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Part G. Section 11: Understudied Populations

Introduction

The charge to the Physical Activity Guidelines Advisory Committee (PAGAC) was to review existing scientific literature to identify where sufficient evidence exists to develop comprehensive public health physical activity recommendations for all Americans and to target them as necessary for specific segments of the population. The higher levels of chronic disease risk and burden in racial/ethnic and/or lower socioeconomic status (SES) communities, and the growing cultural diversity of the United States, make these population segments a priority in considering such targeting. The primary focus of the PAGAC scientific review was research on primary prevention and health/fitness promotion, not research on the delivery of exercise as a therapy or treatment for specific disease conditions (e.g., physical therapy for musculoskeletal disease or injury, cardiac rehabilitation). However, the PAGAC recognized that many of the health benefits of physical activity for the general population also pertained to many people who have some health condition that typically excludes them from physical activity and health research. Included in these populations are people with various disabilities, women during pregnancy and the postpartum period, and races and ethnicities other than non-Hispanic whites. Therefore, the PAGAC decided to conduct a separate review of the scientific literature focusing on these three populations.

The first part of this chapter reviews the science published since 1995 evaluating the general health and fitness benefits of increased activity in persons with selected physical and cognitive disabilities. The second part provides a brief review of the science regarding physical activity performed by women during pregnancy and the postpartum period. The last section provides an overview of the science addressing the question, “Is there evidence that the physical activity dose for improving health and fitness should differ for people depending upon race or ethnicity?” Each PAGAC subcommittee was asked to consider this question in its review of the literature, but committee members agreed that it would help in better understanding this issue if the available evidence was summarized in this section of the report.

Review of the Science: Health Outcomes Associated With Physical Activity in People With Disabilities

Introduction

The lack of participation in beneficial physical activity is a serious public health concern for all Americans, but it is even more acute for people with disabilities, who are demonstrably at much greater risk of developing the types of serious health problems associated with a sedentary lifestyle. *Healthy People* 2010 outlines current levels of physical activity and exercise for various subpopulations in the United States based on cross-sectional surveys, as well as goals for the year 2010 (1). As shown in Table G11.1, individuals with disabilities are currently much less active than their non-disabled counterparts and participate in less regular and less vigorous physical activity. They also report substantially more secondary conditions that are directly or indirectly associated with their disability but are considered preventable (e.g., fatigue, weight gain, deconditioning, pain) (2).

Table G11.1. Healthy People 2010 (HP 2010) Goals for Increasing Physical Activity in Adults

	With Disabilities	Without Disabilities	HP 2010 Target
No leisure-time physical activity	56%	36%	20%
30 Minutes activity 5+ days per week	12%	16%	30%
20 Minutes vigorous physical activity for cardiorespiratory fitness 3+ days per week	13%	25%	30%

Patterns of low physical activity reported among people with disabilities raise serious concern about their health and well being, particularly as they enter their later years, when the effects of the natural aging process are compounded by years of sedentary living and severe deconditioning (3). Although substantial public health initiatives strive to prevent disease, injury, and *disability*, a growing recognition among public policy experts is the need to address people with disabilities as a target population who can benefit from health promotion activities, including increased participation in physical activity (4;5). Recognizing that people with disabilities are less physically active than the general population (6;7), have poorer health status (8), and in particular, are more likely to experience chronic and secondary conditions such as obesity, pain, fatigue, and depression (2), an examination of the existing evidence associated with the effects of physical activity in people with disabilities is urgently needed (9). A first step in this process is to (a) determine whether people with disabilities receive similar cardiovascular, musculoskeletal, metabolic, mental and functional health benefits as people without disabilities, and (b) understand if these benefits outweigh the risks of physical activity in these populations.

Overview of the Questions Asked

Eight categories of physical disability, 3 categories of cognitive disability, and 1 group of combined disabilities are the focus of this review (Table G11.2). These groups were selected because of the higher volume of research identified on these populations compared to other groups, such as spina bifida and polio, where very few research studies were identified.

Table G11.2. Categories of Disability

Physical Disabilities	Cognitive Disabilities	Combined Disabilities
1. Lower limb loss 2. Cerebral palsy 3. Multiple sclerosis 4. Muscular dystrophy 5. Parkinson's disease 6. Spinal cord injury 7. Stroke 8. Traumatic brain injury	1. Alzheimer's disease 2. Intellectual disability including Down syndrome 3. Mental illness	1. Two or more disability groups in same study

For these categories, the following questions were asked:

1. What is the evidence that physical activity improves cardiorespiratory fitness in people with disabilities?
2. What is the evidence that physical activity improves lipid profiles in people with disabilities?
3. What is the evidence that physical activity improves musculoskeletal health in people with disabilities?
4. What is the evidence that physical activity improves functional health in people with disabilities?
5. What is the evidence that physical activity reduces secondary conditions in people with disabilities?
6. What is the evidence that physical activity helps maintain healthy weight and improves metabolic health in people with disabilities?
7. What is the evidence that physical activity improves mental health in people with disabilities?

Following these discussions, the chapter addresses the safety concerns and complications associated with physical activity in people with physical and cognitive disabilities.

Data Sources and Process Used To Answer Questions

The *Physical Activity Guidelines for Americans* Scientific Database (see ***Part F: Scientific Literature Database Methodology*** for a detailed description of the Database and its development) included only a few manuscripts that evaluated the effects in populations with disabilities. Thus, a comprehensive literature review was conducted using the MEDLINE and CINAHL databases. Two abstractors combined several keywords associated with disability and physical activity or exercise. Reference lists in each individual article were also reviewed for additional articles, including meta-analytic articles and systematic review articles. The articles were included if they met the following inclusion criteria:

- Written in English;
- Publication date between January 1995 and November 2007;
- Subjects had one of the 11 disabilities listed in Table G11.2;
- Physical activity was the primary exposure variable;
- Covered the health outcomes listed in the preceding questions; and
- Peer-reviewed.

Studies were excluded if they: (1) involved therapeutic exercise modalities available primarily at a medical facility, such as body weight supported treadmill training or functional electrical stimulation, as the main exposure variable; (2) used single bouts of exercise; or (3) were conducted using qualitative methods or case study.

Each of the identified studies was classified into 3 types of study design: Randomized controlled trial (RCT), non-randomized trial with control group, and pre/post-test with no control group. RCT is listed as the highest level of evidence; non-randomized trials with a control group as middle level of evidence; and pre/post designs with no control group as the lowest level of evidence (10). No cross-sectional, retrospective observational, or prospective observational studies were included in the review.

Data Extraction

A total of 139 articles published between 1995 and 2007 and that met all inclusion criteria were identified and reviewed for this report. Data were independently extracted by 2 reviewers who have backgrounds in disability and rehabilitation using the following categories:

- **Participants/Subjects:** Number recruited; number analyzed; age; disability type; disability characteristics; number of years of disability before intervention.
- **Interventions:** Type of training (i.e., aerobic, strength, flexibility); exercise mode; training frequency; training duration; length of intervention; program progression; attendance and/or compliance; description of control condition.

- **Setting:** Supervised or unsupervised; home or community.
- **Outcome Measures:** Health outcomes associated with the intervention and divided into six categories: cardiorespiratory, musculoskeletal, metabolic including body weight, mental, functional, and secondary conditions.

Figure G11.1 illustrates the number and design type of reviewed trials by disability group. Trials investigating the effects of exercise on people with Stroke had the most number of intervention-related exercise articles (n=23), while lower limb loss had the lowest number of identified articles (n=2).

Types of Evidence

The type of available evidence used in this report to determine the effects of exercise on health outcomes in people with physical or cognitive disabilities was based on a modification of the criteria used by the US Agency for Healthcare Research and Quality (AHRQ, formerly known as the US Agency for Health Care Policy and Research) (11). We did not review the quality of each study (e.g., power, intent-to-treat, different testers on pre/post outcomes) as recommended by AHRQ and we also changed the categories of evidence to parallel the work of the Committee. Non-randomized trials were collapsed under the category of Pre/Post Studies with no Control Group (i.e., Non-RCT).

Level of Evidence

Type 1: Two or more RCTs with positive results and no studies reported significant negative effects.

Type 2a: One RCT with positive results and no studies reported significant negative effects.

Type 2b: At least one Non-RCT with positive results and no studies with significant negative effects.

Type 3a: Well designed prospective cohort studies and case-control studies.

Type 3b: Other observational studies – weak prospective cohort studies or case-control studies; cross-sectional studies or case series.

Type 4: Non-significant findings or no studies investigating the effects of exercise on people with disabilities.

Figure G11.1. Number of Articles Identified by Disability Group and Design (N=139)

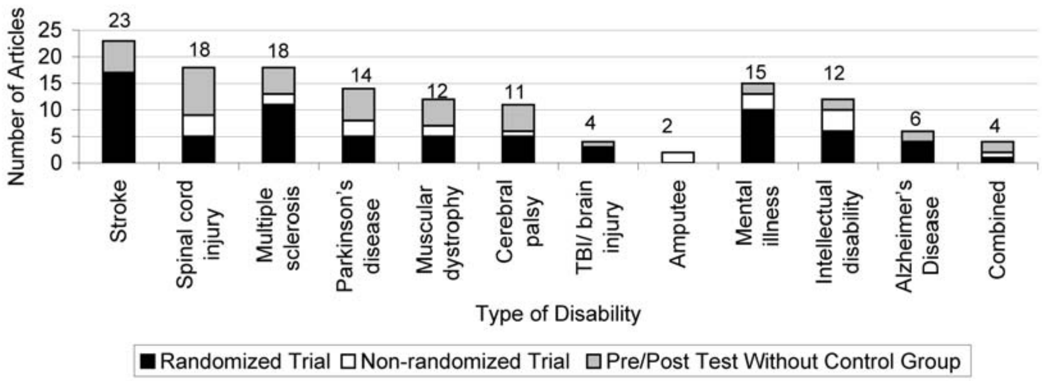

Figure G11.1. Data Points

Categories	Type of Disability	Randomized Trial	Non-Randomized Trial	Pre/Post Test Without Control Group
Neuromuscular	Stroke	17	0	6
Neuromuscular	Spinal cord injury	5	4	9
Neuromuscular	Multiple sclerosis	11	2	5
Neuromuscular	Parkinson's disease	5	3	6
Neuromuscular	Muscular dystrophy	5	2	5
Neuromuscular	Cerebral palsy	5	1	5
Neuromuscular	TBI/brain injury	3	0	1
Neuromuscular	Amputee	0	2	0
Cognitive	Mental illness	10	3	2
Cognitive	Intellectual disability	6	4	2
Cognitive	Alzheimer's Disease	4	0	2
Mixed	Combined	1	1	2
Total	**–**	72	22	45

Question 1. What Is the Evidence That Physical Activity Improves Cardiorespiratory Fitness in People With Disabilities?

Conclusions

Type 1 evidence indicates that cardiorespiratory fitness can be improved in people with Lower Limb Loss, Multiple Sclerosis, Spinal Cord Injury, Stroke, and Mental Illness. Type 2a evidence provides the same findings for people with Traumatic Brain Injury and Intellectual Disability, type 2b evidence provides these findings in persons with Cerebral Palsy, Muscular Dystrophy, and Alzheimer's Disease, and type 4 is indicative of no data or non-significant findings on Parkinson's Disease. Overall, the evidence is highly supportive of the use of physical activity in improving cardiorespiratory fitness among people with physical and cognitive disabilities.

Rationale

Twenty-one RCTs targeted improvements in cardiorespiratory fitness in persons with physical and cognitive disabilities (Table G11.3). Of these 21 RCTs, 18 (86%) reported significant favorable cardiorespiratory fitness outcomes. Of 25 non-RCTs, 21 (84%) reported significant favorable cardiorespiratory fitness outcomes.

Table G11.3. Physical Activity and Cardiorespiratory Fitness in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	2(12;13)	–	–	–	●	–	–	–
Physical: Cerebral Palsy	–	–	1(14)	–	–	–	●	–
Physical: Multiple Sclerosis	4(15-18)	1(19)	1(20)	1(21)	●	–	–	–
Physical: Muscular Dystrophy	–	–	4(22-25)	1(26)	–	–	●	–
Physical: Parkinson's Disease	–	–	–	–	–	–	–	●
Physical: Spinal Cord Injury	2(27;28)	–	7(29-35)	2(36;37)	●	–	–	–
Physical: Stroke	6(38-43)	–	1(44)	–	●	–	–	–
Physical: Traumatic Brain Injury	1(45)	–	1(46)	–	–	●	–	–

Table G11.3. Physical Activity and Cardiorespiratory Fitness in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Cognitive: Alzheimer's Disease	–	–	2(47;48)	–	–	–	●	–
Cognitive: Intellectual Disability	1(49)	1(50)	2(51;52)	–	–	●	–	–
Cognitive: Mental Illness[c]	2(53;54)	1(55)	–	–	●	–	–	–
Combined	–	–	2(56;57)	–	–	–	•	–

[a] S, Significant findings; [b] NS, Non-significant findings; [c] Major depression disorder

Question 2. What Is the Evidence That Physical Activity Improves Lipid Profiles in People With Disabilities?

Conclusions

The evidence on the use of physical activity for cardiovascular risk reduction is less clear than it is for cardiorespiratory fitness. Two RCTs and 2 non-RCTs reported significant reductions in total cholesterol and triglycerides, and two non-RCTs found no differences in cholesterol reduction after the exercise intervention.

Rationale

Health outcomes targeted in these studies included triglycerides and total cholesterol. Among persons with physical disabilities, 3 (75%) of 4 studies showed reduction in cholesterol (spinal cord injury) and triglycerides (multiple sclerosis) (Table G11.4). Among persons with cognitive disability, 1 (50%) of 2 studies reported reduction in triglycerides (mental illness). In 3 of the 4 studies, subjects had high cholesterol and triglycerides at baseline.

Table G11.4. Physical Activity and Lipid Profiles in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis[c]	1(17)	–	1(58)	–	–	●	–	–
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	●
Physical: Parkinson's Disease	–	–	–	–	–	–	–	●
Physical: Spinal Cord Injury[d]	–	–	1(33)	1(30)	–	–	●	–
Physical: Stroke	–	–	–	–	–	–	–	●
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	–	–	–	–	–	–	–	●
Cognitive: Intellectual Disability[d]	–	–	–	1(59)	–	–	–	●
Cognitive: Mental Illness[c]	1(60)	–	–	–	–	●	–	–
Combined	–	–	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c] Triglycerides; [d] Total cholesterol

Question 3. What Is the Evidence That Physical Activity Improves Musculoskeletal Health in People With Disabilities?

Conclusions

Type 1 evidence indicates that resistance exercise, aerobic exercise, or a combination of resistance and aerobic exercise all increase muscle strength in various subgroups with physical and cognitive disabilities. Although less evidence exists on flexibility interventions for the 11 population subgroups, in the 4 RCTs conducted on individuals with Parkinson's disease (n=1), Stroke (n=2) and Traumatic Brain Injury (n=1), findings were significant for each disability group. Of the 4 non-RCTs on flexibility training, 2 studies, which involved subjects with Spinal Cord Injury and Combined Disabilities (i.e., physical and intellectual disabilities), were found to be significant. The other two non-RCTs were not significant in persons with Multiple Sclerosis and Intellectual Disability. Type 1 evidence finds that flexibility can be improved in persons with Stroke, and type 2a evidence finds that it can be improved in persons with Parkinson's disease and Traumatic Brain Injury.

Type 2a evidence exists on the use of exercise in improving bone mineral density (BMD) in people with physical and cognitive disabilities. Only 2 studies were identified that used an exercise exposure to improve BMD, one in youth with Cerebral Palsy and the other study on adults with unilateral Stroke. Both studies supported the use of exercise in improving BMD in these populations, but more evidence is needed to determine whether these findings will be supported by further studies.

Rationale

Muscle Strength

Table G11.5 summarizes the 37 exercise interventions addressing improvements in muscle strength. Of the 17 RCTs, 14 (82%) studies reported significant positive effects. Of the 20 non-RCTs, 19 (95%) trials reported significant improvements in muscle strength.

Flexibility

Table G11.6 summarizes the intervention research on flexibility. Four RCTs targeted improvements in flexibility in persons with physical disabilities. All 4 (100%) studies reported significant positive findings. Of the 4 non-RCTs, 2 (50%) reported significant improvements in flexibility.

Bone Mineral Density

Two studies found in the literature used exercise to improve BMD in people with disabilities. In the first study (RCT), children with cerebral palsy were exposed to a program of various types of upper and lower extremity exercises. The program consisted of 1 hour-long session per week for 8 weeks, which was increased to 3 sessions per week for the next 24 weeks. The program showed significant improvement in BMD compared to controls (61). In the second RCT, researchers concluded that exercise can slow the decline in bone loss in the affected femoral neck of people with unilateral Stroke (41).

Table G11.5. Physical Activity and Muscle Strength in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	1(62)	1(63)	5(64-68)	–	–	●	–	–
Physical: Multiple Sclerosis	2(17;69)	-	1(70)	–	●	–	–	–
Physical: Muscular Dystrophy[c]	1(71)	1(72)	1(73)	–	–	●	–	–
Physical: Parkinson's Disease	1(74)	–	1(75)	–	–	●	–	–
Physical: Spinal Cord Injury	1(76)	–	5 (20;34;36;40;77)	–	–	●	–	–
Physical: Stroke	5 (38;41;43;78;79)	–	3(80-82)	–	●	–	–	–
Physical: Traumatic Brain Injury	–	1(83)	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	–	–	1(47)	–	–	–	●	–
Cognitive: Intellectual Disability	3(49;84;85)	–	–	1(86)	●	–	–	–
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	–	2(57;87)	–	–	–	●	–

[a]S, Significant findings; [b]NS, Non-significant findings; [c]NS in Myotonic Dystrophy group, S in Charcot-Marie-Tooth group; reference was counted only one time.

Table G11.6. Physical Activity and Flexibility in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis	–	–	–	1(88)	–	–	–	●
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	●
Physical: Parkinson's Disease	1(89)	–	–	–	–	●	–	–
Physical: Spinal Cord Injury	–	–	1(37)	–	–	–	●	–
Physical: Stroke	2(43;90)	–	–	–	●	–	–	–
Physical: Traumatic Brain Injury	1(45)	–	–	–	–	●		
Cognitive: Alzheimer's Disease	–	–	–	–	–	–	–	●
Cognitive: Intellectual Disability	–	–	–	1(86)	–	–	–	●
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	–	1(57)	–	–	–	●	–

[a] S, Significant findings; [b] NS, Non-significant findings

Question 4. What Is the Evidence That Physical Activity Improves Functional Health in People With Disabilities?

Conclusions

Functional health has a broad association with several performance measures associated with basic and instrumental activities of daily living (ADL and IADL). This includes walking speed, walking distance, quality of life, functional independence, and balance. Evidence from a variety of studies supports the use of exercise to improve walking speed and distance and other measures of functional health across a range of disabilities.

A total of 74 interventions targeted one or more measures of functional health under the categories of walking speed, walking distance, quality of life/well-being, functional independence, and balance. These studies provided type 1 evidence (Table G11.7) for the use of exercise in improving walking speed in persons with Multiple Sclerosis, Stroke, and Intellectual Disability, type 2a evidence for the use of exercise in persons with Parkinson's disease and Alzheimer's disease, and type 2b evidence for the use of exercise in persons with Cerebral Palsy and Spinal Cord Injury (where the propulsion speed of pushing a wheelchair is used as an equivalent to walking speed). The studies provided type 1 evidence that walking distance can be improved in persons with Multiple Sclerosis, Stroke, and Intellectual Disability (Table G11.8) and type 2a evidence that walking speed can be improved in people with Parkinson's disease. On Quality of Life (Table G11.9), the studies provided type 1 evidence to support exercise for people with Multiple Sclerosis, Spinal Cord Injury, and Stroke and type 2a evidence to support exercise in people with Muscular Dystrophy, Alzheimer's disease, Intellectual Disability, and Mental Illness. For Functional Independence (Table G11.10), the studies provided type 1 evidence supporting the use of exercise in people with Stroke and type 2a evidence supporting exercise in people with Multiple Sclerosis, Parkinson's disease, Traumatic Brain Injury, and Alzheimer's disease. For Balance (Table G11.11), the studies provided type 1 evidence supporting the use of exercise in improving balance only in people with Parkinson's disease and Stroke. The studies had type 2b or 4 evidence for the other disability subgroups.

Rationale

Walking Speed

Table G11.7 summarizes the 35 intervention studies that used walking speed as a health outcome. Of the 19 RCTs, 13 (68%) reported significant increases in walking speed. Of the 16 Non-RCTs, 10 (63%) reported significant increases in walking speed.

Table G11.7. Physical Activity and Walking Speed in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	1(91)	2(64;66)	2(65;67)	–	–	●	–
Physical: Multiple Sclerosis	3 (18;92;93)	1(69)	1(94)	3 (70;88;95)	●	–	–	–
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	●

Table G11.7. Physical Activity and Walking Speed in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Parkinson's Disease	1(96)	–	2(97;98)	–	–	●	–	–
Physical: Spinal Cord Injury[c]	–	–	1(77)	–	–	–	●	–
Physical: Stroke	6 (38;39;79;99-101)	3 (78;102;103)	3 (80;104;105)	1(82)	●	–	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	1(106)	–	–	–	–	●	–	–
Cognitive: Intellectual Disability	2(107;108)	–	1(109)	–	●	–	–	–
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	1(110)	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c] Specific to propulsion speed pushing a wheelchair

Walking Distance

Table G11.8 summarizes the 18 interventions that used walking distance as an outcome. Of the 13 RCTs, 10 (77%) reported significant increases in walking distance. Of the five Non-RCTs, four (80%) reported significant increases in walking distance.

Table G11.8. Physical Activity and Walking Distance in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis	2 (18;111)	–	1(94)	–	●	–	–	–

Table G11.8. Physical Activity and Walking Distance in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Muscular Dystrophy	–	–	-	–	–	–	–	●
Physical: Parkinson's Disease	1(96)	–	1(112)	–	–	●	–	–
Physical: Spinal Cord Injury	–	–	–	–	–	–	–	●
Physical: Stroke	4 (39;41;99;100)	1(101)	1(104)	1(105)	●	–	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	–	1(113)	1(47)	–	–	–	●	–
Cognitive: Intellectual Disability[c]	3 (50;107;108)	–	–	–	●	–	–	–
Cognitive: Mental Illness[d]	–	1(114)	–	–	–	–	–	●
Combined	–	–	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c] Down syndrome; [d] Schizophrenia

Quality of Life and Well-Being

Table G11.9 summarizes the 27 interventions on quality of life/well-being. Of the 19 RCTs, 13 studies (68%) reported significant positive findings. Seven (88%) of the eight non-RCTs (n=8) demonstrated significant improvements in quality of life or well-being.

Table G11.9. Physical Activity and Quality of Life in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●

Table G11.9. Physical Activity and Quality of Life in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Multiple Sclerosis[c]	3 (18;19;115)	3 (15;18;84)	1(21)	1(88)	●	–	–	–
Physical: Muscular Dystrophy	1(116)	1(117)	1(25)	–	–	●	–	–
Physical: Parkinson's Disease	–	1(118)	3 (98;119;120)	–	–	–	●	–
Physical: Spinal Cord Injury	2(76;121)	–	–	–	●	–	–	–
Physical: Stroke[d]	4 (79;90;103;122)	1(90)	–	–	●	–	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	1(123)	–	–	–	–	●	–	–
Cognitive: Intellectual Disability	1(124)	–	1(109)	–	–	●	–	–
Cognitive: Mental Illness	1(125)	–	1(126)	–	–	●	–	–
Combined	–	–	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c]One RCT(18) showed a significant finding in well-being (measured by the emotional well-being subscore in the Multiple Sclerosis Quality of Life-54 scale) but a non-significant finding in quality of life (measured by the overall score in the Multiple Sclerosis Quality of Life-54); [d]One RCT(90) reported a significant finding in well-being measured by the Profile of Mood States instrument) but a non-significant finding in quality of life (measured by the Stroke Specific Quality of Life Scale).

Functional Independence

Table G11.10 summarizes the 35 interventions on functional independence, which was primarily measured by an assessment of ADL, and IADL or motor function (i.e., motor control, function of upper/lower extremity, motor skills). A total of 17 RCTs targeted improvements in functional independence primarily in people with physical disabilities (14 of the 17 RCTs). Out of these 17 RCTs, 9 (53%) reported significant outcomes. In addition, 18 non-RCTs targeted people with physical disabilities, and 14 (82%) of these studies reported significant findings on functional independence.

Table G11.10. Physical Activity and Functional Independence in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	1(62)	5(14;64-66;68)	1(67)	–	–	●	–
Physical: Multiple Sclerosis	1(17)	–	–	–	–	●	–	–
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	●
Physical: Parkinson's Disease[c]	1(127)	1(89)	5 (98;120;128-130)	1(129)	–	●	–	–
Physical: Spinal Cord Injury	–	–	2(36;77)	–	–	–	●	–
Physical: Stroke[d]	5 (78;100;101;103;131)	4 (78;99;101;102)	2(104;105)	2(80;82)	●	–	–	–
Physical: Traumatic Brain Injury	1(83)	–	–	–	–	●	–	–
Cognitive: Intellectual Disability	–	–	–	–	–	–	–	●
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	1(110)	–	–	–	–	–	●

[a] S, Significant findings, [b] NS, Non-significant findings, [c] one Non-RCT (129) showed a significant finding in motor function but a non-significant finding in functional independence; [d] two RCTs (78;101) reported a significant finding in motor function in the lower extremity but a non-significant finding on functional independence.

Balance

Table G11.11 summarizes the 21exercise interventions on balance. Of the 13 RCTs, 6 (46%) reported significant findings. Of the 8 non-RCTs, 6 (75%) reported significant positive findings. The majority of studies were conducted on Parkinson's disease and Stroke.

Table G11.11. Physical Activity and Balance in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	1(64)	–	–	–	●	–
Physical: Multiple Sclerosis	–	1(69)	–	–	–	–	–	●
Physical: Muscular Dystrophy	–	1(116)	–	–	–	–	–	●
Physical: Parkinson's Disease[c]	4 (74;89;96;118)	1(118)	1(98)	1(129)	●	–	–	–
Physical: Spinal Cord Injury	–	–	–	1(132)	–	–	–	●
Physical: Stroke	2 (39;133)	3 (38;41;101)	3 (82;104;105)	–	●	–	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	–	–	–	–	–	–	–	●
Cognitive: Intellectual Disability	–	–	1(109)	–	–	–	●	–
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	1(110)	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c] One RCT (118) under Parkinson's disease indicated a lower prevalence of falls among the exercise group compared to the control group but also reported a non-significant finding on the Berg Balance Score.

Question 5. What Is the Evidence that Physical Activity Reduces Secondary Conditions in People With Disabilities?

Conclusions

Type 1 evidence exists for the use of exercise in reducing fatigue in people with Multiple Sclerosis, type 2a evidence supports exercise in persons with Muscular Dystrophy, and type 4 evidence supports exercise in the remaining subgroups. In addition, type 1 evidence indicates that pain can be reduced in people with Spinal Cord Injury, type 2a evidence based on one study has similar findings for people with Down syndrome, and type 4 evidence exists that exercise can reduce pain on the other subgroups.

Introduction

Individuals with disabilities are likely to be at increased risk for a number of preventable health problems referred to as *secondary conditions*. According to Chapter 6 of the *Healthy People 2010* report (1), secondary conditions are defined as "...physical, medical, cognitive, emotional, or psychosocial consequences to which persons with disabilities are more susceptible by virtue of an underlying impairment, including adverse outcomes in health, wellness, participation and quality of life (p. 163)." Several secondary conditions are prominent among people with disabilities, and pain and fatigue are reported to be two of the most common secondary conditions observed in people with physical and cognitive disabilities (9).

Rationale

Fatigue

Table G11.12 summarizes the 10 interventions on fatigue. Of the 8 RCTs, 4 (50%) reported significant positive health outcomes. Of the 2 non-RCTs, both (100%) showed significant positive reductions in fatigue. The major target subgroup was persons with Multiple Sclerosis.

Table G11.12. Physical Activity and Fatigue Reduction in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis	3 (17;115;134)	3 (18;19;135)	2 (21;70)	–	●	–	–	–
Physical: Muscular Dystrophy	1(117)	–	–	–	–	●	–	–
Physical: Parkinson's Disease	–	–	–	–	–	–	–	●
Physical: Spinal Cord Injury	–	–	–	–	–	–	–	●

Table G11.12. Physical Activity and Fatigue Reduction in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Stroke	–-	–	–	–	–	–	–	●
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	–	–	–-	–	–	–	–	●
Cognitive: Intellectual Disability	–	–	–	–	–	–	–	●
Cognitive: Mental Illness	–	–	–	–	–	–	–	●
Combined	–	1(136)	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings

Pain

Table G11.13 summarizes the evidence on 5 exercise interventions targeting musculoskeletal pain. Two RCTs and 2 non-RCTs indicated significant reductions in pain in people with Spinal Cord Injury. Three studies targeted reduction in shoulder pain in persons with Spinal Cord Injury, and the other study evaluated general pain. Only one RCT involving individuals with cognitive disabilities was identified, and this study reported significant reductions in pain associated with intermittent claudication in persons with Down syndrome.

Table G11.13. Physical Activity and Pain Reduction in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	–
Physical: Cerebral Palsy	–	–	–	–	–	–	–	–
Physical: Multiple Sclerosis	–	–	–	–	–	–	–	–
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	–

Table G11.13. Physical Activity and Pain Reduction in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Parkinson's Disease	–	–	–	–	–	–	–	–
Physical: Spinal Cord Injury	2 (76;121)	–	2 (34;137)	–	●	–	–	–
Physical: Stroke	–	–	–	–	–	–	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	–
Cognitive: Alzheimer's Disease	–	–	–	–	–	–	–	–
Cognitive: Intellectual Disability[c]	1(108)	–	–	–	–	●	–	–
Cognitive: Mental Illness	–	–	–	–	–	–	–	–
Combined	–	–	–	–	–	–	–	–

[a] S, Significant findings; [b] NS, Non-significant findings; [c]People with Down syndrome who suffered from intermittent claudication

Question 6. What Is the Evidence That Physical Activity Helps Maintain Healthy Weight and Improve Metabolic Health?

Conclusions

Type 2a evidence indicates that exercise can improve body composition in persons with Stroke, Intellectual Disability, Mental Illness, Traumatic Brain Injury, and a combined group of individuals with different types of physical disabilities. Type 4 evidence suggests the same finding for the remaining disability subgroups. On metabolic factors, type 2a evidence exists for improvements in fasting glucose and insulin sensitivity in two disability subgroups (Stroke and Mental Illness) and type 4 evidence shows the same result for the remaining subgroups.

Rationale

Body Composition

Table G11.14 summarizes the 19 interventions on body composition including those focused on body weight, body fat, body mass index (BMI), and waist circumference. Of the 10 RCTs, 5 studies (50%) reported significant positive effects in decreasing body weight. Of the 9 non-RCTs, 2 (22%) reported significant positive findings on body composition.

Table G11.14. Physical Activity and Body Composition in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis	–	1(17)	–	1(58)	–	–	–	●
Physical: Muscular Dystrophy	–	–	–	1(138)	–	–	–	●
Physical: Parkinson's Disease	–	–	–	–	–	–	–	●
Physical: Spinal Cord Injury	–	–	–	3 (33;77;139)	–	–	–	●
Physical: Stroke	1(43)	1(40)	–	–	–	●	–	–
Physical: Traumatic Brain Injury	1(45)	–	–	1(46)	–	●	–	–
Cognitive: Alzheimer's Disease	–	–	–	–	–	–	–	●
Cognitive: Intellectual Disability[c]	1(49)	1(50)	–	–	–	●	–	–
Cognitive: Mental Illness[d]	1(60)	2(114)	2(140;141)	1(136)	–	●	–	–
Combined	1(110)	–	–	–	–	●	–	–

[a] S, Significant findings; [b] NS, Non-significant findings; [c] Down syndrome; [d] Schizophrenia

Metabolic Health

Three RCTs also targeted improvements in metabolic factors (fasting glucose, insulin sensitivity, fasting insulin, and insulin-like growth factor-binding protein-3). Two (67%) of these 3 studies reported significant positive findings in people with Stroke (40) and Schizophrenia (60) while one study (33%) reported non-significant findings in people with Spinal Cord Injury (27).

Question 7. What Is the Evidence That Physical Activity Improves Mental Health in People With Disabilities?

Conclusions

Type 1 evidence indicates that exercise can reduce depression in people with Alzheimer's disease and Mental Illness. Type 2a evidence shows the same result in persons with Multiple Sclerosis, Spinal Cord Injury, Stroke, and Intellectual Disability, as does type 4 evidence in the remaining subgroups. The highest level of evidence was reported in people with Mental Illness (6 RCTs reporting significant outcomes). Physical activity also appears to have beneficial effects on several other mental health outcomes including self-esteem, quality of sleep, interpersonal relationships, disruptive behavior, negative symptoms, and anxiety. No type 1 studies were identified for any of these outcomes. However, type 2a evidence was reported for beneficial effects of self-esteem (Muscular Dystrophy, Traumatic Brain Injury, and Intellectual Disability), quality of sleep (Spinal Cord Injury and Alzheimer's disease), interpersonal relationships (Stroke and Mental Illness), and negative symptoms (Mental Illness).

Rationale

Depression

Table G11.15 summarizes the 20 interventions targeting reduction in depression. Out of the 17 RCTs, 12 studies (71%) reported significant reductions in depression. Three non-RCTs (100%) also reported significant reductions in depression.

Table G11.15. Physical Activity and Depression in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	●
Physical: Cerebral Palsy	–	–	–	–	–	–	–	●
Physical: Multiple Sclerosis	1(17)	–	1(21)	–	–	●	–	
Physical: Muscular Dystrophy	–	–	–	–	–	–	–	●
Physical: Parkinson's Disease	–	–	–	–	–	–	–	●
Physical: Spinal Cord Injury	1(121)	1(76)	–	–	–	●	–	–

Table G11.15. Physical Activity and Depression in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Stroke	1(122)	–	–	–	–	●	–	–
Physical: Traumatic Brain Injury	–	–	–	–	–	–	–	●
Cognitive: Alzheimer's Disease	2 (123;142)	1(106)	–	–	●	–	–	–
Cognitive: Intellectual Disability	1(124)	–	–	–	–	●	–	–
Cognitive: Mental Illness	6 (54;55;143-146)	2 (53;125)	1(126)	–	●	–	–	–
Combined	–	1(110)	1(56)	–	–	–	●	

[a] S, Significant findings; [b] NS, Non-significant findings

Other Major Mental Health Outcomes

Table G11.16 summarizes the evidence on 12 exercise interventions targeting other mental health outcomes in persons with disabilities, including self-esteem, quality of sleep, interpersonal relationships, negative psychiatric symptoms, anxiety, and disruptive behavior. In people with Muscular Dystrophy, Traumatic Brain Injury, and Intellectual Disability, the improved health outcome was self-esteem. In people with Spinal Cord Injury and Alzheimer's disease, quality of sleep improved; people with Mental Illness had reduced negative psychiatric symptoms and increased interpersonal relationships; and people with Stroke reported improvements in interpersonal relationships.

Table G11.16. Physical Activity and Other Major Mental Health Outcomes in People With Disabilities

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Lower Limb Loss	–	–	–	–	–	–	–	–
Physical: Cerebral Palsy	–	–	–	–	–	–	–	–

Table G11.16. Physical Activity and Other Major Mental Health Outcomes in People With Disabilities (continued)

Disabilities	Number of Studies [reference] RCT S[a]	Number of Studies [reference] RCT NS[b]	Number of Studies [reference] Non-RCT S	Number of Studies [reference] Non-RCT NS	Type of Evidence 1	Type of Evidence 2a	Type of Evidence 2b	Type of Evidence 4
Physical: Multiple Sclerosis	–	–	–	–	–	–	–	–
Physical: Muscular Dystrophy[c]	1(116)	–	1(24)	–	–	●	–	–
Physical: Parkinson's Disease	–	–	–	–	–	–	–	–
Physical: Spinal Cord Injury[d]	1(147)	–	–	–	–	●	–	–
Physical: Stroke[e]	1(90)	–	–	–	–	●	–	–
Physical: Traumatic Brain Injury[c]	1(83)	–	–	–	–	●	–	–
Cognitive: Alzheimer's Disease[d]	1(142)	–	–	–	–	●	–	–
Cognitive: Alzheimer's Disease[f]	–	1(106)	–	–	–	–	–	●
Cognitive: Intellectual Disability[c]	1(124)	–	–	–	–	●	–	–
Cognitive: Mental Illness[g]	1(145)	–	–	–	–	●	–	–
Cognitive: Mental Illness[e]	1(145)	–	1(148)	–	–	●	–	–
Combined[h]	–	1(110)	–	–	–	–	–	●

[a] S, Significant findings; [b] NS, Non-significant findings; [c] self-esteem; [d] quality of sleep; [e] interpersonal relationships; [f] disruptive behavior; [g] negative symptoms; [h] anxiety

Exercise Doses in the Studies

The majority of studies reviewed in this report included doses of exercise that are typically used in studies targeting the general population. Intensity of cardiorespiratory exercise was set at 50% or higher of target heart rate reserve or VO_{2peak}. Frequency of exercise ranged from 3 to 5 days a week and duration lasted from 30 to 60 minutes per session. The precise quantitative characteristics of the dose-response relationship between improvements in various health outcomes, however, still requires additional research before certain conclusions can be made regarding what doses effect what outcomes in targeted disability groups.

Question 8. What Do We Know About the Safety of Exercise in People With Disabilities?

Introduction

Among some health care professionals, an underlying perception exists that exercise *may* present an increased risk of injury for certain individuals with disabilities. This section provides an overview of the available literature describing issues associated with safety of exercise in people with physical and cognitive disabilities from the 139 articles that the Understudied Populations subcommittee reviewed for this chapter. The 139 exercise trials included 2,961 subjects exposed to an exercise intervention and 1,832 control subjects. The duration of the trials ranged from 1 week to 52 weeks.

Two abstractors carefully reviewed the Methods, Results, and Discussion sections of each article to identify reported side effects or adverse events. In particular, the abstractors focused on the reasons, when available, that the subject withdrew from the study, to determine whether it was related to the exercise exposure. The data are reported in frequencies and percentages and separated by exercise and control groups. The information contained in this section includes the most commonly reported complications or adverse events reported for each disability subgroup.

To determine whether a reported event was considered a complication (not serious) or adverse event (serious), we considered the following criteria from the Office for Human Research Protections (OHRP, 2007) (149): event was (1) undesirable in nature; (2) related or possibly related to the intervention; and (3) harmful to the participant either physically or psychologically. For the purpose of this review, the subcommittee modified these criteria to classify health complications associated with the intervention as *not serious adverse events* and *serious adverse events*. Serious adverse events frequently caused participants to drop out of the study.

What Is the Frequency of Reported Adverse Events Among People With Disabilities in the Exercise and Control Groups?

Adverse events were reported for 53 exercise subjects and 11 control subjects (Table G11.17). The percentage of exercise subjects (1.8%) and control subjects (0.6%) with any reported adverse event was not substantially different. Similarly, the percentage of exercise subjects (1.1%) and control subjects (0.6%) reported to have an adverse event serious enough to cause them to drop out of the study also were not substantially different.

Table G11.17. Number and Percentage of Subjects With Adverse Events by Seriousness of Event and Exposure Group

Exposure Group	Serious[a]	Non-serious	Total
Exercise Groups (n=2961)	34 (1.1%)	19 (0.6%)	53 (1.8%)
Control Groups (n=1832)	11 (0.6%)	0 (0.0%)	11 (0.6%)

[a] Serious adverse events involved those in which the subject dropped out of the study.

What Were the Commonly Reported Adverse Events in Exercise Trials Among People With Disabilities?

This review of evidence identified very few reported adverse events associated with exercise in people with physical and cognitive disabilities. Disability-related risks and activity-related risks are two common issues related to exercise training interventions in people with disabilities (150). We reviewed all the reported serious and non-serious adverse events and arranged them into 4 categories: (a) progression or recurrence of disease (i.e., disability-dependent risks) including recurrent Stroke or Multiple Sclerosis exacerbation, and/or worsening of conditions associated with the disability such as elevated spasticity, bladder spasms, mild seizure, recurrence of inguinal hernia, and increased depression; (b) cardiovascular problems including angina symptoms, dizziness, drop in blood pressure, acute myocardial infarction, and abnormal electrocardiogram; (c) falls; and (d) exercise-related musculoskeletal problems, including muscle soreness, pain, and increased fatigue.

Among the total number of adverse events [serious + non-serious] reported in the exercise group (n=53) (Table G11.18), musculoskeletal problems were the most commonly reported adverse event (n=24, 45%). Falls, cardiovascular problems, and increased fatigue were the other adverse events reported but occurred at a much lower rate. Table G11.18 also illustrates that recurrent Stroke, exacerbation in persons with Multiple Sclerosis, and cardiovascular problems were the major reported adverse events in the control group. A detailed overview of complications for each specific disability group can be found in Table G11.A1 (this table can be accessed at http://www.health.gov/paguidelines/report/).

Table G11.18. Classification, Number, and Percentage of Serious/Non-Serious Adverse Events in Exercise and Control Groups

Classification of Adverse Events	Exercise Group Percent (n/N)	Control Group Percent (n/N)
Progression or Recurrence of Disease: Recurrent stroke[a]	1.1% (6/538)	0.6% (2/335)
Progression or Recurrence of Disease: Mild seizure[a]	0.2 % (1/538)	0.0% (0/335)
Progression or Recurrence of Disease: Recurrence of inguinal hernia[a]	0.2 % (1/538)	0.0% (0/335)

Table G11.18. Classification, Number, and Percentage of Serious/Non-Serious Adverse Events in Exercise and Control Groups (continued)

Classification of Adverse Events	Exercise Group Percent (n/N)	Control Group Percent (n/N)
Progression or Recurrence of Disease: Exacerbations of multiple sclerosis[b]	1.1% (4/363)	1.9% (5/266)
Progression or Recurrence of Disease: Increased spasticity[b]	0.6% (2/363)	0.0% (0/266)
Progression or Recurrence of Disease: Increased depression[c]	0.2% (1/522)	0.0% (0/210)
Progression or Recurrence of Disease: Bladder spasms[d]	0.5 (1/208)	0.0% (0/75)
Falls	0.2% (5/2961)	0.0% (0/1832)
Cardiovascular Problems	0.1% (4/2961)	0.1% (2/1832)
Musculoskeletal Problem: Soreness or pain	0.8% (24/2961)	0.05% (1/1832)
Musculoskeletal Problem: Fatigue	0.1% (4/2961)	0.05% (1/1832)

[a]Includes only subjects in studies of persons with a history of stroke; [b]Includes only subjects in studies of persons with multiple sclerosis; [c]Includes only subjects in studies of persons with mental illness; [d]Includes only subjects in studies of persons with spinal cord injury.

What Adverse Events or Complications Are Concerns for Individuals With Stroke Who Want To Participate in a Physical Activity Program?

People with Stroke can exercise safely without serious adverse events by performing a careful prescreening exam and being supervised during exercise. No data indicate that exercise will increase the rate of recurrent Stroke if the appropriate monitoring and precautions are taken.

Among the 23 reviewed trials in which 538 Stroke survivors participated in some type of exercise intervention, 6 participants (1.1%) experienced a recurrent Stroke (39;103). In controls (n=335), recurrent Stroke occurred in 2 participants (0.6%) (102). The incidence of recurrent Stroke in the exercise group was lower than the incidence rate (2.9% to 6.0%) reported among individuals 3 to 6 months after their Stroke who are not involved in an exercise intervention (101).

Angina symptoms, dizziness, mild seizure, and drop in blood pressure during exercise or VO_{2peak} testing were reported in 2 studies (43;78). All reported side effects improved and all participants, with the exception of one individual who had a drop in post-exercise blood pressure and was removed from the study, received medical clearance to complete the exercise trial. Complications occurred in 2 Stroke participants who reported excess fatigue and dropped out of the study (41;131). Three other participants experienced back or knee pain but were able to complete the intervention (82).

Does Exercise Increase the Incidence of Exacerbation in Individuals With Multiple Sclerosis?

Although it is important to closely monitor any changes in disease symptoms for people with Multiple Sclerosis during and after the exercise training sessions, the concern of potential worsening symptoms related to the exercise exposure does not appear to be justified based on this literature review. This finding is in agreement with a recent report by Ginis and Hicks (7), who were charged with the development of a physical activity guide for Canadians with physical disabilities. In particular, there is no scientific evidence to support the notion that individuals with certain forms of Multiple Sclerosis may have worsening symptoms related to increased core temperature during/after exercise (7).

A total of 16 exercise trials involving persons with Multiple Sclerosis were reviewed. Among the participants in the exercise groups (n=363), 4 experienced musculoskeletal problems (1.1%), 2 reported elevated spasticity (0.6%), and 4 had an exacerbation (1.1%). In terms of the total number of subjects in the control groups (n=266), 1 subject experienced knee pain (0.4%) and 5 subjects had an exacerbation (1.9%). More specifically, 3 RCTs indicated no difference in relapse symptoms between the exercise and control groups (15;18;19). One trial reported that 2 participants in the exercise group experienced exacerbations while none did in the control group (115). However, 2 other trials reported that only participants in the control group (n=3) had an exacerbation of symptoms compared to no relapse in the exercise groups (16;69). Two studies indicated adverse events related to the exercise exposure. Two subjects in the intervention group experienced elevated spasticity of the lower extremity after completing the exercise test (16), and a few participants reported temporary low back muscle soreness (n=1) and leg muscle soreness (n=3) during the initial training period (70). Based on this literature review, there is currently no evidence to support the notion that exercise imposes a higher risk of exacerbation or harm in people with Multiple Sclerosis. This finding is consistent with a recent report published in Canada (7) that concluded that exercise has no effect on disease progression and should be an important component of disease management.

Is It Safe for People With Muscular Dystrophy to Exercise?

Back pain, muscle soreness, and feelings of fatigue were the most commonly reported adverse events associated with exercise in subjects with Muscular Dystrophy. Among 230 subjects in the exercise groups of 12 examined studies, 7 participants reported musculoskeletal problems (3.0%), compared to no reported adverse events in the control groups (n=155). Specifically, 2 subjects withdrew from the exercise intervention due to training-related back pain (73;151). Some subjects complained of transient muscle strength reduction (n=3) at the beginning of the exercise program (25;71;151) or expressed worsening fatigue (n=2) (22;23), but all subjects were able to complete the intervention.

What Types of Adverse Events Were Associated With Exercise Interventions in People With Spinal Cord Injury?

Muscle pain was the most commonly reported adverse event in people with Spinal Cord Injury who participated in an exercise intervention. Among 208 subjects, 4 (1.9%) experienced muscle pain during the aerobic training sessions (77) or after isokinetic testing (31). None of these complications affected their ability to complete the exercise program. One study (77) noted that exercise did not worsen the skin health of people with Spinal Cord Injury, and in 2 of 4 subjects who had pressure sores not associated with the exercise intervention, they healed by the completion of the study. One RCT reported that exercise using an arm ergometer in the supine position caused one participant (0.5%) to have bladder spasms (28).

What Types of Complications Were Associated With Exercise Interventions in People With Cerebral Palsy?

In the 11 reviewed studies involving 123 subjects in the exercise group and 69 subjects in the control group, no studies reported any complications in individuals with Cerebral Palsy, and only one study reported that a 6-week strengthening exercise intervention had negatively affected self-concept in children with Cerebral Palsy, but the reasons behind the unexpected reduction were unclear (152).

Is It Safe for Older Adults With Alzheimer's Disease To Exercise?

The major concern regarding exercise interventions for older persons with Alzheimer's disease is risk of falls. Among 229 individuals with Alzheimer's disease in 6 different exercise trials in which the primary exercise mode was walking, one study reported that there was no difference in the incidence of falls over a one year period between the exercise and control group referred to as the routine medical care group (139 versus 136) (106).

Is It Safe for People With Parkinson's Disease To Exercise?

In the 14 exercise interventions reviewed consisting of 287 subjects in the exercise condition and 183 subjects in the control condition, no adverse events related to the exercise exposure in people with Parkinson's disease occurred. In one study that was conducted to determine whether high-force eccentric resistance exercise caused subjects with Parkinson's disease muscle damage to their lower extremity, the researchers noted that the exercise exposure did not have a negative impact on muscle damage or function (75).

Is It Safe for People With Mental Illness or Intellectual Disability/Down Syndrome To Exercise?

Mental Illness

In the 15 studies that addressed the effects of exercise in participants with major depression disorder (n=335), only 2 RCTs reported adverse events related to the exercise exposure.

These included musculoskeletal injuries (n=8, 2.4%), chest pain (n=1, 0.3%), and increased severity of depressive symptoms (n=1, 0.3%) (54;144). One study concluded that compared to medication use, subjects in a treadmill exercise program experienced a lower incidence of diarrhea or loose stools (21% for those exercising at home and 10% in supervised exercise group) compared to those in the antidepressant group (31%) (53). Further, no adverse events related to exercise training were reported in 135 participants who were diagnosed with schizophrenia and bipolar disorder (n=11). Among all control group participants (n=210), no reported adverse events occurred.

Intellectual Disability

In the 12 exercise trials involving persons with Intellectual Disability including Down syndrome, none of the studies reported any physical complications. Only one trial reported that swimming in an integrated environment caused negative effects on perceived athletic competence for youth with intellectual disability compared to a segregated swimming class, although the swimming performance of subjects in the integrated setting increased (153).

Overall Summary and Conclusions

This report systematically evaluated published evidence regarding the effects of physical activity on people with physical and cognitive disabilities. Table G11.19 presents the findings in aggregate form, collapsing all physical disabilities into one group and cognitive disabilities into another group. Aggregating these data allows for a summary of the changes associated with exercise by health outcome and disability group (physical versus cognitive).

To determine the strength of evidence, each health outcome across the 6 categories evaluated in this report was identified and categorized by level of evidence according to the following criteria: Strong: 75% or more of reviewed trials had significant findings; Moderate: 50% to 74% of reviewed trials had significant findings; Limited: less than 49% of reviewed trials had significant findings. Two or more studies with significant findings on the identified health outcome were required for classification into strong or moderate level of evidence. Based on this classification scheme, for people with physical disabilities there was strong evidence that exercise can increase cardiorespiratory, musculoskeletal and mental health outcomes; moderate evidence to improve a variety of functional health outcomes and reduce the effects of certain types of secondary conditions (i.e., pain and fatigue associated with the primary disability); and limited evidence in improving healthy weight and metabolic health. For people with cognitive disabilities, there was strong evidence that exercise can improve musculoskeletal health, select functional health and mental health outcomes; moderate evidence for improving cardiorespiratory, musculoskeletal, and healthy weight and metabolic health; and limited evidence for reducing secondary conditions.

Table G11.19. Summary Table on Level of Evidence by Health Outcome Aggregated by Physical and Cognitive Disabilities

Health Outcome:	Significant Number of Trials	Significant Percent	Non-Significant Number of Trials	Non-Significant Percent	Level of Evidence Strong	Level of Evidence Moderate	Level of Evidence Limited	Level of Evidence No Evidence
Physical Disability: Cardiorespiratory Health	33	84.6%	6	15.4%	●	–	–	–
Physical Disability: Musculoskeletal Health	33	89.2%	4	10.8%	●	–	–	–
Physical Disability: Functional Health	50	63.3%	29	36.7%	–	●	–	–
Physical Disability: Secondary Conditions	10	71.4%	4	28.6%	–	●	–	–
Physical Disability: Healthy Weight and Metabolic Health	4	30.8%	9	69.2%	–	–	●	–
Physical Disability: Mental Health	10	83.3%	2	16.7%	●	–	–	–
Cognitive Disability: Cardiorespiratory Health	8	72.7%	3	27.3%	–	●	–	–
Cognitive Disability: Musculoskeletal Health	4	80%	1	20%	●		–	–
Cognitive Disability: Functional Health	10	83.3%	2	16.7%	●	–	–	–
Cognitive Disability: Secondary Conditions	1	100%	0	0%	–	–	●	
Cognitive Disability: Healthy Weight and Metabolic Health	4	50%	4	50%	–	●	–	–
Cognitive Disability: Mental Health	11	78.6%	3	21.4%	●	–	–	–

In summary, since the publication of the *Surgeon General's Report on Physical Activity and Health* in 1996 (154), a growing volume of research, including a number of RCTs, supports the use of physical activity to improve health and function among people with disabilities. With appropriate screening procedures, physical activity is considered to be a relatively safe, effective, and very important health recommendation for people with physical and cognitive disabilities. Data on select disability groups show improvements in various health outcomes including cardiorespiratory, musculoskeletal, functional, metabolic, and mental health, in addition to reducing certain secondary conditions associated with the primary disability such as pain and fatigue. An important caveat in interpreting these findings is that each study had its own prescreening evaluation for entrance into the study, which may have limited the sample to a select group of individuals within a certain range of health and function. Within this limitation, however, the consistency of the findings suggest that exercise training is an effective intervention for promoting health at a low risk of complications/adverse events in individuals with physical and cognitive disabilities.

This report also provides a framework for continuing to build an evidence base that can identify specific doses of physical activity in relation to key health outcomes in people with a variety of physical and cognitive disabilities. New studies and other disability groups can be added to the database as more research is published. In the future, in areas where data are lacking, researchers will be able to review the evidence and develop interventions that target key health outcomes in underserved groups of individuals with disabilities.

The development of appropriate inclusion/exclusion criteria is an important approach to ensuring that exercise is safe for a specific subgroup of people with disabilities. In all of the studies reviewed, screening and specific inclusion/exclusion criteria were important in terms of distinguishing individuals who were or were not appropriate for the intervention, usually based on level of current health or functional limitations. With younger, less disabled groups, risks associated with exercise appear to be typical of the general population. Given the high rate of physical inactivity reported among people with disabilities, it is critical for policymakers to promote physical activity guidelines among professional groups and associations that have regular contact with people who have disabilities (e.g., rehabilitation providers, fitness professionals, health care professionals, public health programs, service providers), and to support efforts to increase access to physical activity venues including indoor and outdoor sports, recreation and fitness facilities.

Safety of Exercise

This review also provides strong evidences that the benefits of physical activity for people with physical and cognitive disabilities far outweigh the risks. Very few reported serious adverse events (n=34, 1.15%). Although most of the studies were done in a controlled setting and may have excluded severely disabled subjects, the existing evidence supports the use of physical activity as a recommended health promoting activity among people with disabilities, including those with progressive disorders (i.e., multiple sclerosis) or more severe conditions (i.e., muscular dystrophy).

Limitations

This report does not account for differences in methodological quality. In the future, it would be helpful to qualify the RCTs based on selection criteria such as adequate sample size, equal groups (control and experimental) at baseline, blinding of study staff (i.e., different assessors for pre- and post-testing), recording of participant completion and dropout, and intention to treat. Studies were evaluated by their level of significance and not according to their effect sizes. We focused on 11 key disability groups only and did not include other disabled populations, such as those with rheumatoid arthritis, and populations in which disabilities occur at low incidences, such as those with spina bifida and polio, where not enough studies were available to include in this review.

All of the studies reviewed in this report had several outcomes (e.g., physical and emotional well being, reduced fatigue, increased fitness), and used a variety of interventions and doses of exercise (length of training, frequency, duration, intensity, modality). Several studies included individuals with a wide range of function and age, which may have attenuated the potential effects of the training regimen on certain subgroups within the larger sample (e.g., younger versus older subjects). Although heterogeneous populations make it easier to recruit subjects (e.g., using individuals with para- and tetraplegia in the same study) and obtain higher levels of statistical power, generalizability to the entire population (i.e., Spinal Cord Injury or Multiple Sclerosis) may be limited because of variations in health and function among the different subjects.

Another limitation was that the studies did not necessarily represent individuals with severe forms of the disability (i.e., tetraplegia versus paraplegia, severe cerebral palsy versus mild cerebral palsy; advanced types of multiple sclerosis). Therefore, it is not possible to generalize the findings to various subgroups within each disability who may have had an advanced condition. Data on certain subgroups (i.e., lower limb loss, cerebral palsy) also were limited, which reduced their generalizability.

Although we identified all the complications/adverse events reported in the 139 studies that were reviewed, it is possible that some of the studies did not report certain complications or adverse events.

Research Needs

It is important to identify optimal doses of exercise based on evidenced-based outcomes that delineate the safety of the activity and the specific health outcomes achieved by various exercise regimens for various disabled populations. The lack of data pertaining to the frequency, intensity, duration, and modality components of an exercise prescription for persons with disabilities has made it difficult to recommend specific training regimens to improve certain health outcomes or reduce the severity of certain secondary conditions associated with the disability (e.g., pain, fatigue).

The questions posed for this review suggest several lines of research to understand the dose-response effects of exercise in the treatment and management of targeted health outcomes. In order to establish a focused research agenda, studies should have an acceptable level of homogeneity (i.e., age, health status, functional level), and a consistent methodology, training dose and targeted outcome(s).

The very low exercise participation rate observed among people with disabilities may be associated with the gap between an individual's needs, interests and functional level, and the barriers that are often present in the environment. Environmental factors also can have a significant role in a person's ability to exercise, including access to exercise equipment or programs/classes, available transportation to and from the facility, and cost of the program. Collectively, these factors can make it extremely difficult for someone with a disability to participate in regular exercise. Health professionals must increase their awareness of the personal and environmental barriers that can have a substantial negative effect on participation in people with different types and severities of disabilities.

Specific Research Recommendations

1. There are no prospective cohort studies on people with disabilities. These studies should be conducted to determine the frequency, intensity, or duration of physical activity associated with key health outcomes, including reduction in certain secondary conditions associated with the specific disability subgroup (e.g., pain in spinal cord injury, fatigue in multiple sclerosis, deconditioning in intellectual disability). Studies should be stratified by age, functional level, and severity of disability.

2. The heterogeneity between and within disability groups and the low incidence of many disabilities make it extremely difficult to obtain an adequate sample size when recruiting from one setting. Multi-center clinical exercise trials are recommended to achieve adequate statistical power and to be able to generalize findings to certain subgroups within the targeted disability (e.g., young adults with paraplegia). A high level of intervention fidelity must be established that employs the same testing instruments, procedures and training regimen.

3. RCTs are needed to examine the effects of various *types* of exercise in addition to the actual training volume (frequency, intensity, duration). Group exercise such as tai chi or yoga may have the additional social benefit, which may improve outcomes but may also confound the benefit of the specific dose of exercise. Future studies should control for the social aspect of exercise in order to obtain accurate data on the exercise regimen itself versus the social benefits associated with exercising in a group.

4. Numerous self-report assessment tools have been developed to measure changes in health. It is difficult to make comparisons between studies when instruments are not the same or not explained well enough to make critical comparisons between them.

Given the small sample of many disabled subgroups, it would be helpful to have a recommended set of instruments for each targeted outcome with good psychometric properties so that data from various studies can be compared to each other.

5. Innovative strategies for recruiting individuals who generally do not volunteer for research studies must become a high priority. Because most experimental research is conducted with volunteers, it is difficult to generalize the study's findings to the entire subgroup. People who volunteer for exercise-related research may generally be younger and/or have a higher functional level. This is a common problem in experimental research but may be an even greater issue among people with disabilities because sample selection is limited to a small subset of the population and barriers such as transportation limit opportunities for participation in clinical research.

6. Several studies emphasized the unique aspects of improving social integration and/or quality of life. These measures are often obtained from self-report measures. It would be helpful to better understand how these measures are associated with objective measures, such as quantifying an increase in community participation (i.e., increased number of outdoor and/or social activities, greater amount of time outside the home for social events, increased employment). The fact that physical activity can improve mental health and quality of life is an intriguing concept that should be examined in future research with objective measurement of these outcomes.

7. Given the difficulty in identifying and recruiting subjects from certain populations with disabilities that have low incidence (e.g., spina bifida, muscular dystrophy, cerebral palsy), categorizing subjects by function rather than disability may be an alternative approach to increasing recruitment size and identifying key health outcomes that generalize across disability groups. Use of the International Classification of Functioning Disability and Health (ICF) (155) model would allow researchers to identify specific eligibility criteria by impairments (e.g., lower extremity paralysis) and/or activity limitations (e.g., unable to walk) rather than by disability.

Review of the Science: Physical Activity During Pregnancy and the Postpartum Period

Introduction

Early studies on physical activity and pregnancy were concerned more with harm to the mother and fetus than with potential benefits. Most studies used animal models, though some human studies examined cardiorespiratory responses and thermoregulation in the mother, fetal heart rate, and pregnancy outcomes such as birth weight, gestational length, and adverse events.

The American College of Obstetricians and Gynecologists (ACOG) developed the first exercise guidelines for pregnant women in 1985 (156). Those guidelines were based on limited data and were conservative. They included upper limits of 140 beats per minute for maternal heart rate and recommended that sessions of strenuous activity be limited to 15 minutes. The guidelines also noted the potential need to individualize physical activity recommendations.

Between 1985 and 1994, nearly 600 relevant studies were published, most of which focused on doing no harm. Many studies were laboratory investigations with small sample sizes, and most involved acute maternal responses to exercise. The data suggested no detrimental effects of the targeted exercise to mother or fetus, possible reduced length of labor, possible improvement in gestational diabetes, and relatively little loss of fitness by chronic exercisers. The use of a target heart rate was found to be quite problematic. ACOG updated its guidance for exercise during pregnancy in 1994 (157) and again 8 years later (158). Currently, ACOG recommends that pregnant women participate in 30 minutes of moderate-intensity physical activity on most days of the week in the absence of medical/obstetrical complications (158). Although this recommendation does not endorse participation in vigorous activities for all (for which information is scarce), it does not recommend against women being strenuously active during pregnancy.

Overview of Questions Asked

This part of the ***Understudied Populations*** section addresses 3 questions:

1. What does recent research indicate about the possible risks of moderate- or vigorous-intensity physical activity by women who are pregnant?
2. Does being physically active while pregnant provide any health benefits?
3. Does being physically active during the postpartum period provide any health benefits?

Data Sources and Process Used To Answer Questions

The evidence presented here was based on references included in the review of the literature for the 2006 Institute of Medicine report on physical activity and health (159) and an updated search of the Cochrane Library and MEDLINE for published RCTs, meta-analyses, and review articles. Search terms included exercise, physical activity, pregnancy, postpartum, the names of experts in the field and/or a combination of these terms. Search limits included human studies in women published in the English language from 1996 onward. Relevant articles were reviewed and the subcommittee’s conclusions were summarized and presented here.

Question 1. What Does Recent Research Indicate About the Possible Risks of Moderate- or Vigorous-Intensity Physical Activity by Women Who Are Pregnant?

Moderate-intensity leisure-time physical activity is not associated with an increased risk of low birth weight, preterm delivery, or early pregnancy loss (160;161). A recent review concluded that moderate-intensity leisure-time physical activity during pregnancy normally does not affect birth weight. However, participation in vigorous activities has been associated with small reductions (about 200 to 400 grams) in birth weight compared to birth weights of babies born to less active women (160). Similar results were reported in a meta-analysis published in 2003 (162).

Information on strenuous activity during pregnancy is very limited. A prospective study in the United States found that participation in vigorous (6 or more METs) activities in the first and second trimesters was associated with non-significant risk reductions for preterm delivery (163). Similarly, a prospective Australian study found no significant effects of vigorous physical activity during pregnancy on gestational age at birth or birth weight (164). Results from these studies must be applied cautiously as only a select subset of pre-trained women chose to continue vigorous activity during pregnancy.

Question 2. Does Being Physically Active While Pregnant Provide Any Health Benefits?

In 2005, an expert panel was assembled to examine the impact of physical activity during pregnancy and the postpartum period on maternal chronic disease risk (165). The panel also addressed the association of physical activity with the risk of preeclampsia and gestational diabetes mellitus (GDM). Regular physical activity in early pregnancy has been found to be associated with a reduced risk of preeclampsia in 2 case-control studies (166;167) and one cohort study (168). The evidence is not strong, but is consistent. A more recent Cochrane Review of RCTs found a non-significant reduction in risk of preeclampsia associated with moderate physical activity during pregnancy; although only two trials with a combined sample size of 45 women met review criteria (169). A Cochrane Review for GDM also showed no significant effect of physical activity (170). However, reviews of observational studies consistently show a reduced risk of GDM associated with moderate physical activity participation before and/or during early pregnancy (160;171). Although conclusions from these reviews along with data from a large population-based prospective study (172) confirm that leisure-time physical activity reduces risk and helps to treat GDM, data are insufficient to develop specific optimal physical activity guidelines for GDM prevention.

Investigators also have evaluated maternal physical activity in relation to health-related fitness, psychological health, and the course of labor and delivery. The evidence clearly supports that maternal physical activity of any kind helps to maintain fitness levels, which normally decrease during pregnancy (161;173). Fewer studies have considered maternal mood during pregnancy, yet available evidence suggests that maternal physical activity improves mood and is associated with increased self-esteem (161;174). Conflicting results exist relating maternal physical activity to the course of labor and delivery. Some studies report easier and shorter deliveries, others find no effect, and some show that induction of labor is used more often among women who exercise (161). Variances in methodology and activity definitions make these studies difficult to summarize and compare. A recent study (175) showed that women who exercised during pregnancy were less likely to have preterm delivery compared to their sedentary counterparts. However, the authors were not able to clearly separate the role of moderate versus vigorous activity on this effect.

Question 3. Does Being Physically Active During the Postpartum Period Provide Any Health Benefits?

Available evidence has shown maternal physical activity during the postpartum period is associated with enhanced mood (165;176;177), increased cardiovascular fitness (177;178), and obesity prevention (179). Larson-Meyer (177) reviewed approximately 60 cross-sectional studies and RCTs on postpartum weight reduction, specifically, looking at postpartum exercise. When compared to no physical activity, moderate physical activity did not appear to increase postpartum weight reduction unless caloric restriction was included. Studies also have showed that moderate intensity aerobic exercise did not adversely affect milk volume, composition, or infant growth (165;177;180). Some longitudinal data on future disease risk come from Rooney and colleagues (179) who examined nearly 800 women immediately postpartum and again 15 years later. Disease and risk factor development (diabetes, heart disease, dyslipidemia, and hypertension) were directly related to weight gain over 15 years. Women who continued to perform aerobic exercise postpartum were less likely to become obese than those who did not. In summary, in the absence of medical complications, physical activity during the postpartum period is beneficial to the overall health of the mother (both in the short- and long-term) while not adversely affecting her newborn's development.

Overall Summary and Conclusion

Although the benefits of maternal physical activity have clearly been demonstrated, prospective, randomized intervention studies in diverse populations are greatly needed. Based on current evidence, unless there are medical reasons to the contrary, a pregnant woman can begin or continue a regular physical activity program throughout gestation, adjusting the frequency, intensity, and time as her condition warrants. Very little evidence exists for the dose of activity that confers the greatest health benefits to women during pregnancy and the postpartum period. In the absence of data, it is reasonable for women during pregnancy and the postpartum period to follow the moderate-intensity physical activity recommendations set for adults unless specific medical concerns warrant a reduction in activity. Habitual exercisers with high fitness levels undergoing a healthy pregnancy need not drastically reduce their activity levels, provided that they remain asymptomatic and maintain open communication with their health care providers so that adjustments can be made if necessary. This same communication should be continued into the postpartum period, where the time needed before a woman returns to performing regular physical activity should be governed by medical safety concerns, rather than a set time period.

Review of the Scientific Evidence: Racial and Ethnic Diversity

Introduction

The charge to the PAGAC by the Secretary of Health and Human Services was to review the science pertaining to physical activity and public health, including the literature that would help ensure that new federal physical activity guidelines and policy statements would apply to all Americans and, as best possible, also meet the needs of specific subgroups of the population.

Chronic disease risk and disease burden in the United States are higher in racial/ethnic minority communities than in non-Hispanic whites. Thus, special attention to the particular physical activity needs and requirements of these groups is warranted. To summarize the science addressing racial/ethnic specific health-related responses to various doses of physical activity, each subcommittee identified and reported data for specific racial/ethnic groups. The objective was to determine whether such responses significantly differed from those observed for non-Hispanic white men and women.

Compared to the large number of studies published since 1995 investigating the role of physical activity in disease prevention and health promotion, quite limited data exist on race-ethnic specific responses (181-185). Many studies have included only non-Hispanic white participants, or have included small sub-samples of other racial and ethnic groups, precluding meaningful sub-group analyses by race/ethnicity. Also limiting a comprehensive review of this issue is the failure of some authors to include (and editors to require) precise information on the racial/ethnic characteristics of the study populations (186). A few, mostly observational, studies have included data on several racial/ethnic populations or on one population other than non-Hispanic whites. Most of the latter have been studies conducted in countries other than the United States. The contexts for the physical activity-disease association in other countries may differ for similar populations living in the United States. However, studies in other countries provide a broader and more diverse perspective than may be obtained from US data alone.

Background

The public health burden imposed by physical inactivity may be disproportionately high in ethnic minority and lower SES communities (187-192). African Americans, American Indians/Alaska Natives, Asian Americans, Pacific Islanders, and Latinos have significantly lower levels of regular physical activity, and significantly higher levels of inactivity than do whites (6;193). Though Asian Americans and Pacific Islanders have traditionally been merged together in most data sets, disaggregation of these groups is critical because they tend to be at the opposite ends of the spectrum of body weight, which influences and is influenced by physical activity (Asian Americans have less, and Pacific Islanders, more obesity, compared to other population groups). Growing but smaller ethnic minority populations who are not always separately identified (e.g., South Asian and Middle Eastern), also likely experience challenges in achieving adequate physical activity participation (194). These differences are magnified by the recent data documenting the extremely low levels of objectively measured moderate-to-vigorous physical activity, and high levels of sedentariness, across the entire United States population, but especially among ethnic minorities (195;196).

Disparities exist in most physical activity-related chronic diseases and conditions. For example, overweight and obesity rates vary substantively by ethnicity, even taking into account SES (e.g., (197); (198), (199)). Despite the public health consensus that physical inactivity is an important determinant in a host of health disparities across population segments, racial/ethnic differences in the contribution of physical activity to various health outcomes have rarely been systematically investigated. Several reasons for possible differences have been postulated. There may be modest differences in the energy cost of physical activity, for example, as a result of racial anthropomorphic variations (see ***Part G. Section 4: Energy Balance*** for additional discussion). Alternatively, the dose response of physical activity on health outcomes may be similar across racial/ethnic populations, while cultural and contextual factors may lead to differences in the achieved effective dose of a particular intervention (implementation) or in the accuracy of a particular measure in capturing the dose delivered (evaluation).

The marked skewing of racial-ethnic minority populations toward lower SES compared with whites complicates interpretation of these observations of racial/ethnic differences in public health surveillance (200). SES explains some, but usually not all, racial/ethnic differences. In some studies, ethnicity was no longer significant when other sociodemographic variables reflecting SES were included in multivariate analyses of physical activity (185;201). In others, the magnitude of physical activity variation by ethnicity was statistically significant but much less substantive than variations related to other socio-demographic and health status characteristics (193;202).

This skewing makes it difficult, if not impossible, to examine the influence of SES independent of race/ethnicity on physical activity-related outcomes. In fact, because the data are so scant, heterogeneity between and within racial/ethnic groups generally limits extrapolation between studies. Inter-ethnic, and even intra-ethnic comparisons are further complicated because of the substantial confounding of race/ethnicity and SES. Lower SES non-Hispanic whites comprise a relatively low proportion of the white population overall, and are underrepresented in public health research. In contrast, substantial numbers and in some cases a majority of African American, Latino, Pacific Islander and American Indian study participants are of lower SES. As a result, inadequate sub-samples of lower income non-Hispanic whites or higher income ethnic minority participants hinder analytical disaggregation by race/ethnicity and SES. Therefore, we will focus on racial/ethnic differences, recognizing that race/ethnicity is, in part, a proxy measure for SES.

Overview of Questions Asked

This portion of the ***Understudied Populations*** section addresses one major question:

1. Is there evidence that the physical activity dose for improving health should vary for people depending on race or ethnicity?

Data Sources and Process Used To Answer Questions

A search of the *Physical Activity Guidelines for Americans* Scientific Database identified research articles on the effect of physical activity on racially/ethnically diverse groups. These articles were not readily identifiable within the database, as many articles retrieved using racial- or ethnic-specific keywords had very small minority samples and mention of racial/ethnic variations in outcomes were rare. Because so few relevant studies were available in the Database, pertinent reviews available through a MEDLINE search were considered, as were recently published and "in press" journal articles identified through reference lists of articles cited and through expert consultation.

Question 1. Is There Evidence That the Physical Activity Dose for Improving Health Should Vary by Race or Ethnicity?

Conclusions

Data addressing race- and ethnicity-specific responses to physical activity are still extremely limited. Very few subgroup analyses were reported that permitted direct comparisons between racial/ethnic groups. No clinically significant differences were identified in the review of studies comparing responses to physical activity between different racial or ethnic groups or in analyses adjusting for race and ethnicity. Data on various health outcomes in prospective observational studies involving populations other than non-Hispanic white men and women do not suggest any race- or ethnicity-specific responses to physical activity. However, too little evidence is available to draw firm conclusions. While additional data are being generated, the available evidence suggests that the major health benefits of physical activity are not race- or ethnicity-specific.

Rationale

Provided below is a brief summary of published research addressing the issue of race- and ethnicity-specific health-related responses to physical activity. For additional information about the health outcomes described here and for information about race/ethnicity data for other outcomes, the reader is referred to the remaining chapters in ***Part G: The Science***

Base. In general for these outcomes, data are insufficient to draw any conclusions regarding race- or ethnicity-specific effects or dose response.

All-Cause Mortality

Three studies included nationally representative samples of participants (203-205) and another comprised 48.3% blacks (206). In addition, 2 studies specifically enrolled Hispanics (207) and Japanese-American men (208). Five studies were conducted in Asia enrolling Chinese and Japanese subjects (209-213). No inter-ethnic/racial differences in the effect of physical activity on all-cause mortality were apparent.

Cardiorespiratory Health

Few studies conducted in the US have had an adequate sample size and clinical outcomes to evaluate the association between physical activity and cardiovascular disease (CVD) clinical events in race-ethnic groups other than non-Hispanic whites. An analysis of this issue in data from the Women's Health Initiative Observational Study (214) included 61,574 white women and 5,661 black women with a mean follow-up of 3.2 years. The relation between physical activity level (quintiles of MET-hours per week) and CVD clinical events was significant for both groups of women with relative risk (RR) for the highest versus lowest quintile of activity for white women being 0.56 (P for trend <0.001) and for black women 0.48 (P for trend = 0.02). In contrast to these results, a report on the Atherosclerosis Risk in Communities (ARIC) study population indicated that although there was a significant inverse relation between activity level and CVD clinical events in white men and women, no such relation was found for either black men or women (215). The authors suggest that this lack of association in blacks may be due to the limited number of blacks reporting vigorous physical activity (5% in black men versus 15% in white men). The different geographic locations of the black (primarily Mississippi) and white (Washington State, Minnesota, and North Carolina but not Mississippi) cohorts in ARIC may be relevant here. However, outside the United States where the relation between physical activity level and CVD clinical events has been evaluated in racial/ethnic populations other than whites, no indication exists that the favorable association frequently reported for non-Hispanic white men and women is absent. For example, physically active Japanese men and women living in Japan (216) and older Japanese men living in Hawaii (208) had lower CVD mortality rates than their least active counterparts. Similar results have been reported for Chinese women living in Shanghai (212) and Chinese men and women living in Hong Kong (210). In a case-control study that included men and women, conducted in New Delhi and Bangalore India, the RR for myocardial infarction of 145 or more MET-minutes per day of LTPA versus no activity was 0.44 (95% CI 0.27-0.41) and time spent in non-work sedentary activity also was directly associated with risk of myocardial infarction (RR for at least 215 minutes per day versus less than 70 minutes per day = 1.58 [95% CI: 1.05-2.36]). In an aerobic exercise training study lasting 20 weeks that included African-American and non-Hispanic white men and women, no racial-ethnic differences were observed in the percent increase in VO_{2max} (217).

Cancer

Within the United States, associations between increased physical activity and decreased breast cancer incidence have been observed in multiethnic populations (218-220) as well as in investigations in specific racial/ethnic minorities: black (219;221), Hispanic (220;222), and Asian American women (223). No differences in the magnitude or quality of this association were apparent.

Energy Balance

Twenty-four articles that included data on various racial-ethnic groups were identified during the systematic literature review. Half reported on studies conducted outside of the United States, including 9 in Asia/Pacific Islands, 2 in Africa, and 1 in Central America. Fourteen were cross-sectional studies (185;202;224-235), 3 were longitudinal cohort studies (201;231;236), and 7 were interventions (192;237-242). Only one of the intervention studies included a direct comparison between two racial-ethnic groups, whites and blacks (239). The actual body weight lost during the 20 weeks of exercise was the same for both groups – 0.2 kilogram – and this loss was statistically significant in whites but not blacks, most likely because of a lower statistical power for the blacks due to their much smaller sample size. It should also be noted that this was designed as an exercise training study and not a weight loss study. Also, adjustments for subtle racial/ethnic anthropomorphic variations that might explain any racial/ethnic differences (e.g., shorter trunk length in blacks), identified in experimental exercise physiology studies (243) were not reported (239).

Metabolic Disorders

Preventing the Metabolic Syndrome

The majority of studies with large sample sizes was either conducted in Europe or was composed of whites of American or European descent. Though some of the better studies were conducted in populations composed of both African Americans and non-Hispanic whites, no studies examined the physical activity-metabolic syndrome association in an African-American or Hispanic population only (244-246). Thus, limited data are available on the relation between physical activity or fitness and preventing metabolic syndrome in populations other than non-Hispanic whites. It should be noted that studies that used populations composed of both whites and African Americans, such as NHANES (cross-sectional) and CARDIA (prospective), showed a strong dose response between activity (or fitness) and prevention of metabolic syndrome (245;246).

Preventing Type 2 Diabetes

In observational studies that included women only, 3 large US cohort studies (247-250) all found that greater physical activity was associated with a lower incidence of diabetes. However, in one study, this relation was present only in white women and not in women of African-American, Hispanic or Asian descent (250). These findings await confirmation because the study may not have been powered to detect differences across all racial/ethnic groups. Results were based on self-report of diabetes diagnosis in the total population but were confirmed in a subset using blood samples and physician reports. Data from RCTs as well as observational studies suggest clearly that, overall, women and men benefit from increased levels of physical activity in terms of preventing type 2 diabetes. In the Diabetes Prevention Program (251), treatment effects did not differ significantly according to either sex or racial/ethnic group. Although participant numbers became too small for clear results when grouped by ethnicity, it appears that risk reduction compared with placebo was greater for the lifestyle group (both diet and physical activity were parts of this intervention) than for the group taking the common diabetes drug, Metformin in whites (50% versus 12%, respectively) and Hispanics (57% versus 2%, respectively) (252). In African Americans (42% versus 29%) and Native Americans (43% versus 42%), the lifestyle and Metformin groups showed more similar efficacy. For Asian Americans, Metformin showed a non-significantly greater reduction than intensive lifestyle intervention (62% versus 30%).

Overall Summary and Conclusions

Given the paucity of outcome-specific studies providing useful information about racial/ethnic minority populations, evidence of physical activity influences **across** content areas was assessed generally.

- Across studies, results indicate that physical activity is related to a host of health outcomes in racial/ethnic minority populations. The direction of the association is the same in all racial/ethnic groups for which data were examined, with physical activity generally exerting a protective effect.
- Across studies, findings suggest that no minimum threshold of effect exists, especially for chronically inactive people (i.e., the majority of American adults). The lack of minority racial/ethnic inclusiveness of the physical activity promotion research literature may actually underestimate effects of a given dose, as more advantaged participants may have less capacity to benefit from preventive interventions (ceiling effects) (253). Recently reported data support that engaging in some amount of physical activity is better than doing nothing, and higher amounts of physical activity are associated with greater benefits and a broader spectrum of benefits.
- Subgroup analyses permitting head-to-head inter-racial/-ethnic comparisons of the influence of physical activity were rare. The very limited data available provide no indication that dose response differs between racial/ethnic groups.

Research Needs

- An increased number of federally-funded studies should be powered to include sufficient representation of at least one racial/ethnic minority or lower SES population, with sufficient sample size to permit subgroup analyses by race/ethnicity or SES. Adequate sampling of at least one understudied group should take precedence over achieving population representative samples, which usually have inadequate sample sizes for inter-group comparisons. The latter requirement has been enforced by review committees for more than a decade, with little progress in identifying racial/ethnic variations in the spectrum or level of benefit of a given dose of physical activity. Requests to be excused from this requirement should have strong scientific justification. Strict exemption criteria should be established in advance, and then rigorously applied by scientific review committees as a part of their scrutiny of racial/ethnic group inclusion overall.

- Cultural proficiency of recruitment and retention approaches and adequacy of resources directed toward recruitment and retention should be scrutinized by grant review committee members with special expertise in this area, similar to the separate assessments of adequacy of study methods and analytical approaches by review committee statisticians.

- Federal program officers should manage and balance their portfolios to ensure that racial/ethnic differences in PA-related exposures and outcomes are under active investigation, using RFAs and other mechanisms to direct funding toward disparities examination and elimination.

- Journals should require reporting of race/ethnicity, sex and SES of samples in the abstract as well as the body of the text.

- Subgroup analyses should be requested by journal editors and reviewers when sample size is sufficient, and further data disaggregation encouraged, to examine interactions between sociodemographic characteristics, e.g., sex-ethnicity, SES-ethnicity.

- Abstraction databases should include search criteria that permit ascertainment of inclusiveness, i.e., subgroup analyses by race/ethnicity or SES.

- Specific research questions deserve particular emphasis, such as the precise role in weight maintenance of racial anthropomorphic variations in resting or activity-related energy metabolism (as opposed to or in concert with age or sex-related differences) or in body composition.

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