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Research Article

Outdoor Mobility and Use of Adaptive or Maladaptive Walking Modifications Among Older People

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Abstract

Background: In old age, decline in functioning may cause changes in walking ability. Our aim was to study whether older people who report adaptive, maladaptive, or no walking modifications differ in outdoor mobility.

Methods: Community-dwelling people aged 75–90 years (N = 848) were interviewed at baseline, of whom 761 participated in the 2-year follow-up. Walking modifications were assessed by asking the participants whether they had modified their way of walking 2 km due to their health. Based on the responses, three categories were formed: no walking modifications (reference), adaptive (eg, walking more slowly, using an aid), and maladaptive walking modifications (reduced frequency of walking, or having given up walking 2 km). Differences between these categories in life-space mobility, autonomy in participation outdoors, and unmet physical activity need were analyzed using generalized estimation equation models.

Results: Participants with maladaptive walking modifications (n = 238) reported the most restricted life-space mobility ($\beta = -9.6$, $SE = 2.5$, $p < .001$) and autonomy in participation outdoors ($\beta = 1.7$, $SE = 0.6$, $p = .004$) and the highest prevalence of unmet physical activity need (odds ratio = 4.3, 95% confidence interval = 1.1–16.5) at baseline and showed a decline in these variables over time. Those with no walking modifications (n = 285) at baseline exhibited the best values in all outdoor mobility variables and no change over time. Although at baseline those with adaptive walking modifications (n = 325) resembled those with no modifications, their outdoor mobility declined over time.

Conclusion: Adopting adaptive modifications may postpone decline in outdoor mobility, whereas the use of maladaptive modifications has unfavorable consequences for outdoor mobility.

Keywords: Physical activity, Functional performance, Physical function, Aging

Mobility can broadly be determined as a person's ability to move independently from one place to another, either on foot or by using other forms of transportation (1). Mobility is an important element and prerequisite of participation in valued activities and community life in old age (2). Although aging and age-related diseases and physical impairments affect mobility (3–5), their impacts on individuals vary depending on their psychological (6,7) resources and environmental demands (8,9). Walking modifications are conscious or subconscious changes in walking which occur when older people start to experience functional decline. Typical self-reported walking modifications include reduced walking speed, resting during walking, using an aid, reducing walking frequency, or giving up walking longer distances (10). Earlier studies have reported that people who do not report walking difficulty but have modified their walking form an intermediate group between those with and without walking difficulties in terms of lower extremity performance and muscle strength (10,11). In line with this, it has been shown that walking modifications may be viewed as preclinical signs of walking difficulties that identify people who are at increased risk for future walking difficulties (11).

According to Lawton and Nahemow's ecological theory of aging (12), in the adaptive stage, a person has matched his/her individual capacity to the task or environmental demand. Some studies have indicated that walking modifications may also be advantageous as they help older people to reduce environmental press and hence continue participating in out-of-home activities despite functional decline (13,14). To explore whether some walking modifications influence outdoor mobility more favorably than others, we divided self-reported walking modifications into adaptive and maladaptive modifications on a discretionary basis, drawing on the ecological theory of aging (12). Adaptive walking modifications, such as using an aid or lowering walking speed, can be viewed as facilitators or enablers of walking when facing physiological impairments. In contrast, we assumed that maladaptive walking modifications, such as giving up or reducing the frequency of walking longer distances, could have harmful consequences for outdoor mobility.

The aim of this study was to compare changes in outdoor mobility over 2 years according to self-reported adaptive, maladaptive, or no walking modifications at baseline. We studied outdoor mobility with respect to three outdoor mobility indicators: life-space mobility (15), autonomy in out-of-home participation (16), and unmet physical activity need (17). These measures correlate with each other although they express different aspects of mobility. Life-space mobility refers to actual mobility behavior in daily life (15), whereas autonomy in out-of-home participation indicates an individual's level of satisfaction with their opportunities to move where and when they want (16). Unmet physical activity need refers to a situation where people would like to increase their outdoor physical activity but perceive no opportunities to do so (17).

Methods

Design and Study Participants

The data for this observational study were drawn from data collected for the "Life-Space Mobility in Old Age" (LISPE) project, a 2-year prospective cohort study conducted between the years 2012 and 2014. A more detailed description of the LISPE study and nonrespondent analysis have been reported previously (18). Briefly, the study targeted community-dwelling people aged 75–90 years whose personal data were extracted from the Finnish population register based on their age and residence in the municipalities of Jyväskylä and Muurame (age-stratified random sample N = 2,550). Based on a preliminary review of potential participants' street addresses, those living in assisted living facilities were excluded. In total, 2,269 persons were contacted to enquire about their willingness to take part in the study. The inclusion criteria were being community dwelling, resident in the study area, willing to participate, and able to communicate and provide an informed consent. After exclusions, 848 participants were interviewed in their homes at baseline and 761 took part in the 2-year follow-up (drop-out rate 10%). The Ethical Committee of the University of Jyväskylä approved the LISPE study project.

Measurements

Self-reported modifications in walking 2 km were studied at baseline with a validated assessment tool for capturing early signs of mobility decline (10). Participants were asked: "Have you noticed any of the following changes when walking 2 kilometers due to your health or physical functioning?" Changes were listed as follows: walking slower, resting during walking, using an aid, reduced frequency of walking, and given up walking distances of 2 km. The response options were "yes" or "no" and participants were asked to report all walking modifications. Walking slower, resting during walking, and using an aid were considered to reduce the task demands and indicate a striving to continue doing the task and thus were categorized as adaptive modifications. Those who reported adaptive walking modifications and also reduced frequency of walking were also categorized as using adaptive walking modifications. Given up walking 2 km and reduced frequency of walking 2 km distances, in the absence of adaptive modifications, were considered to represent maladaptive modifications indicating reduced striving to continue the activity potentially stemming from task demands exceeding personal capacity.

Life-space mobility was measured at baseline and at the 2-year follow-up using the Finnish version of the University of Alabama (UAB) Study of Aging Life-Space Assessment (15,19). The Life-space Mobility Assessment captures the individual's actual mobility performance in daily life during the preceding 4 weeks, taking into account all forms of mobility from walking to driving and using public transportation. Participants were asked on how many days per week (less than once a week, one to three times a week, four to six times a week or daily) they reached each life-space level (bedroom, other rooms, outside home, neighborhood, town, and beyond town), and if they needed help from others or assistive devices. A life-space composite score (range 0–120) comprising level, frequency, and assistance needed was then calculated based on the participant's responses (15). Higher scores indicate greater life-space mobility. A change of more than 10 points in the life-space mobility score is considered to indicate clinically meaningful change (19).

Autonomy in participation outdoors was measured using the relevant domain of the Impact on Participation and Autonomy questionnaire. The Impact on Participation and Autonomy questionnaire has been shown to be a reliable and valid instrument for assessing autonomy and participation in older populations (16). The autonomy outdoors domain consists of five items: visiting relatives and friends, making trips and traveling, spending leisure time, meeting other people, and living life the way one wants to. Each item is scored from 0 (very good possibilities) to 4 (very poor possibilities), with a higher sum score indicating more autonomy restrictions in participation (range 0–20).

Unmet physical activity need was measured using two questions: "Would you like to increase your level of outdoor physical activity?" and "Do you feel that you would have the opportunity to increase your level of outdoor physical activity if someone recommended you to do so?" The response options for each of these questions were "yes" and "no." People wanting to increase their outdoor physical activity while perceiving no opportunity to do so were defined as experiencing unmet physical activity need (17).

Covariates were measured at baseline and selected based on existing knowledge on variables that correlate with mobility. Data on age and gender were gathered from the population register extract used as the basis for recruitment. During the home interview, the participants reported their years of education. Physician-diagnosed chronic conditions were elicited with a list of 22 specified chronic conditions followed by an open-ended question on other any other diseases the participant might have. Based on the responses, we calculated the number of chronic conditions (20). Depressive symptoms were assessed with the Center for Epidemiologic Studies Depression Scale, CES-D (range 0–60; higher scores indicate more depressive symptoms) (21), and cognitive function was measured using the Mini-Mental State Examination (22). Lower extremity function was assessed using the Short Physical Performance Battery (23). The tests comprise standing balance (feet together, semi-tandem, full tandem), walking at normal gait speed for 2.44 m, and repeated chair rise (five times). Each test was scored from 0 to 4 and a sum score ranging from 0 to 12 calculated, with higher scores indicating better lower extremity function (20). The sum score was calculated only for those who completed at least two of the three tests. Participants were categorized based on self-reported difficulties in walking 2 km at baseline (10) for the sensitivity analysis. Participants were asked whether they had difficulties in walking 2 m with the following response options: (i) able to manage without difficulty; (ii) able to manage with some difficulty; (iii) able to manage with great deal of difficulty; (iv) able to manage only with help from another person; and (v) unable to manage even with help. Those who reported needing help to manage or being unable to walk 2 km even with help were categorized as being unable to walk 2 km independently.

Statistical Analysis

Participants who reported no walking modifications were selected as the reference category. Participant characteristics and mobility according to the three walking modification categories (adaptive, maladaptive, or no modifications) were described using means and *SD* for continuous variables and percentages for categorical variables. Differences between categories were tested with chi-square test or one-way analysis of variance.

Generalized estimation equation (GEE) models (24) with unstructured working correlation matrix were used to compare changes between the walking modification categories in life-space mobility and autonomy in participation outdoors over the 2-year follow-up. GEE binary logistic regression was used to study changes in the prevalence of unmet physical activity need over time. In the GEE models, the group difference is the difference between groups in the level of the score or prevalence at the baseline and at the 2-year follow-up. Group × time interaction represents the differences between groups in change over time. The first models were adjusted for age and gender, whereas the second models also included years of education, number of chronic conditions, depressive symptoms, and cognitive function. The final models, in addition to all the previous covariates, included extremity function.

Those who died during the follow-up (n = 41) or were admitted to institutional care (n = 15) were excluded from the longitudinal GEE analyses. Thus, the final model comprised 792 participants in the life-space mobility and autonomy in participation outdoors analyses and 787 participants in the unmet physical activity need analysis. Six participants had missing information for years of education, four for depressive symptoms and seven for Short Physical Performance Battery; these 17 participants were not included in the fully adjusted models. Multivariate imputation by chained equation was used to calculate missing scores for follow-up life-space mobility (n = 35), autonomy in participation outdoors (n = 44), and unmet physical activity need (n = 42). The sensitivity analyses showed that imputation did not change the results. Post hoc analyses were conducted using GEE modeling with maladaptive walking modifications set as the reference. Finally, to test the robustness of our findings, we conducted further sensitivity analyses by excluding from the prospective analyses all the participants who were unable to walk 2 km independently.

All the analyses were carried out with IBM SPSS version 24 (SPSS Inc., Chicago, IL). The results were regarded as statistically significant if the 95% confidence intervals did not include 1 or when p value was <.05.

Results

The mean age of the participants was 80.6 (*SD* = 4.3) years and 62% of the participants were women. At baseline, 285 (34%) were categorized as having no modifications in walking 2 km, 325 (38%) as having adaptive, and 238 (28%) as having maladaptive walking modifications. Those with maladaptive walking modifications were older, more often women, less educated, and had more chronic conditions, depressive symptoms, poorer cognitive function, and poorer lower extremity performance than those without walking modifications (p < .002 for all; Table 1). People with adaptive walking modifications formed an intermediate group between those with maladaptive walking modifications and those without walking modifications in age, education, lower extremity function, depressive symptoms, and number of chronic conditions. Participants categorized as using adaptive walking modifications used on average 2.1 walking modifications. The majority of them (80.3%) walked more slowly, 45.6% needed to rest during walking, 37.2% used walking aids when walking 2-km distances, and 50.2% had also reduced their frequency of walking 2-km distances. In the maladaptive walking modifications category, the majority (85.5%) had given up walking 2-km distances, whereas 14.5% had reduced their frequency of walking 2-km distances and reported no adaptive walking modifications.

Life-space mobility scores were highest at baseline and remained almost unchanged during the follow-up among those without walking modifications. Those who used maladaptive walking modifications at baseline had the lowest life-space mobility scores and at follow-up their scores had decreased more than the scores of those with no walking modifications (group difference β = −9.6, *SE* = 2.5,

Table 1. Participant Characteristics by 2-km Walking Modifications at Baseline (N = 848)

Characteristics	No Walking Modifications (n = 285) Mean (*SD*)	Adaptive Walking Modifications (n = 325) Mean (*SD*)	Maladaptive Walking Modifications (n = 238) Mean (*SD*)	p Value
Age, y	78.9 (3.7)	80.9 (4.2)	82.3 (4.2)	<.001[a]
Education, y	10.3 (4.5)	9.5 (4.0)	8.8 (3.8)	<.001[a]
Number of chronic conditions	3.3 (2.0)	4.6 (2.4)	5.3 (2.5)	<.001[a]
CES-D, score	7.4 (5.8)	10.2 (6.3)	11.6 (7.9)	<.001[a]
MMSE, score	26.6 (2.5)	26.1 (2.9)	25.7 (3.0)	<.001[a]
SPPB, score	10.8 (1.4)	9.7 (2.00)	8.1 (3.3)	<.001[a]
Women, % (n)	54 (154)	64 (209)	69 (163)	.002[b]

Notes: CES-D = Center for Epidemiologic Studies Depression Scale; MMSE = Mini-Mental State Examination; SPPB = Short Physical Performance Battery.
[a]Tested with one-way analysis of variance. [b]Tested with chi-square test.

p < .001, group × time p = .010; Table 2). In the age- and gender-adjusted model, the life-space mobility scores were slightly lower in the adaptive walking modifications group than reference group (group difference β = −5.2, *SE* = 2.4, p = .026), although this difference was attenuated after further adjustments. However, over the follow-up, their values declined more than those of the reference category (group × time p = .001).

Further post hoc analyses (not shown) indicated that the life-space scores of those with adaptive walking modifications and those without walking modifications were higher than among those with maladaptive walking modifications. The difference was statistically significant (p < .001 for those with no walking adaptations; p < .001 for those with adaptive walking modifications) and on average clinically significant (β = 9.6, *SE* = 2.5; β = 8.9, *SE* = 2.5, respectively).

The participants with maladaptive walking modifications at baseline showed significantly lower scores for autonomy in participation outdoors (group difference β = 1.7, *SE* = 0.6, p = .004; Table 3) and a significantly higher prevalence of unmet physical activity need (group difference odds ratio 4.3, 95% CI = 1.1–16.5, p = .033; Table 4) than those without walking modifications. Over the follow-up, they remained on the same lower level, with the same slope of change as that of the reference category (group × time p = .971; group × time p = .611). In turn, although the baseline scores of those with adaptive walking modifications resembled those without walking modifications, their scores for autonomy in participation outdoors had increased at the 2-year follow-up compared with those of the reference category (group × time p = .003).

Finally, to test the robustness of our findings, we conducted sensitivity analyses by excluding from the prospective analyses all those who at baseline had reported being unable to independently walk 2 km. This decreased the number of participants in the maladaptive walking modifications category from 207 to 114 and in the adaptive walking category from 309 to 305. These analyses did not change the results for life-space mobility (Supplementary Table 1). The results for autonomy in participation in outdoor activities remained similar for the most part (Supplementary Table 2). However, the difference in the autonomy in participation outdoor scores over time between those using maladaptive and those reporting no walking modifications was no longer statistically significant in the model adjusted also for lower extremity function (group difference β = 0.9, *SE* = 0.6, p = .145). The difference in the prevalence of unmet physical activity need between those with maladaptive walking modifications and those without walking modifications was also no longer statistically significant (Supplementary Table 3).

Table 2. Changes in Life-Space Mobility Scores Over 2-Year Period by Walking Modification Category Among Community-Dwelling People Aged 75–90 Years at Baseline

	Baseline	2-y Follow-up	Model 1			Model 2			Model 3		
	n = 792	*n* = 757									
Category	Mean (*SD*)	Mean (*SD*)	β (*SE*)	Group Difference, *p*	Group × Time, *p*	β (*SE*)	Group Difference, *p*	Group × Time, *p*	β (*SE*)	Group Difference, *p*	Group × Time, *p*
No walking modifications	77.3 (15.6)	76.4 (17.2)	Ref.			Ref.			Ref.		
Adaptive walking modifications	63.9 (17.9)	58.4 (18.8)	−5.2 (2.4)	**.026**	**.001**	−2.7 (2.4)	.223	**.001**	−0.8 (2.4)	.739	**.001**
Maladaptive walking modifications	49.1 (18.1)	44.3 (18.6)	−18.2 (2.5)	**<.001**	**.009**	−14.8 (2.5)	**<.001**	**.010**	−9.6 (2.5)	**<.001**	**.010**

Notes: Reference category: no walking modifications. Model 1: adjusted for age and gender; Model 2: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, and cognitive function; and Model 3: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, cognitive function, and lower extremity function. Statistically significant values are bolded.

Table 3. Changes in Autonomy in Participation Outdoors Scores Over 2-Year Period by Walking Modification Category Among Community-Dwelling People Aged 75–90 Years at Baseline

	Baseline	2-y Follow-up	Model 1			Model 2			Model 3		
	n = 792	*n* = 748									
Category	Mean (*SD*)	Mean (*SD*)	β (*SE*)	Group Difference, *p*	Group × Time, *p*	β (*SE*)	Group Difference, *p*	Group x Time, *p*	β (*SE*)	Group Difference, *p*	Group × Time, *p*
No walking modifications	4.5 (3.00)	4.8 (3.4)	Ref.			Ref.			Ref.		
Adaptive walking modifications	6.1 (3.3)	7.2 (3.6)	0.4 (0.5)	.338	**.003**	−0.3 (0.4)	.577	**.003**	−0.5 (0.4)	.271	**.003**
Maladaptive walking modifications	8.2 (4.3)	8.7 (4.0)	3.2 (0.6)	**<.001**	.957	2.3 (0.6)	**<.001**	.962	1.7 (0.6)	**.004**	.971

Notes: Reference category: no walking modifications. Model 1: adjusted for age and gender; Model 2: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, and cognitive function; and Model 3: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, cognitive function, and lower extremity function. Statistically significant values are bolded.

Table 4. Changes in Prevalence of Unmet Physical Activity Need Over 2-Year Period by Walking Modification Category Among Community-Dwelling People Aged 75–90 Years at Baseline

	Baseline	2-y Follow-up	Model 1			Model 2			Model 3		
	n = 787	*n* = 750									
Category	% (*n*)	% (*n*)	OR (95% CI)	Group Difference, *p*	Group × Time, *p*	OR (95% CI)	Group Difference, *p*	Group × Time, *p*	OR (95% CI)	Group Difference, *p*	Group × Time, *p*
No walking modifications	4.4 (12)	5.5 (15)	Ref.			Ref.			Ref.		
Adaptive walking modifications	11.8 (36)	19.0 (56)	1.7 (0.5–6.6)	.427	.410	1.4 (0.4–5.5)	.610	.402	1.3 (0.3–5.2)	.687	.398
Maladaptive walking modifications	26.1 (54)	26.6 (49)	6.6 (1.8–24.6)	**.005**	.640	5.2 (1.4–19.7)	**.016**	.603	4.3 (1.1–16.5)	**.033**	.611

Notes: CI = confidence interval; OR = odds ratio. Reference category: no walking modifications. Model 1: adjusted for age and gender; Model 2: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, and cognitive function; and Model 3: adjusted for age, gender, years of education, number of chronic conditions, depressive symptoms, cognitive function, and lower extremity function. Statistically significant values are bolded.

Discussion

The levels and changes in outdoor mobility differed between those using adaptive or maladaptive walking modifications and those with no walking modifications. Older people who used maladaptive modifications had the lowest life-space mobility, the poorest perceived autonomy in participation outdoors, and the highest prevalence of unmet physical activity need at both baseline and at the 2-year follow-up. The outdoor mobility of those who used adaptive walking modifications resembled those with no modifications at baseline but declined over time. To the best of our knowledge, this is the first study to divide walking modifications into adaptive and maladaptive categories and examine their potentially different influences on outdoor mobility. Although our results are in line with those of previous studies indicating that walking modifications may facilitate continued participation in meaningful activities (9,14) and postpone reduction in life-space mobility (13), they expand them by distinguishing between adaptive and maladaptive walking modifications and using indicators of different aspects of outdoor mobility as outcomes.

According to the ecological theory of aging, maladaptive behavior occurs when environmental press is higher than the level of individual competence, whereas in the adaptive stage, a person has matched his/her performance to the demands of the task or environment (12). Our results show that in the early phases of declining health and physical performance, some older people lower the task demands of walking by using adaptive walking modifications and thus optimize their walking in relation to their capabilities, thereby postponing the decline in outdoor mobility. This notion is in line with the model of selection, optimization and compensation, which posits that older people use these three strategies to maintain participation in their valued activities (25). The fact that differences in health and physical performance explained the differences between those with no and those with adaptive walking modifications supports this explanation. For those with maladaptive walking modifications, differences in health and physical performance did not attenuate the results. This suggests, first, that the task demands of walking longer distances exceed their capabilities and, second, that factors other than health and physical performance underlie the result. An earlier study has shown that, for example, fear of falling or fear of crime, living alone, and ambient conditions such as poor weather correlate with lower outdoor mobility and especially affect people with lower physical capabilities (26). Another recent study suggested that older people who tenaciously pursue their goals but are also able to change them when needed, report better possibilities to participate in outdoor activities and are more often able to maintain their outdoor mobility at a higher level (7). Moreover, some features of the environment may restrict possibilities for outdoor activities (17,27,28), whereas others may support the use of assistive devices or provide places to rest during the outdoor activity. However, precisely how environmental features influence the choice of walking modifications warrants further study.

Another departure from earlier studies is that our analysis included people who reported walking difficulties. Previous studies have used self-reported walking modifications as indicators of preclinical disability and assessed them solely among those without walking difficulty to establish which came first (11,29). However, our aim was to evaluate whether some modifications could postpone or help maintain outdoor mobility among people who may experience walking difficulties but who are nevertheless able to continue walking. It is possible that some older people interpret the use of walking modifications as difficulties in walking (30); thus, the distinction between walking modifications and walking difficulties may be artificial. For example, a person who needs to rest when walking longer distances will probably report difficulty walking longer distances, even though optimizing the performance by resting in the middle of it helps to maintain the ability to walk longer distances. There might also be differences in reporting walking difficulties between those who have recently experienced pronounced functional decline and those whose functional ability has decreased over a longer period of time (31). In our sensitivity analyses, we excluded participants who reported that they were no longer able to walk 2 km independently or with help from others from the GEE models. Although most of the exclusions were from the category of maladaptive walking modifications, the results did not materially change. Consequently, we believe that the actual inability to walk does not explain the differences observed between the walking modification categories. Some individuals had stopped walking 2-km distances even though they could have continued walking.

The strengths of this study include the large population-based sample of community-dwelling older people. In addition, the possibility to utilize 2-year follow-up data in longitudinal analyses allowed us to study changes in three outdoor mobility variables in three walking modifications categories. Moreover, our categorization of walking modifications into adaptive and maladaptive was based on a self-reported walking modifications measure that has been shown to be a validated and reliable indicator of preclinical disability (10). Use of three different outdoor mobility variables that are conceptually different from walking difficulty or walking modifications enabled us to acquire knowledge that will help lay the foundation for actions to prevent or delay mobility limitation and restrictions on participation. However, the study also has its limitations. We did not have an opportunity to study the reasons behind the use of walking modifications. In addition, all the covariates in the models were assessed at baseline and changes in them were not accounted for.

The findings of the study indicate that categorizing walking modifications into two categories—adaptive and maladaptive—was meaningful as it showed that some older people may postpone age-related decline in outdoor mobility by using adaptive walking modifications, whereas for others, the use of maladaptive walking modifications reduces their outdoor mobility. Because the majority of people experience age-related functional decline, it is important to identify their individual mobility needs to support their full participation in society. Encouraging the use of adaptive walking modifications when needed and designing age-friendly environments, for example, by providing suitable transportation options and opportunities to rest when walking outdoors, may help older people to maintain their life-space mobility and autonomy to participate in outdoor activities, and protect them from unmet physical activity need. Future studies should bear in mind that different walking modifications may have different effects on people.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

Ta.R. serves on the *Journal of Gerontology: Medical Sciences* editorial board. Otherwise, the authors declare no conflicts of interest.

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