from observational studies of EAAT in selected populations with PTSD (including US Veterans), MS, or CVA who agreed to participate in these programs. Many outcomes of interest were infrequently reported, including self-esteem/perceived competence, community integration/social functioning, and employment. No studies reported on health care utilization.

Evidence for the effectiveness of adaptive ***sports activity participation*** is largely from observational studies enrolling selected individuals with SCI and involving multiple sports. We found no studies exclusively enrolling individuals with PTSD, CVA, TBI, MS, ALS, or hearing loss or deafness, and few studies limited to a specific adaptive sport.

There was little evidence of harms associated with adaptive sports program participation, although few adaptive sport or populations of interest were represented in the literature. Few studies were designed to capture specific harms associated with participation.

Barriers to participation were similar across sports and population and were mainly due to physical environmental factors including lack of information, cost, accessibility, and transportation concerns. Personal barriers included fear of injury or pain, lack of time, and low self-esteem. Facilitators of participation included social factors (social contacts, participation in society, interaction with others with similar disabilities) and personal beliefs (improved health/fitness, increased self-esteem and self-efficacy, improved skills, and new experiences).

Strength of Evidence

We did not formally rate risk of bias or strength of evidence. We assessed quality characteristics of included studies and found that approximately half of the included experimental and observational studies did not provide clearly defined inclusion criteria or indicated that participants were “selected”. Many provided little demographic data to allow for a determination of the generalizability of findings. Most studies assessed outcomes using validated questionnaires or objective outcomes measures but, for questionnaires, response rates were less than 50% in 42% of the studies. Of the studies where it would be appropriate to adjust for confounding factors, there was evidence of adjustment in about 50%.

For the qualitative studies, approximately 66% reported congruity between theory and research methods. Nearly all did provide evidence of congruity between the research methods and the research questions, were considered to have adequately represented the participants, and included evidence of ethical approval of the study.

APPLICABILITY OF FINDINGS TO THE VA POPULATION

Our findings have implications for VHA and Veterans in the design, development, implementation, and assessment of adaptive sports activities and programs. There appears to be

some evidence that EAAT, in selected populations with PTSD, MS, or CVA who agreed to participate in these programs, can be beneficial. However, there is no information on resource use or the applicability to broader populations of individuals and/or program-specific details. In these populations there is little evidence of harm, though providing for broader populations (*eg*, those that are not interested in EAAT or with other medical conditions) should be done with caution and should be evaluated. Other sports activities, populations, and settings have a limited empiric base for program development and implementation. Future programs could be derived from existing programs, modified to specific populations and settings, and should undergo evaluation. Because there is general agreement that sport participation should be encouraged, future questions should examine how this can be done in populations with physical challenges that differ from those not requiring sport activity adaptation. Our findings also help categorize and describe important barriers and facilitators to participation that require additional evaluation and incorporation to ensure successful participation at acceptable costs.

LIMITATIONS

Limitations of the available literature include generally low quality of evidence (*ie*, non-randomized designs, small sample sizes, selected populations) and few studies for many of the adaptive sports and conditions of interest. Disabling conditions were often self-reported and little information was provided about severity of the condition, etiology, comorbidities, or participant demographics. Marked variation in populations, interventions, and outcomes assessment limited data pooling or even semi-quantitative assessment of effect consistency or applicability. Results from EAAT, golf, and fly-fishing programs for individuals with PTSD, MS, or history of CVA may not be generalizable to other sports and other populations. Few studies provided follow-up data to assess whether participation continued and/or whether benefits were maintained.

Participants in the studies included in our review likely had a high level of interest in sports participation (many having participated prior to injury/illness); individuals with severe illness or disability and comorbid conditions were typically excluded from the studies.

Common limitations of studies reporting harms were poor documentation and definition of adverse events. Sample sizes were generally low, and most sports activity participation studies lacked comparators. Potential harms associated with adaptive sports participation in many sports of interest or by many populations of interest are unknown.

RESEARCH GAPS/FUTURE RESEARCH

The Adaptive Sports Grant Program, facilitated and managed by NVSP&SE, may provide an opportunity for future research. The Grants Program supports entities with significant experience in managing a large-scale adaptive sports program, including programs affiliated with a National Paralympic Committee or a National Governing Body authorized to provide Paralympic sports and programs in which at least 50 persons with disabilities participate or the eligible participants reside in at least 5 different congressional districts. Federal agencies are encouraged to partner with non-federal entities to jointly create national, regional, and community-based programs that provide adaptive sports activities for disabled Veterans and members of the Armed Forces.

Our findings strongly support the need for rigorous design and outcome evaluation across a spectrum of individuals, health conditions, interventions and settings. Specific recommendations pertaining to the key questions addressed are provided below.

Key Questions 1 and 2

Future research could address benefits and harms of participation for other adaptive sports and other medical conditions. Studies could be designed to assess whether effectiveness and harms vary by severity of condition, time since disability or diagnosis, skill level of the participants, or their age, gender, or race, and participants could be followed to assess long-term outcomes. Standardized outcome measures should be used to assess a broad range of outcomes including health/wellness, daily functioning, health care utilization, and employment.

Ideally future research into benefit and harms would utilize randomized study designs with appropriate control groups. However, it has been noted that it can be difficult to recruit an adequate sample size and funding for such research may be difficult to obtain.[124]

Key Question 3

The understanding of barriers to and facilitators of participation would benefit from longitudinal studies that assessed the factors influencing regular participation over an extended period in the individual's life. Such work could be built into any new regional or national programs. The bulk of evidence reported addressed why people continued to participate in sports versus facilitators to assist individuals in initiating participation.

A gap in the evidence remains concerning the applicability and generalizability to larger populations, including a broader US population including those without an overt interest in sports participation, women, and racial and/or ethnic minorities. Several sports of interest including hand-cycling, para-triathlon, sled hockey, snowboarding, soccer, surfing, wheelchair fencing, and wheelchair lacrosse, were not represented in the literature.

CONCLUSIONS

Evidence for the effectiveness of adaptive sports programs is largely from studies of EAAT in selected populations with a history of PTSD, MS, or CVA. Thus, the strength of evidence to inform developing, implementing, making available, and evaluating the effects of adaptive sports programs or informal adaptive sports participation is low. There is insufficient evidence for other adaptive sports or populations and it is unknown whether findings from a particular sport in a particular population are generalizable. There was little evidence of harms associated with adaptive sports program participation although, again, few adaptive sports or populations of interest were represented in the literature. Barriers to and facilitators of adaptive sports participation were similar across studies reporting on a broader range of medical conditions and adaptive sports. Future research could focus on other adaptive sports and populations, other outcomes including harms, and long-term follow-up to determine if participation is sustained and if benefits are maintained.

REFERENCES

1. Federal Register. Grants for Adaptive Sports Programs for Disabled Veterans and Disabled Members of the Armed Forces. 2014. https://www.federalregister.gov/documents/2014/07/01/2014-15191/grants-for-adaptive-sports-programs-for-disabled-veterans-and-disabled-members-of-the-armed-forces. Accessed 19 April 2018.
2. Disabled Sports USA - Early History. https://www.disabledsportsusa.org/about/our-mission/early-history/. Accessed 7 December 2018.
3. Adnan Y, McKenzie A, Miyahara M. Self-efficacy for quad rugby skills and activities of daily living. *Adapt Phys Activ Q.* 2001;18(1):90-101.
4. Akbar M, Brunner M, Ewerbeck V, et al. Do overhead sports increase risk for rotator cuff tears in wheelchair users? *Arch Phys Med Rehabil.* 2015;96(3):484-488.
5. Arnold R, Wagstaff CR, Steadman L, Pratt Y. The organisational stressors encountered by athletes with a disability. *J Sports Sci.* 2017;35(12):1187-1196.
6. Ashton-Shaeffer C, Gibson H, Holt M, Williming C. Women's resistance and empowerment through wheelchair sport. *World Leis J.* 2001;43(4):11-21.
7. Aydoğ E, Aydog ST, Cakci A, Doral MN. Dynamic postural stability in blind athletes using the Biodex Stability System. *Int J Sports Med.* 2006;27(5):415-418.
8. Aytar A, Pekyavas NO, Ergun N, Karatas M. Is there a relationship between core stability, balance and strength in amputee soccer players? A pilot study. *Prosthet Orthot Int.* 2012;36(3):332-338.
9. Barbin JM, Ninot G. Outcomes of a skiing program on level and stability of self-esteem and physical self in adults with spinal cord injury. *Int J Rehabil Res.* 2008;31(1):59-64.
10. Bauerfeind J, Koper M, Wieczorek J, Urbanski P, Tasiemski T. Sports injuries in wheelchair rugby - a pilot study. *J Hum Kinet.* 2015;48:123-132.
11. Beinotti F, Christofoletti G, Correia N, Borges G. Effects of horseback riding therapy on quality of life in patients post stroke. *Top Stroke Rehabil.* 2013;20(3):226-232.
12. Beinotti F, Correia N, Christofoletti G, Borges G. Use of hippotherapy in gait training for hemiparetic post-stroke. *Arq Neuropsiquiatr.* 2010;68(6):908-913.
13. Bennett JL, Lundberg NR, Zabriskie R, Eggett D. Addressing posttraumatic stress among Iraq and Afghanistan Veterans and significant others: an intervention utilizing sport and recreation. *Ther Recreation J.* 2014;48(1):74-93.
14. Bennett JL, Piatt JA, Van Puymbroeck M. Outcomes of a therapeutic fly-fishing program for Veterans with combat-related disabilities: a community-based rehabilitation initiative. *Community Ment Health J.* 2017;53(7):756-765.
15. Bennett JL, Van Puymbroeck M, Piatt JA, Rydell RJ. Veterans' perceptions of benefits and important program components of a therapeutic fly-fishing program. *Ther Recreation J.* 2014;48(2):169-187.
16. Blauwet C, Sudhakar S, Doherty AL, Garshick E, Zafonte R, Morse LR. Participation in organized sports is positively associated with employment in adults with spinal cord injury. *Am J Phys Med Rehabil.* 2013;92(5):393-401.
17. Blauwet CA, Cushman D, Emery C, et al. Risk of injuries in Paralympic track and field differs by impairment and event discipline: a prospective cohort study at the London 2012 Paralympic Games. *Am J Sports Med.* 2016;44(6):1455-1462.
18. Blauwet CA, Yang HY, Cruz SA, et al. Functional and environmental factors are associated with sustained participation in adaptive sports. *PM R.* 2017;9(7):668-675.

19. Boninger ML, Robertson RN, Wolff M, Cooper RA. Upper limb nerve entrapments in elite wheelchair racers. *Am J Phys Med Rehabil.* 1996;75(3):170-176.
20. Bragança S, Castellucci I, Gill S, Matthias P, Carvalho M, Arezes P. Insights on the apparel needs and limitations for athletes with disabilities: The design of wheelchair rugby sports-wear. *Appl Ergon.* 2018;67:9-25.
21. Bragaru M, Dekker R, Dijkstra PU, Geertzen JH, van der Sluis CK. Sports participation of individuals with major upper limb deficiency. *Br J Sports Med.* 2015;49(5):330-334.
22. Bragaru M, Meulenbelt HEJ, Dijkstra PU, Geertzen JHB, Dekker R. Sports participation of Dutch lower limb amputees. *Prosthet Orthot Int.* 2013;37(6):454-458.
23. Bragaru M, van Wilgen CP, Geertzen JH, Ruijs SG, Dijkstra PU, Dekker R. Barriers and facilitators of participation in sports: a qualitative study on Dutch individuals with lower limb amputation. *PLoS One.* 2013;8(3):e59881.
24. Broman D, Ahmed OH, Tscholl PM, Weiler R. Medication and supplement use in disability football world championships. *PM R.* 2017;9(10):990-997.
25. Calsius J, Courtois I, Feys P, Van Asch P, De Bie J, D'hooghe M. "How to conquer a mountain with multiple sclerosis". How a climbing expedition to Machu Picchu affects the way people with multiple sclerosis experience their body and identity: a phenomenological analysis. *Disabil Rehabil.* 2015;37(26):2393-2399.
26. Campayo-Piernas M, Caballero C, Barbado D, Reina R. Role of vision in sighted and blind soccer players in adapting to an unstable balance task. *Exp Brain Res.* 2017;235(4):1269-1279.
27. Campbell E, Jones G. Sources of stress experienced by elite male wheelchair basketball players. *Adapt Phys Activ Q.* 2002;19(1):82.
28. Campbell E, Jones G. Cognitive appraisal of sources of stress experienced by elite male wheelchair basketball players. *Adapt Phys Activ Q.* 2002;19(1):100.
29. Carin-Levy G, Jones D. Psychosocial aspects of scuba diving for people with physical disabilities: An occupational science perspective. *Can J Occup Ther.* 2007;74(1):6-14.
30. Carless D. Narrative transformation among military personnel on an adventurous training and sport course. *Qual Health Res.* 2014;24(10):1440-1450.
31. Carless D, Peacock S, McKenna J, Cooke C. Psychosocial outcomes of an inclusive adapted sport and adventurous training course for military personnel. *Disabil Rehabil.* 2013;35(24):2081-2088.
32. Chard S. Qualitative perspectives on aquatic exercise initiation and satisfaction among persons with multiple sclerosis. *Disabil Rehabil.* 2017;39(13):1307-1312.
33. Côté-Leclerc F, Boileau Duchesne G, Bolduc P, et al. How does playing adapted sports affect quality of life of people with mobility limitations? Results from a mixed-method sequential explanatory study. *Health Qual Life Outcomes.* 2017;15 (1) (no pagination)(22).
34. Curtis KA, Black K. Shoulder pain in female wheelchair basketball players. *J Orthop Sports Phys Ther.* 1999;29(4):225-231.
35. da Silva ES, Fischer G, da Rosa RG, et al. Gait and functionality of individuals with visual impairment who participate in sports. *Gait Posture.* 2018;62:355-358.
36. Derman W, Runciman P, Schwellnus M, et al. High precompetition injury rate dominates the injury profile at the Rio 2016 Summer Paralympic Games: a prospective cohort study of 51198 athlete days. *Br J Sports Med.* 2018;52(1):24-31.
37. D'hooghe MB FP, Deltour S, et al. . Impact of a 5-day expedition to Machu Picchu on persons with multiple sclerosis. *Multiple Scl Int.* 2014;2014(761210).

38. Earles JL, Vernon LL, Yetz JP. Equine-assisted therapy for anxiety and posttraumatic stress symptoms. *J Trauma Stress.* 2015;28(2):149-152.
39. Eilat R, Hazor B, Carmeli E. Association between quality of life and team achievement among wheelchair basketball players - A survey study. *Int J Disabil Hum Dev.* 2015;14(2):161-166.
40. Fagher K, Jacobsson J, Dahlstrom O, Timpka T, Lexell J. An eHealth application of self-reported sports-related injuries and illnesses in Paralympic sport: pilot feasibility and usability study. *JMIR Hum Factors.* 2017;4(4):e30.
41. Ferrara MS, Buckley WE. Athletes with disabilities injury registry. *Adapt Phys Activ Q.* 1996;13(1):50-60.
42. Fiorilli G, Iuliano E, Aquino G, et al. Mental health and social participation skills of wheelchair basketball players: a controlled study. *Res Dev Disabil.* 2013;34(11):3679-3685.
43. Foreman PE, Cull J, Kirkby RJ. Sports participation in individuals with spinal cord injury: Demographic and psychological correlates. *Int J Rehabil Res.* 1997;20(2):159-168.
44. Fullerton HD, Borckardt JJ, Alfano AP. Shoulder pain: a comparison of wheelchair athletes and nonathletic wheelchair users. *Med Sci Sports Exerc.* 2003;35(12):1958-1961.
45. Garshick E, Mulroy S, Graves DE, Greenwald K, Horton JA, Morse LR. Active lifestyle Is associated with reduced dyspnea and greater life satisfaction in spinal cord injury. *Arch Phys Med Rehabil.* 2016;97(10):1721-1727.
46. Giacobbi PR, Jr., Stancil M, Hardin B, Bryant L. Physical activity and quality of life experienced by highly active individuals with physical disabilities. *Adapt Phys Activ Q.* 2008;25(3):189-207.
47. Goodwin D, Johnston K, Gustafson P, Elliott M, Thurmeier R, Kuttai H. It's okay to be a quad: wheelchair rugby players' sense of community. *Adapt Phys Activ Q.* 2009;26(2):102-117.
48. Guchan Z, Bayramlar K, Ergun N. Determination of the effects of playing soccer on physical fitness in individuals with transtibial amputation. *J Sports Med Phys Fitness.* 2017;57(6):879-886.
49. Hammer A, Nilsagard Y, Forsberg A, Pepa H, Skargren E, Oberg B. Evaluation of therapeutic riding (Sweden)/hippotherapy (United States). A single-subject experimental design study replicated in eleven patients with multiple sclerosis. *Physiother Theory Pract.* 2005;21(1):51-77.
50. Hanson CS, Nabavi D, Yuen HK. The effect of sports on level of community integration as reported by persons with spinal cord injury. *Am J Occup Ther.* 2001;55(3):332-338.
51. Hawkeswood J, Finlayson H, O'Connor R, Anton H. A pilot survey on injury and safety concerns in international sledge hockey. *Int J Sports Phys Ther.* 2011;6(3):173-185.
52. Hawkins BL, Cory AL, Crowe BM. Effects of participation in a Paralympic military sports camp on injured service members: implications for theraputic recreation. *Ther Recreation J.* 2011;45(4):309-325.
53. Haykowsky MJ, Warburton DER, Art Quinney H. Pain and injury associated with powerlifting training in visually impaired athletes. *J Vis Impair Blind.*. 1999;93(4):236-241.
54. Herzog T, Swanenburg J, Hupp M, Mittaz Hager AG. Effect of indoor wheelchair curling training on trunk control of person with chronic spinal cord injury: a randomised controlled trial. *Spinal Cord Ser Cases.* 2018;4:26.

55. Jaarsma EA, Dekker R, Koopmans SA, Dijkstra PU, B. Geertzen JH. Barriers to and facilitators of sports participation in people with visual impairments. *Adapt Phys Activ Q.* 2014;31(3):240-264.
56. Jaarsma EA, Geertzen JH, de Jong R, Dijkstra PU, Dekker R. Barriers and facilitators of sports in Dutch Paralympic athletes: An explorative study. *Scand J Med Sci Sports.* 2014;24(5):830-836.
57. Jackson DL, Hynninen BC, Caborn DN, McLean J. Electrodiagnostic study of carpal tunnel syndrome in wheelchair basketball players. *Clin J Sport Med.* 1996;6(1):27-31.
58. Johnson RA, Albright DL, Marzolf JR, et al. Effects of therapeutic horseback riding on post-traumatic stress disorder in military veterans. *Mil Med Res.* 2018;5 (1) (no pagination)(3).
59. Jolk C, Dalgas U, Osada N, Platen P, Marziniak M. Effects of sports climbing on muscle performance and balance for patients with multiple sclerosis: A case series. *Int J Ther Rehabil.* 2015;22(8):371-376.
60. Kars C, Hofman M, Geertzen JH, Pepping GJ, Dekker R. Participation in sports by lower limb amputees in the Province of Drenthe, The Netherlands. *Prosthet Orthot Int.* 2009;33(4):356-367.
61. Kim W, Lee L, Lans D, Tostenrude D, Lee K. Perception of employment by the Veterans participating in the National Veterans Wheelchair Games: a survey study. *PM R.* 2018;10(3):263-268.
62. Kurková P, Valkova H, Scheetz N. Factors impacting participation of European elite deaf athletes in sport. *J Sports Sci.* 2011;29(6):607-618.
63. Laferrier JZ, Teodorski E, Cooper RA. Investigation of the impact of sports, exercise, and recreation participation on psychosocial outcomes in a population of Veterans with disabilities: A Cross-sectional Study. *Am J Phys Med Rehabil.* 2015;94(12):1026-1034.
64. Lanning BA, Krenek N. Examining effects of equine-assisted activities to help combat veterans improve quality of life. *J Rehabil Res Dev.* 2013;50(8):vii-xiii.
65. Lape EC, Katz JN, Losina E, Kerman HM, Gedman MA, Blauwet CA. Participant-reported benefits of involvement in an adaptive sports program: a qualitativestudy. *PM R.* 2018;10(5):507-515.
66. Lastuka A, Cottingham M. The effect of adaptive sports on employment among people with disabilities. *Disabil Rehabil.* 2015:1-7.
67. Lindroth JL, Sullivan JL, Silkwood-Sherer D. Does hippotherapy effect use of sensory information for balance in people with multiple sclerosis? *Physiother Theory Pract.* 2015;31(8):575-581.
68. Litchke LG, Hodges JS, Schmidt EA, Lloyd LK, Payne E, Russian CJ. Personal meaning of wheelchair rugby participation by five male athletes. *Ther Recreation J.* 2012;46(1):26-41.
69. Littman AJ, Bouldin ED, Haselkorn JK. This is your new normal: A qualitative study of barriers and facilitators to physical activity in Veterans with lower extremity loss. *Disabil Health J.* 2017;10(4):600-606.
70. Lundberg N, Bennett J, Smith S. Outcomes of adaptive sports and recreation participation among Veterans returning from combat with acquired disability. *Ther Recreation J.* 2011;45(2):105-120.
71. Macdougall H, O'Halloran P, Sherry E, Shields N. Needs and strengths of Australian para-athletes: identifying rheir subjective psychological, social, and physical health and well-being. *Sport Psychol.* 2016;30(1):1-12.

72. Magno e Silva M, Bilzon J, Duarte E, Gorla J, Vital R. Sport injuries in elite paralympic swimmers with visual impairment. *J Athl Train.* 2013;48(4):493-498.
73. Magno e Silva M, Morato, Bilzon JLJ, Duarte E. Sports injuries in Brazilian blind footballers. *Int J Sports Med.* 2013;34(3):239-243.
74. Magno e Silva M, Winckler C, Costa e Silva A, Bilzon J, Duarte E. Sports injuries in Paralympic track and field athletes with visual impairment. *Med Sci Sports Exerc.* 2013;45(5):908-913.
75. Malinowski K, Yee C, Tevlin JM, et al. The effects of equine-assisted activities therapy on plasma cortisol and oxytocin concentrations and heart rate variability in horses and measures of symptoms of posttraumatic stress disorder in Veterans. *J Equine Vet Sci.* 2018;64:17-26.
76. McVeigh SA, Hitzig SL, Craven BC. Influence of sport participation on community integration and quality of life: A comparison between sport participants and non-sport participants with spinal cord injury. *J Spinal Cord Med.* 2009;32(2):115-124.
77. Miki Y, Kanayama C, Nakashima S, Yamasaki M. Health-related quality of life in active persons with spinal cord injury. *Jpn Phys Fit Sports Med.* 2012;61(2):177-182.
78. Molik B, Zubala T, Słyk K, Bigas G, Gryglewicz A, Kucharczyk B. Motivation of the disabled to participate in chosen Paralympics events (wheelchair basketball, wheelchair rugby, and boccia). *Physiotherapy / Fizjoterapia.* 2010;18(1):42-51.
79. Mowatt RA, Bennett J. War narratives: Veteran stories, PTSD effects, and therapeutic fly-fishing. *Ther Recreation J.* 2011;45(4):286-308.
80. Munoz-Lasa S, Ferriero G, Valero R, Gomez-Muniz F, Rabini A, Varela E. Effect of therapeutic horseback riding on balance and gait of people with multiple sclerosis. *G Ital Med Lav Ergon.* 2011;33(4):462-467.
81. Muraki S, Tsunawake N, Hiramatsu S, Yamasaki M. The effect of frequency and mode of sports activity on the psychological status in tetraplegics and paraplegics. *Spinal Cord.* 2000;38(5):309-314.
82. Nam JS, Lee KE, Jun AY, Parke CS, Kim HY, Chae YH. Dilemmas of Korean athletes with a spinal cord injury to participate in sports: a survey based on the ICF Core Set for Spinal Cord Injury. *Ann Phys Rehabil Med.* 2016;40(5):893-901.
83. Nettleton L, Hassett L, Scheibe F, Price R, Kirkham C, Sherrington C. Sport and physical activity participation among people with disabilities reported at a sports exhibition and six months later. *Ther Recreation J.* 2017;51(3):206-220.
84. Olenik LM, Matthews JM, Steadward RD. Women, disability and sport: unheard voices. *Can Womens Stud.* 1995;15(4):54-57.
85. O'Neill SB, Maguire S. Patient perception of the impact of sporting activity on rehabilitation in a spinal cord injuries unit. *Spinal Cord.* 2004;42(11):627-630.
86. Perrier MJ, Latimer-Cheung AE, Ginis KAM. An investigation of seasonal variation in leisure-time physical activity in persons with spinal cord injury. *Spinal Cord.* 2012;50(7):507-511.
87. Perrier MJ, Shirazipour CH, Latimer-Cheung AE. Sport participation among individuals with acquired physical disabilities: group differences on demographic, disability, and Health Action Process Approach constructs. *Disabil Health J.* 2015;8(2):216-222.
88. Phillips AA, Squair JR, Currie KD, Tzeng YC, Ainslie PN, Krassioukov AV. 2015 ParaPan American Games: autonomic function, but not physical activity, is associated with vascular-cognitive impairment in spinal cord injury. *J Neurotrauma.* 2017;34(6):1283-1288.

89. Pluym SM, Keur TJ, Gerritsen J, Post MW. Community integration of wheelchair-bound athletes: a comparison before and after onset of disability. *Clin Rehabil.* 1997;11(3):227-235.
90. Ponchillia PE, Strause B, Ponchillia SV. Athletes with visual impairments: Attributes and sports participation. *Journal of Visual Impairment and Blindness.* 2002;96(4):267-272.
91. Prokopowicz G, Molik B, Prokopowicz K, et al. Motives for participation in Paralympic sailing - opinions of Polish and foreign athletes with physical disabilities. *Postepy Rehabilitacji.* 2016;30(3):17-26.
92. Rauch A, Fekete C, Oberhauser C, Marti A, Cieza A. Participation in sport in persons with spinal cord injury in Switzerland. *Spinal Cord.* 2014;52(9):706-711.
93. Rogers CM, Mallinson T, Peppers D. High-intensity sports for posttraumatic stress disorder and depression: feasibility study of ocean therapy with veterans of Operation Enduring Freedom and Operation Iraqi Freedom. *Am J Occup Ther.* 2014;68(4):395-404.
94. Sá MM, Azevedo R, Martins MC, Machado O, Tavares J. Accessibility of sports facilities for persons with reduced mobility and assessment of their motivation for practice. *Work.* 2012;41 Suppl 1:2017-2023.
95. Scarpa S. Physical self-concept and self-esteem in adolescents and young adults with and without physical disability: the role of sports participation. *Eur J Adap Phys Act.* 2011;4(1):38-53.
96. Schachten T, Jansen P. The effects of golf training in patients with stroke: A pilot study. *Int Psychogeriatr.* 2015;27(5):865-873.
97. Shatil S, Ivanova TD, Mochizuki G, Garland SJ. Effects of therapeutic golf rehabilitation on golf performance, balance, and quality of life in individuals following stroke: pilot study. *Physiother Canada.* 2005;57(2):101-112.
98. Shimizu Y, Mutsuzaki H, Tachibana K, et al. A survey of deep tissue injury in elite female wheelchair basketball players. *J Back Musculoskelet Rehabil.* 2017;30(3):427-434.
99. Silkwood-Sherer D, Warmbier H. Effects of hippotherapy on postural stability, in persons with multiple sclerosis: a pilot study. *J Neurol Phys Ther.* 2007;31(2):77-84.
100. Silveira SL, Ledoux T, Cottingham M, Hernandez DC. Association among practice frequency on depression and stress among competitive US male wheelchair rugby athletes with tetraplegia. *Spinal Cord.* 2017;55(10):957-962.
101. Skordilis EK, Koutsouki D, Asonitou K, Evans E, Jensen B, Wall K. Sport orientations and goal perspectives of wheelchair athletes. *Adapt Phys Activ Q.* 2001;18(3):304-315.
102. Skučas K. Obstacles and possibilities for participation in sport after spinal cord injury. *Educ Physical Train Sport.* 2013;88(1):82-87.
103. Sporner ML, Fitzgerald SG, Dicianno BE, et al. Psychosocial impact of participation in the National Veterans Wheelchair Games and Winter Sports Clinic. *Disabil Rehabil.* 2009;31(5):410-418.
104. Stephens C, Neil R, Smith P. The perceived benefits and barriers of sport in spinal cord injured individuals: a qualitative study. *Disabil Rehabil.* 2012;34(24):2061-2070.
105. Tasiemski T, Brewer BW. Athletic identity, sport participation, and psychological adjustment in people with spinal cord injury. *Adapt Phys Activ Q.* 2011;28(3):233-250.
106. Tasiemski T, Kennedy P, Gardner BP, Blaikley RA. Athletic identity and sports participation in people with spinal cord injury. *Adapt Phys Activ Q.* 2004;21(4):364-378.

107. Tasiemski T, Kennedy P, Gardner BP, Taylor N. The association of sports and physical recreation with life satisfaction in a community sample of people with spinal cord injuries. *NeuroRehabilitation.* 2005;20(4):253-265.
108. Tasiemski T, Wilski M, Mędak K. An assessment of athletic identify in blind and able-bodies tandem cyclists. *Hum Mov.* 2012;13(2):178-184.
109. Taylor LP, McGruder JE. The meaning of sea kayaking for persons with spinal cord injuries. *Am J Occup Ther.* 1996;50(1):39-46.
110. Urbański P, Bauerfeind J, PokaczajŁO J. Community integration in persons with spinal cord injury participating in team and individual sports. *Trends Sport Sci.*. 2013;20(2):95-100.
111. Ustunkaya O, Edeer AO, Donat H, Yozbatiran N. Shoulder pain, functional capacity and quality of life in professional wheelchair basketball players and non-athlete wheelchair users. *Pain Clinic.* 2007;19(2):71-76.
112. Velikonja O, Curic K, Ozura A, Jazbec SS. Influence of sports climbing and yoga on spasticity, cognitive function, mood and fatigue in patients with multiple sclerosis. *Clin Neurol Neurosurg.* 2010;112(7):597-601.
113. Vella EJ, Milligan B, Bennett JL. Participation in outdoor recreation program predicts improved psychosocial well-being among veterans with post-traumatic stress disorder: a pilot study. *Mil Med.* 2013;178(3):254-260.
114. Vermöhlen V, Schiller P, Schickendantz S, et al. Hippotherapy for patients with multiple sclerosis: A multicenter randomized controlled trial (MS-HIPPO). *Mult Scler J.* 2017;01.
115. Wickham SE, Hanson CS, Shechtman O, Ashton C. A pilot study: attitudes toward leisure and leisure motivation in adults with spinal cord injury. *Occup Ther Health Care.* 2000;12(4):33-50.
116. Wu SK, Williams T. Factors influencing sport participation among athletes with spinal cord injury. *Med Sci Sports Exerc.* 2001;33(2):177-182.
117. Yazicioglu K, Yavuz F, Goktepe AS, Tan AK. Influence of adapted sports on quality of life and life satisfaction in sport participants and non-sport participants with physical disabilities. *Disabil Health J.* 2012;5(4):249-253.
118. You BC, Lee WJ, Lee SH, Jang S, Lee HS. Shoulder disease patterns of the wheelchair athletes of table-tennis and archery: a pilot study. *Ann Phys Rehabil Med.* 2016;40(4):702-709.
119. Zoerink DA, Carter MJ. A case report of a physical activity intervention for adults with stroke. *Ther Recreation J.* 2015;49(3):238-252.
120. Zwierzchowska A, Zebrowska A, Szkwara M. Sports activities and satisfaction of living of men after cervical spinal cord injury. *Pol Ann Med.* 2017;24(2):205-208.
121. Mulligan HF, Hale LA, Whitehead L, Baxter GD. Barriers to physical activity for people with long-term neurological conditions: a review study. *Adapt Phys Activ Q.* 2012;29:243-265.
122. World Health Organization. International Classification of Functioning, Disability and Health (ICF). https://www.who.int/classifications/icf/en/. Accessed 22 February 2019.
123. van der Ploeg HP, van der Beek AJ, van der Woude LHV, van Mechelen W. Physical activity for people with a disability: a conceptual model. *Sports Med.* 2004;34(10):639-649.
124. Gailey RS, Cooper RA. Sports - medicine for the disabled. The time for specialization in prosthetics and orthotics is now. *Prosthet Orthot Int.* 2009;33(3):187-191.