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Pedro Arezes *Editor*

Advances in Safety Management and Human Factors

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Preface

Injury prevention is a common thread throughout every workplace, yet keeping employee safety and health knowledge consistently is a continual challenge for all employers. The discipline of Safety Management and Human Factors is cross-disciplinary concerning safety, health and welfare of the people engaged in work or employment. The book offers a platform to showcase research and for the exchange of information in safety management and human factors. Mastering safety management and human factors concepts is fundamental to both the creation of products and systems that people use and the design of work systems to avoid stresses and minimize the risk for accidents.

This book focuses on the advances in the safety management and its relationship with human factors, which are critical in the design of any human-centered technological system. The ideas and practical solutions described in the book are the outcome of dedicated research by academics and practitioners aiming to advance theory and practice in this dynamic and all-encompassing discipline.

A total of six sections are presented in this book. Each section contains research papers that have been reviewed by members of the International Editorial Board. Our sincere thanks and appreciation to the following Board members:

Domestic Safety and Accidents Risk Perception by Active Elderly

Laura Martins, Béda Barkokébas Jr., João Baptista and Pedro Arezes

Abstract The improvement in the quality of life of older people goes far beyond the responsibility of the healthcare sector. Thus, it seems necessary to create accident prevention strategies and manage all the conditions involving the physical and social environment of the elderly. Although it is widely recognized that aging is a process that affects all human beings, it is noted that very often the elderly refuse to notice or consider this process, since the residential dwellings remain without any adjustments or with slightly adaptations, for almost their entire life. The purpose of this study is to discuss the perception of the elderly regarding the relationship between accident risk at home and their physical condition when performing daily activities, by establishing a comparison between the activities carried out by the elderly and the needed home adjustments throughout their life cycle.

Keywords Home safety · Perception of accident risk · Active elderly

1 Introduction

The world is growing old. World Health Organization (WHO) stated that world's population over 60 years is increasing from current 841 million to 2 billion in 2050, and alert that in 2020 there will be, for the first time in history, a higher number of people over 60 years than the number of children up to five years [1].

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This finding leads to considerations related to elderly people, about their role in society, life quality and the interventions oriented to support the aging process. In that matter, this paper presents considerations about the development of strategies of accident prevention and management of the physical and social environment of seniors.

The current study consists in the discussion of the elderly perception in the matter of the relationship between accident risks in their domestic environment and their physical condition in performing everyday activities. This observation emerged from documental and literature review, tracing a parallel between activities carried out by seniors and the adaptions needed in home environment throughout their life cycle.

As described by Arking [2], aging is a chronological, degenerative and progressive process that occurs to all living beings in higher and lower proportions, although environmental factors may contribute to accelerate or slow down this process. Despite this diagnosis, the prognosis of increased life expectancy begins to change paradigms that old age is the twilight of life and the elderly do not have more vitality and intellectual and professional performance. On contrary, it is notable in the twenty-first century a return of this population to the labor market, social living and productivity.

Corroborating this idea, Fontaine [3] explain that the convergence of pharmaceutical discoveries, the improvement of living conditions and a raise of cultural level caused an "explosion" of competitive, healthy and happy elderly.

In contrast, what is noticed is that the elderly do not realize or consider relevant to perform changes in their homes foreseeing the aging process, due to the observation that houses seemed to remain without any adjustments (or with only slight adjustments), rather than functional and deeper alterations, related to habitational space configuration, furniture and appliances.

The senior's domestic environment is the fundamental space in the process of independence and autonomy. Several factors contribute for them to stay in the same environment for several years. In this sense, while the space should inspire confidence and safety, it must recognize that the knowledge of the environment in their small details is a strong appeal in order to bring internal tranquility for the elderly, ensured by a sense of identity.

According to Ferrara [4], the territories of a space are characterized by their cultural consequences. By overcoming its physical or conceptual dimension, the space faces its constructability and, through it, turns into sign that builds a story and a dynamic. The inexorable fact is that, with aging, material references become stronger, translating in to the attachment to artifacts, spaces and memories that recollect the past. According to the author, the environment experience, through sensation and perception, leaves a residue of knowledge or cognitions on the central nervous system. Many of our experiences within the physic environment have a significant load of affection, resulting in emotions, beliefs, feelings, attitudes, judgments and values.

In the current article, it is defended that residence for the elderly becomes their unconditional refuge, where they feel safe and are capable of managing their everyday activities.

Environments offer the elderly a sense of belonging and identity where they recognize themselves and dominate the space. Humans established strong bonds with spaces throughout life and this attachment translates as an important element in this construction, with all references concentrated in a specific environment. This is one of the aspects that contribute most to the resistance of change, unconsciously forcing seniors to stay where they feel safe. Influences of the environment on individuals have become object of research in several fields of scientific knowledge, and environmental psychology played an important contribution in this specific area.

The relationship with home environment can be attenuated by knowing its physical and cognitive characteristics, making it less hostile and allowing greater efficiency performing daily activities.

According to Moser [5], environmental psychology can analyze, explain and provide information that can identify conditions involved in person-environment congruence and wellbeing, improving decision-making process.

In aging process, physiologic aspects of the organism experience a process of natural wear, that occurs in a slow, gradual way, non-perceptible by the elderly, who are used to perform specific tasks during several years.

Darè [6] observes that for most people, the living environment is accessible and can be used in a natural way, but at different times of our lives, difficulties can be experienced in the same living spaces and also using products. Facing those difficulties, people will force, on daily basis, an adaption that most of the times brings injuries that are only perceived later. The elderly are, therefore, risking their physical integrity and increasing the risk of falls and injuries while performing everyday tasks.

In that matter, maintaining independence and autonomy is a fundamental and priority factor for the elderly and must be considered in any adaption proposition aimed at this population.

In this context, the issue of quality of life of the elderly in home environments generates a growing concern of services and public policies focused in health, safety and social inclusion. The matter needs to be dealt in several spheres of society and some concepts can contribute to this understanding.

2 Active Aging

The World Health Organization (WHO) adopted the term “active aging” in the late 90s. It seeks to convey a broader message than “healthy aging” and recognize, in addition to health care, other factors that affects how individuals and populations age [7].

The politics structure for active aging, according to the WHO [8], is based in the United States Principles for Older Adults such as independence, participation, assistance, self-fulfillment and dignity. Therefore, it requires actions on three basic pillars: health, participation and safety. In the health aspect, assuming that with risk factors kept low and protection factors kept high, people enjoy a better quality of life, remaining healthy and able to care for their own lives, as they get older. Concerning participation, with the support of the labor market, education, social and health policies and programs for full participation in socioeconomic, cultural and spiritual activities, according to their fundamental human rights, capacities, needs and preferences allowing individuals to continue to contribute socially with paid and unpaid activities as they age. Finally, regarding safety, assuming policies and programs addressed to the needs and rights of the elderly to social, physical and financial security, ensuring protection, dignity and assistance through support to families and community in the care of older people.

The elderly from the twenty-first century are more socially and economically active than their predecessor. The decline in fertility after 1970 and the retreat of the entry age in active life—due to longer schooling because of specialization levels demanded in the labor market—combined with retirement funding problems and the need to increase family income, contributed to the elderly beginning to play a more significant role in society.

The World Assembly on Ageing, organized by the UN in Vienna, in October 1982 [8], pointed out that many concerns attributed only to the family should be shared by the public and private services supporting the elderly. Therefore, in order to fulfill its social responsibility, governments should provide community actions to minimize possible damage from elderly discrimination.

According to Keinert and Rosa [9], responsibility for aging well, supported by law, is addressed to the person, society and the state. The state need to create conditions so that the individual and society are able to play their roles, especially in terms of prevention and improving life quality of the elderly; which does not relieve the state to provide adequate public services to guarantee their rights.

It is argued that public policies must consolidate the active aging concept, tracing guidelines that consider elderly people a community resource, citizens with rights and duties.

3 Aging and Accident Risk

Considering relevant to the research, it is also important to approach a few physiological aspects of aging and its consequences on the everyday living of the elderly.

In that subject, a question arises about the matter: can the elderly perceive if the environment, furniture and equipment with which they interact on a daily basis meet their needs, from the ergonomic point of view, without prejudice to their

physical constitution? Do they simply get used to live and relate to that environment without realizing their inadequacies, thereby increasing the accident risk?

In order to understand the process of environmental perception that occurs during aging in home context, it is necessary to acknowledge the main physiological changes in the human body and, from that, seek viable solutions for a safe and comfortable relationship with the environment.

Arking [2] affirms that, "I believe that is important to people familiar with the sociological and psychological aspects of gerontology also know the biological aspects of aging and the implications of current researches in their own field".

Laville and Volkoff [10] set some effects of the decline process of physiological and mental functions, mobilized by labor activity: Decreased ability to intense physical effort and joint mobility; Weakening of the body's balance system, responsible for many of the falls experienced by elderly people; Fragility of sleep; Decrease in speed of information processing; Fragility of immediate memory and sustained attention.

Thus, with aging, acquisition and treatment of new information become slower. This process occurs in every aspect, in relationships between people and between individuals and equipment. In this aspect, it has to be considered that the individual initial education is one of the determining factors in this process because, from the first years of school, individuals framed for themselves cognitive tools that facilitate learning through life.

The theory of "Disposable Soma", presented in the 70s by the biologist Thomas Kirkwood, now director of the Aging and Health Institute of the University of Newcastle, in England, is one of the most consensual view among aging researches. According to this theory, people begin the aging process at 30 years old because they fail to be interesting from an evolutionary point of view, this happens because the soma—our body with its tissues and organs—starts to lose the functions of protection and carrying the genes of reproductive cells. It is, therefore, a process of natural selection. Starting at age 25, the body begins to lose 1 % of its functional capacity every year. Sensorial organs, being the means by which our body relates to the outside world, are the first ones to realize the sensations arising from this relationship. In old age, these senses undergo profound modifications, except the taste, contributing to changes in the perception of the environment [11].

Exemplifying those modifications, Arking [2] discuss the vision, "[…] It is assumed that changes in the structure of the crystalline protein are correlated with decreased visual acuity on aging […]". Further, Arking states that aging is a degenerative process presented in two different ways. First, aging increases the likelihood of death with time. Second, it reduces the ability of the individual to resist extrinsic stress, commonly considered as the loss of vigor or vitality.

Thus, the relation of the elderly physical condition with their accident risk perception at home, during the course of daily activities throughout their life cycle, is a topic that deserves a depth research and analysis.

The nature of perception is considered a process of information extraction from people to obtain knowledge about their environment.

According to Perracini [12], home accidents resulting from falls are a major public health problem, representing two thirds of accidental deaths.

In this regard, much has been researched on the issue of falls, in particular related to physical and material aspects, with a wide field yet to be studied regarding individual perception within home safety in order to develop accident prevention strategies and management of the conditions that involve physical and social environment.

4 Risks and Domestic Safety

Despite all technological advances, domestic accidents are still a reality, which brings consequences for the victim, their family and society. Unfortunately, this situation is still accepted as inevitable fact, with few actions towards prevention.

It is observed that, most times, preventive measures are taken after the accident occurs. Accident prevention requires knowledge of risks and awareness of all those involved in order to avoid such conditions, not only in the home environment, but also at workplaces, in traffic and in public places.

Designing an effective accident control system demands treating the causes. Therefore, some questions need answers: Why the insecure action occurred? What are the existing unsafe conditions? Which system and environment failures exist?

In addition, some concepts should be understood, such as human errors, unsafe environment condition and classification of environmental risks and risks factors.

Human error is a fault committed in the execution of a task that may cause accidents. Human errors can occur for the following items:

- Negligence, which is the lack of attention and the use of inadequate equipment while performing a task;
- Incompetence, described by the lack of knowledge in performing a task;
- Malpractice/Unskillfulness, when performing a task or working in the wrong way due to the lack of knowledge of the activity [13].

Unsafe conditions in the environment are related to unsafe conditions at home. It is the lack of necessary care required to properly perform a task without accidents. Therefore, there must be constant vigilance regarding what actions may cause accidents in domestic environment, informing the person in charged so the measures are taken, avoiding possible accidents [14].

Regarding the classification of environmental risks and risks factors it is relevant to refer that environmental risks are classified according to causative nature. Thus the risk types can be grouped in: chemical, which are cause by chemicals (vapors, gases, liquids, dusts, mists, fumes); physical, caused by energy exchange between the person and the environment (heat, electricity, infrared and ultraviolet radiation, ionizing radiation, pressure, impacts and others); and biological, caused by agents that produces infections and allergies (virus, bacteria and fungi) [15].

When risk factors are found in the environment, an unsafe condition is established. Often it is believed that danger only exists outside of the perimeters of the house, but statistics show that most of the houses or domestic spaces (kitchens, bedrooms, bathrooms, gardens, etc.) are responsible for several types of accidents, where the main affected are the elderly and children.

Several factors can cause accidents. Firstly it is highlighted those related to the physical and psychological conditions of people, then those related to physical, social and cultural conditions of the living environment.

Elderly people present certain characteristics that frequently lead them to become domestic accident victims. Some symptoms of aging, such as the decrease in physical strength, lack of attention and concentration, weaker vision and hearing, slower movements and slower reactions, state the beginning of a life more frequently dependent of others and more willing accidents, such as falls. Besides, advanced age is usually followed by the loss of their spouses, partners or friends and by other restrictions that can lead to feelings of loneliness and isolation.

For family members of the elderly, the emotional and physical load of taking care of someone in those circumstances can be large, causing stress situations, depression and nervous exhaustion. In the case of an accident of the elderly, that load increase significantly.

5 Domestic Environments Suited to Active Elderly

Culturally, accidents are noticed as inevitable situations, not wished by people, especially because people usually think it is never going to happen to them. However, facing and thinking about the accident, it is perceived that, in many cases, the situation could be avoided.

In the matter of the elderly, prevention consists in anticipate the situations, avoiding that any damage happens, through physical, material, emotional and social care exercises. In that way, prevention should be understood and performed by families and government sectors, through public politics.

A safe house consists in a residence designed with the intent of minimize accident risks, introducing a new concept that aims to provide safety, comfort, independence and quality of life for the elderly.

Thorough analysis of each environment, difficulties in performing tasks in specific spaces can be diagnosed:

- Bedroom—The activities performed in the bedroom, in general, are: sleeping, resting, watching television, reading, writing, clothing choosing, etc. That means that bedrooms should be wide, ventilated, well-lit and comfortable. Windows with interesting views act as positive stimulation, as the contact with the outside can positively influence the emotional state of the elderly. Furniture should include the use of wheelchair, which is a very common need for the elderly.

- Bathroom—The bathroom is one of the places with highest rates of accidents, especially because it is a wet area. A proper planning of these environments should consider a non-slip floor, especially in the bathroom box; bathtubs should be avoided; support bars near the shower and the sink; mirror at the proper height for the elderly; toilet with higher elevation; good lightning and, if possible, with presence sensors; faucets with lever handle; and an adequate space for wheelchair maneuvers.
- Kitchen—Just as the bathroom, the kitchen is a dangerous space for elderly, because, besides being a wet area, presents several accident risks, including falls, burns and injuries while handling sharp objects. It is important to reiterate that the article discuss active seniors living in their homes and often prepare their meals.
- Hall/Passageway and stairs—Circulation areas should be well lit, with light switches at each end of the stairs. The first and the last steps must be signalized and non-slip floor should appear in all steps. A firm handrail should be placed on both sides of the stairs. Stairs must always be clear, avoiding putting shoes, books, tools and other objects.
- Deposit or garage—In order to avoid confusion, all chemical products must be kept in their original packaging and properly identified. Hazardous chemicals should be stored in special places. Sharp or potential dangerous tools must be kept in proper functioning and stored in special places. For example, gasoline and other inflammable products must be kept in closed containers away from heat sources (preferable outside the residence limits).
- Other outhouses from the residence—Keep the terraces, balconies and hallways without puddles. All areas should be well lit. Protective screens securely fixed to the windows. Avoid poisonous plants and thorns in the garden or inside the house. Keep attention to the pool areas. Plan escape routes in case of fire or emergency and train all residents of the house to practice these routes.

It is possible to engage actions that, without a doubt, will contribute to make residential environments safer. Primarily, to achieve safety, obedience of the norms is crucial, performing maintenance and relevant inspections. In addition, it is required care and special attention both with the elderly and children. Lastly, safe habits are requisition for all equipment, installations and environments.

The analysis performed in this paper included manual analysis [16], report analysis [17] and the authors' experience resulting in the most common accidents in domestic environment and its main causes:

1. Accident by fall—In residential environments there may be two types of falls: the ground level caused by slipping, tripping, being pushed, etc.; and by level difference caused by stair falling, high doorjamb or step, or when climbing chairs or other furniture that does not have this purpose.
2. Accident by poisoning, allergies, irritation and burning—Poisoning usually result from ingestion or inhalation of toxic products; allergies are consequence

of inhalation, ingestion or skin contact with several products; and irritation and burning are produced by skin contact.
3. Accident by burn—Burns can be caused by contact, projection of objects, particles or liquids at elevated temperatures or by contact with caustic products like soda, acids, etc.
4. Accident by fire and explosion—Starting a fire requires three elements present in every household: air, fuel and heat focus. When the fuel is gas, its leakage or similar situation can cause an explosion.
5. Accident by electric shock—The risk of electric shock is always present in homes, but the risk becomes more evident when the environment is damp and/or the person is barefoot. It is necessary to keep a permanent alert state in electricity use, with special attention to bathroom, laundry and kitchen areas, and also appliances such as refrigerator, washing machine, dish washer, etc.
6. Accident by respiratory asphyxia—Asphyxia occurs from lack of oxygen by its impossibility of reaching lungs or blood. Oxygen cannot reach the lungs when the airways are obstructed.
7. Accident per hit and stumbling—Produced in disorderly environments or caused by the presence of objects and equipment in the circulation areas.
8. Accident by animal or insect bites—dogs, cats, rats, etc. may become dangerous for the elderly. These animals usually can be carriers of contagious and deadly diseases such as rabies and anger, or simply can cause injury by negligence or without intention.

6 Final Considerations

From the discussion on the perception of the elderly as the relationship between risk of accidents at home and their physical condition in performing daily tasks, it is understood that the activities carried out by the elderly and the necessary adjustments in the home environment, throughout the life cycle, is a complex theme. The issue involves not only the architecture field, but requires a dialogue between the several involved areas of knowledge, such as ergonomics, safety engineering, medicine, physiotherapy and others related to the specific situation.

In this sense, the goal is life quality and autonomy. Improving accessibility, comfort and safety is, therefore, essential in planning an elderly person's house.

The study of the process of human perception and its relation with the built space facilitate the understanding of how the levels of perception suffer with aging, caused by the wear of the sensory organs.

Changings in the environment can cause conflicts with elderly people used to determined procedures and the safety in their living space for decades, which means a familiar space. The affectivity feeling that elderly people have about their living place is fundamental when there is a redefinition or planning of a new way of living. It is important to consider and preserve their references.

Thus, the environment influences on people have been object of research, but the perceiving and dealing with those references is a subject that deserve further study.

Analyzing the accidents raised in the research, its causes and prevention measures proposed, it is concluded that domestic accidents can be avoided if they are previously studied and if proper prevention measures are adopted. Such preventive measures must be developed from the understanding of the elderly life cycle, aiming their comfort, safety and autonomy.

All the aspects about domestic accidents with elderly people raised and discussed in this paper seem to highlight that only from the clear understanding of how they happen and what are the direct consequences for people involved, it is possible to determine the basis for the project adjustments of the environments designed for the elderly.

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