Physical Activity and Older Adults
Systematic Literature Review

Contents

Membership Lists

The following groups contributed to the development of this report.

Literature Review Team: ICF Next

- Carolyn Hinton, PhD, MA, Senior Research Specialist, Project Lead
- Sarah Caban, MA, Research Specialist
- Katie Dent, MPH, MCHES
- Rebekah Wicke, MA
- Kirsten Pool, MA
- Joei Robertson, MS
- Samantha Goodman, MS
- Jeremy Frye, MSLS
- Nicole Vetter, MLS
- Chinenye Chukwu, MPH
- Sanon Williams, MPH
- Shauna Simon, PhD
- Sam Wilson, MA
- Nema Kebbeh, MA
- Maya Williams, MA
- Samantha Correll, MA
- Bernadette Okwu, PhD

Literature Review Team: President's Council on Sports, Fitness & Nutrition Science Board

- Barbara J. Nicklas, PhD – Wake Forest School of Medicine, *Science Board Chair*
- Susan W. Buchholz, PhD, RN, ANP-BC, FAANP, FAAN– Michigan State University
- David E. Conroy, PhD, FACSM, FSBM – The Pennsylvania State University
- Cheryl Der Ananian, PhD – College of Health Solutions, Arizona State University
- Loretta DiPietro, PhD, MPH, FACSM – Milken Institute School of Public Health, The George Washington University
- Mark Fenton, MS – Tufts University, Friedman School of Nutrition Science & Policy
- Deborah H. John, PhD, MS – Oregon State University, College of Public Health & Human Sciences
- NiCole R. Keith, PhD, FACSM, FNAK – Indiana University-Purdue University, Indianapolis
- David X. Marquez, PhD, FNAK, FACSM, FSBM, FGSA – University of Illinois Chicago
- Jacqueline Osborne, DPT – The Academy of Geriatric Physical Therapy of the American Physical Therapy Association
- Dori E. Rosenberg, PhD, MPH, FSBM – Kaiser Permanente Washington Health Research Institute

U.S. Department of Health and Human Services Staff

Office of the Assistant Secretary for Health, Office of Disease Prevention and Health Promotion

- Alison Vaux-Bjerke, MPH, MCHES – Federal Liaison to the Science Board
- Rachel Fisher, MS, MPH, RD – Acting Executive Director, President's Council on Sports, Fitness & Nutrition
- Katrina L. Piercy, PhD, RD, ACSM-CEP, FACSM
- Malorie Polster, MPH, CHES
- Noelle Harada, MPH

- Kate Olscamp, MPH, PMP, CHES

Centers for Disease Control and Prevention

- Ken Rose, MPA
- Deborah A. Galuska, PhD, MPH
- Janet E. Fulton, PhD
- David R. Brown, Ph.D., FACSM
- Geoffrey Whitfield, PhD, MEd
- Graycie W. Soto, MPH

National Institutes of Health

- Stephanie George, PhD, MPH, MA
- Richard P. Troiano, PhD
- Lyndon Joseph, PhD
- Dana L. Wolff-Hughes, PhD
- Nancy L. Terry, MS, MLS

Introduction

The most recent *Physical Activity Guidelines for Americans*, 2nd edition,[1] provides recommendations for the type and amount of physical activity older adults need to optimize overall health and function. The Guidelines synthesized the latest scientific evidence to revise prior physical activity recommendations to include an emphasis on participating in balance-improving activities and reducing sedentary behavior across the day.

As described in the Guidelines, adults aged 65 years and older should strive to participate in:

- At least **150 minutes a week** of **moderate-intensity activity** such as brisk walking OR at least 75 minutes a week of **vigorous-intensity activity** such as hiking, jogging, or running,
- At least 2 days a week of activities that **strengthen muscles**, and
- Multicomponent physical activities that include activities to **improve balance** in addition to aerobic and muscle-strengthening activities.

Given the inherently broad differences in health status and physical and cognitive functional abilities among adults over 65 years, these guidelines importantly emphasized that "*if chronic conditions affect ability to meet these recommendations, be as physically active as abilities and conditions allow*." Accumulating evidence and recent reviews since the second edition of the Guidelines was released continue to provide evidence of the health benefits of participating in physical activity, including light movement throughout the day to minimize time spent sedentary, even in those who can no longer exercise at a moderate to vigorous intensity.[2-5]

Although the second edition of the Physical Activity Guidelines provided much-needed updated guidance on physical activity for older Americans, the scientific review focused on the health benefits of different types and levels of activity. The guidelines emphasized *why* and *what* dose of exercise is needed to elicit optimal health benefits, rather than *how* or *where* older adults could or should perform physical activity. Thus, it is critically important to supplement the current Physical Activity Guidelines with information regarding the evidence base for the effectiveness of different individual and community-level strategies for promoting physical activity and the attainment of the key guidelines for older adults.

This literature review summary reports the findings from current scientific literature regarding evidence for the effectiveness of behavioral strategies, intervention modes and settings, and policy-driven approaches used to promote adoption of the Physical Activity Guidelines. The literature review was completed by a team made up by ICF Next staff with support from the President's Council on Sports, Fitness & Nutrition Science Board.

The literature review summary has 4 main sections. This Introduction provides background information about the rationale for focusing on older adults and the process for reviewing the literature and developing the conclusions. The Methods utilized by the Literature Review Team are detailed in the following section. The Evidence Review in the third section provides a review of the current scientific evidence. The review addresses the effectiveness of individual-level interventions and behavior-change strategies (Question 1) as well as existing evidence for how the behavioral environment shaped by various government, transportation, health sector, and other policies affects physical activity participation among older adults (Question 2). The limitations of the current evidence, the public health impact, the gaps in the literature, and ideal needs for future research are highlighted for each question within its subsection. The report ends with an overall Conclusion summarizing the state of knowledge (or lack thereof) on the effectiveness of different strategies and settings, and associations of different

environments, systems, and policies, for promoting optimal levels of physical activity among all older adults.

Background and Rationale for a Focus on Older Adults

A major demographic transition is underway in the United States. The U.S. Census Bureau projects that older adults will outnumber children and youth by 2035.[6] Older adults currently account for over a third of all health care spending, the largest share of any age group, 5 times greater than per capita spending on children and 3 times greater than per capita spending on working-age adults.[7-9] Moreover, health care expenditures for older adults are projected to increase as this population grows and people live longer.[10] There is widespread agreement that these increases are not sustainable and that preventive strategies must be identified and implemented to control health care expenses in the United States. Promoting physical activity may be the single highest-yield option for improving population health in the most rapidly growing and health care–utilizing segment of the population.

While there is an abundance of evidence demonstrating the different health benefits of consistent performance of all components of physical activity (aerobic exercise, strength/balance exercise, and daily movement) in older adults, the number of older adults meeting these current guidelines is quite low. For example, self-report data show that the percentage of older adults who meet the key guidelines for aerobic activity is only 46% among those aged 65 to 74 years, and 32% of those 75 or older.[11] Device-based measurement of physical activity using accelerometers shows the proportion of older adults who obtain the recommended 150 min/week of moderate to vigorous physical activity is even smaller, with as few as 25% of adults aged 64-74 years, and only 15% of adults ≥75 years, meeting the key aerobic guideline.[12] Conversely, sedentary behavior is highest among older adults, who, on average, spend >60% of their wake time (9-10 hrs/day) as sedentary.[13-15] The statistics are even lower for older adults who meet both recommended aerobic and muscle-strengthening physical activity guidelines, with just 16.4% of those aged 65 to 74 years, and 10.2% of those 75 or older, meeting the guidelines.[11]

Though participation in regular physical activity is low among all age groups in the United States, there are likely factors unique to older adults that affect the efficacy of intervention strategies that promote physical activity, whether these be at the community level (e.g., altering environments or policies) or individual level (e.g., settings or strategies for delivering physical activity programs). These factors highlight the importance of reviewing and understanding the scientific literature on how best to elicit and support physical activity behavior change, as well as maintenance or adoption of change, throughout the life span and in the face of specific challenges older adults may encounter.

Most contemporary theories of health behavior, including social-cognitive theory, the health belief model, the theory of planned behavior, and the health action process approach, posit that barriers can reduce physical activity.[16-20] One study indicated that nearly 90% of older adults report one or more barriers to physical activity and that many may experience multiple barriers.[21] From a descriptive perspective, several barriers that reduce older adults' physical activity have been identified, primarily for adults aged 65-80 years.[22-25] Drawing on the behavior-change wheel, these barriers may be linked to older adults' capabilities, opportunities, or motivation.[26] *Capability-related barriers* include physical and/or cognitive function limitations caused by normative aging processes or accelerated by chronic disease or accidents, pain, or fatigue. *Opportunity-related barriers* include constrained affordances of the built environment in residential neighborhoods and communities (e.g., poor-quality sidewalks, poor lighting that reduces perceived safety); limited access to specialized facilities or equipment for exercise—especially for muscle-strengthening exercise; and natural constraints, such as distance to facilities or group classes, challenging landscapes or terrains, and poor weather (e.g., excessive heat or cold, precipitation, high winds) which older adults find more uncomfortable. *Motivation-related barriers*

to physical activity include a perceived lack of time, insufficient social support (often rooted in ageism and societal expectations around appropriate levels of physical activity in older adults),[27] fear of falling or injury, internalized stigma associated with aging and physical activity,[28] lack of knowledge about physical activity and its role in healthy aging, and motivational deficits due to depression. Interventions for promoting physical activity often include some attention to barriers, but little is known about the specific barriers that impact intervention effects. These high-priority barriers need to be identified before they can be targeted. This report attempted to chronicle the array of barriers experienced by older adults engaged in physical activity intervention trials to identify those most likely to require attention when scaling programs for maximal uptake.

The Literature Review Team was particularly attuned to the fact that not only do individuals become more heterogeneous with aging, but there are also important socioeconomic, cultural, and access or opportunity disparities among older adults that will require some strategies to be tailored to an individual, or adapted and targeted to reach a group, to elicit optimal benefit. In other words, it is highly unlikely that a "one-size-fits-all" approach to strategies geared toward increasing physical activity participation is appropriate for all older adults. Therefore, this review specifically examined whether there are reported differences in intervention effects among older adults of varying physical and cognitive abilities, races and ethnicities, health conditions and literacies, sex and gender identities, living contexts, and income and education levels.

Methods

The U.S. Department of Health and Human Services, led by the Office of Disease Prevention and Health Promotion (ODPHP) in coordination with the Center for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), and the President's Council on Sports, Fitness & Nutrition (PCSFN) contracted with researchers at ICF Next (ICF) to conduct a literature review to inform the 2023 Physical Activity Guidelines Midcourse Report. The President's Council on Sports, Fitness & Nutrition (PCSFN) Science Board (Science Board) also supported the literature review team. The literature review evaluated current evidence available on interventions focused on promoting physical activity among older adult populations.

ICF used a methodology supported by best practices for systematic literature reviews developed by the United States Department of Agriculture (USDA)'s Nutrition Evidence Systematic Review (NESR),[29] the Agency for Healthcare Research and Quality (AHRQ),[30] the Cochrane Collaboration,[31] and the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine standards to review, evaluate, and synthesize published, peer-reviewed physical activity research.[32] This review process was largely guided by the approach taken to review the literature for the 2018 Physical Activity Guidelines Advisory Committee (PAGAC) Scientific Report.[1] This approach was undertaken to maximize transparency, minimize bias, and ensure the review conducted was relevant and of high quality.

This effort sought out and examined original literature rather than conducting a "review of reviews," as was done for the 2018 PAGAC report. Original literature was the preferred approach to this review for the purpose of (a) identifying the timeliest research available and (b) providing greater flexibility in the types of, and levels of depth in, research questions that could be posed. The following steps were undertaken to execute the literature review:

Step 1. Develop Systematic Review Questions and Conceptual Framework

Under the direction of ODPHP, this effort mirrored many conceptual elements of the 2013 PAG Midcourse Report (focused on youth populations),[33] by taking a multilevel approach to account for

intervention settings and strategies that are effective in promoting physical activity behavior among older adults.

The research questions and corresponding sub-questions are as follows:

Question 1: What are effective intervention strategies to increase physical activity among older adults?

a) Does the mode of delivery (e.g., virtual, in person, phone) impact the effectiveness of interventions?
b) Does the setting impact the effectiveness of the interventions?
c) What barriers exist to engaging or participating in the intervention? What are the retention, attrition, and/or attendance rates?
d) Do personal characteristics (e.g., ability, age, sex, race/ethnicity, socioeconomic status) or chronic health conditions influence participation?
e) Do interventions assess changes in participant mental health, quality of life, well-being, resilience, or social connection and isolation?

Question 2: What are effective policy, systems, and environmental (PSE) strategies to increase physical activity among older adults?

a) Is there a dose-response relation between the scope and reach of the PSE strategy and "success"?
b) Does the "success" of the PSE strategy vary by geographical location or by sociodemographic subgroup?

Step 2. Develop Systematic Review Strategy

The Literature Review Team developed analytical frameworks for each respective literature review. Then inclusion and exclusion criteria for each research question were created (see **Tables 1 and 2**). These criteria were used to determine whether studies were eligible to be selected for each respective systematic literature review and whether studies would provide data to support the focal research questions. For Question 1, only studies published since 2012 with at least 50 completed study participants per group and an age minimum of 65 years were included. These studies included those with randomized, controlled trial (RCT) designs and those with quasi-experimental designs. For Question 2, only studies published since 2012 using various non-randomized experimental and nonexperimental designs that assessed participants in the United States with a minimum age of 50 years were included in the evidence base.

The research questions, analytical frameworks, and inclusion criteria informed the development of the search strategy. When creating these two search strategies, to the Literature Review Team developed sets of search terms most relevant to each review. These sets included terms capturing a broad range of articles based on study design, intervention approach, and physical activity outcomes. Databases used to collect articles were PubMed, CINHAL, and PsychINFO. These databases were selected due to the subject matter of articles included within each database.

Table 1. Question 1 Inclusion and Exclusion Criteria

Include
Published in English Language
English Language Publication
Peer-Reviewed Literature
Published From 2012 to 2022
Original Research

Human Participants
Intervention Study (Comparison Required)
Must Measure Physical Activity Outcome
Older Adults (minimum or mean age of 65 years or older)
Designs Include Randomized Controlled Trials, Non-Randomized Controlled Trials, and Quasi-Experimental Studies
Exclude
Studies of Older Adults in Long-Term, Memory, or Hospice Facilities
Studies of Disease-Specific Therapeutic Exercise Delivered in Health/Medical Facility

Table 2. Question 2 Inclusion and Exclusion Criteria

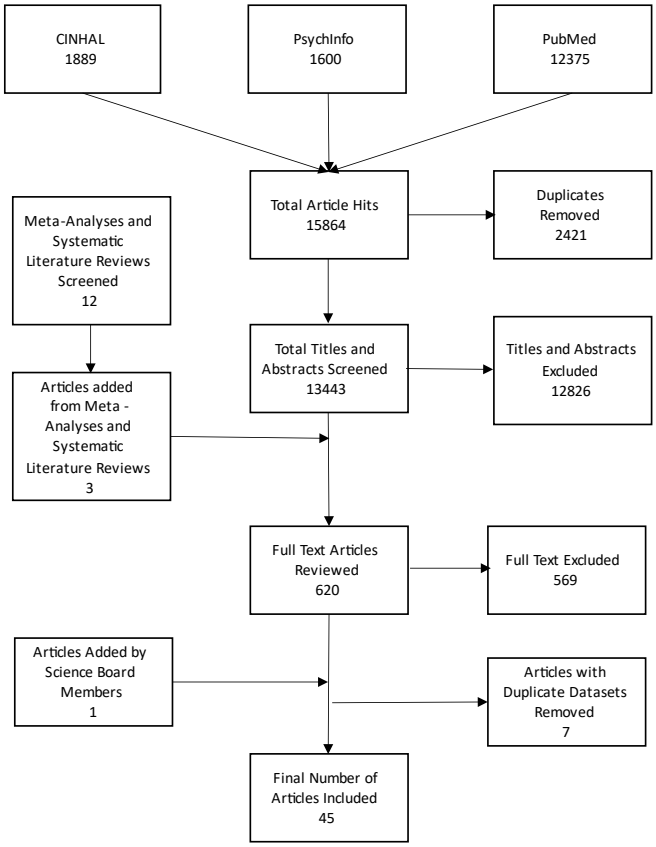
PSE Inclusion Criteria
Include
Published in English Language
Peer-Reviewed Literature
Published from 2012-2022
Original Research
Human Participants
Study Conducted in the United States
Intervention Study (PSE Intervention)
Must Measure Physical Activity Outcome
Older Adults, Middle Age (50+ years) and Older
Designs Include Non-Randomized Controlled Trials, Prospective Cohort, Retrospective Cohort, Case-Control, Cross-Sectional, Before and After, Geospatial, Environmental, and Surveillance
Exclude
Studies of Older Adults in Long-Term, Memory, or Hospice Facilities
Studies of Disease-Specific Therapeutic Exercise Delivered in Health/Medical Facility

Step 3. Search, Screen, Select Evidence to Review

Two individual searching and screening processes were undertaken to collect a thorough body of original research needed to support each systematic review. All titles/abstracts underwent two rounds of review by trained members of the triage team. Triage team members were instructed to first review titles to assess eligibility and then move to abstracts if the article appeared relevant. Triage team members were asked to then include or exclude articles based on information provided within the abstract. Remaining articles underwent two rounds of full-text review by trained triage team members and/or members of the Science Board. At each stage, conflicts were resolved by triage team members, Science Board members, or an additional member of the Literature Review Team. Science Board members were also asked to provide additional suggestions for articles that did not make it into the pool for final abstraction. Additional steps were taken to hand-review reference sections from relevant systematic reviews and meta-analyses.

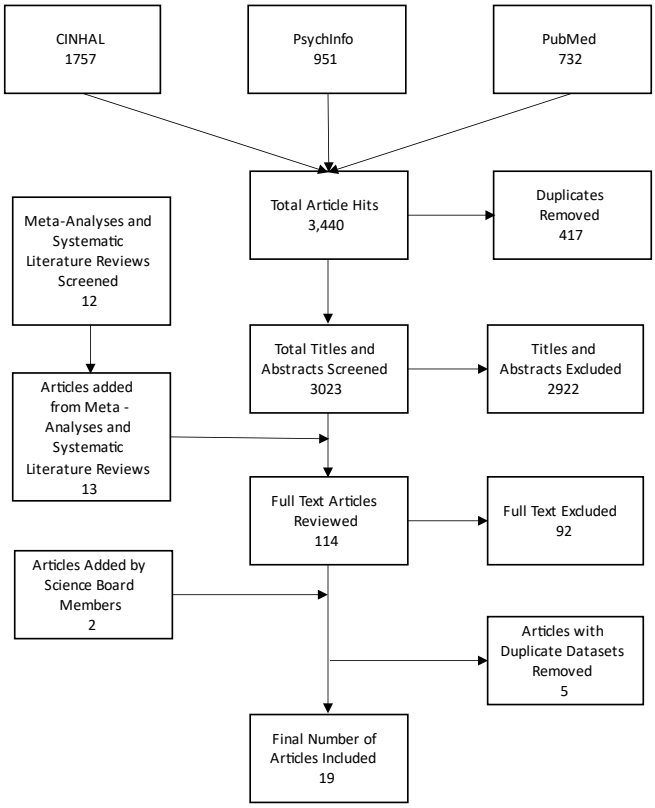
For Question 1, 13443 titles/abstracts were screened, 620 full text articles were reviewed, and 52 articles were included in the final review. Seven articles from this pool of 52 were designated as supplemental because these articles reported data already accounted for through other articles included in the review (without substantially different or novel findings). Abstraction and trend analysis was completed on the 45 articles remaining in the pool for review (see **Figure 1**).

Figure 1. Literature Tree Diagram for Question 1



For Question 2, 3440 titles/abstracts were screened, 114 full text articles were reviewed, and 24 articles were included in the final review. Five articles from this pool of 24 were designated as supplemental because these articles made use of data that was duplicative of other articles included in the review. Data analysis and abstraction was completed 19 articles left in the final review pool (see **Figure 2).**

Figure 2. Literature Tree Diagram for Question 2



Step 4. Abstract Data and Assess Risk of Bias

The abstraction process was used to collect and summarize key characteristics of each study that supported the systematic literature review research questions. All relevant articles identified that met inclusion criteria after full-text review were abstracted. Abstractors worked in pairs to independently review articles, abstract articles, and document findings. All categories below were abstracted for one or both reviews.

Basic/Methodological Information: Study purpose, supplementary material, funding source, sample power, initial sample size reported, final sample size reported, attrition rate, study country, data collection date, study design

Intervention Information: Delivery setting, delivery modality, intervention length, length of time to first intervention assessment, type of intervention, synchronicity, barriers to implementation, adverse events reported

Demographics: Demographics reported in sample, demographic inclusion criteria, age criteria, whether outcomes were disaggregated based on demographic characteristics, whether/how data were presented by age groups

Well-Being Outcomes: Presence or absence of assessment of mental health, well-being, resilience, social-connectedness, quality of life, and social isolation

Physical Activity Outcomes: Approach to measuring physical activity, physical activity outcomes, physical activity domains, number of physical activity outcomes measured, direction of physical activity outcome change (increase/decrease/no change) between the physical activity intervention group and a

comparator group, dose-response (activity length, frequency of activity, intensity of activity, duration of activity, and follow up period)

Articles were also evaluated for risk of bias or internal validity. Depending on study design, either the Robins-I or Robins-E tool was used for this assessment.[34,35] These tools assess risk of bias in studies that compare the health effects of interventions or exposures across a range of study types (e.g., RCTs, observational).. The risk of bias assessment for each study was completed by two reviewers (from either ICF or the Science Board). When discrepancies arose, the reviewers discussed and resolved discrepancies.

Step 5. Describe the Evidence

To facilitate the analysis of the evidence, the Literature Review Team prepared evidence portfolios for each review. The evidence portfolios documented the full process followed for both reviews, including the sources of evidence, conclusions, evidence grades, description of evidence, populations analyzed, individual evidence summary tables, risk of bias and quality assessment charts, search strategies, literature trees, references, and rationales for exclusion of articles during full-text triage.

Step 6. Evidence Review and Conclusion Statements

Next, the evidence was synthesized and graded and conclusion statements and key evidence for those conclusions were drafted. Research gaps were also identified.

The grading criteria used to assess the strength of the evidence supporting each conclusion statement were modeled after the 2020 Dietary Guidelines Advisory Committee Grading Criteria (Table C-2 in the Scientific Report of the 2020 Dietary Guidelines Advisory Committee)[36] and slightly adapted for this report. Grading the strength of the evidence was based on the cumulative risk of bias, consistency, directness, precision, and generalizability to the population of interest (i.e., U.S. population of older adults). Descriptions of the evidence grades are shown in **Table 3**.

Table 3. Physical Activity and Older Adults Literature Review Grading Criteria

Grade	Definition
Strong	The conclusion statement is based on a strong body of evidence as assessed by risk of bias, consistency, directness, precision, and generalizability. The level of certainty in the conclusion is strong, such that if new evidence emerges, modifications to the conclusion are unlikely to be required.
Moderate	The conclusion statement is based on a moderate body of evidence as assessed by risk of bias, consistency, directness, precision, and generalizability. The level of certainty in the conclusion is moderate, such that if new evidence emerges, modifications to the conclusion may be required.
Limited	The conclusion statement is based on a limited body of evidence as assessed by risk of bias, consistency, directness, precision, and generalizability. The level of certainty in the conclusion is limited, such that if new evidence emerges, modifications to the conclusion are likely to be required.
Grade Not Assignable	A conclusion statement cannot be drawn due to either a lack of evidence or evidence that has severe limitations related to risk of bias, consistency, directness, precision, and/or generalizability.

Evidence Review

Effective Intervention Strategies to Increase Physical Activity Among Older Adults

Introduction

The literature review search yielded 45 eligible papers reporting results based on a total sample across papers of 22,918 older adults.[37-81] Unique outcomes from one trial (FlexToBa) was reported in two papers[48,51]; unique outcomes from the LIFE study were reported in three papers.[49,67,79] Adjusting for these shared samples, the 45 eligible papers were based on 19,341 unique older adults.

The inclusion criteria limited the age range of participants. Most papers reported samples whose minimum age was 65 years or older (n = 20),[41-43,48,52,54-56,58-61,63,66,68,70,76-78,80] 70 years or older (n=11),[40,45,46,49,57,67,69,72,74,75,79] 75 years or older (n=5),[37,38,44,47,71] or 60 years or older (n=3).[53,62,64]

The 45 eligible papers reported 130 physical activity behavioral outcomes. As shown in **Figure 3**, most papers reported only a single behavioral outcome. The median number of outcomes per paper was two with a range of 1 to 14. **Figure 4** shows that, overall, most physical activity interventions had no effect on one or more physical activity outcomes (n = 66 [51%]) or showed an increase in one or more outcomes (n = 60 [46%]) when compared to an intervention without a comparable physical activity component. Only four physical activity outcomes (3%) decreased in response to a physical activity intervention.

Different intervention strategies are likely warranted for enhancing various types of physical activities recommended for older adults. **Figure 5** summarizes the types of physical activity outcomes assessed across the 45 papers. Most papers reported outcomes involving participation in aerobic activity (n = 32 [71%]) or total physical activity (measured in METs or minutes; n = 32 [71%]). Fewer papers reported outcomes for sedentary behavior (time spent sitting or lying down; n = 7 [16%]), participation in muscle-strengthening exercise (n = 3 [7%]), or multicomponent activity (n = 2 [4%]). None of the eligible studies reported participation in balance training as an outcome. Thus, the primary focus of the review was on the effects of different strategies, modes, and settings on overall and aerobic activity. In addition, even though the feasible and lower-cost use of accelerometers, inclinometers, and consumer wearables that track physical activity has made it possible to directly measure several parameters of both movement and sedentary behavior,[82,83,84] over 90% of the outcomes were assessed using self-report.

The length of the intervention and the follow-up assessment period are important considerations when examining whether interventions promoted short-term or long-term maintenance of physical activity. **Figure 6** summarizes the length of the physical activity interventions and the duration of follow-up prior to assessment of outcomes. Of the 45 eligible papers, 21 (46.7%) of them included an intervention with a duration of six months or less, with a median intervention duration of 12 weeks.[43,44,46,48,51,53-58,60-64,68,70,77,80,81] The shortest intervention time frame was a one-time exposure to physical activity messaging.[64] Two studies had an intervention that ranged from seven[53] to 10 weeks.[62] Ten studies[44,55,57,60,61,63,68,70,80,81] had an intervention length of approximately three months; two studies had an intervention length of four months[43,77]; and six had a duration of six months.[46,48,51,54,56,58]

The follow-up assessment periods for these 21 short-term intervention (< 6 months) studies varied from immediately post-intervention completion to 24-months post-intervention completion. Five studies [51,54,55,63,80] did not include follow-up assessments of physical activity outcomes beyond the end of the intervention. Eight studies had follow-up assessments of physical activity between two weeks and three months post-intervention.[43,44,53,57,60,62,64,70] Eight studies evaluated maintenance of physical activity for a

minimum of 6-months post-intervention.[46,48,56,58,61,68,77,81] Two studies[46,48] evaluated physical activity outcomes at 6-months post-intervention. Five studies implemented assessments of outcomes at 8 to 11 months post-intervention.[61,68,69,77,81] Finally, two studies assessed physical activity outcomes at 24-months post-intervention.[56,58] There were two additional studies that included a 9-month[65] and a 48-week[78] physical activity intervention. Both only assessed physical activity outcomes at the conclusion of the intervention. The length of the intervention is unknown for one study.[75] Outcomes were assessed in this study at 12 months, but it is not known whether this reflects findings from the immediate conclusion of the intervention or another time frame.

Twenty-one (46.7%) of the studies reviewed were longer-term interventions, engaging participants in the intervention for a minimum duration of 12 months. Twelve of these studies (24.4%) included interventions that were 12 months in duration.[37,38,41,42,45,52,59,66,69,73,74,76] Six studies (13.0%) included physical activity interventions that were 24 months in length.[47,49,50,67,71,79] Three studies (6.5%) included interventions that were three years[39,40] or five years[72] in length.

Most of the long-term intervention studies (n=12) assessed physical activity during the intervention or immediately post-intervention, with no additional post-intervention follow-up assessments.[40-42,45,47,49,52,59,67,69,76,79] Only six studies with long-term interventions collected long-term follow-up data on physical activity participation; five of these studies[37,38,66,73,74] reported 12-month post-intervention physical activity outcomes, and one collected outcomes at 18-months post intervention.[71] Finally, three studies reported interim findings of on-going, long-term studies.[39,50,72] Thus, the lack of long-term follow-up assessments in the majority of studies prevented a definitive analysis of the effectiveness of physical activity interventions to assess adoption or maintenance of behavior change.

Ultimately, the conclusion statements about the effectiveness of each behavioral strategy (primary question) or the effects of specific settings or modes of intervention delivery (sub-questions) were drawn by evaluating the study's physical activity outcomes with respect to whether the intervention resulted in an increase, decrease, or no difference from the comparator intervention group. Individual conclusion statements do not account for interactions or combinations of behavioral strategies, modes, settings, intervention duration, or evaluation timelines, each of which will impact exposures and outcomes.

Figure 3. Frequency of Number of Physical Activity Outcomes Reported in Each Paper.

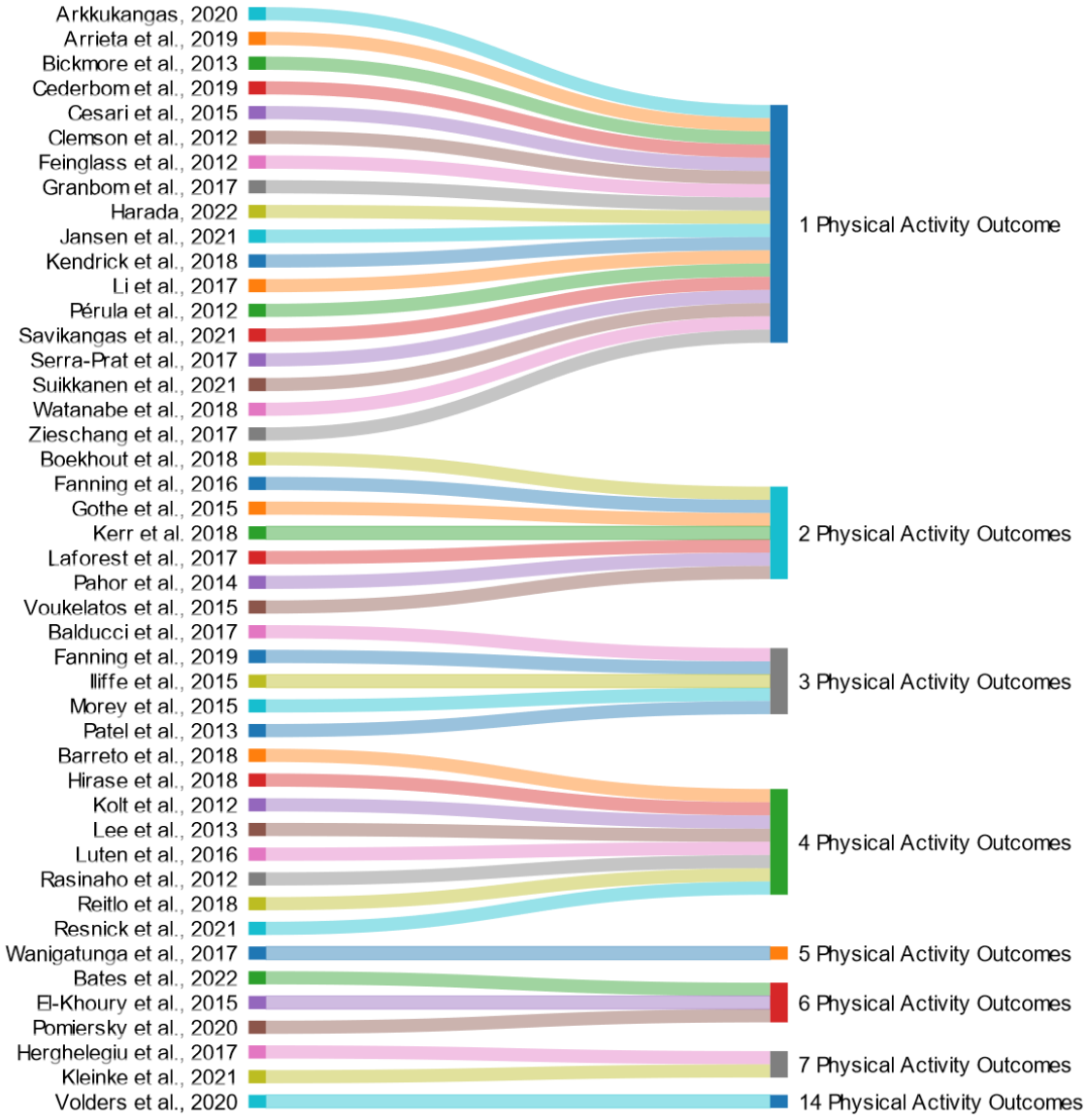


Figure 4. Frequency of Effect Directions in Each Paper.

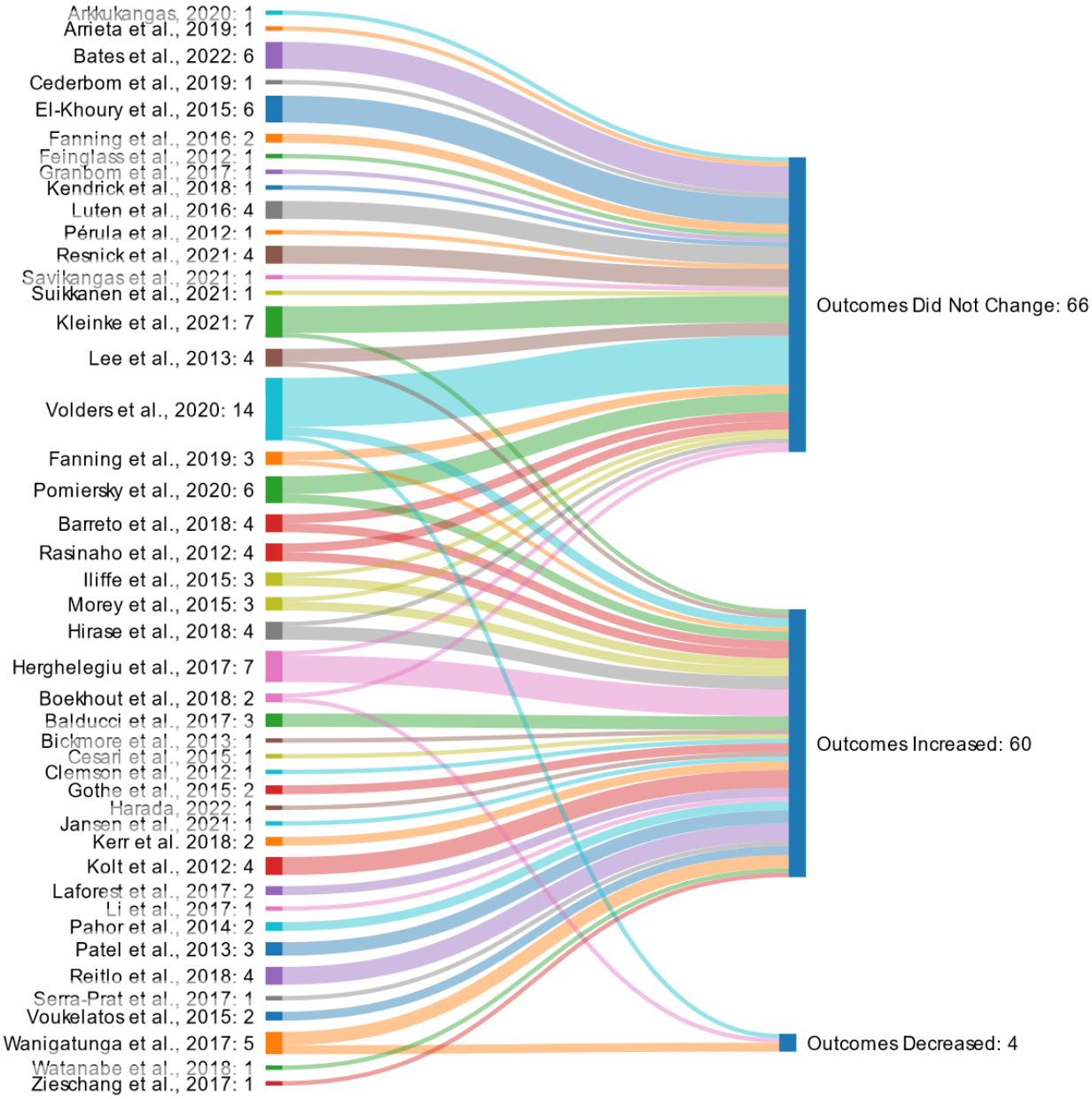


Figure 5. Frequency of Types of Physical Activity Outcomes Measured in Each Paper.

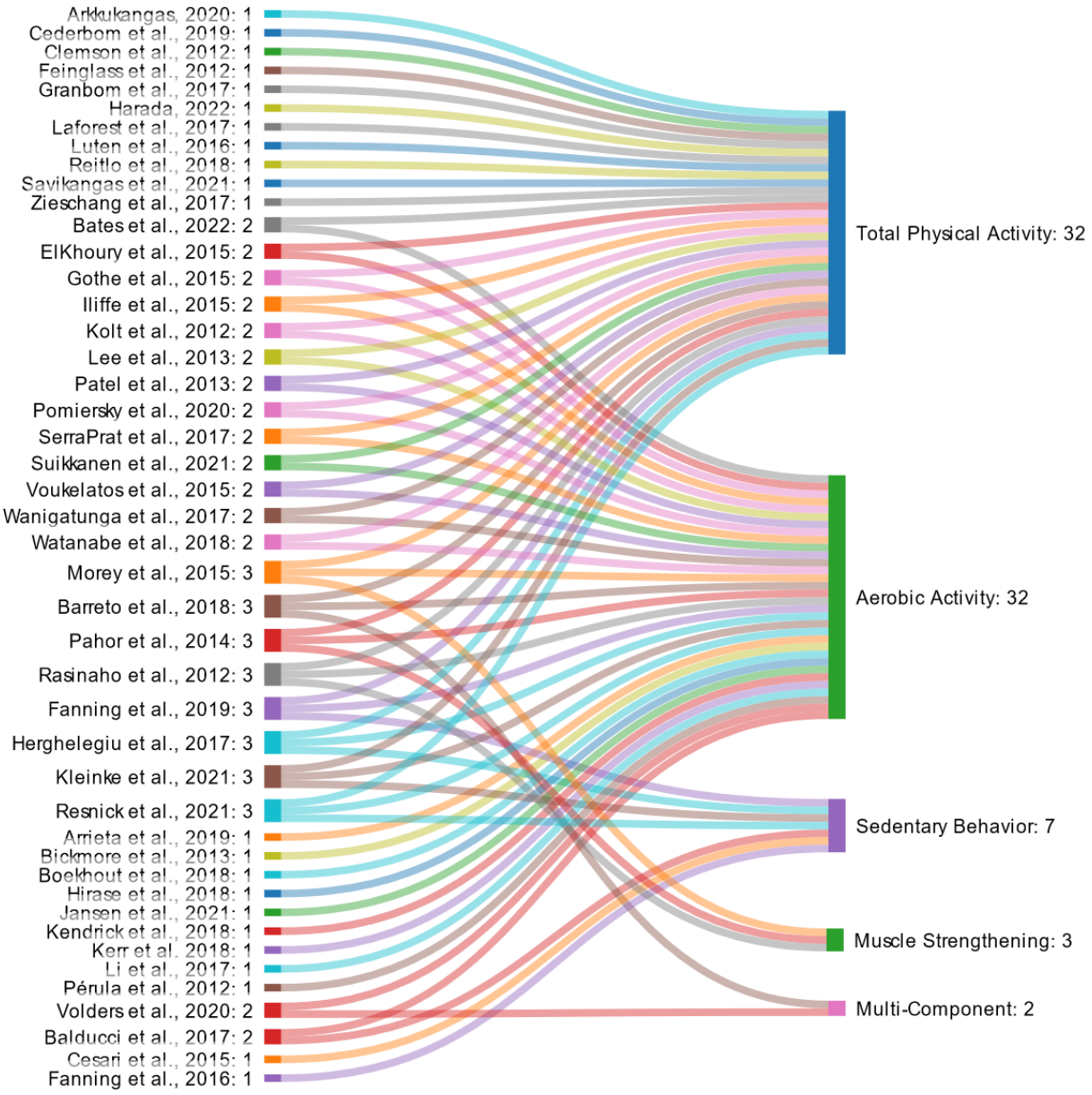
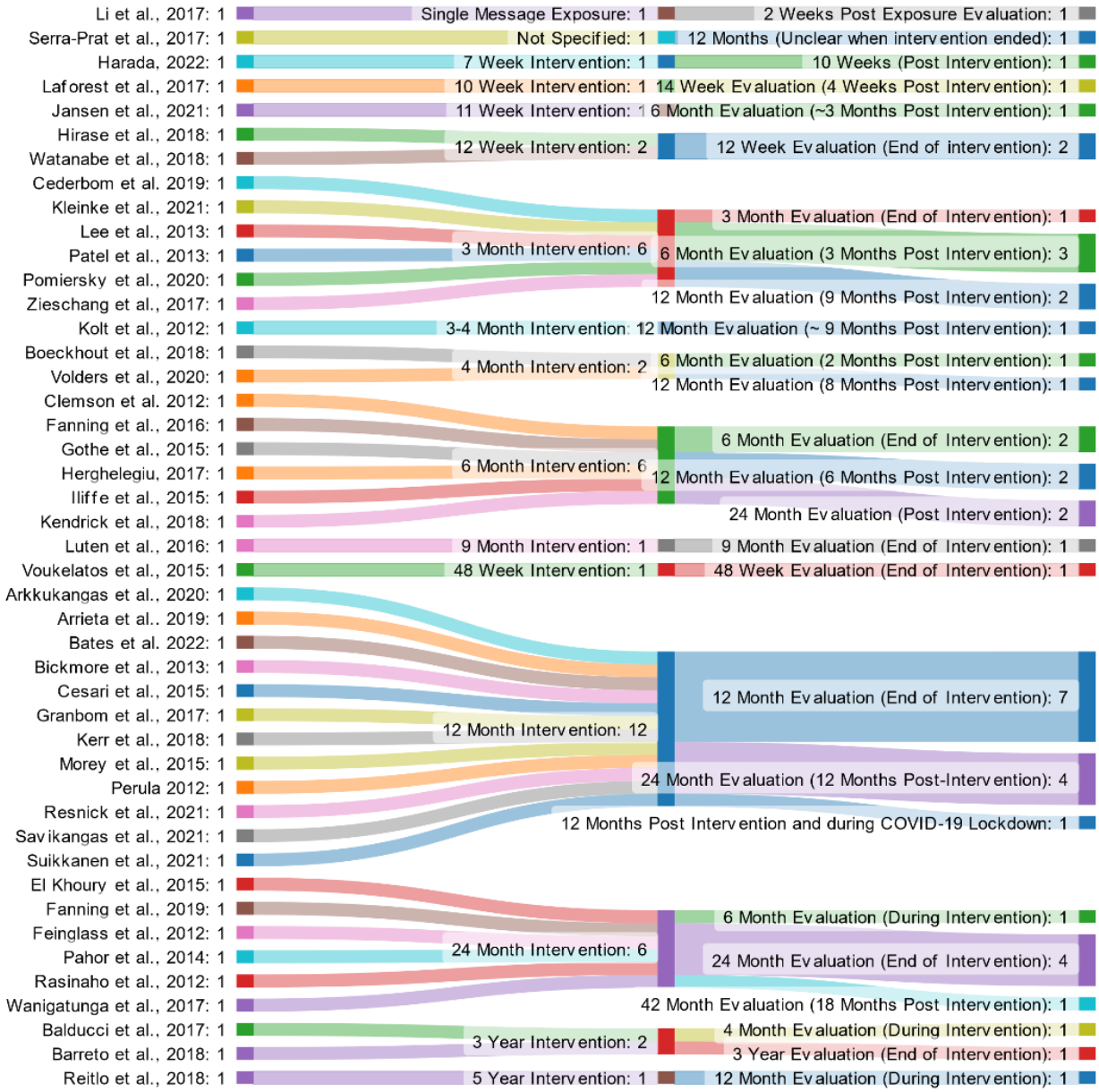


Figure 6. Frequency of Physical Activity Intervention Length and Follow-Up Assessment Period Reported in Each Paper.



Question 1: What are effective intervention strategies to increase physical activity among older adults?

Source of Evidence

Original research.

Introduction

Evaluating intervention strategies that successfully lead to sustained, increased physical activity participation in older adults is necessary to determine effective interventions that enhance uptake and compliance to the Physical Activity Guidelines for older adults. This review summarizes the evidence for the effectiveness of the strategies used in interventions that measured effects on physical activity behavior. In evaluating the effectiveness of physical activity interventions, studies were examined to determine the: 1) key behavioral change strategies used, 2) the characteristics of the physical activity programming, and 3) the types of physical activity components used in the interventions.

Conclusions

Strong evidence demonstrates using individual-level cognitive-behavioral strategies as part of a physical activity intervention is effective in improving physical activity in older adults. These strategies include goal-setting, self-monitoring of behaviors, problem-solving, and barrier identification. **Grade: Strong**

Strong evidence demonstrates that lifestyle-based interventions are effective at improving physical activity in older adults. **Grade: Strong**

Moderate evidence indicates that the use of physical activity counseling or tailored physical activity advice delivered as part of exercise intervention is effective in increasing physical activity in older adults. **Grade: Moderate**

Moderate evidence indicates using physical activity monitors as part of a physical activity intervention is effective in increasing physical activity in older adults. **Grade: Moderate**

Moderate evidence indicates that individually prescribed exercise or tailored exercise programs are effective at improving physical activity in older adults. **Grade: Moderate**

Moderate evidence demonstrates that multicomponent exercise programs are effective at improving physical activity in older adults. **Grade: Moderate**

Limited evidence suggests potential for interventions focused on interpersonal relationships such as enhancing provision of social support or enhancing social networks to promote physical activity participation in older adults; however, the evidence is inconsistent. **Grade: Limited**

There is **insufficient evidence** to determine what intervention strategies or approaches are effective for promoting decreased sedentary behavior in older adults. **Grade: Not Assignable**

There is **insufficient evidence** to determine what intervention strategies or approaches are effective for promoting short-term changes in physical activity versus long-term adherence to physical activity in older adults. **Grade: Not Assignable**

There is **insufficient evidence** to determine whether or not interventions focused on institutional or community-level approaches promote participation in older adults. **Grade: Not Assignable**

There is **insufficient evidence** to determine whether or not multilevel interventions are effective for promoting sustained physical activity in older adults. **Grade: Not Assignable**

Review of the Evidence

Key behavioral change strategies used with physical activity interventions

Interventions mainly focused on individual-level behavior-change strategies. These strategies primarily emphasized self-regulation such as goal-setting, self-monitoring of physical activity behavior, barrier identification, problem-solving, social support, and physical activity knowledge or awareness (see **Table 4**). When behavior-change strategies were used during an intervention, they were typically associated with improved physical activity. In addition, interventions often employed more than one behavior-change strategy to improve physical activity.

Physical activity goal-setting. Twenty studies included goal-setting as a behavior-change strategy.[39,42-45,48,49,50,51,53-55,59,61,62,67,68,77-79] Of these, an improvement in at least one measure of physical activity was observed in 16 of the studies. Interventions with a goal-setting component primarily encouraged participants to set their own goals for exercise or physical activity, within the context of the overarching physical activity goal of the study. Goal-setting was a consistent component of interventions that included physical activity counseling delivered in person,[39,44,50,54,55,59] via phone,[38,44,61,68,78] via embodied conversational agent (ECA) technology),[42] or as part of tailored physical activity advice via print or text materials.[43,48,51,77] Goal-setting was most frequently used in combination with self-monitoring of physical activity[42,44,48,50,51,53,55,59,61,62,68] or along with an assessment of physical activity behaviors.[39,42,48,51,53,54] One study defined goal-setting as identifying a goal behavior related to function, and a physical therapist used this information to tailor the exercise program.[44]

Physical activity self-monitoring. Sixteen studies included self-monitoring as a behavior-change strategy.[42,44,46,48,50,51,53,55,59,60-64,68,80] Of these, improvements in physical activity were observed in 13 of the studies.[42,46,51,53,55,59-64,68,80] Interventions with a self-monitoring component encouraged participants to monitor their physical activity level by using (a) a device such as a pedometer[42,50,55,59,61,62,68,80] or accelerometer[60,64] to monitor physical activity (b) a log, worksheet, or other written instrument to record physical activity,[46,48,51,55,63,80] or (c) a computer recording of steps as part of virtual coaching.[42] One study asked participants to wear a research-grade accelerometer and provided feedback to the participants on their physical activity.[64] Self-monitoring was frequently used in conjunction with goal-setting during physical activity counseling.[42,44,50,53,54,59,61,68] Likewise, it was used in combination with a physical activity assessment or performance appraisal.[46,48,51,53,80] Self-monitoring was a consistent component of interventions that included physical activity counseling delivered in-person,[44,50,55,61,68] via phone,[38,50,59,61,68] via ECA technology,[42] or as part of tailored physical activity advice via print or text materials.[48,51,53]

Physical activity barrier identification. Twelve studies included barrier identification as a behavior-change strategy.[39,42,43,48,50,51,53,54,59,61,69,71] Of these, improvements in physical activity were observed in 9 of the studies.[39,42,51,53,54,59,61,68,71] Similar to goal-setting and self-monitoring, barrier identification was usually a component of physical activity counseling (seven studies),[39,50,54,59,61,68,71] tailored physical activity advice[43,53] (two studies), or ECA coaching,[42] and was most commonly implemented in conjunction with problem-solving.[39,42,43,50,53,54,61,68,71]

Physical activity problem-solving. Nine studies included problem-solving as a behavior-change strategy.[39,42,43,50,53,54,61,68,71] Of these, improvements in physical activity were observed in seven of the studies.[39,42,53,54,61,68,71] Similar to goal-setting and self-monitoring, problem-solving was usually a component of physical activity counseling,[39,50,54,61,68,71] tailored physical activity advice,[43,53] or ECA coaching.[42] Problem-solving was most commonly implemented in conjunction with barrier identification.[39,42,43,50,53,54,61,68,71]

Physical activity social support. Eight studies included social support, apart from social support that could be received via physical activity counseling, as a behavior-change strategy.[48,51,53,54,56,58,59,70] Of these, improvements in physical activity were observed in seven of them.[51,53,54,56,58,59,70] The majority of the studies encouraged social support through group interaction that was a part of the intervention.[54,56,58,59,70] One study provided intentional information on receiving effective social support.[53]

Physical activity knowledge or awareness. Increasing knowledge is a cognitive-behavioral change strategy. Providing information about different aspects of physical activity was a natural part of each of the studies. However, there was variance in the type, delivery, and timing of how knowledge was shared. Most of the studies provided health education information focused on physical activity awareness or knowledge, such as the health benefits of physical activity and how much physical activity is needed. Studies also provided information on exercise programs, done either with supervision in a group setting,[55,57,70,80,81] supervised in a home setting,[37,38,41,44,57,76,80] or unsupervised in a home setting.[48,51,56,58,80] Information was delivered verbally, either in person[39,54,55,59] or by phone.[38,45,49,61,68,79] However, it was also delivered via print materials[43,48,51,77,78] and occasionally delivered digitally.[42,43,77] Information was also delivered at different time points, including at the beginning of the study as well as throughout the study. No specific patterns emerged regarding the type, delivery, or timing of physical activity information that was associated with interventions where an increase in physical activity was seen.

Table 4. Key Behavioral Change Strategies Used with Physical Activity Interventions

Paper	Goal-Setting	Self-Monitoring	Identifying Barriers	Problem-Solving	Social Support	Knowledge
Arkkukangas et al. 2020						X
Arrieta et al. 2019						X
Balducci et al. 2017*	X		X	X		X
Barreto et al. 2018 *						X
Bates et al. 2022						X
Bickmore et al. 2013*	X	X	X	X		X
Boekhout et al. 2018	X		X	X		X
Cederbom et al. 2019	X	X				X
Cesari et al. 2015*	X					X
Clemson et al. 2012*		X				X
El-Khoury et al. 2015						X
Fanning et al. 2016	X	X	X		X	X
Fanning et al. 2019 *	X					X
Feinglass et al. 2012	X	X	X	X		X
Gothe et al. 2015*	X	X	X		X	X

Paper	Goal-Setting	Self-Monitoring	Identifying Barriers	Problem-Solving	Social Support	Knowledge
Granbom et al. 2017						X
Harada et al. 2022*	X	X	X	X	X	X
Herghelegiu et al. 2017*	X		X	X	X	X
Hirase et al. 2018*	X	X				X
Iliffe et al. 2015*					X	X
Jansen et al. 2021*						X
Kendrick et al. 2018					X	X
Kerr et al. 2018*	X	X	X		X	X
Kleinke et al. 2021*		X				X
Kolt et al. 2012*	X	X	X	X		X
Laforest et al. 2017*	X	X				X
Lee et al. 2013 *		X				X
Li et al. 2017*		X				X
Luten et al. 2016						X
Morey et al. 2015*						X
Pahor et al. 2014 *	X					X
Patel et al. 2013*	X	X	X	X		X
Pérula et al. 2012						X
Pomiersky et al. 2020*					X	X
Rasinaho et al. 2012*			X	X		X
Reitlo et al. 2018*						X
Resnick et al. 2021						X
Savikangas et al. 2021						X
Serra-Prat et al. 2017*						X
Suikkanen et al. 2021						X
Volders et al. 2020*	X					X
Voukelatos et al. 2015*	X					X
Wanigatunga et al. 2017*	X					X
Watanabe et al. 2018*		X				X

Paper	Goal-Setting	Self-Monitoring	Identifying Barriers	Problem-Solving	Social Support	Knowledge
Zieschang et al. 2017*						X
*Significant increase in at least one measure of physical activity with the intervention group.						

Characteristics of Physical Activity Programming of Physical Activity Interventions

Overall, the characteristics of the interventions used to promote physical activity varied widely across the studies included in the review, making it challenging to identify which specific intervention characteristics consistently led to improved physical activity outcomes. In most studies, the structure, frequency, intensity, type, and duration of exercise were purposely designed and prescribed to achieve primary health or functional outcomes. In contrast, other studies used lifestyle-based interventions which were intentionally designed to increase physical activity behaviors. Lifestyle-based interventions typically focused on individual-level behavior-change strategies, equipping participants with the knowledge and behavioral capability to engage in physical activity throughout their day rather than prescribing structured exercise. Other studies used a combination of prescribed exercise programming and behavior-change strategies. Due to the complexity of the interventions reviewed, and the lack of mediation analyses, it is not possible to discern which distinct aspects or components of the intervention caused improvements in physical activity. We are limited to synthesizing common features of interventions that were consistently associated with improved physical activity across studies.

Among studies reporting the use of behavior-change strategies or techniques, individual-level behavior-change strategies were most frequently described. From a sociological perspective, individual-level behavior-change strategies focused on knowledge, skills, attitudes, and beliefs.[85] In studies where physical activity increased, the most frequently described individual-level behavior-change strategies involved cognitive-behavioral methods or self-regulation. Specific strategies identified included goal-setting, self-monitoring, barrier identification, problem-solving, action planning, and implementation planning. These strategies were often the active mechanism of physical activity counseling or advice, regardless of mode of delivery (e.g., in person, phone, virtual coaching).

There was a wide range of physical activity programming general strategies used in these 45 studies (see **Table 5**). Physical activity counseling and individually tailored programs, along with structured exercise and lifestyle physical activity programs and physical activity monitors, were used to deliver the intervention. Community-focused programs were represented in only a small number of studies. Multicomponent exercise programs were often seen in these intervention studies.

Physical activity counseling or advice. Physical activity counseling or tailored advice were used as an intervention strategy in 20 studies,[37-40,42-44,50,52,54,55,57,59,61,66,68,69,71,77,78] of which 13 demonstrated improvements in physical activity.[39,40,42,54,55,57,59,61,66,68,71,77,78] The provision of physical activity counseling or advice varied across studies.[37-40,42-44,46,50,52,54-56,59,61,66,68,69,71,77,78] Physical activity counseling was used as an adjunct component of structured or prescribed exercise programs[37-39,44,55,57,69] and programs that used a lifestyle or informal approach.[42,43,46,50,54,57,59,61,66,68,77,78] Similarly, a virtual platform delivered physical activity counseling focused on goal-setting.[42] The ECA physical activity intervention incorporated counseling as a component of both lifestyle and informal physical activity.[42] Motivational interviewing was used in 3 of the physical activity interventions to deliver physical activity counseling.[37,69,71] Three studies only provided tailored physical activity advice.[43,66,77]

Individually tailored programs. Individually tailored programs were used in 27 studies,[37-42,43-47,49,50,52,55,57,66,67,69,70,72,74,76,77,79-81] of which 16 demonstrated improvements in physical activity.[39,40,42,45,46,49,55,57,66,67,70,72,77,79-81] In general, individualized programs, which also included prescribed exercise programs, were tailored to the individual participants' physical function, health conditions, fitness level, physical activity level, and/or psychosocial characteristics, and/or to improve a specific health outcome. Tailored or prescribed exercise programming was delivered as supervised in-person programs, as supervised home-based exercise programs, and as lifestyle-based programs. Supervised, in-person or home-based programs usually included tailored, progressive exercise programs and/or

personalized recommendations and advice.[37-39,41,44-47,49,55,57,67,69,70,72,74,76,79-81] Lifestyle-based approaches usually included exercise counseling or advice tailored to the individual's physical activity level or psychosocial characteristics (e.g., readiness for change).[42,43,46,57] Individually tailored or prescribed exercise programs were most often led by physical therapists, individuals with degrees or training in exercise science, or other health care professionals.

Structured exercise programs. Structured exercise programs were used in 25 studies,[37-39,41,44-47,49,51,55-58,63,67,69,70,72,74-76,79-81] of which 16 demonstrated improvement in physical activity.[39,45,46,49,51,55-57,63,67,70,72,75,79-81] Structured exercise programs comprised both supervised and unsupervised exercise programming. Interventions with supervised exercise programming had an exercise professional, health care professional, or qualified instructor who provided guidance on the exercise program and/or the progression of the exercise program. Supervised exercise programs were implemented as (a) group-based and led by an instructor,[55,57,70,80,81] (b) home-based with supervision from an exercise instructor or health professional,[37,38,41,44,57,76,80] or (c) a combination of supervised, group-based exercise programming and exercises to be performed at home or outside the group setting.[38,45-47,49,56-58,63,67,69,72,74,75,79] Improvements in physical activity were observed in two of the seven supervised home-based exercise studies.[57,80] Ten of the 15 studies that involved a combination of a supervised group-based exercise program and home exercises demonstrated improvements in physical activity.[39,45,46,49,56,63,67,72,75,79] There were demonstrated improvements in physical activity in all five of the supervised group-based programs.[55,57,70,80,81]

Lifestyle physical activity programs. Lifestyle-based interventions were used in 16 studies,[42,43,46,50,53,54,57,59-62,64,66,68,77,78] of which 14 demonstrated improvements in physical activity.[42,46,53,54,57,59-62,64,66,68,77,78] Lifestyle physical activity interventions are those that encourage increased participation in moderate-intensity exercise or physical activity, increased leisure-time physical activity, or decreased sedentary behavior.[86] A central component of lifestyle behavior-change interventions is the application of theoretical models of behavior change and participants' capability to engage in physical activity throughout their day. Instead of doing prescribed activities, the individuals select them.[86] Lifestyle-focused interventions used cognitive-behavioral approaches such as goal-setting, problem-solving, barrier identification, and self-monitoring to increase physical activity, emphasizing increased daily step counts or minutes of physical activity. These programs typically did not have a structured or prescribed exercise program associated with them.

Physical activity monitors. Physical activity monitors were used in 10 studies, all of which demonstrated improvement in physical activity.[42,50,55,59,60-62,64,68,80] Eight of the studies used pedometers[42,50,55,59,61,62,68,80] and two used accelerometers[60,64] to promote physical activity. Physical activity monitors were used to help individuals focus on physical activity goals and monitor their own physical activity in real time. Several studies supplemented the use of monitors with logs or diaries to record steps.[42,55,80]

Institutional and community-level approaches. The social-ecological model suggests interventions that promote institutional or community-level change may have an impact on behavior change either by providing direct support for the behavior or through interactions with other levels of the model such as intrapersonal factors.[85] These institutional or community-level approaches are conceptually different from offering a program within the community; rather, they emphasize changing the institution or community to be more supportive of behavior change as part of the intervention. Intervention approaches that promoted community or institutional support for physical activity were observed in three studies,[59,65,73] one of which demonstrated improvement in physical activity.[59] In addition to individual-level approaches, Kerr et al.[59] addressed community and environmental support for physical activity within retirement communities. They encouraged group walks, community advocacy, and

pedestrian community change projects as part of the intervention. Similarly, Luten et al.[65] developed an intervention that focused on both psychological and environmental determinants of behavior change. The intervention included a media campaign and environmental approaches that were created and implemented by older adults and professionals as key stakeholders. The environmental approaches included the promotion of physical activity by peers and health care professionals, and organized events and meetings to enhance opportunities to try different activities. Resnick and colleagues[73] addressed institutional support for physical activity within assisted living facilities through "function-focused care." Intervention approaches included focusing on the residents' functional capability when promoting physical activity, interactions between direct care workers and the residents, and environmental and policy factors related to physical activity.

Table 5. Characteristics of Physical Activity Programming of Physical Activity Interventions

Paper	Physical Activity Counseling or Advice	Individually Tailored Programs	Structured Exercise Programs	Lifestyle Physical Activity Programs	Physical Activity Monitors	Community Level Programs
Arkkukangas et al. 2020	X	X	X			
Arrieta et al. 2019	X	X	X			
Balducci et al. 2017*	X	X	X			
Barreto et al. 2018 *	X	X				
Bates et al. 2022		X	X			
Bickmore et al. 2013*	X	X		X	X	
Boekhout et al. 2018	X	X		X		
Cederbom et al. 2019	X	X	X			
Cesari et al. 2015*		X	X			
Clemson et al. 2012*		X	X	X		
El-Khoury et al. 2016		X	X			
Fanning et al. 2016			X			
Fanning et al. 2019*		X	X			
Feinglass et al. 2012	X	X		X	X	
Gothe et al. 2015*			X			
Granbom et al. 2017	X	X				
Harada et al. 2022*				X		
Herghelegiu et al. 2017*	X			X		
Hirase et al. 2018*	X	X	X		X	
Iliffe et al. 2015*			X			

Paper	Physical Activity Counseling or Advice	Individually Tailored Programs	Structured Exercise Programs	Lifestyle Physical Activity Programs	Physical Activity Monitors	Community Level Programs
Jansen et al. 2021*	X	X	X	X		
Kendrick et al. 2018			X			
Kerr et al. 2018*	X			X	X	X
Kleinke et al. 2021*				X	X	
Kolt et al. 2012*	X			X	X	
Laforest et al. 2017*				X	X	
Lee et al. 2013 *			X			
Li et al. 2017*				X	X	
Luten et al. 2016						X
Morey et al. 2015*	X	X		X		
Pahor, et al. 2014*		X	X			
Patel et al. 2013*	X			X	X	
Pérula et al. 2012	X	X	X			
Pomiersky et al. 2020*		X	X			
Rasinaho et al. 2012*	X					
Reitlo et al. 2018*		X	X			
Resnick et al. 2021						X
Savikangas et al. 2021		X	X			
Serra-Prat et al. 2017*			X			
Suikkanen et al. 2021		X	X			
Volders et al. 2020*	X	X		X		
Voukelatos et al. 2015*	X			X		
Wanigatunga et al. 2017*		X	X			
Watanabe et al. 2018*		X	X		X	
Zieschang et al. 2017*		X	X			
*Significant increase in at least one measure of physical activity with the intervention group.						

Type of Physical Activity Component

Physical activity intervention studies used different physical activity components as part of their intervention, including aerobic activities, muscle-strengthening activities, balance training, or, most typically, a combination of these different activities (see **Table 6**). Some studies also used different intervention components outside of these physical activity components to improve physical activity.

Aerobic physical activity component

Twenty-nine studies either had a structured aerobic activity component or promoted participation in aerobic or cardiovascular activity as part of the intervention.[37-40,42,43,45,49,50,53,56,58-64,66-68,71,72,74,75,77-80] Of those, 23 demonstrated an increase in physical activity.[39,40,42,45,49,53,56,59-64,66,67,68,71,72,75,77-80] Of the 23 studies that showed an improvement in physical activity, 18 assessed an aerobic activity outcome,[39,40,42,49,56,59-61,63,64,66-68,71,77-80] 17 assessed total physical activity,[40,49,53,56,60-63,66-68,71,72,75,78-80] four assessed sedentary behavior,[39,45,49,60] and three assessed strength as a physical activity outcome.[66,67,71]

Strength physical activity component

Twenty-four studies included a strength or resistance training component as part of the intervention.[37-39,41,45-49,51,55,56-58,63,67,69,70,74-76,79-81] Of those, 15 demonstrated an improvement in at least one measure of physical activity assessed.[39,45,46,49,51,55-57,63,67,70,75,79-81] Of those 15 studies, 11 assessed an aerobic activity outcome,[39,49,51,55-58,63,70,79,80] nine assessed total physical activity,[46,49,51,56,63,70,75,79,80] and three assessed sedentary behavior as an outcome.[39,45,49] Only one of the studies that included a strength training intervention component assessed strength training as an outcome.[67]

Balance physical activity component

Twenty studies included a balance component in the exercise intervention.[37,38,41,45-49,51,55-58,63,67,69,74-76,79] Of those 20 studies, 11 demonstrated an improvement in a physical activity outcome.[45,46,49,51,55-57,63,67,75,79] Of those 11 studies, nine studies assessed an aerobic activity outcome,[49,51,55-57,63,67,75,79] 8 assessed total physical activity,[46,49,51,56,63,67,75,79] and two assessed sedentary behavior.[45,49] No study assessed participation in balance exercises as an outcome.

Multicomponent physical activity component

Twenty-two studies included multicomponent physical activity training.[37-39,41,45-49,51,55-58,63,67,69,74-76,79,80] Of those, 13 demonstrated an improvement in physical activity.[39,45,46,49,51,55-57,63,67,75,79,80] Multicomponent physical activity and exercise programs addressed two or more domains of exercise, including aerobic exercise, muscle strengthening, balance exercise, functional training, and/or flexibility. Most of the multicomponent exercise programs were structured in nature, involving either in-person classes led by a professional along with a prescribed or packaged exercise routine to be completed at home, group-based classes, or a supervised, home-based program. Gothe et al.[51] and Fanning et al.[48] both implemented the FlexToBa™ program which included the use of DVDs to deliver a multicomponent exercise program at home.

Other components

Five studies had physical activity–related components that did not directly align with the physical activity components of aerobic activity, strength training, or balance training.[44,52,54,65,73] Of those studies, only one demonstrated an improvement in physical activity.[54] All five of these studies used a total physical activity measure. Physical activity was a generalized part of the component of improving health in two studies.[44,54] Physical activity was encouraged via function focused care and institutional support in one study.[73] A multifactorial component preventative approach was used to decrease frailty in one

study.[52] A community-based physical activity media campaign and environmental support for physical activity was used in one study.[65]

Table 6. Type of Physical Activity Components in the Physical Activity Interventions

Paper	Aerobic Activity	Strength Training	Balance Training	Multicomponent Physical Activity	Other Components**
Arkkukangas et al. 2020	X	X	X	X	
Arrieta et al. 2019	X	X	X	X	
Balducci et al. 2017*	X	X		X	
Barreto et al. 2018 *	X				
Bates et al. 2022		X	X	X	
Bickmore et al. 2013*	X				
Boekhout et al. 2018	X				
Cederbom et al. 2019					X
Cesari et al. 2015*	X	X	X	X	
Clemson et al. 2012*		X	X	X	
El-Khoury et al. 2015		X	X	X	
Fanning et al. 2016		X	X	X	
Fanning et al. 2019 *	X	X	X	X	
Feinglass et al. 2012	X				
Gothe et al. 2015*		X	X	X	
Granbom et al. 2017					X
Harada et al. 2022*	X				
Herghelegiu et al. 2017*					X
Hirase et al. 2018*		X	X	X	
Iliffe et al. 2015*	X	X	X	X	
Jansen et al. 2021*		X	X	X	
Kendrick et al. 2018	X	X	X	X	
Kerr et al, 2018*	X				
Kleinke et al. 2021*	X				
Kolt et al. 2012*	X				

Paper	Aerobic Activity	Strength Training	Balance Training	Multicomponent Physical Activity	Other Components**
Laforest et al. 2017*	X				
Lee et al. 2013 *	X	X	X	X	
Li et al. 2017*	X				
Luten et al. 2016					X
Morey et al. 2015*	X				
Pahor, et al. 2014*	X	X	X	X	
Patel et al. 2013*	X				
Pérula et al. 2012		X	X	X	
Pomiersky et al. 2020*		X			
Rasinaho et al. 2012*	X				
Reitlo et al. 2018*	X				
Resnick et al. 2021					X
Savikangas et al. 2021	X	X	X	X	
Serra-Prat et al. 2017*	X	X	X	X	
Suikkanen et al. 2021		X	X	X	
Volders et al. 2020*	X				
Voukelatos et al. 2015*	X				
Wanigatunga et al. 2017*	X	X	X	X	
Watanabe et al. 2018*	X	X		X	
Zieschang et al. 2017*		X			

*Significant increase in at least one measure of physical activity with the intervention group.

**The "Other Components" column denotes studies where the sole physical activity component that was used in the intervention did not align strictly with aerobic, strength, balance, or a combination of the three.

Question 1a: Does the mode of delivery (i.e., virtual, in person, phone) impact the effectiveness of interventions?

Source of Evidence

Original research.

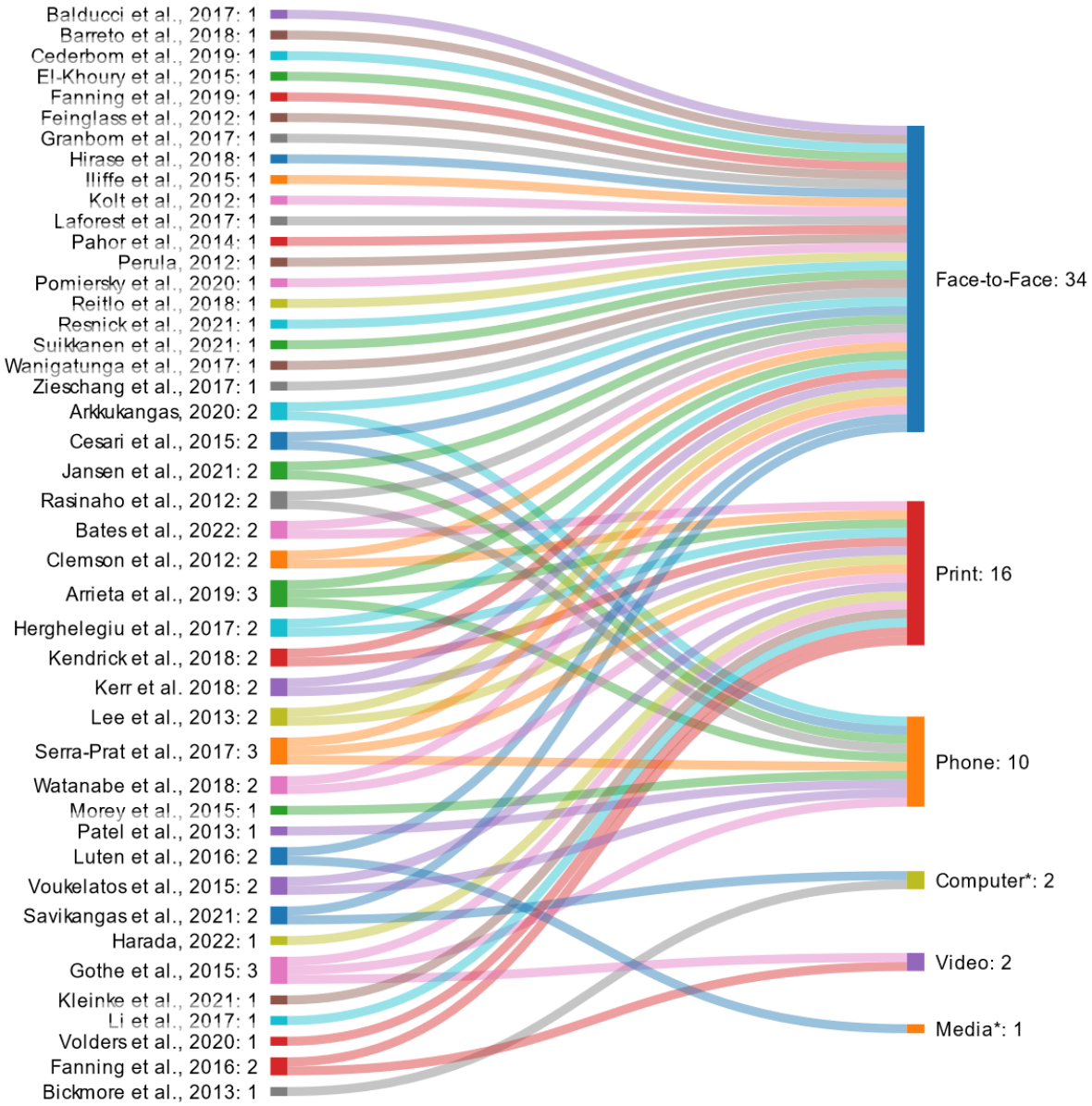
Introduction

The large variability in the means by which health information is provided to older adults led to the question of which mode of intervening to increase physical activity is most effective for this demographic subset of the U.S population. To address this question, "how" the different intervention materials and content were delivered within the studies was extracted and summarized (e.g., face-to-face, print, phone, computer, video, mass media). These modes of intervention delivery have a direct bearing on the potential for large-scale implementation because they directly impact the cost, acceptability, feasibility, reach, and potentially effectiveness of interventions.

As expected, a wide variety of intervention delivery modes were utilized by study investigators, ranging from time- and cost-intensive face-to-face counseling/coaching or individualized "personal" training to the more hands-off approach of providing written or digital educational materials without direction or counseling. Many interventions were delivered using multiple modes either simultaneously or sequentially (e.g., initially it was face-to-face followed by a period of phone delivery). These multiple modes of intervention delivery were not analyzed as a separate category but were included in each mode component utilized by the study intervention.

Of the 45 studies reviewed, 42 permitted comparisons of participants who received an intervention via one mode with participants who did not receive that mode of intervention. As seen in the Sankey plot (**Figure 7)**, face-to-face alone was the most common mode of intervention (34 studies), followed by print (16 studies) and phone (10 studies). Interventions were delivered via a single mode in 26 studies, two modes in 15 studies, and three modes in three studies.

Figure 7. Frequency of Different Intervention Modes Used to Promote Physical Activity



Conclusions

Moderate evidence indicates that using in-person (face-to-face) contact or phone contact for delivering intervention materials and content to older adults is effective for increasing physical activity. **Grade: Moderate**

Moderate evidence indicates that print can be an effective complement to other modes of intervention delivery but is unlikely to be effective for increasing physical activity when used as the sole mode of intervention delivery in older adults. **Grade: Moderate**

There is **insufficient evidence** to determine whether other modes of intervention (computer, video, social media, and video games) are effective for increasing physical activity when used as the sole mode of intervention delivery in older adults. **Grade: Grade Not Assignable**

There is **insufficient evidence** to ascertain whether one mode of delivery is more effective than other modes. **Grade: Grade Not Assignable**

Review of the Evidence

Face-to-face intervention delivery

Description of evidence. The most frequently used mode of intervention delivery in the reviewed literature was a face-to-face approach in which study participants met in person with study intervention staff. This method of delivering intervention materials/content was used in a total of 34 studies[37-41,44-47,49,50,52,54-59,61-63,65,67,69-76,79-81] involving 18882 study participants and primarily required participants to travel to a community or health care setting; however, in seven studies, the study staff met participants that were either in the community or in a congregate living setting in their homes. In 11 studies, the in-person meeting involved at least some supervised sessions of exercise (either in a group or individually), while the in-person meeting in the other studies involved face-to-face counseling, coaching, or education regarding the physical activity intervention goals participants were to achieve outside of the intervention sessions.

The length of interventions in these 34 studies ranged from 10 weeks to three years, and the median duration was 12 months. Importantly, the assessment of the physical activity behavioral outcomes primarily occurred either while study participants were involved in the intervention (just before intervention end) or immediately after the end of intervention (within one week). Only four studies conducted physical activity assessments after a follow-up period of no intervention ranging from four weeks to two years. The outcomes measured at these later time points were not analyzed separately from those measured immediately after intervention.

Key findings. A total of 92 physical activity outcomes were analyzed in response to interventions with a face-to-face mode of delivery. Collectively, 45 of these physical activity outcomes showed that interventions using an in-person approach to delivering content improved physical activity relative to a control group without a similar physical activity intervention. Although 45 of the outcomes did not differ between the face-to-face physical activity intervention and control groups, the majority of these were either assessed via self-report or were the single outcome measured in a study. One study[79] found that an objective measure of total physical activity of adults aged 70 to 89 years decreased over 24 months of follow-up in both the physical activity and control groups, but the decline was almost twice as much in the control group (-112 vs -68 min/wk).

There was broad diversity in the types of physical activity behavioral outcomes assessed, as well as in how the behaviors were measured across these studies. With regard to current Physical Activity Guidelines, total physical activity (reported in minutes per week or in Metabolic Equivalents of Task [MET]) and some type of aerobic activity (primarily walking) were the most frequently measured physical activity outcomes assessed (23 and 26 studies, respectively). Only two studies[67,72] assessed changes in muscle-strengthening activity and one[67] reported weight training combined with walking, thus precluding determining the effects of the intervention on muscle-strengthening activity alone. None of the studies specifically assessed changes in balance-enhancing exercises. By far, most outcomes were assessed using self-report, and only 10 studies used device-based measures of physical activity.

Notably, five studies[39,45,49,54,73] assessed the effects of the interventions on sedentary behavior—four using an objective measure of sitting time and two via self-report. Three of these studies showed that

interventions delivered via a face-to-face mode resulted in an improvement (e.g., decline) in sedentary behavior while the other two[49,73] showed no change between intervention groups.

Print intervention delivery

Description of evidence. Interventions delivered via print provided participants with written materials in the form of a diary, handout, pamphlet, brochure, or manual/handbook. Interventions with print components were evaluated in 16 studies involving 6192 older adults with assessment of 60 physical activity outcomes.[38,41,46,48,51,53,54,58-60,63,64,75,77,78,80] Twelve of the 16 studies combined print with at least one other mode of intervention delivery (e.g., face-to-face, phone, video). In studies with print intervention components, participation in aerobic activity (13 studies) and total physical activity (10 studies) were the most common outcomes. Sedentary behavior was an outcome in three studies, and multicomponent exercise was the outcome in one study. There were no studies on participation in muscle strengthening or balance training outcomes.

Print intervention durations lasted from seven weeks to 12 months with a median duration of six months; however, print materials were typically provided at the beginning of the intervention period. Physical activity outcomes were assessed anywhere from two months to one year following the beginning of the intervention with a median end point of six months.

Key findings. In those 16 studies, 21 behavioral intervention outcomes indicated that physical activity increased (12 studies), one behavioral intervention outcome indicated that physical activity decreased (1 studies), and 31 behavioral intervention outcomes did not indicate differential change between treatment and control groups (eight studies). One study[77] with a negative outcome had two positive outcomes and 11 null outcomes. Of the eight studies that included a null result,[38,41,48,54,58,60,63,77] four studies reported no increases in any physical activity outcomes[38,41,48,58,] and two of those studies only reported a single physical activity outcome.[38,58] Nine studies reported participation in multiple physical activity outcomes[41,48,51,54,59,60,63,77,78] and seven of nine reported at least one outcome indicating an increase in physical activity.[51,54,59,60,63,77,78]

Two of the four trials that used print as the exclusive mode of intervention delivery accounted for a substantial share of the null outcomes (17 of 31 outcomes assessed).[60,77] In contrast, the trial that provided the most consistent evidence for print interventions increasing physical activity used print in combination with face-to-face interventions.[54] Based on this evidence, we conclude that print interventions are unlikely to increase physical activity by themselves but may be effective when used as a complement to other modes of intervention delivery.

Phone intervention delivery

Description of evidence. Interventions delivered by phone used periodic telephone contact with participants to provide education about or motivational support for physical activity. These studies do not include studies that exclusively used telephone contact to promote compliance with a physical activity assessment protocol. Interventions delivered (in part) by phone were evaluated in 10 studies involving 3573 older adults and 19 physical activity outcomes. The most common behavioral outcomes were aerobic activity (eight studies)[38,51,57,66,68,71,75,78] and total physical activity (seven studies).[37,51,66,68,71,75,78] Two studies[66,71] evaluated changes in muscle-strengthening exercise participation, and one study[45] evaluated changes in sedentary behavior. None of the identified studies investigated participation in balance-training or multicomponent physical activity as outcomes. Interventions lasted from three months to two years with a median duration of 12 months. Physical activity end points ranged from three months to two years with a median length of 12 months.

Key findings. Of the 19 behavioral outcomes assessed, interventions delivered by phone increased 14 physical activity outcomes (eight studies)[45,51,57,66,68, 71,75,78] and had no effect on five physical activity outcomes (four studies).[37,38,66,71] Interventions delivered by phone did not decrease any physical activity outcomes. Two studies reported no physical activity outcomes that increased, but each reported only a single physical activity outcome (aerobic activity at 12 months in one study and total physical activity at 12 months in the other study).[37,38]

In the eight studies that measured aerobic physical activity, seven (88%) reported an increase in at least one physical activity outcome.[51,57,66,68,71,75,78] In the seven studies that measured total physical activity, six (86%) reported an increase in at least one physical activity outcome.[37,51,66,68,71,75,78] The two studies evaluating changes in muscle-strengthening exercises both reported a mix of positive (four outcomes) and null (three outcomes) effects on physical activity.[66,71] The one study evaluating changes in sedentary behavior reported significant improvements in favor of the group receiving the phone intervention.[45] Based on this evidence, we conclude that moderate evidence indicates that phone interventions can increase aerobic or total physical activity, but there is insufficient evidence regarding the effects of phone interventions on participation in balance training, muscle-strengthening activities, or sedentary behavior.

Video intervention delivery

Description of evidence. Interventions with video delivery modes provided older adults with video recordings of exercise sessions to guide their exercise. Interventions with video components were evaluated in two published studies from a single trial involving 307 older adults with three physical activity outcomes: aerobic activity, total physical activity, and sedentary behavior.[48,51] Participation in muscle-strengthening exercise, balance training, and multicomponent exercise were not included as outcomes in any of the studies using video interventions. Outcomes in these studies were assessed at the end of a six-month intervention period.

Key findings. The video intervention group increased both aerobic activity and total physical activity more than the control group but did not change their sedentary behavior in this trial. [48,51] Of note, these outcomes were assessed with research-grade accelerometers worn at the waist in relation to an attention control group.

Computer intervention delivery

Description of evidence. Interventions with computer delivery mode used the computers to assess participants, provide tailored advice (including via an embodied conversational agent), and engage participants in cognitive training to improve executive functions needed to translate motivation into action. Interventions with a computer mode were evaluated in two published studies involving 577 older adults with two physical activity outcomes: aerobic activity and total physical activity (one study each).[42,74] Participation in muscle-strengthening exercise, balance training, or multicomponent exercises were not included as outcomes in any studies delivered by computer. The computer was the only mode of intervention delivery in one study[42] and was complemented by a face-to-face intervention in the second study.[74] These interventions both lasted from 12 months and the first physical activity end points were at 12 months.

Key findings. Of the two behavioral outcomes assessed, interventions delivered by computer increased one physical activity outcome in one study[42] and had no effect on one outcome in the other study.[74] The study that reported no change in physical activity only assessed a single outcome.[74] The computer-delivered intervention in that study was cognitive training, which has generally not demonstrated transfer effects to other behaviors (i.e., far transfer).[87]

Media campaign intervention delivery

Description of evidence. A single study used mass media to deliver a physical activity intervention to older adults.[65] The study included four physical activity outcomes involving total physical activity. There is no evidence on mass media campaign effects on participation in aerobic activity, balance training, muscle-strengthening activities, or sedentary behavior. Mass media was the only mode of intervention delivery in that study. This intervention lasted nine months with a 9-month end point for physical activity outcomes.

Key findings. Of the four physical activity outcomes assessed, interventions delivered by mass media campaigns had no effect on any of these outcomes in this study. [65]

Social media and video game intervention delivery

Description of evidence. Neither social media nor video games were used to deliver physical activity interventions to older adults in the studies reviewed.

Key findings. There is no evidence.

Question 1b: Does the setting impact the effectiveness of the interventions?

- Care or assisted living facilities
- Community settings
- Faith-based settings
- Health care settings
- Home/independent living/neighborhood settings

Source of Evidence

Original research.

Introduction

The second edition of the Physical Activity Guidelines for Americans included recommendations specifically for older adults for the frequency, duration, intensity, and components of physical activity engagement to gain and sustain substantial health benefits.[1] The Move Your Way® campaign was developed to relay the importance of these recommendations and the associated health benefits and to provide tips for how consumers can meet these recommendations. Chapter 8 of the Physical Activity Guidelines also pointed out that access to facilities where different populations of older adults can safely implement physical activity guidelines is limited. [1] Therefore, one area of focus of this literature review was to explore settings where physical activity engagement has been studied to identify if the setting utilized impacts the effectiveness of the physical activity intervention. The settings in this systematic literature review included care or assisted living facilities, community settings, health care settings, individuals' homes and neighborhood settings, or some combination of these settings. While the search attempted to find faith-based settings for analysis, none were identified.

Conclusions

Strong evidence demonstrates that behavior-change interventions that take place in one's home/neighborhood alone result in positive change in physical activity outcomes relative to control groups. **Grade: Strong**

Moderate evidence indicates that behavior-change interventions that take place in a health institution alone result in positive change in physical activity outcomes relative to control groups. **Grade: Moderate**

Limited evidence suggests that behavior change interventions that take place in the community result in positive change in physical activity outcomes relative to control groups. **Grade: Limited**

Limited evidence suggests that behavior change interventions that take place in retirement setting result in positive change in physical activity relative to control groups. **Grade: Limited**

Limited evidence suggests that behavior change interventions that take place in one's home/neighborhood and are combined with a virtual component result in positive change in PA relative to control groups. **Grade: Limited**

Moderate evidence indicates that behavior-change interventions that take place in the community and are combined with a home/neighborhood component result in positive change in physical activity relative to control groups. **Grade: Moderate**

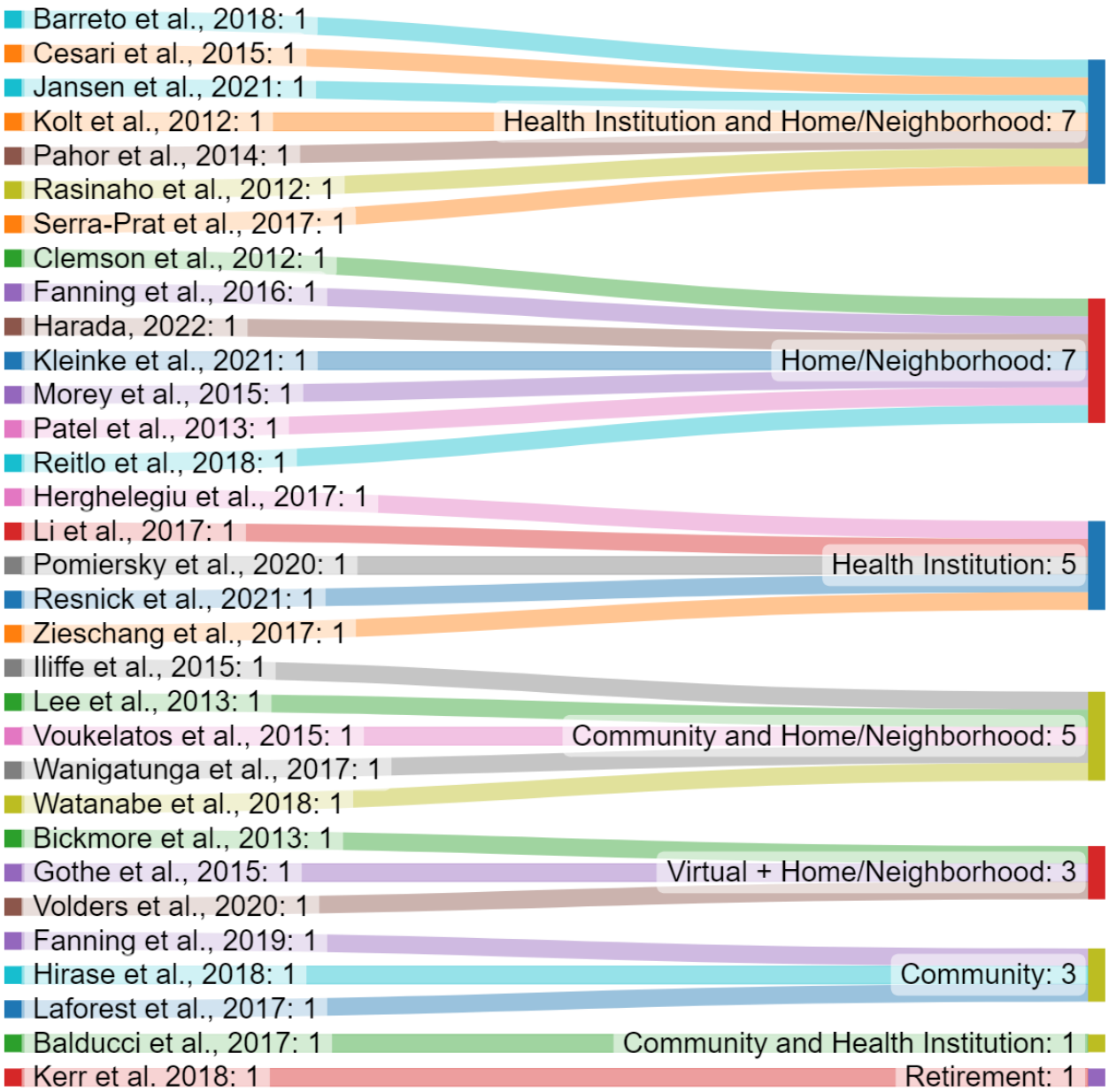
Limited evidence suggests that behavior-change interventions that take place in the community and are combined with a health institution setting result in positive change in physical activity relative to control groups. **Grade: Limited**

Strong evidence demonstrates that behavior change interventions that take place in a health institution and are combined with a home/neighborhood component result in positive change in physical activity relative to control groups. **Grade: Strong**

Review of the Evidence

Of the 45 studies reviewed, 32 studies identified different settings where behavior-change interventions resulted in positive physical activity outcomes for community-living older adults. **Figure 8** summarizes the frequencies of settings in which these interventions were delivered to older adults. The most common settings where behavior-change strategies resulted in positive outcomes were in older adults' homes either alone or in conjunction with a health institution. The least utilized settings were retirement communities.

Figure 8. Frequency of Settings Where Physical Activity Interventions Were Delivered



Home/neighborhood settings

Description of evidence. Twelve studies[37,43,44,46,48,52,53,60,66,68,72,76] were identified as delivering behavior-change interventions to influence engagement in physical activity in the home environment alone. Despite variation in the types of behavioral interventions applied and the modes used to deliver them, positive physical activity outcomes were identified in seven studies (58%) with a combined sample size of 2562,[46,48,53,60,66,68,72] indicating that 42% of these studies with a combined sample size of 798 participants[37,43,44,52,76] identified a decrease or no change in physical activity outcomes when behavioral interventions were applied in the home environment alone.

For those studies that identified increased physical activity outcomes, interventions were implemented in the home via DVD,[48] printed materials,[53] timed feedback based on actual physical activity levels,[60] lifestyle counseling,[66] and prescribed physical activity[72] reinforced with follow-up phone calls.[46,68] Baseline physical activity outcomes were compared with outcomes after three,[68] six,[46,48,60] and 12 months [66,72] of intervention. One study [53] assessed outcomes approximately two weeks after the intervention ended.

In addition to the variation in behavior-change intervention strategies utilized, significant variation existed in the methods used to measure changes in physical activity. Self-report measures included exercise logs[48,53,72] and questionnaires designed to capture day-to-day physical activity patterns.[46,60,66,68] Two studies[48,60] used accelerometry. The most common component of physical activity assessed in the home environment alone was total physical activity in six studies,[46,53,60,66,68,72] followed by aerobic activity in three studies,[60,66,68] sedentary behavior (decrease in) in two studies,[48,60] and muscle strengthening in one study.[66]

Key findings. Three studies[48,60,66] that identified an increase in physical activity outcomes also identified at least one physical activity outcome that did not significantly change due to the behavior-change intervention implemented when compared with the control group.

Five studies (42%)[37,43,44,52,76] identified a decrease or no change in physical activity outcomes when implemented in the home or neighborhood setting alone. All of these studies implemented a self-report method of reporting physical activity outcomes, suggesting that a higher level of accountability was needed for physical activity adherence when implemented in only the home environment. However, there was variability among the behavior-change strategies implemented in this setting, which may also affect physical activity implementation. Arkkukangas et al.[37] supplemented an evidence-based fall-prevention program with motivational interviewing strategies and primarily focused on the 2-year follow-up rather than on physical activity increases that may have occurred immediately after the 12-month intervention period. Boekhout et al.[43] delivered tailored exercise advice designed to target motivational psychosocial constructs such as awareness, knowledge, attitude, social influence, self-efficacy, intention, action-planning, and coping and focused on the 2-month follow-up rather than on the period immediately after the 4-month intervention. These outcomes suggest that the timing of the follow-up influenced physical activity–level maintenance rather than the setting in which the activity was implemented. Cederbom et al.[44] integrated verbal and written advice with individual in-person and phone counseling; however, only 32% of the study sample adhered to the behavior-change intervention. Granbom et al.[52] identified an increase in leisure-time physical activity due to participation in an individually tailored case management program at three months that was not sustained by the end of the 12-month intervention period. Lastly, Suikkanen et al.[76] implemented a tailored, multicomponent exercise program that included strength, balance, mobility, and flexibility exercises. They demonstrated that self-report physical activity did not increase over and above participating in this program during the 12-month intervention period, suggesting that participants perceived participation in the program to be an appropriate amount of weekly physical activity.

Overall, strong evidence supports the use of the home environment to increase physical activity levels for community-living older adults when measurement is implemented during the intervention period.

Health care settings

Description of evidence. Seven studies[38,54,64,69,70,73,81] were identified as delivering behavior-change interventions to influence engagement in physical activity in the health institution environment alone.

Four of these seven studies (57%) with a combined sample size of 598[54,64,70,81] were identified as implementing behavior-change strategies carried out in a health institution alone to increase at least one physical activity outcome. These settings included ambulatory geriatrics clinics,[54,64,70,81] and a geriatrics hospital.[81] Three of the seven studies (43%)[38,69,73] that applied behavioral interventions in the health institution setting alone identified no change in any physical activity outcome. Specifically, these settings included a hospital-based outpatient cancer treatment center,[38] and rural and urban outpatient health centers,[69] and assisted living settings.[73]

Interventions designed to influence change in physical activity outcomes in health institution settings included loss-framed educational materials,[64] physical activity promotion and training programs that focused on resistance and functional training,[70,81] and physical activity counseling.[54]

In addition to the variation in behavior-change intervention strategies utilized, significant variation existed in the subpopulations of older adults included in each study, such as frail older adults,[54] those with type 2 diabetes,[64] and those with dementia.[70,81] The components of physical activity assessed in the health institution environment alone also varied substantially and included total physical activity,[54,70,73,81] sedentary behavior (decrease in),[54]and aerobic activity.[54,64,70] No studies in the health institution alone assessed the muscle-strengthening component of physical activity.

Key findings. Two studies (29%) that identified an increase in physical activity outcomes also identified at least one physical activity outcome that did not significantly change due to the behavior-change intervention implemented when compared with the control group.[54,70]It is unclear if this lack of change is due to the method of physical activity outcome measurement (self-report[54,70]), the timing of the outcome measurement (3-months[70]or 6-months[54]), the behavior-change strategy implemented, or the setting where the behavior-change intervention was carried out.

Three studies (43%) identified no change in any measured physical activity outcome when implemented in a health institution setting alone.[38,69,73] Two studies implemented a self-report method of reporting physical activity outcomes [38,69] and one study directly measured outcomes with accelerometry.[73] Arrietta et al.[38] integrated a tailored exercise program that included strength, balance, flexibility, and aerobic training with phone advice and an educational visual exercise booklet for those living at home and actively undergoing cancer treatment. Pérula et al.[69] also implemented a multicomponent exercise program designed to improve flexibility, muscle strength, balance, and gait; however, outcomes were measured 12 months after the 3-week intervention period, suggesting that the intervention period was not long enough to capture changes in self-reported physical activity or that any changes were not sustained 12 months after the intervention ceased.

Overall, moderate evidence supports the use of the health institution environment alone to increase physical activity levels for community-living older adults when measured during the intervention period.

Community settings

Description of evidence. Three studies with a combined sample size of 1418 participants[49,55,62] were identified as implementing behavior-change strategies carried out in the community setting alone to increase physical activity outcomes among older adults. Significant improvements were identified in the frequency[62], duration,[55,62] and intensity[49] of physical activity among those with diabetes, congestive heart failure, or stroke[49]; chronic pain[55]; or memory concerns[62] who were participating in group-based exercise programs.

Interventions designed to influence change in physical activity outcomes in the community setting included participation in a multicomponent physical activity program that included group-based aerobic, strengthening, balance, and flexibility exercises[49,55] and group-based memory strategies implemented

during a self-directed walking program.[62] The components of physical activity assessed in the community setting alone included aerobic activity,[49, 55] total physical activity,[49,62] and sedentary time (decrease in)[49] No studies in the community alone assessed the muscle-strengthening or balance components of physical activity.

Key findings. Two studies[49,55] that identified an increase in physical activity outcomes also identified at least one physical activity outcome that did not significantly change due to the behavior-change intervention implemented when compared with the control group. There were no studies carried out in the community setting alone that identified no change or a decrease in physical activity outcomes.

Overall, limited but promising evidence supports the use of the community setting to increase physical activity levels for community-living older adults when implemented during the intervention period.

Retirement settings

Description of evidence. One study[59] with a sample size of 241 implemented a group-based, multicomponent behavior-change intervention that included group-based goal setting, counseling, and walking for older adults living in retirement communities.

Key findings. Improvements in the overall duration of light and moderate-to-vigorous activity as measured by accelerometry increased by the end of the 12-month intervention period, but the evidence on retirement settings is limited to this one study.

Home/neighborhood and virtual settings combined

Three studies[42,51,77] with a combined sample size of 1071 were identified as implementing behavior-change strategies in the home and neighborhood settings with an additional virtual component to increase physical activity outcomes among community-living older adults.

Bickmore et al.[42] utilized an animated virtual coach on a take-home touch screen tablet to simulate face-to-face communication coupled with in-person use of an interactive kiosk during follow-up outpatient visits. Gothe et al.[51] utilized a DVD-based exercise program that included balance strength and flexibility exercises. Volders et al.[77] gave tailored physical activity advice and education based on participant characteristics through a website-based application and through regular mailings to the participants' homes.

Bickmore et al.[42] indicated improvements in aerobic physical activity in those with higher health literacy at the conclusion of the 1-year intervention period, and Gothe et al.[51] demonstrated improvements in leisure and moderate-to-vigorous physical activity (MVPA) at the conclusion of the 6-month intervention period. Volders et al.[77] indicated that participants' likelihood to perform walking and MVPA in cycling per week remained increased three months after the 3-month intervention period. Volders et al.[77] also identified at least one physical activity outcome that decreased or did not change significantly as a result of the intervention.

No studies carried out in the home/neighborhood setting and combined with a virtual component identified no change or a decrease in physical activity outcomes.

Overall, limited evidence supports the use of the home or neighborhood setting combined with a virtual component to increase physical activity levels for community living older adults when implemented during the intervention period.

Community and home/neighborhood settings combined

Description of evidence. Ten studies[41,47,56,58,63,65,74,78,79,80] were identified as delivering behavior-change interventions to influence engagement in physical activity in the community setting combined with a home/neighborhood component.

Five studies (50%) with a combined sample size of 3534[56,63,78,79,80] were identified as implementing behavior-change strategies that increased physical activity outcomes when implemented in the community setting combined with a home/neighborhood component.

Interventions designed to influence change in physical activity outcomes in the community setting and combined with a home/neighborhood component varied. Iliffe et al.[56] combined a supervised group-based exercise program focused on strength and dynamic balance with an unsupervised home-based exercise program. Lee et al.[63] and Wanigatunga et al.[79] also combined a supervised group-based exercise program with a home exercise component and included an aerobic and flexibility component in addition to strengthening and balance. Lee et al.[63], however, carried out behavior-change intervention in the community, health institution, and home/neighborhood settings. Voukelatos et al.[78] delivered a self-paced progressive walking program that occurred at participants' preferred times and locations. Wantanbe et al.[80] combined instructions on resistance training, increasing daily physical activity, oral motor exercise and care, and a well-balanced diet. Baseline physical activity outcomes were compared with outcomes 12 months after a 6-month, 3-month, 48-week, 1-year, and 2-year intervention period, respectively.[56,63,78,79,80] All five of these studies that identified increased physical activity outcomes in the community setting combined with the home/neighborhood setting included aerobic activity and total physical activity. None of these studies assessed the muscle-strengthening or balance components of physical activity.

Key findings. Three studies[56,63,79] that identified an increase in physical activity outcomes also identified at least one outcome that did not significantly change due to the behavior-change intervention implemented when compared with the control group.

Five studies (50%) with a combined sample size of 1928[41,47,58,65,74] identified no change in any measured physical activity outcome when carried out in the community setting and combined with a home/neighborhood component.

Two studies implemented a home-based program to improve strength and balance supplemented with in-person workshops.[41,58] Each study applied a different frequency and duration of the intervention. Another study[74] applied a multicomponent exercise program that included supervised resistance, walking, and balance training and a home-based component. One study[47] identified improvement in walking hours per week at 12 months, but this increase was not sustained at the end of the 2-year intervention period. Luten et al.[65] implemented a local media campaign and environmental approaches designed to stimulate physical activity and healthy eating.

It is unclear if these studies did not identify changes in physical activity due to the population of participants targeted in these community settings, the method of physical activity outcome measurement, the timing of the intervention, the behavioral change strategy implemented, or the setting where the behavior-change intervention was carried out.

Overall, moderate evidence supports the use of the community setting combined with a home/neighborhood component to increase physical activity levels for community-living older adults when implemented during the intervention period.

Community and health care settings combined

Description of evidence. One study[39] with a sample size of 300 implemented a unique counseling program for older adults with type 2 diabetes that consisted of one theoretical in-person session focused on assessing current behavior and setting individualized goals for implementing physical activity. This session was combined with eight practical sessions, where participants engaged in physical activity that included low-to-moderate intensity resistance and aerobic exercise performed 2 times per week.

Key findings. Changes were more marked in the intervention group than in the control group, but light physical activity and MVPA increased significantly in both groups, so there was no difference by study group.

Health care and home/neighborhood settings combined

Description of evidence. Eight studies[40,45,50,57,61,67,71,75] were identified as delivering behavior-change interventions to influence engagement in physical activity in a health institution combined with a home/neighborhood component.

Seven studies (88%)[40,45,57,61,69,71,75] with a combined sample size of 5024 were identified as implementing behavior-change strategies carried out in a health institution combined with a home/neighborhood component to increase physical activity outcomes among community-living older adults.

Intervention strategies designed to influence change in physical activity outcomes in a health institution combined with a home/neighborhood component varied. Barreto et a.l[40] implemented a group-based cognitive, nutritional, and physical activity counseling intervention that met in person for eight weeks and was combined with a 34-week home-based program with once-monthly in-person sessions. Two studies implemented a multicomponent program that included endurance, flexibility, muscle-strengthening, and balance activities.[45,67] Cesari et al.[45] implemented the program for 24 weeks in a center and 16 weeks in the participants' homes. Pahor et al.[67] utilized two center-based visits and three to four home-based visits per week for the 2.5-year intervention period. Jansen et al.[57] implemented an 11-week balance and strength program including promoting activities embedded into everyday routines that was reinforced with follow-up phone calls. Two studies provided face-to-face counseling advice related to engaging in physical activity that was subsequently followed up by phone calls focused on goal setting,[61] and motivational interviewing was used to develop and reinforce a personalized physical activity plan.[71] Serra-Prat et al.[75] implemented a multicomponent exercise program including aerobic, strengthening, balance, and coordination activities that was introduced at an initial in-person training session and monitored with regular phone calls; however, the frequency of monitoring was not specified. Baseline physical activity outcomes were compared with outcomes after a 3-month,[61] 12-month,[45,75] 2-year,[71] 2.5-year,[67] and 3-year[40] intervention period, and 6 months after the start of an 11-week intervention.[57]

Key findings. Two studies[40,75] that identified an increase in physical activity outcomes also identified at least one outcome that did not significantly change due to the behavior-change intervention implemented when compared with the control group.

One study[50] with a sample size of 226 carried out in a health institution setting and combined with a home/neighborhood component identified no change in physical activity outcomes. In this study, participants received physical activity counseling (frequency and duration not reported). After the first 6 months of a 2-year intervention, no change was identified in average daily step counts in community-living older adults with arthritis.

Overall, strong evidence supports the use of a health institution setting combined with a home/neighborhood component to increase physical activity outcomes among community-living older adults.

Question 1c: What barriers exist to engaging or participating in the intervention? What are the retention, attrition, and/or attendance rates?

Source of Evidence

Original research.

Introduction

Barriers to intervention participation and engagement are important to understand to help shape future intervention research studies that are designed to minimize barriers to engagement. Very few studies included in this review specifically mentioned barriers to engagement or participation explicitly. We examined reasons for attrition and characteristics of those lost to follow-up as proxy indicators of barriers to participation. A notable reason for attrition is death, as these studies include older adults. However, death is not a choice nor a barrier in which a researcher can intervene to increase participation; therefore, we did not include it here.

Conclusions

Strong evidence demonstrates that compromised health status (chronic health conditions, hospitalization, pain, injury, medical events) is a barrier to remaining in physical activity interventions. **Grade: Strong**

Moderate evidence indicates that relocation and loss of interest are barriers to remaining in physical activity interventions. **Grade: Moderate**

Limited evidence suggests that traveling, being too busy, and caregiving or household responsibilities are barriers to remaining in physical activity interventions. **Grade: Limited**

There is **insufficient evidence** to determine if loss of contact, study burden, lack of motivation, dislike of the intervention, institutionalization, inadequate health literacy, low computer literacy, concerns about privacy, and weather are barriers to remaining in physical activity interventions. **Grade: Not Assignable**

There is **insufficient evidence** to determine if worse physical function, lower baseline physical activity, being older, and having more chronic conditions are common characteristics of those that drop out of physical activity interventions. **Grade: Not Assignable**

There is **insufficient evidence** to determine the specific attrition, retention, and attendance rates of physical activity interventions in older adults. **Grade: Not Assignable**

Review of the Evidence

Barriers to remaining in physical activity interventions

Twenty-four of the reviewed publications provided reasons for attrition. Twenty-three studies reported that poor health, including pain, injury, illness, and serious medical events, contributed to attrition.[39-41,44,46,47,49,51,55,56,57,59,61,62,69,70,71,74,76-78,81,89] Eight studies reported that relocation[46,47,49,51,59,61,69,71] or losing interest[40,47,51,57,59,74,77,78] in the study were reasons for attrition. Furthermore, being too busy[41,42,57,59,61,78] and caregiving responsibilities[41,46,49,57,59] were reported as reasons for attrition in six and five studies respectively. Four studies reported that traveling was a reason for attrition.[41,44,61,62] Losing contact,[54,61,62] the study being too burdensome,[56,57,62] lack of motivation,[41,70,81] and institutionalization[57,59,76] were reported in three studies each. Inadequate health literacy[66,51] and dislike of the study[56,57] were reported

as reasons for attrition in two studies. One study each reported that low computer literacy,[42] concerns about privacy,[42] weather,[51] and trouble comprehending [59] were reasons for dropping out.

Barriers to participating in physical activity interventions

Only seven studies specifically reported barriers to intervention participation. Laforest et al.[62] reported high participation in their exercise program with reasons for nonparticipation including health problems, lack of interest, and traveling. Serra-Prat et al.[75] noted that living alone, depressive symptoms, no outdoor activities prior to the study, and more frailty were risk factors for poor adherence to their intervention. Clemson et al.[46] and Fanning et al.[49] reported that caregiving and terminal illness experienced by the participants and their loved ones were barriers to physical activity participation. Zieschang et al.[81] found that physical activity participation declined after the intervention and noted that "participants were discouraged by the lack of available facilities in the proximity and transportation costs." Fanning et al.[48] mentioned that promoting self-efficacy, altering social norms, and providing models for behavior in various domains of physical activity (e.g., household, transportation) may influence participation. In Herghelegiu et al.[54], reasons for not planning to increase physical activity were self-reported by participants, and the top reasons included already being active and pain when physically active (reported by 44% and 32%, respectively, in the intervention group).

Characteristics of intervention dropout

Few studies reported the characteristics of those who dropped out, but those that did reported that dropout rates were higher among women[78] and among participants who were at older ages,[56,63,70,77,88] had more chronic conditions,[56,88] took more medications,[56,88] had worse physical function,[56,63,74,87] had greater cognitive impairment,[63] worked in routine or manual labor,[56,88] were ex-smokers,[56,88] had more depressive symptoms,[63] had prior falls,[63,78] had lower quality of life,[56,88] had lower outcome expectations for exercise,[56,87] had higher BMIs,[72] had worse self-reported physical health,[56,88] had more social isolation,[56,88] had lower education,[56,78,87] had less physical activity at baseline,[56,72,74,88] and had caregiving responsibilities.[46,49]

Attrition, retention, and attendance rates

Overall, attrition rates varied among the studies. Eleven studies had attrition rates of less than 10%.[41,53,54,62-64,69,71,74,80,81] Fifteen studies had attrition rates of 10% to 20%[37,38,44,47,51,60,61,65,70,72,76,77,78,79,89] Eight studies had attrition rates higher than 20%.[40,42,48,49,56,57,75,77] Five studies did not provide attrition rates.[39,45,58,68,73]

Key findings. Not all of the reviewed studies provided intervention attendance and participation rates and barriers to participation. Furthermore, studies defined adherence in different ways. Some reported adherence to study procedures like phone calls, while others reported adherence to completing prescribed physical activity. Some studies reported high participation rates. Pomiersky et al.[70] reported very high adherence (>92%) to their group-based structured physical activity intervention for people with dementia, as did Hirase et al.[55], who also utilized a structured, weekly exercise program (>90%). In Jansen et al.[57], there was more than 88% adherence to attending 75% or more sessions in both a group-based approach and a home-based approach. In Suikkanen et al.[76], a 75% participation rate with physical therapy supervised exercises was achieved by 85% of the participants with frailty. Arrieta et al.[38] had over 80% adherence to completion of 18 phone calls over 12 months. In Balducci et al.[39], adherence to exercise sessions, including aerobic and resistance training, was around 80%. In Fanning et al.[49], about 80% adherence was observed to both group meetings and exercise sessions.

Other studies had lower adherence. In Barreto et al.[40], only 51.1% of those receiving the structured, group-based, multi-domain intervention adhered to greater than 75% of the exercise sessions.

Cederbom et al.[44] found that only 59% of participants received the intended number of physical therapy sessions focusing on functional exercises. Clemson et al.[46] identified that adherence was only 36% to strength and balance exercise programs; however, 76% of the unstructured strength and balance program participants were still exercising at the end of six months, while this rate was 60% in the structured arm and 71% in the control arm.

Adherence may wane over time. Bates et al.[41] had lower participation in exercise sessions as their intervention progressed, going from 96% attendance in Week 1 to 85% in Week 4 and 79% in Week 12. There was a similar reduction in use of a virtual coach over 12 months in another study. Attendance rate in Cesari et al.[45] was over 70% at six months and declined to 60.9% at 12 months.

Several studies mentioned the importance of addressing physical activity engagement given the outbreak of the COVID-19 pandemic in March 2020. One study suggested that social distancing and other precautions will be needed to ensure older adults in group settings can safely engage in physical activity.[73] Another study suggested that providing older adults with tools during the pandemic, such as resistance bands and exercise instructions, helped study participants.[74] The authors also recommended that supportive built environments, using private sports facilities, and better weather for outdoor activities like gardening could be helpful during the pandemic. One study also indicated that virtual training through the use of a computer or smartphone may be successful during early adoption but decline over the course of the intervention.[42]

Question 1d: Do personal characteristics (e.g., ability, age, sex, race/ethnicity, socioeconomic status) or chronic health conditions influence participation?

Source of Evidence

Original research.

Introduction

Physical activity is inequitably distributed in the U.S. population of older adults due to institutional, environmental, and other systemic barriers to physical activity participation.[90] Prevalence data show that male, non-Hispanic White, college-educated, and normal body weight older adults have higher physical activity.[91] Furthermore, those with mobility limitations[92] and chronic health conditions[93] have lower physical activity. To improve health equity, physical activity researchers should ensure that their interventions are inclusive of and work effectively for various populations, including women, people of color, people with lower education, people with high and low BMIs, and people with chronic health conditions, frailty, or mobility limitations. In this section, we examine the included papers for subgroup, predictor, or moderator analyses by sociodemographic or health characteristics to help determine whether personal characteristics or health conditions influence physical activity intervention effectiveness.

Conclusion

There is **insufficient evidence** to determine if personal (e.g., ability, age, sex, race/ethnicity, socioeconomic status) or health characteristics influence participation. **Grade: Not Assignable**

Review of the Evidence

Description of evidence. Only 12 of the studies reviewed provided moderator, predictor, or subgroup analyses by sociodemographic or health characteristics.[50,51,53,58,59,65,66,70,71,74,77,78] In part, the few studies that included such analyses could be due to limited power for analyzing various subgroups. For example, the vast majority of study samples predominantly comprised non-Hispanic White participants or did not report the race/ethnicity of participants. The exceptions were Bickmore et al.,[42] who included Black

older adults (63%); Harada et al.,[53] and Watanabe et al.,[80] who focused on Japanese older adults; Li et al.,[64] who recruited older adults living in Hong Kong; and Perula et al.,[69] who focused on Spanish older adults. Even fewer studies included socioeconomically disadvantaged older adults[65] or those with lower income[69] or education.[77] The studies that included subgroup analyses suggested that there may be differences in participation by demographic or health characteristics. However, the evidence was sparse and somewhat conflicting, suggesting this research field is not well-developed yet. There is a need for researchers to expand the inclusivity of their studies to enhance opportunities for under-studied populations to participate.

Key findings. Participants of older age,[58,59] women,[58,59] and those with lower physical activity,[58,66] higher comorbidities,[70] lower physical function or mobility limitations,[51,58,66,70,71] and worse cognitive performance[74] were reported as being less likely to improve participation in one or more of the physical activity outcomes assessed. However, in some studies, women[65] and those with lower baseline physical activity[50,70] were found to be more likely to increase physical activity participation. In a study of cancer survivors,[66] lower baseline BMI predicted greater improvement in physical activity participation, while in Volders et al.,[77] people with higher BMIs, more physical impairment, and older age benefitted more from the intervention, particularly from low-intensity physical activity. Similarly, in Gothe et al.,[51] older participants (70+ years) had larger improvements in physical activity than younger older adults. One study found that participants with lower education were more likely to increase their physical activity.[65] In Harada et al.,[53] there was no moderation effect of health literacy or sociodemographic factors on physical activity participation in Japanese older adults. The authors concluded that in the older Japanese population, self-regulation interventions promoted physical activity regardless of health literacy or demographics.

Question 1e: Do interventions assess changes in participant mental health, quality of life, well-being, resilience, or social connection and isolation?

Source of Evidence

Original research.

Introduction

Healthy aging includes both physical and mental health and well-being. Physical activity has been linked to improved mental health and well-being across the life span. The 2018 Physical Activity Guidelines Advisory Committee Scientific Report [1] highlighted a number of these benefits to brain health, including reduced risk for depression, reduced depressive symptoms, reduced state anxiety, and improved health-related quality of life. Thus, an important outcome of physical activity interventions for older adults includes psychosocial factors related to well-being. In this review, we sought to identify the scope of psychosocial indicators of healthy aging that are included in physical activity intervention trials with older adults. Priority indicators of interest included mental health, quality-of-life, well-being, resilience, and social connection or isolation.

Conclusions

Moderate evidence indicates that physical activity intervention trials assess effects of physical activity behavior change on older adults' mental health and quality-of-life. **Grade: Moderate**

There is **insufficient evidence** that physical activity intervention trials assess effects of physical activity behavior change on older adults' well-being, resilience, and social connection or isolation. **Grade: Not Assignable**

Review of the Evidence

Description of evidence. Mental health outcomes were assessed in 15 studies with 6913 participants.[40,41,45,46,55,58,59,62,63,68,70,71,75,80,81] Quality-of-life outcomes were assessed in 15 studies with 6531 participants.[37,38,41,44,46-48,56,58,59,60,61,63,75,78] Well-being outcomes were assessed in two studies from one trial with 1635 unique participants.[67,79] Social connection and isolation were assessed in three studies with 2628 participants[56,58,65] and one study with 200 participants, respectively.[54]

Key findings. The 15 studies with mental health outcomes also included measures of intervention-related change in aerobic physical activity (11 studies with 5756 participants)[40,41,55,58,59,63,68,70,71,75,80] and total physical activity (11 studies [69%] with 5323 participants).[40,41,46,62,63,68,70,71,75,80,81] Intervention-related changes in sedentary behavior (one study with 424 participants)[45] and participation in muscle-strengthening (one study with 632 participants[71] or multicomponent exercise programs (one study [6%] with 1680 participants)[40] were less frequent outcomes in studies with mental health outcomes. Intervention-related changes in both balance training participation and mental health outcomes have not been evaluated in any studies.

The 15 studies with quality-of-life outcomes also included measures of intervention-related change in aerobic physical activity (11 studies with 5627 participants)[38,41,47,56,58-61,63,75,78] and total physical activity (11 studies with 4884 participants).[37,41,44,46,47,56,60,61,63,75,78] Two studies with quality-of-life outcomes included measures of intervention-related change in sedentary behavior (513 participants).[48,60] No studies with quality-of-life outcomes examined intervention-related changes in balance-training, muscle-strengthening, or multicomponent exercise program participation.

The two studies from the single trial with well-being outcomes included measures of intervention-related changes in aerobic physical activity (two studies),[67,79] total physical activity (two studies),[67,79] and muscle-strengthening exercise participation (one study).[67] Neither study examined intervention-related changes in balance training participation, multicomponent exercise participation, or sedentary behavior.

The three trials with social connection outcomes included measures of intervention-related changes in aerobic physical activity (two studies),[56,58] and total physical activity (2 studies).[56,65] No trials with social connection outcomes examined intervention-related changes in balance training participation, muscle-strengthening participation, multicomponent exercise participation, or sedentary behavior.

The lone trial with social isolation as an outcome included measures of intervention-related changes in aerobic physical activity, total physical activity, and sedentary behavior.[54] This trial did not examine intervention-related changes in balance training participation, muscle-strengthening participation, or multicomponent exercise participation.

No studies measured the effects of increasing physical activity on resilience.

Public Health Impact

The second edition of the Physical Activity Guidelines for Americans supports that the health benefits of engaging in regular physical activity for older adults include lower mortality risk, lower risk of cardiovascular and metabolic disease, lower risk of some cancers and dementia, improved sleep, reduced weight gain, improved physical function, and decreased fall-related injuries.[1] All of these benefits lead to improved quality-of-life and decreased health system utilization. Furthermore, physical activity is beneficial for active and sedentary older adults, as well as for older adults who are frail or have comorbid conditions such as arthritis or cancer. Based on the recommendations from this systematic literature review, several opportunities exist to apply the evidence at a level intended to impact the health of the older adult population in the United States.

This report specifically identified:

- Behavioral intervention strategies to include in physical activity programs developed for older adults
- Modes of delivery that impact the effectiveness of applied interventions
- Settings where interventions are delivered that impact the effectiveness of applied interventions
- Barriers to physical activity engagement

Intervention Strategies

The behavioral intervention strategies utilized to increase physical activity among older adults are varied and include individual-level cognitive-behavioral strategies such as goal-setting, self-monitoring of behaviors, problem-solving, and barrier identification. Physical activity counseling, tailored physical activity advice and exercise programs, and lifestyle-based interventions are effective for increasing physical activity levels among older adults.

The strength of evidence supporting the variety in these intervention strategies indicates wide applicability to different populations of community-living older adults. The majority of interventions used a combination of individual-level behavior-change strategies, so it is not possible to determine which behavioral factor promoted changes in physical activity behavior. Therefore, programs can implement some component of these identified strategies and know that positive outcomes in physical activity can occur. However, to make a widespread and targeted impact on the diverse population of older adults in the United States, it is imperative that more specific methodology be required to determine which behavioral intervention strategies are most effective for increasing physical activity engagement among older adults.

Modes of Delivery

The modes of delivery that impacted the effectiveness of applied interventions varied. Effective modes included in-person, phone follow-ups, and printed educational materials as long as they were provided in conjunction with other modes of delivery. These intervention delivery modes have a direct bearing on the potential for large-scale implementation because they directly impact the cost, acceptability, feasibility, reach, and potentially the effectiveness of interventions.

Settings

The settings where physical activity is performed that impact the effectiveness of applied interventions on physical activity outcomes include older adults' homes, health institutions such as ambulatory clinics and assisted living facilities, community-based settings, and the combination of a community environment or a health institution environment and a person's home.

According to the 2020 Profile of Older Americans,[94] only 2.2% of those over the age of 65 lived in nursing homes in 2019. This means that nearly 98% of older adults live in their own homes. The ability to remain living at home is related to functional independence and the ability to optimally manage changes in health status. If older adults can participate in physical activity in the community, then it enhances their opportunity to continue living independently in their home.

Many older adults reside in care communities or assisted living settings. In 2016, there were an estimated 286,300 participants enrolled in adult day service centers, 134,7600 nursing home residents, and 811,500 residential care community residents.[95] Individuals residing in these settings often receive assistance with activities of daily living, such as bathing and dressing, and with instrumental activities of daily living, such as managing medications and meal preparation. Consistent physical activity for

individuals in these settings is important due to the resultant health benefits, including improved physical and cognitive function and decreased fall risk.[96]

Older adults have a high prevalence of chronic disease: approximately 85% of older adults have at least one chronic health condition, and 56% have at least two chronic conditions, according to the CDC.[97] As a result, older adults have frequent health care appointments, and data show that 52% of people aged 60 and older have a doctor's visit at least every three months.[98] Given the many touch points of older adults with health care professionals, physical activity programs that take place or begin in health care settings are logical.

Barriers

Several barriers to initiating and sustaining physical activity include compromised health status, lack of interest or motivation, caregiving responsibilities, and low health literacy. Opportunities exist to design interventions to accommodate these known barriers to participation in physical activity among older adults given the evidence related to the strategies, settings, and modes that have been shown to be effective. However, the time frames in which interventions were applied and outcomes were measured varied widely. Therefore, it is critical to identify the interventions, strategies, and settings that yielded an increase in physical activity behavior beyond the end of an intervention period to effectively scale interventions to have a sustained, population-level impact.

It is important to note here that the current body of evidence that indicates null results related to the most effective intervention strategies, modes of delivery, and settings and the barriers to physical activity implementation among older adults does not suggest weak or unimportant findings; instead, it should be interpreted to mean that opportunities exist to create a more robust evidence base by incorporating suggestions into future research.

Limitations and Needs for Future Research—Strategies

This review revealed several substantive and methodological limitations in the literature. Based on the limitations of the studies reviewed here, future research should:

- **Prioritize standardized reporting of effect sizes:** Effect sizes were reported inconsistently, so it was not possible to estimate the average effect of each intervention mode, setting, or behavior-change technique. It was also not possible to compare the effect sizes against recently published benchmarks for physical activity interventions with older adults.[99]
- **Measure physical activity and sedentary behavior in a rigorous manner:** The majority of the studies reviewed focused on health or physical function as the primary outcome, and physical activity (and/or sedentary) behavior was a secondary outcome. We recommend including a thoughtful and rigorous activity assessment so that the behavior changes can be well-characterized and linked to other outcomes, such as health. This evidence will be critical for understanding how to dose behavior-change interventions so they produce sufficient changes in physical activity to stimulate clinically meaningful physiological adaptations that improve health. There is a need to develop a standard methodology to assess physical activity and sedentary behavior as outcomes with guidelines for integrating the use of both self-report (e.g., survey) and device-assessed (e.g., accelerometers) behavior. Establishing rigorous guidelines for assessing physical activity participation across all domains of physical activity in older adults is necessary to accurately quantify the effects of the intervention and to have consistency across research studies.
- **Clearly identify behavior-change mechanisms or techniques and evaluate their mediated effects on physical activity:** Physical activity promotion for older adults has used a "treatment

package" approach that combines multiple behavior-change techniques, modes, and settings. A behavior-change technique, such as goal setting, is an "observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behavior; that is, a technique is proposed to be an 'active ingredient' and often serves as a link between intervention materials and theory. Without this link, replication will be challenging.[100] Little is known about the necessary and sufficient components of a treatment package (i.e., the least expensive set of components that would produce clinically meaningful effects) or the sequence or conditions under which different components should be delivered to older adults. Studies tend to include a combination of individual-level behavior-change strategies in a black box approach so that it is not possible to determine which intervention components promoted changes in behavior. The field would benefit from rigorous research using novel frameworks and methods (e.g., Multiphase Optimization Strategy [MOST], Sequential Multiple Assignment Randomized Trials [SMARTs], micro-randomized trials) to clearly elucidate the behavior-change strategies that are effective at promoting change in physical activity outcomes.

- Furthermore, the dosing of behavior-change techniques delivered via each mode was inconsistently reported. In the context of behavioral interventions, dosing involves describing the frequency, duration, intensity, and amount of exposure to each behavior-change technique.[101] Few studies provided an evidence-based rationale for dosing decisions, so it is not clear if older adults are receiving sufficient exposure to modify behavior or if resources are being expended inefficiently to deliver unnecessary doses. Understanding the mechanisms of action within interventions is necessary to improve physical activity participation in older adults and to develop cost-effective interventions. **Identify intervention strategies to promote participation in strength and balance exercises using rigorous research designs:** There is little focus in the literature on strength and balance participation following interventions, even though these are important components of the Physical Activity Guidelines. Research on strength and balance activity should include a clear theoretical framework with validated targets for promoting these behaviors and identification of the behavior-change strategies and techniques included in the intervention to engage those targets. There should also be a rigorous evaluation of the mediators of increased strength training or balance activity (i.e., intervention targets). Researchers should not presume that directing participants to do these types of activity is sufficient for changing behavior; directly measuring participation in muscle-strengthening and balance activities would improve the body of evidence.
- **Rigorously examine the intervention strategies, settings, and delivery modes to reduce sedentary behavior:** Sedentary behavior is very common among older adults but has received limited attention in physical activity intervention trials. Research on sedentary behavior reduction should include a clear theoretical framework that specifies validated targets for interventions, identification of the behavior-change strategies and techniques included in the intervention to engage those targets, device-based outcome assessments, and evaluation of the mediators of decreased sedentary behavior (i.e., intervention targets). Studies should examine various settings (e.g., workplace, home, community) and delivery modes for interventions specifically targeted to reducing sedentary behavior (e.g., phone, mobile health).
- **Rigorously evaluate the effectiveness of multilevel interventions in older adults:** The majority of the research reviewed focused on individual-level behavior-change strategies. Behaviors occur within many contexts, and thus focusing on upstream factors, in addition to individual approaches, may be more effective.
- **Examine the intervention strategies and characteristics that lead to long-term maintenance of behavior change using rigorous research designs:** Very few of the physical activity outcomes

were measured a sustained period of time after the intervention phase ended. Accordingly, the effects of intervention strategies, settings, or mode on *maintenance* of behavior change is unknown. Maintenance of behavior change is critical for long-term health benefits in older adults, yet most studies focus on relatively short-term outcomes post-intervention.

- **Test digital technologies for intervention delivery:** Digital technologies are often more scalable and can improve intervention reach and will likely need to be relied upon for health promotion efforts to reach the growing older adult population. Computer literacy may have been a barrier in the past for older adults; however, this barrier is lessening. Older adults substantially increased their use of smartphones, social media, and tablets from 2010 to 2021.[102] There still may be some groups of older adults who will be missed by purely digital interventions, so it may be important for researchers to ensure their target population is comfortable with a digital health approach through co-design, community-based participatory research, or other inclusive research methods.
- **Use a broader set of theories and approaches to behavior change:** Most of the included studies relied on cognitive-behavioral theories that emphasized self-regulation without addressing other types of theoretical frameworks that might be worthwhile to examine in future studies. For example, enjoyment, which has been shown to mediate the relationship between motivation and physical activity,[103-106] was not a focus of the studies reviewed here. Furthermore, self-regulation strategies often rely on conscious processes and can ignore unconscious processes that occur around physical activity behaviors. Contemporary behavior-change theories, such as dual process theory and habit formation theory, highlight the important role of automatic processes, including automatic affective associations, which may serve as barriers to physical activity engagement but are largely understudied.[105-107] Future research could test whether interventions that address unconscious processes could improve physical activity and decrease sedentary time.
- **Compare modes of intervention delivery:** Most studies compared exercise interventions against wait-list or attention control groups. Few studies compared two modes of delivering an exercise intervention, so the impact of delivery mode on physical activity behaviors in older adults could not be determined. Many interventions also combined multiple modes, so there is not sufficient evidence to draw conclusions about the minimal number of modes needed to increase physical activity, how modes interact with each other to influence behavior change, or which modes work best for different subgroups of older adults or settings.
- **Examine a broader variety of settings for physical activity interventions:** There are clear gaps in the literature regarding how the setting of physical activity programs impacts the physical activity of older adults. Most of the settings to date for physical activity interventions involve the home or a health institution, while fewer were community-based or in other locations where older adults may prefer to gather (e.g., churches, senior housing facilities). Determining the most effective settings or combination of settings can help with delivery of interventions.
- **Examine the barriers to participation and report reasons for dropout and the characteristics of those who drop out:** Several characteristics of the aging process—including declining health, physical function limitations, caregiving responsibilities, and needing to relocate—were noted as barriers to retention. Researchers should increase efforts to ensure study designs are inclusive of adults with these common challenges associated with aging. For example, conducting studies fully remotely so that participants face less time, transportation, or other types of burdens could support older adults' retention.
- **Examine the effect of age group (e.g., decade), race/ethnicity, sex, sexual orientation, gender identity, income level, ability status, and education level on participation and study outcomes**

as well as which settings and behavior-change techniques work best for which groups of people: We set out in this review to include a focus on whether personal characteristics (e.g., ability status, age, sex, race/ethnicity, socioeconomic status) or chronic health conditions influence participation. However, the included studies by and large did not examine whether intervention participation and efficacy differed by demographic or health characteristics, partially because many studies did not adequately report demographic or health characteristics. Given health inequities related to chronic conditions and mortality in the United States, there is a great need for physical activity research to include underserved communities. Studies should seek to develop and design interventions that address population-specific barriers to engaging in physical activity research, with inclusive research designs such as co-design and community-based participatory research with members of the target community.

Effective PSE Strategies to Increase Physical Activity Among Older Adults

Introduction

The health benefits of regular physical activity in older adults are well-documented.[1] Further, the associations between population health and the environmental context are well-established.[108] In contrast to individual-level determinants, environmental-level determinants are shaped by public policy, such as economic stability and income/employment security, neighborhood and built environments for housing, transportation, outdoor spaces and buildings, education, and health care access and quality.[108] Population strategies, specifically policy, systems, and environmental (PSE) change interventions, represent "upstream" prevention approaches that work at multiple levels. PSE strategies aim to universally expose a whole or target population and/or target strategies to collectively reach large subgroups to address inequalities in opportunities and outcomes. For example, changing the built environment has emerged as a PSE intervention focus for promoting health and healthy lifestyle equity. Modifying features of the built environment to make physical activity the easy choice has great potential to more equally expose people living in the vicinity. Important for population health and equity are those social-environmental determinants that give people and populations the social capital and structural opportunities they need, in the community places where they live and age, to initiate and maintain health-protective behaviors and health-promoting lifestyle habits, including physical activity. Neighborhood design is increasingly being recognized as important for promoting health, habits, connections, and social well-being of a given community.

The community social, cultural, and environmental contexts, such as housing, air and water quality, access to transportation, crime and traffic safety, connectivity, cohesion, and inequality in who has access or feels included in physical activity opportunities, can serve as potent barriers to a healthy lifestyle and contribute to health inequities. The 21st-century field of physical activity in public health[109] has adopted a multilevel, multi-sector PSE framework[110] to address unequal distribution of environmental resources and risk conditions (rather than individual risk factors) that affect physical activity choices and levels, habitual behaviors, and behavioral disparities of people living in a given community or place. Thus, PSE interventions (designed with equity at the core) have great potential for addressing physical activity disparities and improving population health. Here, we apply a PSE framework and equity lens to examine current evidence and determine the strength of associations between attributes of the community environment and physical activity in older adults.

Question 2: What are effective policy, systems, and environmental (PSE) strategies to increase physical activity among older adults?

a) Is there a dose-response relationship between the scope and reach of the PSE strategy and "success"?
b) Does the "success" of the PSE strategy vary by geographical location, physical ability, age, sex, race/ethnicity, or sociodemographic status?

Source of Evidence

Original research.

Conclusions

There is **insufficient evidence** available to determine whether broad-reaching population approaches, specifically national, state, or local transportation, housing, and/or land-use policies, contribute directly to physical activity patterns in adult populations meeting age-related criteria for review. **Grade: Not Assignable**

Moderate evidence indicates that proximal attributes of the built environment in community places and neighborhood spaces, such as walkability (e.g., residential density, land use mix, street connectivity); sidewalk/curb/intersection quality control; and number of, availability of, and easy access to destinations, including parks and recreational facilities, are positively associated with physical activity levels in community-dwelling older adults. This includes walking for transport, walking for recreation, MVPA, total physical activity, and meeting physical activity guidelines (150 min/wk). **Grade: Moderate**

Limited evidence suggests that when compared with urban environments, rural communities have fewer available and easy-to-access built environment features for walkability (design, density, street/sidewalk connectivity) and fewer shopping and service destinations to which residents can travel actively. In rural communities, evidence also suggests fewer available and easily accessible recreational facilities, including parks, exercise/fitness spaces, and community centers, all of which relate to differences in physical activity levels and types and in meeting physical activity guidelines in rural (compared with urban) older adults. **Grade: Limited**

Limited evidence suggests that favorable perceptions of neighborhood social and safety environment, including cohesion, crime, and traffic, are positively associated with walking for both transportation and recreation in older adults. **Grade: Limited**

There is **insufficient evidence** available to determine whether there is a population dose-response relationship between the scope and reach of PSE interventions or strategies and changes or differences in physical activity among older adults. **Grade: Not Assignable**

Review of the Evidence

The literature review search yielded 18 eligible papers, all focused on PSE strategies to which study populations were exposed, that across all studies reached 113,204 study participants in total. All studies were conducted in the United States within predominantly urban/suburban settings (89%),[111-126] while 2 (11%) compared urban and rural geographies.[127,128] Two studies (11%) were longitudinal cross-sectional observations of public parks as the studied environmental exposure.[114,121] One longitudinal study (6%) was a sequential mixed-methods design utilizing a cross-sectional survey of a representative sample of county residents followed by participatory environmental audits conducted in 6 place-based urban and rural communities by trained residents participating in study cohorts.[127] Fifteen studies (83%) utilized cross-sectional design examining neighborhood-level attributes in association with participant outcomes.[111-113,115-120,122-126,128] Ten studies (56%) utilized or incorporated objective measurements of the built environment,[111,116,117,119,120,123-127] such as geolocated intersection density, land use, or walk score data from geographic information systems (GISs), and 2 (11%) of these studies incorporated GISs with confirmatory environmental audits conducted by study participants[127] or nonparticipating team members[124] trained to observe. Two studies (11%) utilized a systematic environmental audit of park features and users conducted by trained observers.[114,121] Six studies (33%) utilized participant surveys to self-assess neighborhood environments for physical activity,[113,115,118,121,122,128] and 1 study[112] utilized an audit tool requiring participants to directly observe assessed features.

All studies included one or more physical activity outcomes in older adult populations, although the population samples varied by study sampling criteria. Study populations and participants included older adults defined by years of age (e.g., ages 60+) in nine studies (50%)[111-113,115,116,119,122,123,128] and an older mean age sample of adults (e.g., ages 70 $\pm$ 16 years) in two studies (11%).[117,126] Four studies (22%) included middle-age and older adult participants (ages 50 years and older),[118,120,125,127] two studies (11%) disaggregated study samples by groups, including older adults, assigned by observed age-associated criteria (e.g., child, teen, adult, senior)[114,121], and two studies (11%) disaggregated by age-specified groups (e.g. 60-64, 65-69, 70-74, 75+) for analysis.[113,124] Additionally, 10 studies reported, analyzed,

and/or studied targeted older adult populations, specifically gender (women, 22%),[117,123,124,126] race (African American/Black, 11%),[120,121] ethnicity (Asian, 6%),[118] and disability/health (mobility limitation, 11%[115,116] or multiple sclerosis, 6% [122]).

Physical activity outcomes were measured as aerobic activity in 16 studies (89%),[111-113,115-120,122-128] walk for transport and/or leisure in 12 studies (67%),[111,112,115,116,118,119,123-128] total physical activity (39%) in seven studies,[113,117,122,124-126,128] and/or MVPA in four studies (22%).[111,112,116,120] Only one (6%) of these studies additionally measured strength and balance exercise.[127] Two studies (11%) measured physical activity outcomes as total park-based physical activity.[114,121] In 15 studies, physical activity outcomes were measured in participants utilizing self-report surveys (83%),[111-113,115-119,122-128] four studies (22%) used tracking devices, such as accelerometers or GPSs to objectively measure physical activity,[111,112,116,120] and two studies (11%) used direct, systematic observations of participants' park-based physical activity.[114,121]

Transportation, housing, and land-use policy

There is a dearth of research that directly connects the implementation of a specific transportation, housing, or land-use policy to changes in physical activity patterns in older adults. This review found no studies that noted examined the implementation of any specific policy to affect the built environment and increase access to and prevalence of physical activity in older people living independently (not in residential facilities) in urban, suburban, or rural communities in the United States. Nonetheless, it is important to recognize that these policies can have significant influence on the built environment through which people move every day. For example, it is common for a zoning ordinance to dictate quite specifically the location, density, and types of housing; mix of residential, commercial, agricultural, and recreational land uses; inclusion of green space or other features in development; and particular roadway design attributes such as block length, intersection density, and presence (or absence) of sidewalks, crosswalks, and curb cuts. These are precisely the types of environmental attributes that were examined in the reviewed studies.

Walkability

As represented in this PSE-related evidence for physical activity promotion, walking is the physical activity most studied, most prevalent, and most frequently reported by older study participants (11 studies). Not surprising, walkability (assessed objectively via GIS audit, walk score, or sprawl index or subjectively via a walkability survey) is positively associated with neighborhood walking,[115,116,122,124,127] walking for recreation,[111,117,125] utilitarian walking,[111,119] and walking/biking for transportation.[112] Cross-sectional data from the Nurses' Health Study (NHS)[117] indicate that walkability, as measured by the urban sprawl index, correlated significantly with multiple measures of physical activity in a large sample of women. In fact, each standard deviation unit increase in the county index score was associated with greater odds of older (66.4 ± 7.1 years) compared with younger (46.2 ± 4.7 years) women meeting physical activity recommendations. This included by walking (5%) and by walking, bicycling, jogging, and running combined (4%), as well as by significant increases in MET-hours per week as self-reported of total physical activity, walking, and combined activities. Evidence supports that distance to destination is inversely associated with the frequency of utilitarian walking [119] Indeed, additional data from the NHS[126] indicate that the density of different facility types (e.g., retail, grocery stores, service, cultural, restaurants) is associated with a greater odds of meeting physical activity recommendations by walking. There is also evidence that walkability correlates with device-measured active trips in middle-and-older-aged adults with mobility disabilities[116] and MVPA in older people.[111] In contrast, however, Richardson et al.[120] observed no associations between device-measured MVPA and objective measures of neighborhood green space and crime aside from walkability in their sample of predominantly African

American men and women (56.1 ± 16.3 years). Although the group of residents presented low prevalence of MVPA regardless of the neighborhood where they lived, for younger women (<65 years), living in more walkable neighborhoods was associated with more time engaged in MVPA. Cain[112] found that some characteristics of residential neighborhood land use mix, such as intersections (e.g., crosswalks, curb height, buffers), streetscape, and aesthetic/social context, were associated positively or negatively with physical activity (for transportation, for leisure/recreation, or MVPA) in older adults (75.0 ± 6.6 years).

Availability and access to facilities

Chaudhury and colleagues[113] observed that older people engage in physical activity most at home (housework, gardening) or close to home (walking, utilitarian and recreational), as well as in nearby parks/trails, shopping centers/malls, and recreation centers/gyms. In a sequential mixed-methods study, John et al[127] found in a representative subsample of older county residents (age 65 and older) that those residing in more urban (vs rural) communities who were reporting good health and higher income had greater odds of walking around their neighborhood ($P < .001$). Older women (vs men) reporting good health and higher income had greater odds ($P < .05$) of exercising for strength and balance regardless of community type. In the subsequent qualitative GIS phase, rural (vs urban) communities were objectively measured as having fewer available, accessible, and affordable facilities and resources and more structural barriers for walking and exercising by a convenience sample recruited from adult centers of older residents (ages 50+) engaged in participatory research. In a study of urban built environments,[111] the number of available parks significantly correlated with device-measured MVPA but not with self-reported walking for leisure; however, number of recreational facilities was associated with walking for leisure. Troped et al.[126] reported that facility density, including physical activity facilities, was associated significantly with greater odds of meeting physical activity recommendations by walking in a sample of older women from the Nurses' Health Study. In contrast, the availability of a recreational facility (park or playground) was not associated with walking for leisure in a sample of older Asian participants.[118]

Perceptions of safety and social connectivity

Perceptions of the built environment are key mediators of physical activity behaviors. In fact, several studies have highlighted the positive associations observed between perceptions of neighborhood safety[111,125] or social cohesion or connectivity[111,113,118,122,125] and walking in older people. Perceptions of self-efficacy in overcoming neighborhood barriers to physical activity also correlate with neighborhood walking, and this may be especially so for older people with mobility limitations.[115] Maisel et al.[128] reported that across 3 neighborhood types combined (rural, urban, and suburban), job walking, transportation walking, and total weekly walking were associated with perceptions of street connectivity. Moreover, differences in perceived traffic safety approached statistical significance for recreation walking, while perceived crime safety was significantly associated with total weekly walking. In the stratified analysis, total weekly walking was associated with overall neighborhood satisfaction in urban neighborhoods, with mixed land use access in suburban neighborhoods, and with perceptions of crime safety in rural neighborhoods. Further, John et al.[127] found that compared with urban residents, rural residents were twice as likely to disagree that information is available about, and on the availability of, a range of local outdoor and indoor activities, services, programs, and events in their community.

Equity and inclusion

Study findings were influenced by design, sampling criteria, and methods that determined who did and did not have opportunity to participate in research and who was and was not included in the body of evidence. Four studies[117,123,124,126] included and assessed changes in physical activity using data from women-only cohort studies whose participants were predominantly White and educated. Further, two

of the four studies had large samples (n=69,253, and n=23,434), [117, 126]resulting in a significant overrepresentation of White, educated women in the body of evidence associating PSE interventions with physical activity behavior. Two studies targeted recruitment and reported findings relative to disability—mobility limitations,[115,116]—and one study targeted and reported findings relative to health—multiple sclerosis status.[122] Three studies included predominantly African American/Black (race) residents of low-income neighborhoods[120,121] or exclusively Asian ethnicity/Asian subgroup members from various urban neighborhoods within one state.[118] Regarding environmental inequities, studies reported that physical activity resource availability and easy access differed in lower- versus higher-income[125,127] and rural versus urban[127,128] residential communities. Living in an area deprived of physical activity resources possibly explained physical activity disparities in older adults living in rural compared with urban and lower- compared with higher-income communities. Lastly, disparities emerged in how the population of "older" adults was categorized across studies that could serve to reinforce ageism in the body of evidence. In the set of included PSE studies, "older" adult sampling criteria varied by minimum age (60 years and older,[115] 66 years and older,[111] and 70 years and older [119]) some samples were further sorted by within-group age ranges for analyses,[113,118,124] and two studies[114,121] used measures that categorized adults as "older" or "senior" using subjective observations based on physical appearance (e.g., child, teen, adult, senior).

Consistency With Previous Findings and Public Policy Implications

Growing and diverse aging demographics and the increased desire for people to "age in place" underscore the importance of creating and maintaining activity-friendly community environments. Scientific and practical consideration of the collective impact of multiple influences on and attributes of the social, natural, and built environment are needed to inform transportation, housing, and land-use policies that can have positive effects on population physical activity patterns. This is a particular need to address physical activity that can be maintained into older adulthood.

The finding of sufficient evidence connecting attributes of the physical environment to leisure and transportation walking and overall physical activity for older adults is in alignment with a large body of research on more general populations. The grading of the evidence as "moderate" should not be misunderstood as suggesting a weakness to the evidence, so much as its relatively limited scope, as only 18 studies met the inclusion criteria and provided specific data on older adults. It is important to recognize that the studies were consistent in the direction of their findings—the built environment does influence physical activity—and they are consistent with an extensive body of research on the built environment and physical activity in broader populations. This is well-illustrated by current policy statements and practice recommendations that reflect this preponderance of evidence.

The 2015 *Surgeon General's Call to Action to Promote Walking and Walkable Communities* undertook a comprehensive literature review and concluded that for the population at large, simply promoting walking as physical activity is insufficient.[129] It found that as a matter of public policy, it is necessary to work toward built and social environments that support walking as a right (for all) rather than privilege (for some). Specifically, the Call to Action focused on four points:

- Walking is an easy way to start and maintain a physically active lifestyle.
- Walking is the most common form of physical activity for people across the country.
- Walking can serve many purposes. It can be a way to exercise; have fun; or get to school, work, or other nearby destinations.
- Making walking easier can help communities by improving safety, connectivity, and cohesion, as well as local economies and air quality.

Though not specifically focused on older adults, this Call to Action is relevant because much of the cited research included older adults as part of their study populations, and the evidence in support of creating equitable access to pedestrian-friendly environments was consistent and strong.

In 2016, the CDC Community Preventive Services Task Force released its findings, titled *Physical Activity: Built Environment Approaches Combining Transportation System Interventions with Land Use and Environmental Design.*[130,131] Based on extensive literature review and expert input, this practice-oriented recommendation found strong evidence in support of a two-pronged approach: improvements to transportation infrastructure—specifically improved street connectivity and sidewalk, trail, bicycle, and public transit infrastructure and access—*in concert with* interventions to support mixed land use environments that increase the diversity and proximity of local destinations where people live, work, and recreate, including access to parks and other public or private recreational spaces. These twin foci of the active transport network (e.g., sidewalks) and land use (mix of destinations) for the population at large reflect the findings of the present review for older adults.

Further, the lack of specific studies connecting the adoption of a specific policy (e.g., a mixed-use zoning ordinance or *Complete Streets* policy) to physical activity outcomes is reflective of the scarcity of research, likely due to the time scale over which such changes occur. A zoning policy requiring construction of walkable destinations and continuous sidewalks can take many years to elicit those physical changes in the built environment, and then additional time is needed for residents to adopt behaviors in response to persistent exposure to that infrastructure change; such studies (in the United States) as yet are scarce. However, the population and built environment impacts of public policies implemented in non-U.S. political contexts are well understood by practitioners and are reflected in the associated policy recommendations by public health entities.[131]

In 2020, the American Heart Association published a science advisory[132] and a policy statement[131] on built environment approaches to increasing population physical activity based on the continually growing body of evidence and practice. The science advisory concludes that the built environment clearly has an impact on physical activity behaviors and is a crucial opportunity for public health policy intervention. The policy advisory enumerates recommended policy actions at 3 levels: the macroscale of land use (mix and proximity of destinations), the mesoscale of transportation networks (e.g. sidewalks, bike facilities), and the microscale of design features that influence safety, security, and social interaction (e.g., crosswalk and curb design, trees and benches). Again, even though data and recommendations were not separately identified by population age group, these 3 levels of influence closely mirror the findings here for older adults.

Specific intervention opportunities identified in these policy and practice recommendations include (a) comprehensive (or master) plans, (b) zoning and land-use ordinances and subdivision guidelines, (c) transportation and transit policies, (d) roadway design and *Complete Streets* policies, (e) housing plans and policies, and (f) recreation and open space plans and policies. As stated previously, walking (whether recreational, utilitarian, or active transport) is the most frequently studied and reported physical activity in older adults, and walking appears to be associated with the walkability context of one's own neighborhood; the proximity, density, and accessibility of different types of facilities; and perceptions of safety and experiences of social cohesion. These associations may be especially important among diverse groups of older adults, such as women, people belonging to racial and ethnic minority groups, and people with health and mobility limitations. Public health is concerned with health equity and the determinants thereof.[108] PSE interventions have the potential to change a community context to make physical activity available and easily accessible for people of all ages, races, and disability and socioeconomic statuses. When addressing physical activity disparities between and within

younger and older populations, PSE interventions can improve health and lead to health equity across the life span.

Limitations and Needs for Future Research—Policy, Systems, Environment

Limitations

A notable limitation of this body of evidence is reliance on cross-sectional design, observational studies, and indirect measures, such as participant self-reported physical activity behaviors and perceptions of built environment attributes, rather than direct, valid, and reliable measures of participant outcomes and exposure contexts. This limitation is reflective of instrumental and methodological challenges associated with measuring scope and scale of PSE influence on incidental and intentional behavior, like physical activity, and behavioral patterns, like active living by design or default. Another noted limitation is how study populations are universally defined by a single criterion, such as "older age," that fails to address factors contributing to disparities within and across populations, including intersectionality within people and inequitable access to PSE approaches in places where the diversity of people live, grow, and grow older. Finally, given the timescale over which policies are implemented and environmental changes occur, it is difficult, if not impossible, to offset costs of studying "Health in All Policies," a "collaborative approach that integrates and articulates health considerations into policymaking across sectors,"[134] when health is measured by physical activity behavior and public-sector policies that shape the behavioral context are not intended to impact population health or address health (and health behavior) inequities.

Research Recommendations

- Employ longitudinal designs and natural experiments evaluating policy implementation at multiple levels and locales; these must explore the connections between policy adoption, systemic changes, and infrastructure development and change, as well as research.
- Conduct research that focuses on the combined or interactive effect of policy and environmental changes coupled with behavioral interventions and physical activity outcomes.
- Conduct research on population dose-response analyses of reach and access to socio-environmental interventions and their effectiveness.
- Employ mixed-method designs integrating objective, subjective, and experiential measures of population and environmental characteristics.
- Update, refine, and utilize valid and reliable summary assessment tools (e.g., walkability indices) and data technologies (e.g., activity monitors), including measurement studies (e.g., remote surveillance [device-measured] alongside self-reported [surveyed] physical activity) to test quality and feasibility of data with marginalized and unrepresented (in the evidence) subpopulations.
- Develop and expand use of objective measures of the built environment and socio-environmental determinants of physical activity behavior to supplement or validate self-reported assessments.
- Identify and expand use of common, harmonized shared measures utilized across studies and types of interventions.
- Increase conduct of operationally stratified (urban/rural residency; high/low household income) sampling and intersectionality analyses to evaluate equity in reach of, benefits of, and disproportionate harms from the PSE strategies.
- Increase collaborations including "nontraditional" researchers, such as multi-sector professionals (e.g., urban planners, architects and landscape architects, transportation

engineers, local and regional governments), in all phases of study, from proposal development, project design, planning, and implementation to evaluation and publication.

- Develop and expand use of research tools, surveillance methods, and analyses that specifically address the significant changes to the context for physical activity that occur as adults age. This might include, for example, recognizing the transition from employment to volunteer activities, residential relocation, caring for family or friends, and dealing with specific health issues.

Conclusion

The benefits of regular physical activity to healthy aging are now well-established. In fact, the most recent edition of the Physical Activity Guidelines for Americans[1] provides specific recommendations for the type and amount of physical activity older adults need for improving and maintaining overall health and function. Despite these guidelines, many older adults do not meet the recommended amounts of aerobic, muscle-strengthening, and balance activity. This systematic literature review summary report provides evidence from the current scientific literature regarding the effectiveness of behavioral strategies, intervention delivery modes and settings, and policy-driven approaches for promoting physical activity in older people.

The strongest evidence indicates that cognitive-behavioral strategies (e.g., goal setting, self-monitoring, problem-solving, and barrier identification) that are home-, community-, and/or health institution-based and targeted to the individual level are indeed effective for increasing physical activity in older people. Individually tailored exercise programs that are delivered face-to-face or by telephone have also demonstrated success in this age group. These types of interventions tend to be resource-intensive, however, and their long-term effect on behavior change (i.e., after intervention ends) remains unclear. Lifestyle interventions that train people how to incorporate physical activities into their everyday routine may prove more sustainable, but the evidence is still limited. Of note is the fact that most of the evidence linking behavioral approaches to increased physical activity pertains to aerobic physical activity alone. To date, there is insufficient evidence to establish the effectiveness of these behavioral strategies on improving muscle-strengthening and balance activities or on decreasing sedentary behavior in older adults, thereby creating important opportunities for future research.

Compromised health status, time constraints, and lack of access remain important individual barriers to participation in physical activity, including physical activity interventions. Population-level strategies, (specifically PSE interventions) work to change environmental resources or alter risk conditions that affect physical activity patterns in a targeted place. These strategies, by definition, have greater potential for addressing physical activity disparities and improving population health. Moderate evidence indicates that several proximal attributes of the built environment, such as the variety and distance to destinations, connectivity of the street network, and quality and safety of infrastructure, are positively associated with physical activity levels in community-dwelling older adults. This includes walking for transport, walking for recreation, MVPA, total physical activity, and meeting physical activity guidelines (150 min/wk). Although the evidence is limited, it suggests that more urban (compared with rural) contexts and favorable perceptions of the neighborhood social and safety environment are also positively associated with walking for both transportation and recreation in older adults. Unfortunately, there are insufficient data to determine whether broad-reaching population approaches (specifically national, state, or local transportation, housing, and/or land-use policies) contribute directly to physical activity patterns in older adult populations. Nonetheless, investments in neighborhood walkability may represent a more sustainable and equitable approach to improving population levels of physical activity across the life span.

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