Physical Activity, Public Health, and Aging: Critical Issues and Research Priorities

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Physical inactivity in older adults is a major public health concern. Although increasing physical activity (PA) is a national health priority (U.S. Department of Health and Human Services [USDHHS], 2000), promoting activity in older adults has only recently been emphasized, as in the National Blueprint for Increasing Physical Activity in Adults Age 50 and Older (Robert Wood Johnson Foundation, 2001). As a result, the evidence for public health efforts to promote PA for older adults is modest and needs strengthening. In order to inform public health practice, this article presents a position paper of the Centers for Disease Control and Prevention Healthy Aging Research Network on the status of research in PA and aging. The mission of the Healthy Aging Research Network is to better understand the determinants of healthy aging, identify interventions that promote healthy aging, and assist in the translation of such research into sustainable community-based programs.

The purpose of this article is to set a research agenda. To do this, we will (a) specify key issues in public health, PA, and aging, (b) identify knowledge needed to make informed public health recommendations and develop PA interventions in older adults, and (c) recommend research priorities to address those gaps. We have organized this article around four questions designed to serve as a framework for a public health agenda in PA and aging:

Q1: What are the types and levels of PA among diverse older populations?

Q2: What are the health benefits of PA and the consequences of sedentary behavior in older adults?

Q3: What factors influence participation in regular PA among older adults?

Q4: Can we develop successful interventions and policies to promote PA—leading to best practices and evidence recommendations?

Where possible, we selected references based on evidence-based reviews of the literature. For points for which we could find no evidence-based reviews, we attempted to select the most recent randomized clinical trial. For content areas that had no clinical trials, such as the effect of PA on all-cause mortality, we noted the basis for the evidence (e.g., prospective cohort designs).

What Are the Types and Levels of PA Among Diverse Older Populations?

Most of what is known about the type, frequency, and intensity of PA in older populations is based on national and regional surveys. National surveys are usually cross-sectional and use self-reported assessments of current levels of PA in response to an activity list. The Surgeon General’s Report on Physical Activity and Health (USDHHS, 1996) summarized findings across prevalence surveys and concluded that, compared with younger adults, PA is lower among older adults across most measures. Surveys such as the National Health Interview Survey and the Behavioral Risk Factor Surveillance System concluded that fewer than one third of persons aged 65 years and older participate in regular, sustained PA. Compared with younger cohorts, fewer older persons meet current PA recommendations of aerobic activity of moderate intensity (e.g. brisk walking) for 30 minutes, 5 or more days per week. In addition, physicians recommend that persons engage in resistance training 2 to 3 days per week (American College of Sports Medicine, 1998; USDHHS, 1996). Older adults are less likely to engage in vigorous PA or resistance training than in aerobic activities, and walking is the most common activity that they report doing (USDHHS).

Researchers have found considerable variation within diverse older populations (e.g., by ethnicity, gender, age, chronic disease) for type and level of PA. For example, leisure-time PA (engagement in any hobbies, sports, or exercise in preceding 2 weeks) is greater among younger (aged 60 to 69) than older (aged 70 years and older) adults, higher among older men than
for Seniors (Stewart, Mills, et al., 2001), the Physical Activity including the Community Health Activities Model Program ers have designed several measures of PA for older adults, Stewart, 2001; Washburn, Heath, & Jackson, 2000). Research- and duration of specific activities (Harada, Chiu, King, &
reflecting different domains of PA and methods used to assess surveys tailored to older adults; inconsistency in defining PA
level of PA among older adults, including a lack of national
design interventions, and engage in marketing PA programs.

Asians and Pacific Islanders, Hispanics), and persons with
derelating arthritis, are sedentary compared with persons without
Prevalence of Leisure-Time Physical Activity, 1997).

These survey findings have documented differences in levels
activity among a limited selection of diverse older adults—
primarily gender and race. However, there is relatively little
information about PA among other relevant diverse groups,
including frail older adults, under-represented populations (e.g.,
Asians and Pacific Islanders, Hispanics), and persons with
chronic illnesses other than arthritis. This information is
essential for health professionals to develop targeted strategies,
design interventions, and engage in marketing PA programs.

There are numerous obstacles to determining the overall
level of PA among older adults, including a lack of national
surveys tailored to older adults; inconsistency in defining PA
across surveys; considerable variation in measures often
reflecting different domains of PA and methods used to assess
PA; and a failure to adequately assess the frequency, intensity,
and duration of specific activities (Harada, Chiu, King, &
Stewart, 2001; Washburn, Heath, & Jackson, 2000). Research-
ners have designed several measures of PA for older adults,
including the Community Health Activities Model Program
for Seniors (Stewart, Mills, et al., 2001), the Physical Activity

Scale for the Elderly (Washburn, Smith, Jette, & Janney, 1993),
and the Yale Physical Activity Survey (DiPietro, Caspersen,
Ostfeld, & Nadel, 1993). Although these measures address
many of the limitations noted above (Harada et al., 2001), their
length limits their practicality for use in large epidemiological
studies of PA. In addition, little information is available
regarding the reliability and validity of these measures with
more diverse older populations. Table 1 presents our recom-
mandations for research on the level of PA in older adults
(Question 1).

<table>
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<tr>
<th>Question</th>
<th>Recommendation</th>
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<tr>
<td>What are the types and levels of various forms of PA among diverse older populations?</td>
<td>• Develop valid and reliable measures that accurately reflect the type, intensity, and duration of PA older adults perform regularly that can be used for surveillance systems. • Determine whether these measures are valid, reliable, and sensitive to change in levels of PA among diverse older populations. • Conduct research on the level of self-reported and objective measures of PA among diverse older populations, including traditionally underrepresented ethnic groups, those with specific chronic illnesses, and those with varying levels of frailty.</td>
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<td>What are the health benefits of PA and the consequences of sedentary behavior in older adults?</td>
<td>• Continue research to reach a scientific consensus on the benefits of PA, and expand research on the benefits of PA to include a broader range of disability and quality-of-life measures. • Develop age-appropriate guidelines for PA for older populations differing on levels of frailty and the presence of specific chronic illnesses. These guidelines should specify the frequency, duration, and intensity for aerobic PA and frequency and intensity for resistance PA necessary to obtain health benefits in these populations. • Conduct research on the benefits of PA among diverse older populations differing by ethnicity, gender, level of frailty, and presence of specific chronic illnesses.</td>
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<td>What factors influence participation in regular PA among older adults?</td>
<td>• Test, expand, and develop models and theories to incorporate issues of adult development and aging and diversity within this population (e.g., ethnic minorities, the frail and disabled, rural elders, the homebound and isolated). • Examine correlates of PA in diverse and particularly sedentary subgroups of older adults. Apply this knowledge to enhance recruitment and participation in PA among these groups. • Conduct research that promotes understanding of the social and environmental contexts that promote PA and that is inclusive of diverse older adults who may respond differently to social and environmental factors. This research will benefit from longitudinal studies and the application of the geographic information systems.</td>
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<td>Can we develop successful interventions and policies to promote PA in older populations, and, if so, what are the criteria on which to evaluate their success?</td>
<td>• Conduct research on the demonstration and dissemination of PA programs, policies, and interventions that meet criteria for success and that are tailored for diverse older populations in community settings. Future versions of the Guide to Community Preventive Services should include sections with tailored recommendations for at-risk populations. • Conduct rigorous process and outcome evaluations of PA programs as they are translated and adapted to different community settings as described by the RE-AIM framework. • Investigate the feasibility of developing multilevel PA interventions that address more than one level at a time (e.g., enhancing self-efficacy for PA in conjunction with the development of safe and convenient places to be physically active).</td>
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Note: PA = physical activity; RE-AIM = Reach, Efficacy and Effectiveness, Adoption, Implementation, and Maintenance.

What Are the Health Benefits of PA and the Consequences of Sedentary Behavior in Older Adults?

Reviews and meta-analyses on the benefits of PA in older adults have addressed a broad range of outcomes among sedentary healthy older populations and persons with specific chronic illnesses. These outcomes can be organized along several public health foci, including domains of the disablement process (pathology, impairment, functional limitations, and disability; Verbrugge & Jette, 1994), elimination of risk factors associated with chronic illness and disability (primary prevention), and improvements in quality of life among individuals with chronic illnesses (secondary and tertiary prevention).

In a review of exercise interventions across domains in the disablement process, Keysor and Jette (2001) reported that PA in older adults improves pathology; impairment; and functional
limitations, including muscle strength, aerobic capacity, flexibility, balance, walking, and physical function. However, they concluded that findings on the effect of PA on disability were insufficient and inconsistent. They suggested this equivocal finding could be explained by shortcomings in disability measures used by investigators and the relatively short duration of the interventions.

There is consensus that regular PA reduces the risk of chronic conditions such as coronary heart disease, hypertension, colon cancer, type 2 diabetes, and osteoporosis (USDHHS, 1996) and that these benefits extend into old age (American College of Sports Medicine, 1998). Evidence-based reviews have concluded that PA may help prevent breast cancer (Friedenreich, 2001) and hypertension (Kokkinos, Narayan, & Papademetriou, 2001), and improve insulin resistance in non-diabetics and persons with type 2 diabetes (Ryan, 2000). Findings from the Nurses Health Study indicated that PA is associated with lower risk of stroke (Hu et al., 2000). A review of prospective cohort studies has also linked PA to increased longevity (Oguma, Sesso, Paffenbarger, & Lee, 2002) and decreased mortality due to coronary heart disease (Fraser & Shavlik, 1997).

One priority is to conduct enough research in order to enable the development of compelling consensus statements about how PA may ameliorate debilitating conditions important to older adults’ functional abilities and quality of life that occur across the full spectrum of the disablement process. These conditions include sleep disorders, cognitive decline, stroke, depression, osteoarthritis, and disability. Although the evidence is not conclusive, PA appears to benefit aspects of mental health, including depressive symptomology and anxiety disorders (Brosse, Sheets, Lett, & Blumenthal, 2002; Dunn, Trivedi, & O’Neal, 2001) and sleep problems (King, Oman, Brassington, Bliwise, & Haskell, 1997). The failure to mention PA in treatment guidelines for depression or its role in improving cognitive function or preventing cognitive decline (USDHHS, 1999) confirms the need for additional evidence on the role that PA plays in preventing and treating these critical indicators of health and quality of life. It may also be that treatment guidelines quickly become dated in emerging areas of PA and aging research or are based on restricted evidence.

Although Healthy People 2010 refrains the elimination of health disparities as a major public health goal, to date research documenting the health benefits of PA has not been used to address health disparities among older ethnic groups and disadvantaged populations. The field needs more research in order to document health benefits in these disadvantaged populations and to apply this research to practice.

Another priority is to examine the extent to which public health guidelines for PA for older people should differ from general adult guidelines. The Institute of Medicine (IOM) recommendations for PA for the general population (IOM, 2002) may not be appropriate for older adults; additional information would be useful in several areas. First, given the possibility of higher risk of injury but potentially greater benefits with vigorous activity in older adults, what should be the emphasis on such activity? Second, as many older adults have low fitness levels, do activity bouts shorter than 10 minutes confer benefits in this group? Third, as there is evidence of a biologic decline in activity with age in all species studied thus far, to what extent should PA goals for older adults involve lower frequency, duration, and intensity than those for younger adults? Fourth, as older adults are a heterogeneous group, to what extent should selected older adults have activity recommendations beyond basic guidelines? For example, should individuals at greater risk for osteoporosis be encouraged to do more resistance exercise? Finally, given that many older adults suffer from multiple chronic illnesses, evidence of the effect of PA among this population would be valuable. Table 1 presents our recommendations for research on the benefits and consequences of PA in older adults (Question 2).

**What Factors Influence Participation in Regular PA Among Older Adults?**

Following the organization outlined by King (2001), this section reviews the psychosocial/demographic, program-related, and environmental (social and physical) correlates of PA in older adults. Understanding the correlates of PA serves several purposes. The study of nonmodifiable correlates of PA (e.g., age, gender, race) allows identification and targeting of subgroups that are least active, at greatest risk of adverse health outcomes, and in greatest need of tailored PA programs. Knowledge of modifiable correlates (e.g., attitudes) can guide the development of interventions to change PA behavior. These modifiable correlates may vary along sociodemographic and disease categories, underscoring the importance of studying correlates in diverse older groups. However, few studies have examined factors unique to underrepresented groups (including older adults of color, the oldest-old, and older adults in rural settings).

Several reviews have described psychosocial/demographic correlates of PA in older adults (Brawley, Rejeski, & King, 2003; King, 2001; Schutzer & Graves, 2004; Wilcox, Tudor-Locke, & Ainsworth, 2002). Age, female gender, race/ethnicity other than White, rural residence, overweight status, living alone, and being a smoker are negative correlates, whereas higher income and education are positive correlates (King; Wilcox et al.). Although changes in health status (e.g., a heart attack) may be a cue to adopt a healthier lifestyle, poor health is consistently associated with a more sedentary lifestyle (Brawley et al.; Schutzer & Graves; Wilcox et al.). Poor baseline health and decreasing health and functioning predict lower adherence rates among older adults in PA programs (Schutzer & Graves).

Self-efficacy for PA (i.e., confidence in one’s ability to be regularly active) is a consistently positive correlate of PA in older adults (King, 2001; Schutzer & Graves, 2004). Self-efficacy for PA is lower and attitudes toward PA appear to be more negative among older rather than younger adults and among older women rather than older men (Wilcox et al., 2002). There is some evidence, however, that self-efficacy may be more important in initiating than maintaining activity (King). Other psychological influences include more positive attitudes toward PA, greater perceived benefits, and fewer perceived barriers (King; Wilcox et al.). Older adults seem to be more motivated than younger adults by health outcomes and less motivated by appearance-related outcomes (Wilcox et al.). Fear of injury and falling are largely age-specific barriers to PA (King). Finally, knowledge regarding the recommended amount of PA and its benefits predicts PA adoption in older adults (Schutzer & Graves).
Life transitions (e.g., widowhood, becoming a caregiver) may impact PA. Among ethnically diverse middle-aged and older women, caregiving duties are frequently reported barriers to PA (King et al., 2000). Experiencing life events during the course of an intervention has been associated with poorer exercise adherence among middle-aged adults (Oman & King, 2000) and poorer adherence to class-based but not home-based PA in older adults. Yet there is evidence, based on longitudinal data, that older adults who are able to exercise during their early bereavement report better self-rated health, physical functioning, and greater energy 19 months post-loss (Chen, Gill, & Prigerson, 2005).

Several reviews have described program-related factors associated with PA (Brawley et al., 2003; Wilcox et al., 2002). Older adults prefer activities that are convenient, including walking and gardening, and prefer more beverages and alcohol (Brawley et al., 2003). Furthermore, a majority of elders prefer activities that can be done on their own and near or in their home, although older women are more likely than older men to prefer group-based PA (King). The lack of access to low-cost community-based programs tailored to the needs of older adults is a barrier to participation.

In addition to the reviews cited earlier, reviews by Eakin, Glasgow, and Riley (2000); Chogahara, Cousins, and Wankel (1998); and Li and colleagues (2005) summarize social environmental factors (e.g., neighborhood supports) associated with PA in older adults. Social support appears to be a more important influence on PA in older rather than younger adults, especially for women (Wilcox et al., 2002). Although older adults also cite the importance of their health care providers in promoting PA, health-care–based interventions have yielded inconsistent findings. Yet, compared to providers not trained, providers who were trained to offer referrals to community exercise programs to patients who were contemplating regular exercise resulted in more referrals and somewhat higher exercise participation rates (Ackermann, Deyo, & LoGerfo, 2005). Unfortunately, older women report receiving less support for PA than men from both health care providers and family members (Cousins, 1995). Finally, there is growing interest in the role of neighborhood cohesion and social capital on PA, and several studies have linked this construct to health and PA participation in older adults (Li et al.).

The role of the natural and built environments in promoting or limiting PA is an exciting and growing area of study (Humpel, Owen, & Leslie, 2002; Sallis, Bauman, & Pratt, 1998). Research has shown that older adults living in neighborhoods with problems (e.g., heavy traffic, noise, trash, poor lighting, and lack of public transportation) experienced greater loss of physical function over a 1-year period relative to older adults living in neighborhoods with no problems (Balfour & Kaplan, 2002). This loss of function may be associated with fewer opportunities to be physically active. Elders reporting at least one neighborhood problem were significantly less physically active than those reporting no problems. Similarly, Humpel and colleagues have reported that proximity to PA resources (e.g., paths and facilities), pleasant scenery, perceived safe environments, and the availability of sidewalks and commercial goods and services have been associated with greater levels of PA in older adults. Despite the rapid expansion of research in this area, few studies have either focused on older populations or examined the association between the physical environment and PA by age (Humpel et al.).

Although behavioral theories and models have guided much of the research examining the correlates of PA in older adults, these theories focus almost exclusively on the individual, ignoring the complex social and physical environments in which people live. Furthermore, most theories and models were developed with younger populations and adapted to older adults, and may thus be inappropriate for predicting PA of older populations. Ecological models are well suited for understanding PA and aging from a public health perspective (Sallis et al., 1998). The thesis of these models is that health and well-being are affected by a dynamic interaction of biological, behavioral, social, environmental, and policy factors, an interaction that unfolds over the life course of individuals, families, and communities. Ecological models identify multiple points of public health interventions, from the biological to the policy and environmental levels (Schwartz, Susser, & Susser, 1999; Smedley & Syme, 2001). Furthermore, ecological models invite examination, through nested or contextual models, of the interacting effects of factors operating at different levels. Table 1 presents recommendations for research on factors influencing participation in regular PA among older adults (Question 3).

**Can We Develop Successful Interventions and Policies to Promote PA in Older Adults, and, If So, What Are the Criteria on Which to Evaluate Their Success?**

Once researchers have established the efficacy and effectiveness of PA programs for older adults, the public health objective is to translate the research for broader dissemination. Several PA programs for older adults are being widely disseminated and criteria for evaluating program dissemination are being developed. Although there is no single, accepted formula for determining a program’s success, the American Public Health Association (APHA; 1987) has developed criteria (including the feasibility and appropriateness of programs across a range of settings) for determining the success of an intervention. Similarly, the IOM has published recommendations for designing effective, successful interventions (Smedley & Syme, 2001). Based on the APHA and IOM reports, we propose criteria organized into three levels: individual, programmatic, and environmental.

**Individual.**—The APHA report recommended that programs address individual risk factors in the environmental context in which they occur. The IOM report also suggested that a behavior-change intervention could be successful if it was designed to consider specific developmental tasks and health risk factors facing the targeted age group. In the case of older adults, the IOM suggested that interventions focus on environmental, social, and behavioral conditions that minimize disability and promote independence and activity. The report identified interventions aimed at increasing self-efficacy and social supports as particularly promising. Thus, criteria for success need to include the extent to which the intervention is tailored to the specific age-related challenges, risk factors, and concerns of the target population.
Programmatic.—In order to be judged successful, a PA intervention needs to produce a significant increase in endurance, strength, flexibility, or balance. Using aerobic capacity as an outcome, the Task Force on Community Preventive Services (2000) identified several important intervention practices, including point-of-decision prompts to encourage stair use, social support in community settings, individually adapted health behavior change programs, and creation of or enhanced access to places for PA combined with informational outreach. The Task Force analysis did not include best practices tailored to age or functional status, however.

In addition, one must consider the duration of behavior change. Brief changes in PA with quick relapses to sedentary behavior are of little value. The impact and reach of an intervention are also important. Glasgow, Vogt, and Boles (1999) included these concepts in their RE-AIM framework (Reach, Efficacy and Effectiveness, Adoption, Implementation, and Maintenance), which provides a method for evaluating the impact of behavior-change interventions. The framework emphasizes the impact of interventions, which are evaluated in terms of (a) the depth and range of settings in which the intervention is adopted, (b) the degree to which the intervention is implemented as intended (at the individual and setting levels), and (c) the degree to which the intervention is maintained and institutionalized in these settings (Glasgow et al.). Currently, there is a considerable gap between the research on PA in older adults and the dissemination of this research into community-based programs.

Environmental.—Environmental factors affect the impact and maintenance of PA programs. Interventions designed to capitalize on community resources have a better chance of being sustained, may reduce delivery costs, and are more likely to reflect the unique characteristics and strengths of a community than programs that do not make use of such resources (APHA, 1987). In addition, interventions that are designed, implemented, and evaluated with input from community members and the target population are more successful than those designed without such partnerships (Smedley & Syme, 2001).

Exemplar programs that meet many of the criteria for success include Community Health Advice by Telephone (King et al., 2002), Lifetime Fitness (Ackermann et al., 2003), Community Healthy Activities Model Program for Seniors (Stewart, Verboncoeur, et al., 2001), Project Active (Dunn et al., 1999), and Strong for Life (Jette et al., 1999). Organizations like the National Council on the Aging have spearheaded efforts to identify PA programs and have highlighted them in their publications of best practices. These PA programs have demonstrated efficacy and effectiveness and are being adopted into wider community settings and environments. Many share program elements, such as strategies to promote self-efficacy for PA and behavior maintenance. As these programs are disseminated, research should focus on the degree to which critical elements are retained and are essential for continued program success.

The RE-AIM framework is also important in assessing the effects of programs and policies that were designed, administered, and evaluated for reasons other than PA. For example, a growing body of research indicates that the level and types of PA in which older adults participate are affected by the design and characteristics of neighborhoods (including population density, proximity of homes to goods and services, and location of parks and walking paths; Li et al., 2005). However, researchers do not know whether the effectiveness of these programs varies by environmental characteristics, such as “neighborhood walkability.” Table 1 provides recommendations for research and evaluation criteria for successful interventions and policies to promote PA among older adults (Question 4).

Conclusion

This article has highlighted the special contributions made by researchers in aging, PA, and public health, as well as the challenges that lie ahead. The potential exists to develop programs and policies to enhance PA in a predominantly sedentary and increasingly diverse aging population. We have noted advances in research: ongoing surveillance of the prevalence of sedentary behavior and PA in older populations; accumulation of evidence on the health benefits of PA; identification of correlates associated with the adoption and maintenance of PA; and development of PA programs through efficacy and effectiveness trials tailored for older adults.

Although investigators have made advances, considerable gaps remain. A summary of the recommendations provided for each of the four questions in Table 1 suggests several cross-cutting themes. The first is the need for additional research providing greater representation of minority and disadvantaged older populations. Many health disparities noted in the general population also exist in these older populations, including functional limitations and disability (Ostchega, Harris, Hirsch, Parsons, & Kington, 2000). Increasing the knowledge base in each of the four areas in more ethnically diverse populations may help to reduce health disparities through culturally appropriate PA programs and policies. Research recommendations across the four questions pertaining to diversity extend beyond ethnicity and gender to other disadvantaged populations, including the frail and older adults with specific chronic conditions.

The second theme is the need for advances in measurement in terms of PA and health outcomes. The field needs age-specific measurement of PA and outcome measures perceived as relevant to health and quality of life by older adults. Some researchers have questioned the validity, reliability, and sensitivity of measures of PA across diverse older populations. Investigators have noted limitations in the types of health outcome measures used, especially in the area of disability (Keysor & Jette, 2001).

A third cross-cutting theme is the need to promote translation of research with proven efficacy and effectiveness into community-based programs and policies. There is a considerable gap between research knowledge in PA and dissemination of these innovations into community programs. Researchers know more about the personal correlates of PA than the social and environmental correlates. Thus, recommendations reflect the need for ecological frameworks and the application of the RE-AIM model to understanding dissemination of evidence-based PA programs in community settings.

A final theme is the need for greater focus on PA assessment, intervention, and evaluation from a social ecological framework. McKinlay (1995) has criticized past approaches that address PA by emphasizing downstream behavioral interventions...
rather than broader upstream ecological approaches at the public health level that deal with populations in their environmental context.

The pervasiveness of sedentary lifestyles in an increasingly diverse older population, the substantial barriers to PA, and limited resources for public health intervention underscore the importance of addressing the topic of PA and its associated challenges. The field may need new approaches to interventions; the ecological approach, in particular, appears promising in this regard. There exists the potential to enhance the health and well-being of all older adults through successful implementation of programs and policies that are tailored to the unique issues of older adults, and based on well-designed programs with proven efficacy and effectiveness.

ACKNOWLEDGMENTS

Please note that the order of authors, after the first author, is alphabetical by last name.

This research was supported by the Centers for Disease Control and Prevention Research Centers Program, Healthy Aging Research Network.

We thank Gwen Moni, University of Washington Health Promotion Research Center, for assistance with this article.

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M412–M423.


