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The Aging in Place Challenge Program at the National Research Council Canada

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ABSTRACT

A number of challenge programs to fund research have been initiated at the National Research Council of Canada in the past several years and the outcomes of the research is likely to influence the design of future dwellings and the retrofit of the existing housing stock in Canada. One of these challenge programs addresses the need to support an aging population. It is estimated that by 2051, adults over the age of 65 will represent 25% of the population of Canada. Most aging adults would prefer to age in place in the dwelling or community of their choice. The Aging in Place Challenge program was launched in 2021 with the goal of developing technologies and innovations to support an increase in the number of aging adults who remain in homes and communities of their choice by 2031. The program supports research projects in collaboration with older adults and family caregivers as well as partners in academia, industry, and government toward enabling advancements in AgeTech in Canada. In addition, a number of Aging in Place projects in the Construction Research Center are focused on developing guidance for the design of dwellings intended for successful aging in place. Acoustics, lighting, climate control and other environmental factors all play an important role support the wellbeing of aging adults. The results of the projects from the Construction Research Center will be publicly available guidance for new buildings and the renovation of existing buildings to support aging in place.

INTRODUCTION

In 2016, Canada became home to a greater number of aging adults (people over the age of 65) than people under the age of 15 [1]. Aging adults also represent Canada's fastest growing demographic [2]. Based on the population projections by Statistics Canada, aging adults may represent a quarter of Canada's population between 2050 (assuming low growth) to 2060 (assuming medium growth) as shown in Figure 1.

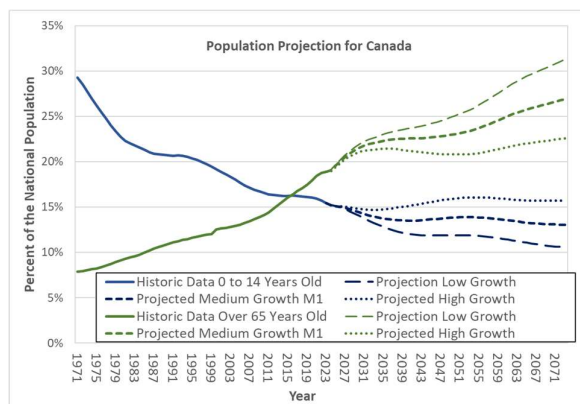


Figure 1: Historic and projected population data for Canada from Statistics Canada [1,3]. More information about the projections is available from Statistics Canada Report 91-520-X: Population Projections for Canada (2023 to 2073) [4].

The number of households comprised of aging adults in Canada is set to increase significantly in the upcoming years with a disproportionate number of these in rural areas [5]. The aging adults tend to remain in their homes with the proportion of aging adults who sell their property is elevated only in relatively advanced age groups [6]. However, the environment in which older Canadians live is not always supportive of health and wellness. There is a clear need for more age-friendly housing, and communities in both urban and rural environments. Loneliness also represents a major challenge for many older individuals, especially within the oldest old age group [7]. Housing, living arrangements and

transportation approaches that are adapted for older adults as they age are areas in urgent need of research [8].

In 2014, the Government of Canada published an action plan which described this demographic shift as presenting both new opportunities and challenges for Canadian society [9]. One of the points that the action plan discussed was the need for age friendly communities and the support for housing for an aging population. Affordability is also a concern with a nationwide housing shortage creating major affordability problems [10]. The importance of a national policy on housing was highlighted by the COVID-19 Pandemic during which aging adults in Canada fared notably worse than their counterparts in many other comparable countries. By the summer of 2020, over 80% of all COVID-19 deaths in Canada occurred amongst aging adults nursing and retirement home settings, compared to an Organization for Economic Co-operation and Development (OECD) average of 42% [2]. There were 74 times more deaths among older Canadians living in long term care settings than among aging adults living in communities, a figure which was three times the OECD average [11].

According to a national survey, 81% of older Canadians would prefer to age in their place of residence [12]. Aging in place can be described as the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or capacity [13]. Nationally, 11% of newly admitted long-term care residents could have potentially been cared for at home with the proper supports in place. Of the 11%, there is wide provincial and territorial variation with the number as low as 8.3% in Ontario and as high as 27.3% in the Yukon Territory [14]. A National Home Modifications Survey found that while many want to age in place in the home or community, only 26% believe that they will be able to do so [15]. An aging adult's home and community might be a comforting, familiar place despite the fact that it is becoming burdensome to maintain or unsafe and a source of anxiety [16]. The survey suggested that home modifications or other measures to support aging in place are a key solution for closing the gap [15].

THE AGING IN PLACE CHALLENGE PROGRAM AT THE NATIONAL RESEARCH COUNCIL CANADA

The Aging in Place (AiP) Challenge program [17] at the National Research Council Canada (NRC) was launched in 2021 with the goal of developing technologies and innovations to support an increase in the number of aging adults who remain in homes and communities of their choice by 2031. The program funds collaborative research with older adults and family caregivers as well as partners in academia, industry, and government toward enabling advancements in AgeTech in Canada. Through research that draws on the NRC's people, equipment and facilities, NRC researchers and external partners can work on collaborative research projects to meet Canada's current and future needs.

Recognizing that aging in place is a multi-faceted concept, the AiP Challenge program strategy proposes three pathways for technology and innovation to support safe, healthy, socially connected aging as shown in Figure 2.



Figure 2: Focus of AiP research at the NRC

The first area of research focuses on preventing transitions in care through improved health and well-being as well as reductions in anticipated risk factors known to cause transitions in care. The research focuses on technologies that enable people to access preventative care and support the early detection of age-related diseases. The second area of research focuses on enabling older adults and their caregivers to continue living well with frailty, cognitive impairment, social isolation and other risk factors leading to transitions in care. The research focuses on technologies to reduce the risk of sentinel events (e.g. hospitalizations, falls, caregiver burnout) and to facilitate activities of daily living. The third area of research focuses on creating age-friendly communities and social structures that address social, political and built environment barriers to aging in place. The research focuses on adapting the social and physical environment and providing opportunities for meaningful contributions to society.

A list of current projects that have been funded by the AiP Challenge program can be found through the NRC's website [18]. Some examples of the research projects include: privacy by design and cybersecurity for safe, effective and reliable home health care for aging in place [19], cultural dimensions affecting the perception of privacy and intrusiveness of video monitoring technologies for aging at home [20], meeting older Canadians' mobility needs via public transportation [21] and the supportive smart home [22].

Healthy aging community living labs

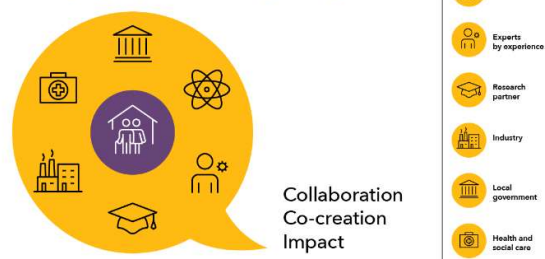


Figure 3: The healthy aging community living labs initiative

To ensure all projects contribute towards the program's impact-oriented goal, AiP focuses on collaboration and co-creation. The AiP Challenge program invites older adults and their caregivers to partner with the researchers as "expert by experience" (EBE) advisors who are engaged throughout the project [23]. These EBE project advisors provide generational knowledge to ensure projects are on track towards creating "real world" solutions. Additionally, AiP's healthy aging community living labs initiative funds projects to bring together interested parties as shown in Figure 3 to co-develop and to evaluate AgeTech innovations and solutions for aging in place [24].

AGING IN PLACE PROJECTS AT THE CONSTRUCTION RESEARCH CENTER

The Construction Research Center at the NRC has supported the AiP Challenge program by funding research to develop guidance for dwellings for successful aging in place. While many municipalities or organizations in Canada may offer guidance for renovations for dwellings intended for aging in place, the guidance typically focuses on modifications such as the installation of grab bars and ramps. While these support devices have an important role in making a home safe, a more holistic approach is needed to focus on all of the aspects of the home that help to support the wellbeing of aging adults. Furthermore, the lack of a central repository of guidance for dwellings for aging in place such as a building code can lead to a lack of consistency throughout the country and modifications to dwellings that don't support aging in place as intended.

For example, the Government of Canada offers a multigeneration home renovation tax credit [25] which can be claimed by qualifying individuals for renovation expenses to create a self-contained secondary unit to allow an aging adult or an adult who is eligible for the disability tax credit to live with a qualifying relative. A now expired tax credit in the province of Ontario [26] could be claimed for eligible renovations that improved the safety and accessibility or helped an aging adult be more functional or mobile at home. The risk for these tax credits is that the lack of central guidance for the improvements may lead to renovations by well-meaning applicants and contractors that don't actually support aging in place. The lack of guidance for renovations creates the possibility for predatory contractors who can take advantage of the tax credit programs by implementing improvements that are overpriced, not correctly installed (e.g. grab bars not fixed to studs or blocking in the wall) or are incorrectly specified (e.g. grab bars with an inadequate weight capacity) and therefore do

nothing to actually improve the livability of the dwelling or may make it worse.

The results of the research at the Construction Research Center will be collected into publicly available research reports and guidance. The reports will support future changes in building codes for specifications for dwellings intended for successful aging in place.

Summaries of three of the projects in the Construction Research Center are presented in the following sections. All of the projects span multiple years and will conclude in 2026.

Developing guidance for integration and future adoption of assistive and smart home technologies

This project is designed to address some of the key challenges to developing and adoption of innovative technologies that can enable older adults to live safe, healthy and socially connected lives whilst remaining in their homes. The project will investigate how to make technologies more readily acceptable to aging adults and to ensure that the technologies are used correctly. In addition, the project will develop the NRC's state-of-the-art research facility, the FlexHouse of the Canadian Centre for Housing Technology (CCHT) shown in Figure 4 as a testbed for the evaluation of new technologies.



Figure 4: FlexHouse at the NRC

The FlexHouse offers a unique real-life house environment that was constructed to demonstrate aging in place principles, including affordability, adaptability and accessibility.

Establishing Guidance for Indoor Environmental Conditions for Healthy Aging in Place

This research project is a collaboration between the NRC, the National Institute of Advanced Industrial Science and Technology (AIST) in Japan and the University of Toronto. The project includes field measurements and social surveys [27] to establish guidance for suitable interior conditions (daily light exposure patterns; in-home acoustic conditions; ventilation, humidity, temperature, and indoor air and lighting quality) to support health and well-being for adults as they age. The guidance will be applied to both new builds and retrofits and will be integrated across building systems where appropriate. For example, the guidance for façade systems can take into account the transmission loss, the daylighting, the available ventilation and the thermal performance. The

outcomes from the projects will be transferred to regulatory bodies to facilitate its uptake and application.

Noise Sensitivities amongst Aging Adults

This research project is a collaboration between the NRC and the National Institute of Advanced Industrial Science and Technology (AIST) in Japan is to determine if aging adults tend to display stronger sensitivity to noise and if noise sensitivity can be successfully determined through a limited number of questions on a questionnaire.

Noise sensitivity increases the susceptibility of individuals to noise and those with high noise sensitivity who are exposed to noise are more likely to pay attention to the noise, to interpret the noise negatively as a threat or annoyance and to react emotionally, compared to those with low noise sensitivity [28]. Understanding the relationship between noise sensitivity and age is important due to the strong correlation between noise sensitivity and health and wellbeing.

A high noise sensitivity can increase the negative effects of noise exposure on health [29,30]. Individuals with high noise sensitivity are likely to be less healthy than individuals with low noise sensitivity [31]. Noise sensitivity has been shown to be related to hypertension and chest pain [32] and noise sensitivity may be a risk factor for cardiovascular mortality in women [33]. Noise sensitivity has been associated with a number of behavioral risk factors for disease such as stress, smoking and hostility [34]. Noise sensitive individuals are more likely to report symptoms of inadequacy, depression, anxiety, sensitivity, anger, tension, inferiority and nervousness [35]. Noise sensitivity is also one of the factors that affects noise-induced sleep disturbance [36,37].

Noise sensitivity can be a predictor of dissatisfaction with the environmental quality of one's environment. Residential satisfaction among older adults has been found to be robustly associated with positive and negative aspects of perceived neighborhood quality and plays a major role for aging well [38]. Noise sensitive persons tend to be less satisfied with their living environment and with their general quality of life [39,40] and tend to report poorer environmental quality in their residential area than less sensitive persons [30]. Neighbor annoyance relates to experiences of negative social interactions that are typically associated with an unpleasant perception of the neighborhood [38]. It has been shown that individuals who express critical or negative judgments about noise will also give negative environmental judgments. By locating the position of an individual on the critical-uncritical dimension, one can predict how this person will tend to evaluate all neighborhood features-noise, air pollution, community services, privacy, safety, neighbors even though these features appear to be distinct and relatively independent [40]. Issues of residential satisfaction are particularly important for aging adults as significant dissatisfaction can create chronic stress with consequent mental and physical health results [41–43].

It would therefore be advantageous to be able to reliably determine if a person is noise sensitive or if a certain age group is likely to be more sensitive to noise since the degree of noise sensitivity can give great insight into the anticipated health and environmental judgments of those

individuals as they age in place. Also, noise sensitivity is believed to change depending on the individual's age or circumstances [29,44] and so an easy means for determining noise sensitivity would be helpful to track the changes.

One of the most commonly used questionnaires for evaluating noise sensitivity was developed by Weinstein [45] in 1978 as part of a study of college student reactions to noise in a dormitory context. The twenty-one question Weinstein Noise Sensitivity Scale (WNSS21) has been translated into numerous languages and may researchers have modified or reduced the questions as part of their studies. Some studies such as [40] have gone further by adding questions about a person's neighborhood in general or if the person planned to take action about aircraft noise [46] to determine if the person completing the questionnaire was a chronic complainer.

One study in Finland [47] asked one question, "do you have a noise sensitivity" whereas another study [48] asked dozens of questions to assess the noise sensitivity. In a study about aircraft noise [46], participants who lived near airports in Australia were asked to rate their annoyance to being woken up by a dog barking, to hearing an answered telephone ringing, to trying to concentrate in a noisy environment, to hearing a lawnmower while trying to rest, to having a conversation interrupted by traffic noise, to hearing a neighbor's TV or radio playing loudly. The results were used to give a number related to noise sensitivity. The researchers then tried to correlate the noise sensitivity to annoyance due to aircraft noise. However, the assumption that those six questions revealed a noise sensitivity is compromised by potential biases. For example, few people like being woken up and so the annoyance rating could be related to that more than the source of the disturbance. The person may also not like dogs and annoyance. However, some have questioned the validity and reliability of these questions because they rely on people remembering how they felt at a point in time about a noise they no longer hear [49]. A means of determining questions that are open to bias or which have no correlation to noise sensitivity is needed.

The project involves both in person and on-line subjective tests where participants are asked a number of questions including the WNSS21 questions. A link to the on-line subjective test is shown in Figure 5.



Figure 5: Link to the online listening test

The participants asked to imagine that they are sitting in their living room as they listen to a series of sounds and are asked to rate their annoyance for each sound. Since noise sensitivity is assessed both through the WNSS21 and through the listening test, the effectiveness of each question of the WNSS21 at determining noise sensitivity can be compared against the measured annoyance levels.

The study will look for specific sensitivities in different age groups based on the results of the annoyance test which are then correlated with the noise sensitivity determined from the WNSS21. Conducting the study both in Canada and Japan allows for a wide diversity in the participants and access to AISTs experience with subjective tests with aging participants, strengthening the results of the study.

If it is found that there is an increase or decrease in noise sensitivity as people age, it may be possible to better establish environments for successful aging in place. Ranges in the data collected from annoyance studies to determine minimum requirements for building codes can be better understood and if aging adults are shown to be typically more sensitive to noise, then higher minimum requirements for sound insulation will be needed. Based on the results of the study, it may be possible to provide data driven evidence to reduce the number of questions used to determine the noise sensitivity if some questions are shown to have small correlations to the sensitivities determined from the annoyance testing. This will also be important for aging in place since an individual's noise sensitivity can indicate anticipated health and wellbeing and a validated questionnaire based on the results of this study would be an advantageous tool for tracking the noise sensitivity.

The study is ongoing, but descriptions of the subjective studies and some preliminary results can be found in conference proceedings [50–54].

DISCUSSION AND CONCLUSIONS

The Aging in Place Challenge program at the National Research Council Canada was developed to fund collaborative projects to allow for a greater number of aging adults to live in the home or the community of their choosing rather than to only have the option to move to long-term care facilities. All of the Aging in Place Challenge program projects described in this paper are ongoing, with results to be published in 2026.

While many of the AiP Challenge projects focus on AgeTech, many of the projects at the NRC's Construction Research Center focus on developing guidelines for the design or retrofit of dwellings intended for aging in place. The results of the subjective studies, social surveys and research will result in guidance that will be made publicly available through the NRC to promote its use and possible inclusion in future building codes.

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