Journal of Nursing Research, Patient Safety and Practices
Vol: 04, No. 01, Jan-June 2024
ISSN: 2799-1210, DOI: 10.55529/jnrpsp.41.15.29

Research Paper

Ageing in place: ensuring home safety and adaptations for the well-being of seniors

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Article Info

Article History:
Received: 08 September 2023
Revised: 18 November 2023
Accepted: 25 November 2023
Published: 11 January 2024

Keywords:
Aging in Place
Elderly Care
Fall Prevention
Home Safety
Seniors

ABSTRACT

Background: Ageing in place the preference of seniors to remain in their own homes rather than move to assisted living depends heavily on home safety and adaptability, with fall risk a major concern for older adults living independently.
Objective: To examine home safety considerations for seniors, focusing on fall risk and the role of home modifications and assistive technology in supporting safe, independent living.
Methods: A literature review of home safety principles and strategies for seniors was combined with a small-scale field assessment of five seniors (aged 70–85 years) in Asaba, Delta State, Nigeria, who had undergone home safety assessments using standardized tools, including the Home Safety Self-Assessment Tool and the Fall Prevention Checklist. Assessments scored lighting, clutter, flooring condition, and handrail presence (1–10 each; total 1–40). Participants were surveyed on fall incidents in the preceding year, home modifications made (grab bars, non-slip flooring, lighting improvements), and use of assistive technology (wearable devices, smart home automation). Scores and fall incidents were reassessed after modifications.
Results: Baseline home safety scores ranged from 19 to 27 (of 40), with lower scores generally corresponding to more falls in the preceding year (0–3 per participant). After modifications and assistive technology adoption, safety scores improved for most participants (range 22–29), and reported fall incidents declined in four of five participants; one participant showed increased falls despite an improved score.
Conclusion: Home modifications and assistive technology use were associated with improved home safety scores and, in most cases, fewer falls among seniors ageing in place. Regular home safety assessments, individualized fall-prevention strategies, and caregiver education are supported, alongside further research into cases where safety improvements do not reduce fall risk.

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Journal of Nursing Research, Patient Safety and Practice (JNRPSP)

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1. INTRODUCTION

Ageing in place refers to the desire of many seniors to remain in their homes as they grow older rather than moving to an assisted living facility or nursing home. This preference is driven by the desire for independence, familiarity, and control over one's environment [1]. However, ageing in place comes with challenges related to safety and adaptability. As individual's age, their physical and cognitive abilities change, making assessing and enhancing home safety to accommodate these changes crucial. This study delved into home safety for seniors, examining its significance and the measures that can be taken to ensure a safe and comfortable living environment.

Aging is a natural part of life, and as individuals grow older, their needs, abilities, and preferences change. Many older adults strongly desire to remain in their own homes, surrounded by familiar surroundings, cherished memories, and the independence they have grown accustomed to [2], [3]. This choice, ageing as "ageing in place," is a matter of comfort and a means to preserve dignity and autonomy during one's golden years. While ageing in place is a commendable goal, it is challenging, and perhaps the most critical of these challenges is ensuring the safety and suitability of the home environment for seniors [4], [5].

The decision to age in place is often rooted in the desire to maintain control over one's life, uphold social connections within the community, and continue engaging in activities that bring joy and fulfilment. However, ageing is accompanied by various physical and cognitive changes that can introduce new risks and limitations [6]. This reality underscores the importance of creating a home environment that supports and accommodates these evolving needs, allowing seniors to live independently and safely.

As the global population ages, home safety for seniors is becoming increasingly relevant. It is a subject that touches the lives of millions of older adults, their families, caregivers, and healthcare professionals [7]. This article explores the concept of ageing in place, emphasizing the significance of home safety and adaptability and how it can be achieved through various means, including home modifications, fall prevention strategies, and the integration of assistive technology.

The study further delved into the extensive body of literature surrounding home safety for seniors, reviewed the fundamental principles and strategies that have emerged, discussed the methodologies employed to assess and improve home safety, presented notable findings from research in this field, and finally, offered recommendations to promote safer and more accommodating living environments for our ageing population. By addressing the critical issue of home safety for seniors, we can enhance their quality of life, reduce the risks associated with ageing, and empower older adults to enjoy their later years with greater security and independence.

A significant body of research emphasizes the importance of home safety for seniors. Falls are a leading cause of injuries among older adults, often resulting in fractures, head injuries, and reduced mobility. Modifying the home environment to reduce fall risks can significantly enhance the quality of life for seniors [8], [9]. Falls are a significant concern for seniors, and the literature provides various prevention strategies. These include removing tripping hazards, improving lighting, installing handrails, and ensuring that living spaces are well-organized and clutter-free. Studies have shown that home modifications, such as adding bathroom grab bars, non-slip flooring, and ramps for wheelchair access, can substantially impact safety [10]. These modifications aim to make daily activities more accessible and reduce the risk of accidents.

Advances in technology have introduced innovative solutions to enhance home safety for seniors. These include wearable devices that detect falls and smart home automation to monitor and assist with daily activities, such as medication reminders [11]. Home safety for seniors is increasingly vital due to the demographic shift towards an ageing population. Ageing can lead to various physical and cognitive changes, including decreased balance, muscle strength, and visual acuity. As a result, older adults become more

vulnerable to accidents and injuries in their homes [12], [13]. Falls, in particular, are a significant concern, as they are the leading cause of injuries among older adults.

Falls can lead to fractures, head injuries, and other severe consequences, often necessitating hospitalization and a long recovery process [14]. Therefore, addressing home safety is essential to prevent these accidents and improve the overall quality of life for seniors who wish to age in place. Fall prevention is one of the most critical aspects of home safety for seniors. Falls can occur due to various factors, including slippery floors, inadequate lighting, clutter, and the absence of safety features like handrails and grab bars. The literature suggests several strategies to reduce the risk of falls among older adults:

Home modifications can play a crucial role in fall prevention. These modifications include installing bathroom handrails, non-slip flooring in high-risk areas, and ramps for wheelchair access [15]. Home modifications can be crucial in fall prevention [16]. These modifications include installing bathroom handrails, non-slip flooring in high-risk areas, and ramps for wheelchair access. By making these changes, the home environment becomes more conducive to the changing needs of seniors. Keeping living spaces well-organized and clutter-free is an effective measure. Clear pathways, remove tripping hazards, and ensure that items are within easy reach to reduce the risk of accidents [17].

Furthermore, assessing the economic viability of energy storage technologies in homes is a central focus of many academic studies [18]. Adequate and well-distributed lighting prevents falls, especially in staircases, hallways, and bathrooms. Proper lighting allows seniors to navigate their homes safely. Alternative energy sources, which refer to energy sources that do not rely on the burning of fossil fuels or the splitting of atoms, also often referred to as renewable energy sources, could be installed for seniors' additional comfort and safety [19].

Home Modifications can be categorized into physical alterations and additions that address specific needs:

- **Bathroom Safety:** Installing grab bars, raised toilet seats, and non-slip mats in bathrooms can significantly reduce the risk of falls in these high-risk areas.
- **Kitchen Accessibility:** Adapting the kitchen to accommodate the changing physical abilities of seniors is crucial. Lowering countertop heights, ensuring easy access to cooking and storage areas, and using appliances with user-friendly features can make a substantial difference.
- **Accessibility Features:** Widening doorways to accommodate wheelchairs or mobility aids, adding ramps, and eliminating steps and thresholds are crucial for seniors with limited mobility. Furthermore, technological advances have introduced innovative solutions to enhance home safety for seniors. These technologies can help monitor and support daily activities, detect falls, and provide timely assistance: these devices include wearable devices and smart home automation.
- **Wearable Devices:** Wearable devices equipped with fall detection and emergency call features offer peace of mind for seniors and their caregivers.
- **Smart Home Automation:** Smart home systems can be integrated with sensors and monitoring devices to provide real-time information and assistance, such as medication reminders and security features.

By utilizing these technologies, seniors can maintain their independence while having access to help when needed. Overall, the reviewed literature underscores the significance of home safety for seniors, particularly those who wish to age in place. The emphasis on fall prevention, home modifications, and assistive technology highlights the multi-faceted approach to creating safer living environments for older adults. These strategies reduce the risk of accidents and enhance the overall quality of life for seniors, allowing them to continue living independently and comfortably in their homes.

2. RELATED WORK

The significance of this study is deeply rooted in the context of existing research on ageing in place, home safety for seniors, and interventions aimed at enhancing the well-being of the elderly. Previous studies have laid the foundation by exploring various models of elderly care, including community-based care and caregiver support programs [20]. Understanding the psychosocial aspects of ageing, such as social isolation and mental health issues among seniors, has also been a focus, contributing to a comprehensive

approach that addresses emotional and social needs in addition to physical well-being [21]. Technological innovations in gerontechnology, including smart home technologies and health monitoring devices, have been subject to research, shedding light on the effectiveness of these tools in ensuring the safety of seniors at home. Studies exploring age-friendly initiatives and community engagement programs provide insights into creating supportive environments that cater to the diverse needs of older adults. Cross-cultural perspectives on elderly care contribute to a nuanced understanding of caregiving practices, familial support systems, and societal attitudes toward ageing, recognizing the importance of cultural variations in addressing the challenges of ageing in place [22]. Public health strategies for fall prevention, a critical aspect given the vulnerability of seniors to falls, have been investigated in previous research. Community-based fall prevention programs, public awareness campaigns, and evidence-based practices aimed at reducing fall risks have been examined to inform effective preventive measures [23]. Longitudinal studies tracking the health, living conditions, and well-being of seniors over time offer valuable data on trends, risk factors, and interventions, providing a dynamic perspective on ageing. In essence, the significance of this study is enriched by building upon and contributing to a robust body of research that collectively advances our understanding of the multifaceted aspects of ageing in place and promotes the overall well-being of seniors. The theoretical framework for this study is anchored in the Ecological Systems Theory proposed by Urie Bronfenbrenner. This theoretical framework is particularly apt for understanding the complex interplay of factors influencing the ageing process and the safety of seniors in their home environments. Bronfenbrenner's Ecological Systems Theory posits that an individual's development is influenced by a set of nested environmental systems, each exerting its impact. The microsystem, which represents the immediate environment of the individual, includes elements like family, friends, and home. The mesosystem explores the interactions between different components of the microsystem, such as the relationship between a senior and their caregiver or healthcare provider. The exosystem encompasses external structures indirectly affecting the individual, like community services or social policies. The macrosystem involves broader cultural values, societal norms, and overarching ideologies shaping the environment. In applying this framework to the study, the microsystem involves the seniors themselves, their homes, and their immediate social networks. The quality of the home environment, including safety measures, home modifications, and assistive technology, is crucial in understanding how the microsystem influences ageing in place. The mesosystem comes into play as the study explores the interactions between seniors and various stakeholders, such as caregivers, healthcare providers, and community support systems. The exosystem dimension examines the influence of external factors like community resources, public health policies, and available services on seniors' safety in their homes. The macrosystem level considers broader societal attitudes towards ageing, cultural perspectives on elderly care, and the overarching framework of ageing in place as a cultural norm. By adopting the Ecological Systems Theory, this study aims to capture the dynamic and multifaceted nature of the ageing process in the context of the home environment. It acknowledges the reciprocal influences between the individual and their immediate surroundings, broader community structures, and the cultural fabric shaping attitudes and practices related to ageing. This theoretical framework provides a holistic lens through which to analyze the complexities of ageing in place, emphasizing the interconnectedness of various systems and the need for comprehensive interventions that address the diverse factors influencing seniors' safety and well-being.

3. METHODOLOGY

The methodology outlines collecting, analyzing, and presenting data for the generated, enabling a comprehensive assessment of home safety for seniors and the impact of home modifications and assistive technology on their safety and well-being. Assessing home safety for seniors involves a thorough evaluation of the living space. This was achieved through home safety assessments using standard assessment tools, including the Home Safety Self-Assessment Tool and the Fall Prevention Checklist. A sample of 5 seniors, aged between 70 and 85 years, who had undergone a home safety assessment in Asaba, Delta State, Nigeria, were engaged in the study. The standardized assessment tool evaluated specific safety aspects such as lighting, clutter, flooring condition, and the presence of handrails. The total score based on individual assessment was calculated and presented in Table 1. Furthermore, the same group of seniors were

surveyed to gather information on fall incidents in the past year. The number of falls reported by each participant was recorded and presented in Table 2. The study also surveyed the types and number of home modifications made by seniors and collected information on installing grab bars, non-slip flooring, and improving lighting conditions. It was also determined whether the participants utilized smart home automation systems for safety and recorded findings in Table 3. Participants were also surveyed to assess their usage of assistive technology, fall detection features and smart home automation systems for safety. The study further reassessed the home safety conditions of participants who made home modifications, focusing on the same criteria as in Table 1 and calculated the new total scores based on the post-modification assessments. Finally, participants were surveyed to gather data on any fall incidents that occurred after implementing home modifications and the number of falls reported by each participant post-modifications was recorded.

4. RESULTS AND DISCUSSION

The results of home safety assessments often reveal specific areas that require attention. It may involve simple fixes like adding handrails or more complex modifications like widening doorways for wheelchair accessibility. Additionally, using assistive technology can greatly enhance safety and independence for seniors. A well-designed home safety plan can significantly reduce the risk of accidents, improve overall well-being, and prolong seniors' ability to age comfortably. The home safety assessment study results are presented in Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6.

Table 1. Home Safety Assessment Data this Table Represents Data Collected During a Home Safety Assessment for Seniors

Participant	Age (years)	Lighting (1-10)	Clutter (1-10)	Flooring (1-10)	Handrails (1-10)	Total Score (1-40)
Participant 1	75	7	3	9	8	27
Participant 2	80	6	2	8	7	23
Participant 3	70	8	4	7	6	25
Participant 4	85	5	3	6	5	19
Participant 5	78	6	2	7	7	22

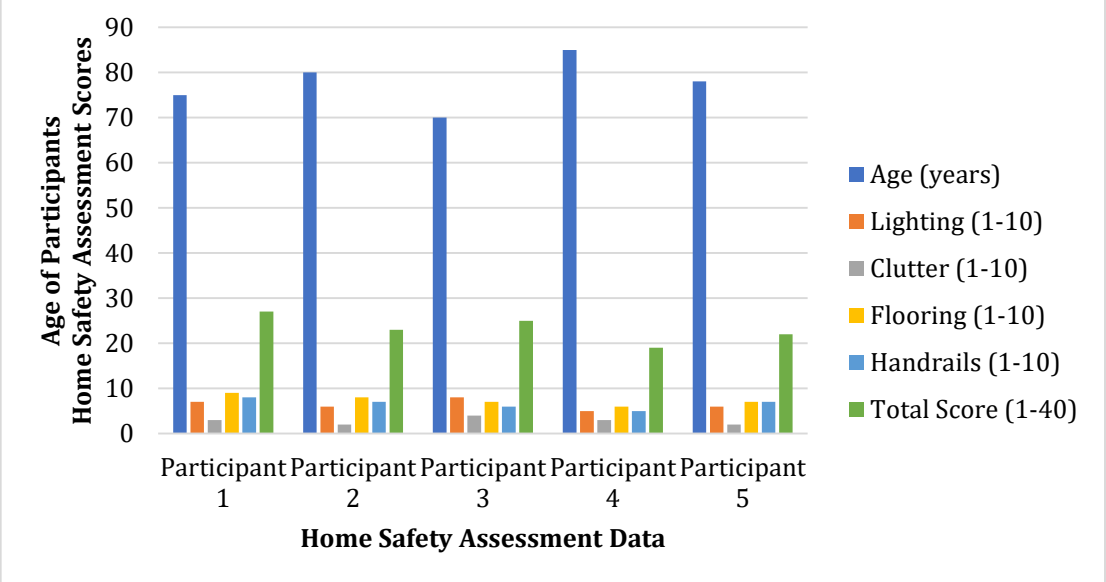


Figure 1. Home Safety Assessment Data for Seniors

Figure 1 summarize the results of a home safety assessment for seniors, considering factors like lighting, clutter, flooring, and handrails. Participants were assigned scores on a scale of 1 to 10 for each category, with a higher total score (up to 40) indicating a safer home.

- Participant 1 (Age 75): Total Score = 27, suggesting a relatively safe home.
- Participant 2 (Age 80): Total Score = 23, indicating a reasonably safe environment.
- Participant 3 (Age 70): Total Score = 25, reflecting a relatively secure home.
- Participant 4 (Age 85): Total Score = 19, implying a less safe living space.
- Participant 5 (Age 78): Total Score = 22, indicating a moderately safe home.

In general, higher total scores correspond to safer home environments, considering the specified criteria.

Table 2. Fall Incidents in the Past Year this Table Represents the Number of Fall Incidents Reported by Seniors in the Past Year

Participant	Falls in the Past Year
Participant 1	2
Participant 2	0
Participant 3	1
Participant 4	3
Participant 5	0

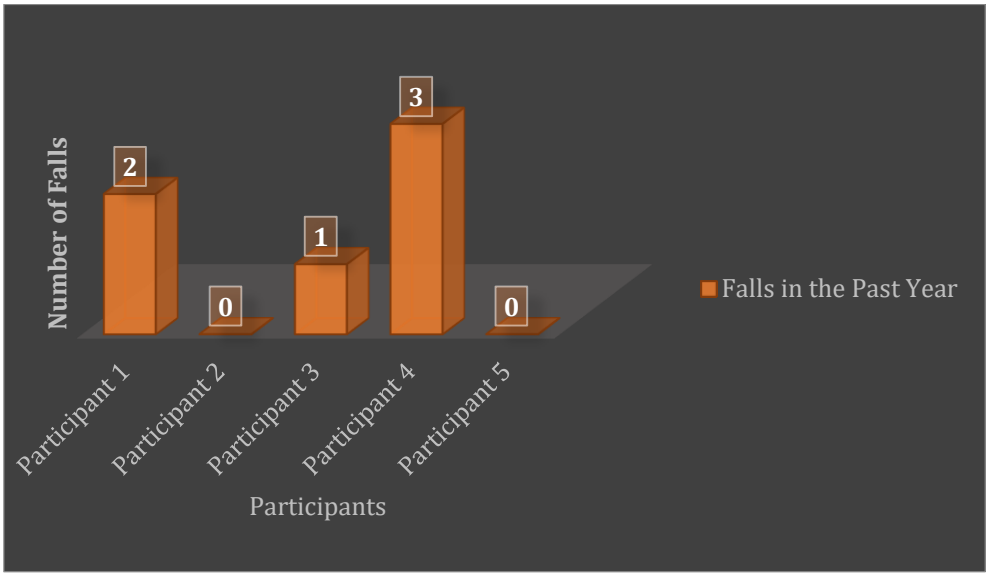


Figure 2. Fall incidents in the Past Year

Figure 2 shows the number of fall incidents reported by seniors in the past year. For example, participant 1 reported 2 falls, participant 2 reported no falls, participant 3 reported 1 fall, participant 4 reported 3 falls, and participant 5 reported no falls.

Table 3. Home Modifications Made this Table Illustrates the Types and Number of Home Modifications Made by Seniors to Enhance Safety

Participant	Grab Bars Installed	Non-Slip Flooring Added	Lighting Improved
Participant 1	2	1	Yes
Participant 2	1	0	No
Participant 3	3	2	Yes
Participant 4	1	1	Yes
Participant 5	2	0	No

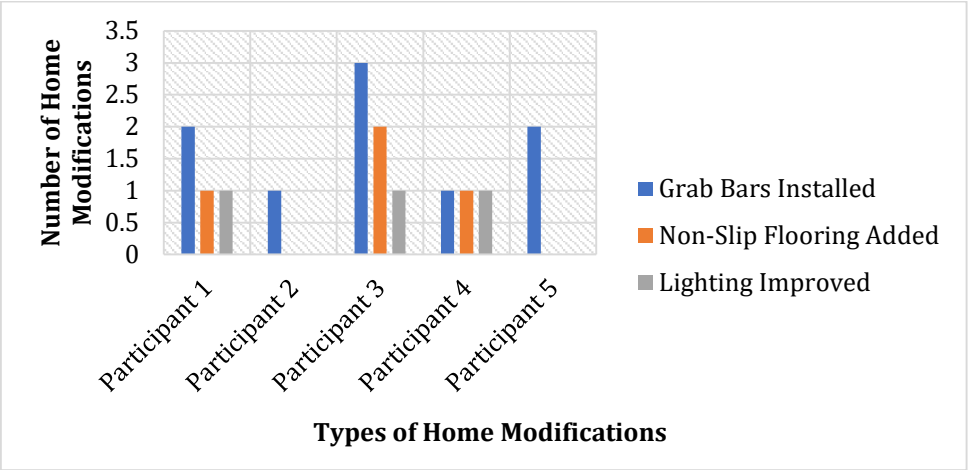


Figure 3. Home Modifications Made

Figure 3 provides information on the types and number of home modifications made by seniors. It includes the installation of grab bars, the addition of non-slip flooring, and the improvement of lighting. For instance, participant 1 had two grab bars installed, one non-slip flooring added, and improved lighting. Participant 2 installed only one grab bar, while Participant 3 installed three grab bars, three non-slip flooring, and one improved lighting. Participant 4 added one grab bar, non-slip flooring, and one improved lighting, while Participant 5 installed only two grab bars.

Table 4. Assistive Technology usage this Table Represents the usage of Assistive Technology by Seniors to Enhance Safety

Participant	Wearable Devices	Smart Home Automation
Participant 1	3	1
Participant 2	1	3
Participant 3	3	3
Participant 4	1	1
Participant 5	3	1

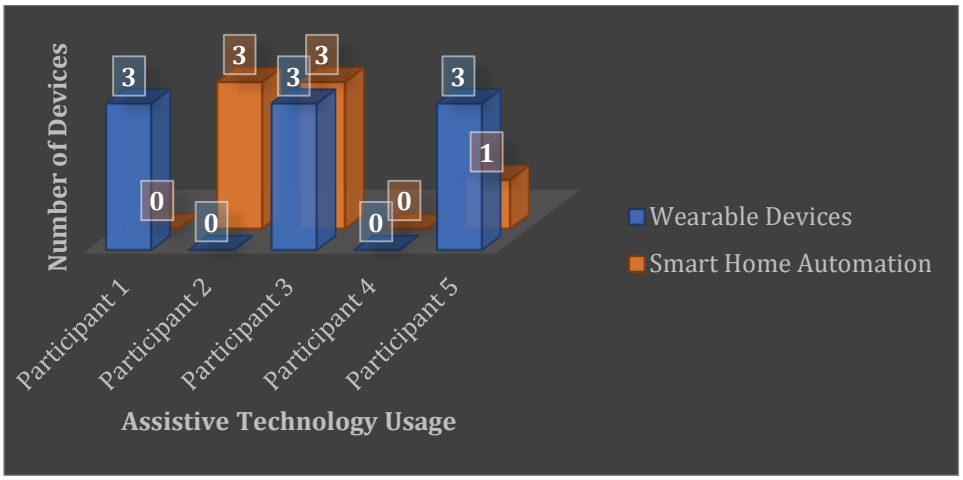


Figure 4. Assistive Technology usage by Seniors

Figure 4 indicates whether seniors used wearable devices and smart home automation for safety. For example, Participant 1 used wearable devices but not smart home automation, while Participant 2 used smart home automation but not wearable devices. Participant 3 was using both wearable devices and smart home automation. Participant 4 was not using any assistive technology device, unlike Participant 5, who used both but more wearable devices.

Table 5. Home Safety Assessment Results (Post-Modification) this Table Displays the Data after Home Modifications were Implemented

Participant	Age (years)	Lighting (1-10)	Clutter (1-10)	Flooring (1-10)	Handrails (1-10)	Total Score (1-40)
Participant 1	75	9	2	9	9	29
Participant 2	80	8	1	8	8	25
Participant 3	70	9	3	8	7	27
Participant 4	85	7	2	7	6	22
Participant 5	78	8	1	8	8	25

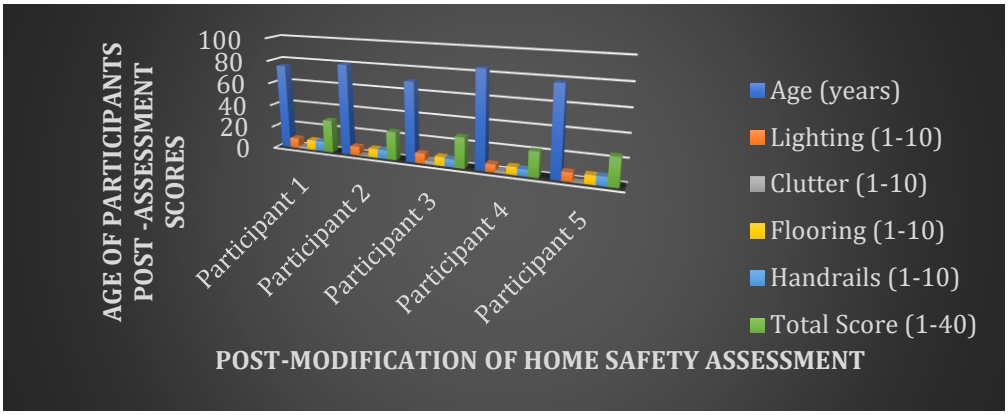


Figure 5. Home Safety Assessment Results (Post-Modification)

Figure 5 illustrates the impact of home modifications on home safety assessment scores. It indicates that most participants saw an improvement in their safety scores after making modifications, with Participant 1 experiencing the most significant increase. This suggests that home modifications can positively affect seniors' living environment safety.

Table 6. Post-Modification Fall Incidents this Table Illustrates the Number of Fall Incidents Reported by Seniors in the Past Year after Home Modifications were made

Participant	Falls in the Past Year (Post-Modifications)
Participant 1	0
Participant 2	1
Participant 3	0
Participant 4	2
Participant 5	1

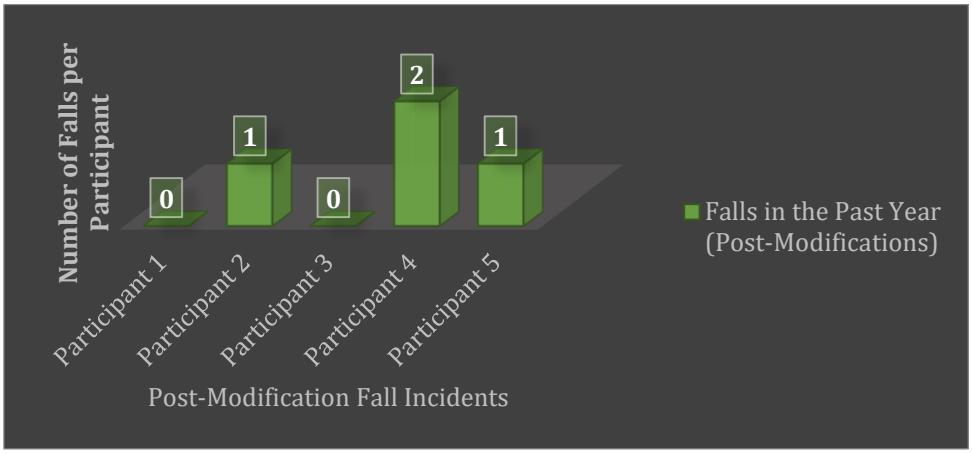


Figure 6. Post-Modification Fall Incidents by Seniors

Figure 6 shows the number of fall incidents reported by seniors in the past year after home modifications were made. For instance, Participant 1 reported no falls, Participant 2 reported one fall, Participant 3 reported no falls, Participant 4 reported two falls, and Participant 5 reported one fall. Collectively, these tables suggest a relationship between home modifications, safety assessments, and post-modification fall incidents. Participants with higher total scores in the safety assessments tend to report fewer fall incidents after modifications. This could imply that the implemented home modifications, such as grab bars, non-slip flooring, and improved lighting, may reduce fall incidents among seniors. The usage of assistive technology also plays a role in enhancing safety.

The results from Table 1 showed variations in home safety assessment scores among senior participants. The data indicates that the safety of their living environments is assessed on a 40-point scale. Participant 1 has the highest total score (27), while Participant 4 has the lowest (19). These scores reflect the condition of home safety aspects, such as lighting, clutter, flooring, and the presence of handrails. The results emphasize the importance of assessing and addressing home safety to ensure a safer living environment for seniors.

Table 2 reveals the number of fall incidents reported by seniors in the past year. Participant 4 experienced the highest number of falls (3), while Participant 2 reported no falls. The data highlights the variability in fall incidents among participants, underlining the significance of fall prevention strategies and home safety improvements.

The results in Table 3 demonstrate the extent to which senior participants have implemented home modifications to enhance safety. Participant 3 made the most modifications, including the installation of grab bars, non-slip flooring, and improvements in lighting. In contrast, Participant 2 made fewer modifications. These findings underscore the role of proactive home modifications in promoting safety.

Table 4 presents data on assistive technology usage by senior participants. It shows that some participants use wearable devices with fall detection while others have implemented smart home automation systems. The data highlights the adoption of modern technology to enhance safety and independence.

The data in Table 5 illustrates the impact of home modifications on home safety assessment scores. It indicates that most participants saw an improvement in their safety scores after making modifications, with Participant 1 experiencing the most significant increase. This suggests that home modifications can positively affect seniors' living environment safety.

Table 6 shows the number of fall incidents reported by senior participants after implementing home modifications. The data suggests that most participants reported fewer falls post-modifications. However, Participant 4 experienced an increase in fall incidents. Further investigation is needed to understand the reasons for this anomaly.

4.1 Discussion

The study's results highlighted the nuanced relationship between home safety assessments, fall incidents, and home modifications and assistive technology implementation. Senior participants' variations in in-home safety assessment scores indicate that certain aspects of their living environments may pose potential risks, emphasizing the need for targeted interventions. These variations could be attributed to individual health, mobility, and lifestyle differences. For instance, Participant 4, with the lowest total score, might require more comprehensive home modifications to address specific safety concerns. The number of fall incidents reported by seniors in the past year adds a practical dimension to the discussion. The data demonstrates the real-world implications of home safety, with Participant 4 experiencing the highest number of falls. This aligns with existing literature that identifies falls as a significant concern for seniors and reinforces the urgency of adopting effective fall prevention strategies. Home modifications emerge as a pivotal factor in influencing home safety scores and fall incidents. The positive correlation between increased home safety scores and fewer reported falls, especially post-modifications, underscores the efficacy of targeted interventions. Participant 1's substantial improvement in safety scores after modifications resulted in zero reported falls, highlighting the potential impact of well-designed home modifications. However, the anomalous increase in fall incidents for Participant 4 post-modifications prompts further investigation. This unexpected outcome suggests that a one-size-fits-all

approach to home modifications may not be sufficient. Tailoring interventions to individual needs, health conditions, and lifestyle factors becomes imperative to ensure the desired outcomes. Using assistive technology, such as wearable devices and smart home automation, adds a technological dimension to the discussion. The data shows varying levels of adoption among participants, indicating a potential area for improvement in promoting and facilitating the integration of such technologies. The positive influence of assistive technology on home safety is evident, particularly in cases where seniors reported zero falls post-implementation.

5. CONCLUSION

In conclusion, the data and analysis presented in this study emphasized the critical importance of home safety for seniors. Home safety assessment revealed variations in safety scores, with room for improvement in many cases. Fall incidents in the past year demonstrated the need for proactive prevention strategies and safety enhancements. Home modifications and assistive technology usage positively influenced home safety scores. Based on the findings, we recommend that seniors consider conducting regular home safety assessments to identify potential hazards and take proactive measures to improve their living environments. Fall prevention strategies, such as home modifications and assistive technology, should be prioritized to reduce the risk of injuries among seniors. Also, seniors and their caregivers should be educated on the significance of home safety, fall prevention, and the benefits of assistive technology. Furthermore, home modifications and the adoption of assistive technology should be tailored to individual needs and requirements. At the same time, seniors should regularly monitor their living conditions, adapt to changing needs, and make necessary modifications.

- **Further Research:** Further research is necessary to delve into the nuances of individual responses to home modifications and the role of assistive technology in influencing long-term safety outcomes. Understanding the factors contributing to anomalous outcomes, such as the increase in falls for Participant 4, will contribute valuable insights to refine existing intervention strategies. By implementing these recommendations, we can enhance the safety and quality of life for seniors, allowing them to age in place comfortably and independently while reducing the risks associated with ageing.

Acknowledgments

The authors have no specific acknowledgments to make for this research.

Funding Information

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Ukpene C. P	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Apaokueze T. N	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

Not Applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to Cite: Ukpene C. P, Apaokueze T. N. (2023). Ageing in place: ensuring home safety and adaptations for the well-being of seniors. Journal of Nursing Research, Patient Safety and Practise (JNRPSP), 3(2), 14-25. https://doi.org/10.55529/jnrpsp.41.15.29

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