

Osteoarthritis Action Alliance (OAAA)
Walkability Audit Phase 1 and Phase 2:
Final Report

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Introduction

Walking is widely recommended for the general adult population to promote health and well-being. For people with arthritis, walking decreases pain and improves function and is well recognized as an important non-invasive strategy for disease management.¹⁻⁴ Greater attention is now paid to the “walkability” of environmental areas as a means to promote or restrict walking and physical activity behaviors.⁵⁻⁷ “Walkability” is a term used widely in the literature with slightly different definitions but generally refers to how well a neighborhood or environment promotes walking and other physical activity behaviors. Numerous measures exist to ascertain the ‘walkability’ of the environment for research and public health needs, yet no gold standard currently exists.

A highly ‘walkable’ environment is associated with greater “walking for transportation” as well as more vigorous physical activity⁸ and lower body mass index scores among community dwelling adults.^{11,12 9,10} Numerous environmental features are identified to support walking and physical activity behaviors in the general adult population including aesthetics, safety, presence of parks, land-use mix, population density, and social support.¹¹⁻¹⁴ In addition, global assessments of the built environment generally show a positive association with physical activity and walking behavior.^{11,15,16}

Less is known about ‘walkability’ environmental needs for people with arthritis, the leading cause of disability among older adults. Walkability needs for people with arthritis may be similar to the general older adult populations since mobility needs are similar. On the other hand, adults with arthritis have a progressive condition and also endure fatigue, pain, muscle weakness, and stiffness. As such, there may be some unique environmental walkability features that affect the physical activity of people with arthritis. A better understanding of the environmental factors that influence walking behaviors among people with arthritis will be useful to public health providers in assessing and developing environments to support walking behaviors for adults with arthritis.

The overall goals of this project were to 1) establish whether existing walkability assessments were adequate for people with arthritis, and 2) identify features of the environment that should be included in walkability tools for people with arthritis. These goals were accomplished in two phases of this “Walkability Project”: Walkability Phase 1 and Walkability Phase 2. In Phase 1, our objectives were to i) perform a literature search to identify evidence-based walkability features for community walking behaviors among people with arthritis, and ii) identify whether the arthritis focused evidence-based features are available on existing walkability assessments. In Phase 2, our objective was to use a modified Delphi approach to develop consensus around walkability environmental features most important to people with arthritis. **The goal of Phase 2 was to identify a ‘short list’ of factors that may be uniquely important to a large number of people with arthritis to promote walking activity in the community. This short list of arthritis-focused factors could then be used in combination with other walkability assessments used by public health departments.** This approach was recommended by the Centers of Disease Control and Prevention at the onset of this project since so many walkability assessments were already in use in public health departments across the United States.

OAAA Walkability: Phase 1 Methods, Results and Discussion

Methods

June - September 2013 and in May 2016, four literature reviews were conducted in PubMed to identify the physical environmental features that are associated with physical activity or walking behavior of 1) older adults, 2) people with lower extremity osteoarthritis or lower extremity pain 3) people who use rolling assistive devices, and 4) people with mobility limitations. The aim of the search was to identify articles that examined the relationship between the environment and walking or physical activity. For articles to be included in the review, specific features of the environment needed to be identified and statistically linked to physical activity (i.e., walking, leisure/fitness activity, or transportation activity) in quantitative studies, and among qualitative studies, the study needed to identify environmental factors related to physical activity or community walking.

“Environment” was defined using the definition proposed by the International Classification of Function, Disability, and Health (ICF) as the “physical, social, and attitudinal environment in which people live,” with a focus on physical features of the environment that could facilitate or inhibit community mobility and physical activity.¹⁷ Physical activity was categorized into two subgroups: i) leisure/fitness, and ii) walking for transportation, and then categorized into an overall/total physical activity group. A few articles used a physical activity measure that combined leisure physical activity and walking for transportation into one summary physical activity score. These studies were combined with the leisure/fitness physical activity subgroup.

The terms “walking, physical activity, exercise, participation, and navigation” were used to identify articles assessing physical activity; “neighborhood, community, and environment” were used to capture the physical environment; and “barriers, facilitators, factors, and restrict” were the terms used to capture the relationship of the environmental features with physical activity.

To identify populations we searched for 1) general older adults using the terms “older adults, aging adults, aging population”; 2) adults with lower extremity osteoarthritis or pain using the terms “osteoarthritis, knee pain, hip pain, ankle pain, and lower extremity,” 3) adults with mobility limitations with the terms “mobility disability, mobility impairment, mobility limitations, decreased mobility, functional limitations, walking difficulties, walking impaired, physical activity limitations, and disabled,” and 4) adults using rolling assistive devices with the terms “wheelchair and walker”.

Articles were excluded if the sample population was younger than age 18, if the article was published in a language other than English, or if the physical environment was not statistically linked to physical activity in quantitative studies. Articles were included if they examined any measure or form of physical activity as a dependent variable.

The results of physical environmental features examined as independent variables in either quantitative or qualitative literature were extracted and recorded based on sample

population type (e.g., older adults, adults with arthritis, adults with mobility limitations, or adults using rolling assistive devices). Environmental features were combined into thirteen environmental categories based in part on the International Classification of Function, Disability and Health (ICF):¹⁸ 1) walking paths/trails, 2) parks/green space, 3) fitness/recreational centers, 4) safety, 5) walkability (defined by residential density, street connectivity, and intersection density), 6) mixed land-use, 7) neighborhood aesthetics, 8) walking infrastructure available (e.g., places for walking/cycling), 9) sidewalk conditions, 10) traffic conditions, 11) public transportation, 12) places to sit and rest, and 13) miscellaneous factors (see Table 1 for descriptions of each environmental category). Statistical significance (quantitative studies), specifically significant or insignificant findings, and counts (qualitative studies) were summed for each environmental category across the four literature searches to draw conclusions.

We summarized the literature using the following approaches. First, for each quantitative study we noted whether the reported relationship with the environmental feature was statistically positive or null. For qualitative studies, each feature related to promoting or restricting walking activities or physical activity was identified. Second, the individual items were categorized into one of the 13 environment categories listed above. Third, for each environmental category, the number of associations *for each individual environmental feature* was summed (See Tables 2-5). (It is worth noting that in some studies the associations of multiple environmental features within an environmental category were reported. In these instances, a single environmental category may have more than one statistical relationship reported and each environmental features was summed within the environmental category. Likewise, in the qualitative study summary score one study may have discussed several environmental features within a given category. In these cases, we reported the number of times any environmental feature was discussed. For example, within our environmental category “walking paths/trails” and physical activity: five studies reported a positive association; three study reported a negative or null association, which we summarized as 5:3. Fourth, we determined whether each environmental category had evidence to support its association with walking behaviors. For the quantitative studies, we began by summing the number of times the environmental category was examined. We started with the premise that if approximately half of the studies reported a positive association and half reported a null association the evidence was “mixed” (e.g., 3 studies reported a positive association; three reported a null association; so in total three out of six studies reported a positive finding and the results were mixed in terms of identifying whether this was an important factor or not. Since an exact 50:50 ratio for the mixed category was unlikely, we characterized features with only one additional study showing a positive or null result as ‘mixed’. For example, if the feature was examined in five studies, with three studies showing a positive finding and two showing a null finding, this was deemed ‘mixed.’ If the majority of studies (defined as 2 or more) identified an environmental feature as statistically significant (positive or negative), then that feature was classified as having evidence to support and association. If a category included six studies and four of the studies reported a significant association, then that environmental feature was identified as having “good” evidence to support. Because of the nature of qualitative studies, environmental features identified as themes impacting physical activity or walking were counted across articles and summed.

Lastly, “walkability” and “rollability” assessment tools or instruments were identified through literature and google searches. Search terms included “walkability” and “rollability.”

Environmental search terms used were “neighborhood,” “environment,” or “community,” and the search terms, “assessment,” “instrument,” “outcome measure,” or “index” were used to identify measurement tools. Additional measurement instruments were found through hand and reference searches of articles identifying walkability measures with a focus on universal design and/or for people with mobility limitations. “Walkability” and “rollability” assessments identified by the literature review were critically reviewed to ascertain whether the instruments included the environmental features identified as “strong evidence for or against inclusion,” “mixed,” from the literature review or the factors identified by the Delphi approach in Phase 2 (discussed later).

Results

3,368 studies were identified in the literature search and hand searches. After reviewing titles and abstracts, 175 articles were included for full review. Based on full review, another 115 articles were eliminated because they did not meet eligibility criteria. 60 articles remained and were included in this review. The environment-physical activity link was examined most extensively in the older adult literature (40 studies: 31 quantitative studies and 9 qualitative studies). Eight articles addressed the environment-physical activity link among people with arthritis (one quantitative study; seven qualitative studies); six articles addressed the link between the environment and physical activity among adults with mobility limitations (four quantitative studies; two qualitative studies); and six addressed adults using wheeled mobility (three quantitative studies; three qualitative studies). The majority of the study samples were recruited from urban populations.

Overall, the literature was very heterogeneous in study methodology, including methods of measurement and definitions of environmental attributes. In the vast majority of the studies, a different attribute of the environment was examined, resulting in few studies examining the same feature in the same way. For example, “access”, “availability” and “safety” of footpaths were identified in individual studies. For the purposes of our literature review findings, we used the overall feature of the environment—i.e., walking paths/trails—and do not specify between access, availability or safety.

The environment-physical activity link was most widely studied among older adults, with the studies examining two dimensions: 1) leisure/fitness, and 2) walking for transportation. In contrast, the studies of people with arthritis, mobility limitations, and those using rolling assistive devices assessed the relationship of features of the environment with leisure/fitness physical activity.

Older Adults:

Overall, there were three environmental features that were significantly associated with both physical activity and walking of older adults in the quantitative literature: i) walking paths/trails, ii) sidewalk conditions, and iii) places to sit and rest (Table 2). Two environmental features were “mixed” for both physical activity and walking: i) traffic conditions (ii) presence of a senior center. Five environmental features were not associated with overall physical activity: i) parks/walking areas, ii) fitness/recreational centers, iii) safety, iv) walkability, and v) public

transportation. Older adults participating in qualitative studies identified safety, walkability, mixed land-use, neighborhood aesthetics, sidewalk conditions, traffic conditions, public transportation, parks/green space, and places to sit or rest as being important for promoting physical activity in their neighborhoods.

People with Mobility Limitations

Six studies were available pertaining to people with mobility limitations. In four quantitative studies, no features were identified as having good evidence to support physical activity.¹⁹⁻²² (See Table 3) In two qualitative studies,^{23,24} however, three features were identified as important: safety, walking infrastructure, and sidewalk conditions.

People who use Rolling Assistive Devices

We identified six studies of environment-physical activity relationships pertaining to people with rolling assistive devices. (See Table 4) Few of the environmental features were studied multiple times between the articles, hence of the quantitative studies, no environmental features had good evidence to support physical activity. Mixed evidence was found for safety and neighborhood aesthetics. Of the three qualitative studies, good evidence was found for safety, walking infrastructure, and accessibility in this population. Mixed qualitative evidence was found for walking paths/trails, mixed land-use, neighborhood aesthetics, and sidewalk conditions.

People with Arthritis (Knee or Hip Osteoarthritis or Pain)

Only one quantitative study of people with knee or hip osteoarthritis or pain was identified, with ‘mixed’ support for parks/green space, safety, sidewalk conditions, and places to sit and rest.²⁵ On the other hand, of six qualitative studies of people with arthritis, sidewalk conditions, safety, walking infrastructure, fitness/recreational centers, public transportation, specific exercise classes/facilities, and accessibility were noted as important for physical activity.²⁶⁻³¹ (See Table 5) Walking paths/trails, parks/green space, places to sit or rest, mixed land-use, and traffic conditions did not have consistent identification in the qualitative literature.^{25-28,31}

Summary/Discussion:

In summary, the literature review of Phase 1 of this study found that while a number of environmental factors are identified in the literature as being associated with physical activity among older adults, there is very limited empirical evidence linking specific features of the environment with physical activity among adults with arthritis, adults with mobility limitations, or adults with rolling assistive devices. Furthermore, the literature was highly heterogeneous with few studies examining the same feature of the environment with the same physical activity outcome; thereby, limiting the generalizability of the results significantly. More research is clearly needed to identify which features of the environment are associated with physical activity, specifically among persons with arthritis since there is some evidence that supports unique needs of people with arthritis. Lastly, more research is needed to better understand how the environment is related to physical activity for transportation.

OAAA Walkability Phase 2: Methods, Results and Discussion

The goal of Phase 2 was to identify a ‘short list’ of factors that may be uniquely important to a large number of people with arthritis to promote walking activity in the community. This short list of arthritis-focused factors could then be used in combination with other walkability assessments used by public health departments.

Study Design and Sampling

A modified Delphi study was conducted to identify important walkability features for people with arthritis. Both consumers with arthritis and health professionals were included. Eligible consumers were community dwelling adults age 21 or older with self-reported physician diagnosed arthritis and access to the internet. Health professionals were eligible if they met the following criteria: i) age 21 or older, ii) were a registered member of the Association of Rheumatology Health Professionals (ARHP), iii) a first or last author on an article examining the relationship between the environment and physical activity, or iv) a member of an organization serving older adults and adults with arthritis. Participants were excluded if they were unable to speak and understand English.

Consumers were recruited through the following approaches: 1) advertisements in the Arthritis Foundation’s online newsletter with a link to the study; and 2) emails obtained through opt-in research participant registries established through Boston University’s Center for Enhancing Activity and Participation among People with Arthritis (ENACT) research center and studies. ENACT’s opt-in registries include participants who have agreed to be contacted for research projects related to exercise and work disability who were not engaged in physical activity-related research studies, consumer members of ENACT’s mailing list, and members of ENACT’s outreach educational initiatives to the African-American community.

We recruited health professionals using the following sources: 1) Association of Rheumatology Health Professionals membership, 2) literature review identifying authors of prominent papers in the field of the environment and physical activity among people with arthritis, 3) list-serves and email distributions of professional organizations affiliated with people with arthritis, and 4) a contact person for members of the Osteoarthritis Action Alliance, a community coalition of organizations supporting people with arthritis.

Data Collection and Data Analysis

Data for the Delphi study were collected in 2 parts using Qualtrics software, an online survey data system. In Part 1, we asked open-ended questions to identify important features of the environment that promote walking activity and general physical activity. Both walking activity and general physical activity were ascertained because both were identified in the literature review. Participants were asked i) “Please list the three most important features of the physical environment that help people with arthritis or rheumatologic conditions **walk** around their neighborhood,” and ii) “Please list the three most important features of the physical

environment that help people with arthritis or rheumatologic conditions do **general physical activity** in their neighborhood.” After completing these questions, participants were provided lists of evidence-based environmental features identified in the Walkability Phase 1 literature review for walking and general physical activity identified in Phase 1. Participants were then asked to list three additional items that are not on the list provided for both walking activity and general physical activity. The purpose of this follow-up question was to attempt to identify items that were important for people with arthritis above and beyond factors commonly reported from older adult populations in the context of general physical activity and environment. We also collected demographic factors including age, sex, education level, type of arthritis, comorbidity, and activity level. The data were analyzed using a modified, qualitative grounded theory approach. Two research assistants (TJ, MV) used open coding to identify content meaning of the responses followed by axial coding to create categories that grouped similar open coded responses. The domains identified in Phase 1 were used as a guiding frameworks to code the qualitative data. This approach allows a grouping of words to be classified into similar environmental categories. Data for each group (consumers and health professionals) were analyzed separately.

For Part 2 of the Delphi study, participants in Delphi Part 1 (both consumers and health professionals) were emailed a follow-up survey with the top environmental features identified (in Part 1) for walking and general physical activity. As a means to obtain consensus on environmental features that are related to walking, consumers were asked the following: “Below are features that people in our study said could restrict or help people with arthritis or related rheumatic conditions **walk** around a neighborhood. Please tell us how much you agree or disagree that each listed feature is important for walking for people with arthritis or a related rheumatological condition.” After participants were asked the extent to which they agreed or disagreed with each environmental feature listed, they were then asked to rank the features in order of importance. Specifically, they were asked, “Now, please rank the previous environmental features in order of importance for **walking** for people with arthritis or rheumatological condition, from #1 (most important) to #15 (least important).” To obtain consensus on environmental features that are related to general physical activity, consumers were asked the following: “Below are features that people in our study said could restrict or help people with arthritis or related rheumatic conditions **to do physical activity** in a neighborhood. Please tell us how much you agree or disagree that each listed feature is important for doing physical activity for people with arthritis or a related rheumatological condition.” Consumers were then asked to rank the listed features. Instructions read: “Now, please rank the previous environmental features in order of importance for **doing physical activity** for people with arthritis or rheumatologic conditions, from #1 (most important) to #14 (least important).” Instructions were similar for health professionals.

The descriptive data collected via consumers and health professionals in Part 2 of the Delphi study were then reviewed to determine if consensus on the most important features was reached. Consensus was identified by determining if at least 80% of respondents agreed or strongly agreed that the feature was important. In addition, the mean of the rank order of the items was calculated and items distributed from most to least important in numerical order. Items were deemed the highest priority for inclusion on an instrument if 80% of people agreed or strongly agreed that the feature was important.

Results:

In part 1 of the Delphi study, 149 consumers and 26 health professionals completed the online surveys to identify environmental features important for people with arthritis and rheumatic conditions. (See tables 6 and 7 for demographic information) One hundred and five consumers (70% retention) and 19 health professionals (73%) completed Part 2 of the Delphi study. The results from the two parts of the Delphi study found that the top 8 environmental features for both walking and physical activity were consistent, with 90% of consumers reporting agree or strongly agree for each feature. (See Tables 8 and 9) The environmental features identified as listed below in Figure 1.

Environmental Features for Walking & Physical Activity for People with Arthritis are listed below in Figure 1:

1. Safety from crime
2. Safety from injury
3. Walkways free of objects blocking the path
4. Walking areas separate from roads (e.g., sidewalks)
5. Smooth and level walkways
6. Street lighting
7. Places to sit and rest
8. Ramps and railings at stairs

The results from health professionals and researchers for environmental features revealed similar results. (See Tables 10 and 11) The factors ranked the highest were: safety from injury, walking areas separate from roads (e.g., sidewalks), smooth and level walkways, places to sit and rest, and ramps and railings at stairs. In contrast to the features identified by consumers, health professionals identified the presence of green spaces as important for general physical activity. The recommendation of the final items for an arthritis walkability assessment tool followed the recommendations of consumers, with significant overlap from expert arthritis professionals.

These final items listed in Figure 1 above are included in an Arthritis Walkability Assessment in Appendix A.

Discussion

We identified several features of the environment that should be included on community environmental assessments for promotion of walking and physical activity for people with arthritis. A few of the currently available assessment tools include many of the features and could be considered for use. Most of the assessment tools include some items noted as important among older adults; however, persons with arthritis identify some important features of the environment that were not noted on any current assessment tool. These environmental features

were identified in the qualitative studies of people with arthritis in Phase 1. More quantitative studies are needed to statistically link the environmental features noted among people with arthritis to walking and physical activity.

It should be noted, however, that when matching the “required” environmental features to assessment tools, the global environmental feature was used rather than noting specifically about the attribute. For example, the global environmental feature “parks/walking areas” was used instead of specific attributes of parks/walking areas (e.g., accessibility or availability of parks/walking areas). In other words, this review has identified “global” environmental features—the importance of which specific attributes of the environmental feature, in most instances, is not able to be determined based on the current quality of the literature.

Our findings generally support the literature linking the environment to physical activity among the general older adult population. Land use diversity, traffic conditions and walkability characteristics of the environment (e.g., sidewalk conditions, places to sit or rest) are associated with physical activity, particularly walking for transportation.^{14,32-41} Walking paths and trails are associated with leisure and fitness physical activity among older adults.^{14,35,36,42,43} In contrast, our findings suggest that sidewalk conditions, accessible paths and buildings, street connectivity, and weather are important factors for people with mobility limitations. Specifically, people with arthritis identify the need for facilities with arthritis programs and knowledgeable instructors.

Of note is the finding that environmental features seem to be related to leisure/fitness physical activity and walking for transportation of older adults differently. The differences in leisure and fitness physical activity and walking for transportation are not well described among older adults or persons with mobility limitations. Based on our review, there appears to be a more common association between the environment and walking for transportation (as compared to leisure/fitness physical activity) among older adults in the quantitative literatures, which contradicts the findings in the qualitative literature. However, it is unclear what the relationship is among the other three populations (e.g. people with mobility limitations) as none of the studies included walking for transportation as an outcome.

REFERENCES

Table 1: Environmental Category and Specific Attributes Assessed

Environmental Category	Attribute Ascertained in Assessment
Walking Paths/Trails	safe footpaths, walking paths, path quality, trails, easy access to bike lanes, pedestrian paths, trails ^{14,35,36,42,43}
Parks/Green Space	presence of park, number of parks/trails, outdoor sport field, available park, existence of green areas ^{13,14,35,36,41-45}
Fitness/Recreational Center	fitness/recreational facilities, indoor/covered places for walking, indoor places for walking, available swimming pool, available exercise halls, available golf course, available bowling green, available tennis court ^{13,14,36,37,39-41,43}
Safety	pedestrian/traffic safety (NEWS), traffic safety, safe to walk in neighborhood during the day, safe to walk at night, safety from crime, safety from crime (NEWS-A, NEWS, NEWS-CS), street lighting ^{35-43,45,46}
Walkability (residential density, street connectivity, intersection density)	walkability (composite of density, retail floor area ratio, intersection density), no. of street intersections, residential density, residential density (NEWS, NEWS-CS), street connectivity (NEWS, NEWS-A, NEWS-CS), senior population density ^{13,34,36-41,44,46,47}
Mixed Land-Use	higher density of neighborhood destinations, short distance to services, access to shops, land-use mix-access (NEWS, NEWS-CS) ^{33,36-40,45}
Neighborhood Aesthetics	Aesthetics (NEWS, NEWS-A) ^{13,36,38,40,46,48}
Walking Infrastructure Available	places for walking/cycling (NEWS, NEWS-A), infrastructure for walking (NEWS-CS), existence of flat streets, existence of sidewalks, absence of ramps ^{13,35-40,45-47}
Sidewalk Conditions	quality of sidewalks, sidewalk conditions, crowdedness (NEWS-CS), physical barriers to walking (NEWS-CS), hills limit pathway, safety for walking (e.g. unsafe sidewalks, physical obstacles in sidewalks) ^{35,39,41,42,45}
Traffic Conditions	Traffic, traffic (NEWS-CS), difficulty walking due to traffic, percentage of high traffic volume streets, percentage of med traffic volume streets, percentage of low traffic volume streets ^{14,35,39,47}

Public Transportation	no. of bus lines, access to public transport, access to public transport (NEWS-CS) ^{37,39,45,47}
Places to Sit or Rest	sitting facilities (NEWS-CS) ³⁹
Miscellaneous	easy access of home entrance (NEWS-CS),community/senior center, accessibility, weather, exercise classes ^{14,39}

*NEWS: Neighborhood Environment Walkability Scale; NEWS-CS: Neighborhood Environment Walkability Scale for Chinese Seniors; NEWS-A: Neighborhood Environment Walkability Scale - Abbreviated

Table 2. Number of Studies Reporting a Positive or Null/Negative Association of each Environmental Category with Physical Activity among Older Adults

	Quantitative Studies			Qualitative Studies
	Physical Activity for Leisure/Fitness Number Yes: Number No	Walking for Transport Number Yes: Number No	Total Physical Activity Number Yes: Number No	Physical Activity/Leisure Number of Articles Mentioning Category
Walking Paths/Trails 14,35,36,42,43,49	5:1 (yes)	0:2 (no)	5:3 (yes)	N/A
Parks/Green Space 13,14,35,36,41-45,49-53	7:4 (no)	1:5 (no)	8:16 (no)	2 ^{54,55}
Fitness/Recreational Center 13,14,36,37,39-41,43,49,50,56,57	5:19 (no)	4:6 (no)	9 / 25 (no)	N/A
Safety 32,35-43,46,49,51,56,58-60	3 / 21 (no)	7:11 (no)	10:32 (no)	7 ^{32,54,55,61,62}
Walkability (residential density, street connectivity, intersection density) 13,34,36-41,46,47,50,56,59,60,63,64	7:20 (no)	4:10 (no)	11:30 (no)	2 ^{61,65}
Mixed Land-Use 33,34,36-41,45-47,52,56,57,59,60	9:15 (no)	8:4 (yes)	17:19 (no)	6 ^{32,54,55,61,65,66}
Neighborhood Aesthetics 13,14,36-38,40,46,56,57,59 Wu, 2016 #7075	8:8 (mixed)	2:5 (no)	10:13 (no)	2 ^{32,66}
Walking Infrastructure Available 13,32,35-40,46,47,49,56,57,59,60	4:18 (no)	5:6 (mixed)	9:24 (no)	1 ⁵⁴
Sidewalk Conditions 15,35,39,41,42,49,56,57	5:6 (mixed)	9:6 (yes)	14 / 12 (yes)	8 ^{65 32,54,55,62,67}

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Traffic Conditions 14,35,39,47,49	3:4 (mixed)	2:1 (mixed)	5:5 (mixed)	3 ^{55,65,66}
Public Transportation 37,39,45,47,52,56,57	0:6 (no)	4:5 (mixed)	4:11 (no)	4 ^{32,61,65,66}
Places to Sit or Rest ^{39,56}	1:0 (mixed)	3:1 (yes)	4:1 (yes)	6 ^{32,55,61,65-67}
Senior Center ¹⁴	1:1 (mixed)	N/A	1:1 (mixed)	N/A

Table 3. Summary of Quantitative and Qualitative Results of the Relationship of the Environment with Leisure/Fitness Physical Activity among Adults with Mobility Limitations

Environmental Feature	Quantitative Results	Qualitative Results (counts)
Walking Paths/Trails	N/A	N/A
Parks/Green Space	N/A	N/A
Fitness/Recreational Center	0 :2 ²⁰	1 ²³
Safety	0:6 ¹⁹⁻²¹	2 ²⁴
Walkability (residential density, street connectivity, intersection density)	1:0 ²¹	N/A
Mixed Land-Use	1:1 ^{19,22}	N/A
Neighborhood Aesthetics	0:2 ²⁰	N/A
Walking Infrastructure Available	1:1 ²⁰	2 ²⁴
Sidewalk Conditions	1:0 ²²	8 ²⁴
Traffic Conditions	N/A	N/A
Public Transportation	N/A	N/A
Places to Sit or Rest	N/A	N/A
Accessibility	N/A	1 ²³
Weather	N/A	1 ²³
Specific Exercise Classes/Facilities	N/A	1 ²³

Table 4. Summary of Quantitative and Qualitative Studies Examining the Relationship of the Environment with Leisure/Fitness Physical Activity among People with Rolling Assistive Devices

	Quantitative Results	Qualitative Results (counts)
Walking Paths/Trails	N/A	1 ⁶⁸
Parks/Green Space	N/A	N/A
Fitness/Recreational Center	N/A	N/A
Safety	1:0 ⁶⁹	2 ⁶⁸
Walkability	0:2 ⁶⁹	N/A
Mixed Land-Use	N/A	1 ⁶⁸
Neighborhood Aesthetics	1:1 ^{70,71}	1 ⁶⁸
Walking Infrastructure Available	0:2 ^{70,71}	2 ⁶⁸
Sidewalk Conditions	N/A	1 ⁶⁸
Traffic Conditions	N/A	N/A
Public Transportation	0:1 ⁶⁹	N/A
Places to Sit or Rest	N/A	N/A
Accessibility	N/A	2 ^{72,73}

Table 5. Summary of Quantitative and Qualitative Studies Examining the Relationship of the Environment with Leisure/Fitness Physical Activity among People with Arthritis

	Quantitative Results	Qualitative Results (counts)
Walking Paths/Trails	N/A	1 ³¹
Parks/Green Space	1:0 ²⁵	1 ³¹
Fitness/Recreational Center	N/A	3 ^{30,31}
Safety	0:1 ²⁵	3 ^{28,31}
Walkability	N/A	N/A
Mixed Land-Use	N/A	1 ²⁸
Neighborhood Aesthetics	N/A	N/A
Walking Infrastructure Available	N/A	2 ^{27,28}
Sidewalk Conditions	0:1 ²⁵	3 ^{27,28,31}
Traffic Conditions	N/A	1 ²⁷
Public Transportation	0:2 ²⁵	2 ^{26,29}
Places to Sit or Rest	0:1 ²⁵	N/A
Specific Exercise Classes/Facilities	N/A	3 ^{26,29}
Accessibility	N/A	3 ^{26,28}

Table 6. Demographic Characteristics of Consumers with Arthritis or Related Rheumatic Condition in Delphi Study

Variable	N=161 (%)
Age, mean (std)	58.6 (11.6)
Female, n (%)	145 (90.0)
Race, n (%)	
White/Caucasian	135 (83.9)
Black/African American	10 (6.2)
American Indian/Alaskan Native	2 (1.2)
Asian or other Pacific Islander	4 (2.5)
Mixed race or other	10 (6.2)
Ethnicity, n (%)	
Hispanic	7 (4.3)
Non-Hispanic	147 (91.4)
Prefer not to answer	7 (4.3)
Education, n (%)	
High school or less	8 (4.9)
Some college	33 (20.5)
College graduate	45 (28.0)
Some graduate school	18 (11.2)
Graduate degree	57 (35.4)
Arthritis Diagnosis, n (%)	
Osteoarthritis	110 (68.3)
Rheumatoid Arthritis	71 (44.1)
Lupus	8 (5.0)
Psoriatic Arthritis	11 (6.8)
Systemic Lupus Erythematosus	8 (5.0)
Fibromyalgia	30 (18.6)
Other	46 (28.6)
History of Comorbidities, n (%)	
Asthma	34 (21.1)
Back pain	107 (66.4)
High blood pressure	54 (33.5)
Low blood pressure	16 (9.9)
Bone fractures	42 (26.1)
Cancer	15 (9.3)
High Cholesterol	59 (36.6)
Diabetes	17 (10.6)
Emphysema	0 (0)
Epilepsy	5 (3.1)
Heart Disease	7 (4.3)
Hernia	20 (12.4)
Joint or Ligament Injuries	83 (51.6)
Muscle Injuries	50 (31.1)
Neck pain or injury	77 (47.8)
Osteoporosis	44 (27.3)
Surgery	95 (59.0)
Terminal illness	1 (0.6)

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Vertigo or lightheadedness	46 (28.6)
Other	46 (28.6)
Activity level	
Vigorous Physical Activity, n (%)	85 (52.8)
Days/week, mean	3.4
Mins/day, mean	82.2
Moderate Physical Activity, n (%)	115 (71.4)
Days/week, mean	3.9
Mins/day, mean	80.0
Walking > 10 mins at a time, n (%)	147 (91.3)
Days/week, mean	5.0
Mins/day, mean	65.6
Time spent sitting	
Hours/day, mean	6.1

Table 7. Demographic Characteristics of Consumers with Arthritis or Related Rheumatic Condition in Delphi Study

Variable	N=21 (%)
Age, mean (std)	Not Collected
Female, n (%)	16 (76.2)
Race, n (%)	
White/Caucasian	16 (76.2)
Black/African American	3 (14.3)
American Indian/Alaskan Native	0 (0)
Asian or other Pacific Islander	1 (4.8)
Mixed race or other	1 (4.8)
Ethnicity, n (%)	
Hispanic	3 (14.3)
Non-Hispanic	18 (85.7)
Prefer not to answer	0 (0)
Education, n (%)	
High school	1 (4.8)
Some college	0 (0)
College graduate	2 (9.5)
Some graduate school	0 (0)
Graduate degree	18 (85.7)
Organization membership, n (%)	
Arthritis Foundation	5 (31.2)
American College of Sports Medicine	5 (31.2)
American Academy of Orthopaedic Surgeons	2 (12.5)
American College of Rheumatology	4 (25.0)
Association of Rheumatology Health Professionals	4 (25.0)
American College of Sports Medicine	5 (31.2)
American Council on Exercise	2 (12.5)
American Physical Therapy Association	3 (18.7)
American Society for Nutrition	1 (6.2)
Centers for Disease Control & Prevention	2 (12.5)
International Council on Active Aging	1 (6.2)
National Alliance for Hispanic Health	1 (6.2)
National Coalition for Promoting Physical Activity	1 (6.2)
National Recreation and Park Association	1 (6.2)
National Strength and Conditioning Association	2 (12.5)
Obesity Society	1 (6.2)
Osteoarthritis Research Society International	1 (6.2)
Osteoarthritis Action Alliance	1 (6.2)
Shape Up America!	1 (6.2)
UNC Thurston Arthritis Research Center	1 (6.2)
University of Illinois Extension	1 (6.2)
U.S. Bone & Joint Decade/Initiative	1 (6.2)
American Public Health Association	1 (6.2)
Canadian Physiotherapy Association	1 (6.2)
Discipline/Specialty, n (%)	
Epidemiologist	4 (20.0)

Exercise Physiologist	3 (15.0)
Health Educator	6 (30.0)
Health Services Researcher	1 (5.0)
Medical Director	1 (5.0)
Nutritionist	1 (5.0)
Occupational Therapist	3 (15.0)
Personal Trainer	1 (5.0)
Physical Therapist	5 (25.0)
Physician	3 (15.0)
Research Coordinator	1 (5.0)
Research-Clinical	2 (10.0)
Research-Evaluation	1 (5.0)
Research-Health Science	4 (20.0)
Research-Population Health	2 (10.0)
Retired	1 (5.0)
Social Scientist	2 (10.0)
Professional Work Settings, n (%)	
Academic Medical Center	3 (15.0)
Government Clinical Setting	3 (15.0)
Government Non-Clinical Setting	2 (10.0)
Hospital Based Practice	1 (5.0)
Other Clinical Setting	1 (5.0)
Other Non-Clinical Setting	2 (10.0)
Non-profit organization	4 (20.0)
Non-governmental organization	1 (5.0)
Wellness center	2 (10.0)
University/Academic Setting	5 (25.0)
Other	1 (5.0)
Areas of Practice/Expertise, n (%)	
Advocacy/Public Policy	5 (25.0)
Assistive Devices/Orthoses	3 (15.0)
Behavioral Approaches	6 (30.0)
Biologics	1 (5.0)
Biomechanics	2 (10.0)
Developmental/Life Skills	2 (10.0)
Disability/Participation	6 (30.0)
Economics/Cost of Health Care	1 (5.0)
Epidemiology	5 (25.0)
Fatigue	2 (10.0)
Functional Status	5 (25.0)
Nutrition	1 (5.0)
Pain Management	6 (30.0)
Patient/Family Education & Counseling	3 (15.0)
Physical Activity/Exercise	14 (70.0)
Psychosocial Issues	2 (10.0)
Public Health	5 (25.0)
Quality of Life	11 (55.0)
Rehabilitation	1 (5.0)
Work Disability	2 (10.0)
Other	1 (5.0)
Years of practice, n (%)	

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2-5 years	1 (5.0)
6-10 years	2 (10.0)
10+ years	17 (85.0)
Age group of patients, n (%)	
Pediatric	1 (5.0)
Adult	14 (70.0)
Geriatric	10 (50.0)
N/A	7 (35.0)
Rheumatologic/Orthopedic diagnoses seen in practice	
Ankylosing spondylitis	7 (41.2)
Fibromyalgia	11 (64.7)
Gout	8 (47.1)
Hypermobility syndrome	3 (17.7)
Lupus	6 (35.3)
Obesity	10 (58.8)
Orthopedics	7 (41.2)
Osteoarthritis	17 (100.0)
Osteoporosis	9 (52.9)
Overuse syndromes	5 (29.4)
Psoriatic Arthritis	6 (35.3)
Rheumatoid Arthritis	11 (64.7)
Systemic Sclerosis	2 (11.8)
Sports Medicine	3 (17.7)
Systemic Lupus Erythematosus	5 (29.4)
Vasculitis	2 (11.8)
Other	2 (11.8)

Table 8. Environmental features important for walking for consumers: results of Delphi Study. (n=105 consumers)

	Disagree or Strongly Disagree, n (%)	Neutral n (%)	Agree or Strongly Agree, n (%)	Ranking
Safety from crime	1(1.0)	3 (2.9)	101 (96.1)	1
Smooth and level walkways	0 (0)	7 (6.7)	98 (93.3)	2
Walking areas separate from roads (e.g., sidewalks)	1 (1.0)	6 (5.7)	98 (93.3)	3
Safety from injury (e.g., falling; collisions with cars, bikes, or people)	0 (0)	6 (5.7)	99 (94.3)	4
Places to sit	1 (1.0)	11 (10.5)	93 (88.5)	5
Ramps and railings at stairs	0 (0)	14 (13.3)	91 (86.7)	6
Walkways free of objects blocking the path	0 (0)	7 (6.7)	98 (93.3)	7
Street lighting	0 (0)	9 (8.6)	96 (91.4)	8
Curb cuts at sidewalk crossings	1 (1.0)	21 (20.0)	83 (79.0)	9
Few or no hills	14 (13.3)	19 (18.1)	72 (68.6)	10
Pleasant surroundings (e.g., trees, no litter)	1 (1.0)	16 (15.2)	88 (83.8)	11
Green space and parks	3 (2.9)	16 (15.2)	86 (81.9)	12
Little traffic in walking areas (people, bikes, strollers, etc.)	7 (6.7)	19 (18.1)	79 (75.2)	13
Weather	5 (4.8)	16 (15.2)	84 (80.0)	14
Little traffic on roads	6 (5.8)	18 (17.1)	81 (77.1)	15

Table 9. Environmental features important for physical activity of consumers: results of Delphi Study. (n=94 consumers)

	Disagree/Strongly Disagree, n (%)	Neutral n (%)	Agree/Strongly Agree, n (%)	Ranking
Safety from crime	1(1.1)	8 (8.5)	85 (90.4)	1
Smooth and level walkways	0 (0)	3 (3.2)	91 (96.8)	2
Safety from injury (e.g., falling; collisions with cars, bikes, or people)	0 (0)	3 (3.2)	91 (96.8)	3
Walking areas separate from roads (e.g., sidewalks)	0 (0)	10 (10.6)	84 (89.4)	4
Places to sit	3 (3.2)	9 (9.6)	82 (87.2)	5
Ramps and railings at stairs	1 (1.1)	9 (9.6)	84 (89.3)	6
Walkways free of objects blocking the path	0 (0)	5 (5.3)	89 (94.7)	7
Street lighting	1 (1.1)	14 (14.9)	79 (84.1)	8
Walking trails	2 (2.1)	18 (19.1)	74 (78.8)	9
Curb cuts at sidewalk crossings	2 (2.1)	19 (20.2)	73 (77.7)	10
Pleasant surroundings (e.g., trees, no litter)	3 (3.2)	16 (17.0)	75 (79.8)	11
Green space and parks	3 (3.2)	24 (25.5)	67 (71.3)	12
Swimming pool	9 (9.6)	22 (23.4)	63 (67.0)	13
Weather	7 (7.4)	25 (26.6)	62 (66.0)	14

**Bolded items are the 8 items with consistency across ranking approaches*

Table 10. Environmental features important for walking of health professionals: results of Delphi Study. (n=19 health professionals)

	Disagree/Strongly Disagree, n (%)	Neutral n (%)	Agree/Strongly Agree, n (%)	Rankings from below
Smooth and level walkways	0 (0)	0 (0)	19 (100)	1
Walking areas separate from roads (e.g., sidewalks)	0 (0)	0 (0)	19 (100)	2
Safety from injury (e.g., falling; collisions with cars, bikes, or people)	0 (0)	0 (0)	19 (100)	3
Ramps and railings at stairs	0 (0)	1 (5.3)	18 (94.7)	4
Places to sit	0 (0)	2 (10.5)	17 (89.5)	5
Street lighting	0 (0)	0 (0)	19 (100)	6
Walkways free of objects blocking the path	0 (0)	1 (5.3)	18 (94.7)	7
Curb cuts at sidewalk crossings	0 (0)	1 (5.3)	18 (94.7)	8
Safety from crime	0 (0)	0 (0)	19 (100)	9

Table 11. Environmental features important for physical activity of health professionals: results of Delphi Study. (n=19 health professionals)

Features Important for Physical Activity (n=19 health professionals/researchers)

	Disagree/Strongly Disagree, n (%)	Neutral n (%)	Agree/Strongly Agree, n (%)	Rankings
Smooth and level walkways	0 (0)	0 (0)	19 (100)	1
Walking areas separate from roads (e.g., sidewalks)	0 (0)	0 (0)	19 (100)	2
Green space and parks	0 (0)	0 (0)	19 (100)	3
Places to sit	0 (0)	1 (5.2)	18 (94.7)	4
Safety from injury (e.g., falling; collisions with cars, bikes, or people)	0 (0)	0 (0)	19 (100)	5
Walkways free of objects blocking the path	0 (0)	1 (5.2)	18 (94.7)	6
Safety from crime	0 (0)	1 (5.2)	18 (94.7)	7
Street lighting	0 (0)	2 (10.5)	17 (89.5)	8

Appendix A Arthritis Walkability Assessment

This arthritis walkability assessment should be used in conjunction with other walkability assessment tools that assess the environment for activity for general adult populations. **The items on this tool are recommended as important for adults with arthritis and related rheumatologic conditions.** (Note some of these items are included on other walkability assessments and can be omitted from this assessment.) Please consider these factors in the environment, in particular, for people with arthritis and rheumatic conditions.

1. Is the environment safe from crime?
Yes_____ No_____

2. Is the environment safe from injury?
 - a. Are walkways free of objects blocking the path?
Yes_____ No _____

 - b. Are walking areas separate from roads (e.g., sidewalks)?
Yes_____ No _____

 - c. Are walking areas smooth and level?
Yes_____ No _____

 - d. Is the area well lit?
Yes_____ No _____

3. Are benches or places to sit and rest present?
Yes_____ No _____

4. Are ramps and railings present at stairs?
Yes_____ No _____

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