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Toward a person-centred, multidisciplinary method to assess the vulnerability of the elderly

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Abstract—Over the last decade, the population ageing has increased considerably, with a growing portion of dependent seniors. In France, the elderly have expressed their willingness to age at home. However, this place is seldom adapted for that purpose and the reasons pushing elderly people to leave home are still not identified in a systemic way. In this paper, we present an evidence-based review of vulnerability determinants and frailty models that could help to improve existing solutions for ageing at home. A person-centred and multidisciplinary approach is presented, inspired by the *International Classification of Functioning, Disability and Health (ICF)*¹, while going beyond its limitations. This approach will allow us to define the parameters to be measured for an efficient assessment of vulnerability.

Index Terms—Vulnerability, Frailty, Elderly, ICF, Social inequalities, Health Determinants

I. INTRODUCTION

The population ageing in the European Union countries is gradually being observed, as the so called "baby boomers" have become the single largest demographic cohort in their societies. In 2019, the "Concertation Grand Âge" has allowed French citizens to express their wish regarding ageing. Their answers are listed in the Libault report and highlight as the second most mentioned priority: To be able to choose to stay at home freely. However, many obstacles must be removed for this to become a reality. Vulnerability and frailty are multifaceted evolving concepts somehow correlated. Understanding the mechanisms and risk factors for both conditions is still a paramount. Under certain circumstances in the aging population, physiologic and social vulnerability put this group at risk for frailty which is one of the main reasons for leaving home.

In the US, a classification of the *Diagnosis Related Groups (DRGs)*² has been elaborated. It relies on *grouping people with homogeneous medico-economic needs*. The French classification of homogeneous groups of patients is derived from the DRGs system. Therefore, French geriatricians often provide health care focusing on medical grids to assess frailty (e.g., *Fried*) and *take part in medico-economic evaluations* (e.g., *AGGIR*). However, this approach, focused on frailty only, and limited to age, physical and mental impairments, might be too restrictive as opposed to the analysis of vulnerability.

From this perspective, the *Dahlgren-Whitehead rainbow model of health determinants* [1], exhibits the importance of socio-economic, cultural and environmental factors. The elderly must be well supported by their surroundings, have a good income and live in an adapted home. They also seek to maintain social relationships outside the confines of their home. Free mobility and activities of daily living (ADLs) are also mandatory, so they can feel completely safe. Regular follow-ups and early management of cognitive disorders and functional limitations are equally important. A deterioration in any of these determinants can expose the elderly to a state of vulnerability.

In this work, we seek to present a set of determinants that helps to understand, design, and implement a person-centred and coordinated method, capable of predicting the vulnerability state of the elderly, thus the probability of leaving their home. The root causes of departure from home in the elderly population must be understood before formulating effective strategies to address them. In this vision, the proposed approach is not just limited to frailty, but also goes deeper into the identification of the underlying variables that are indirectly predictive of vulnerability.

The remainder of this paper is organized as follows. Section II presents the current ageing context and existing solutions for its management. Section III introduces environmental, personal and health conditions determinants to assess the vulnerability. Finally, section IV outlines the work in perspective, including technology integration and ambient intelligence, based on the identified determinants.

II. AGEING BACKGROUND

While institutionalization is not the first choice of the elderly, it has often been adopted as an alternative to cope with the ageing consequences. Therefore, the home is still not considered adequate to address the various forms of vulnerability, because of lacking evaluation strategies and mainly the limits of the implemented solutions.

A. Evaluation Tools

In [2], *Fried et al.* studied the frailty as a medical syndrome represented by a phenotype (prefrail, frail, robust). The identified criteria are weight loss, exhaustion, weakness, slow walking speed and low physical activity. However, this

¹ICF

²DRG

phenotype has important limitations. On one hand, their vision of frailty is purely functional, not taking into account other pathologies that do not alter biological capacities. On the other hand, the measurement of these 5 criteria in a clinical context, given the constraints of time and space, is seen as stigmatizing.

The national grid *Autonomy Gerontology Groups Iso-Resources (AGGIR)*³ is a tool for assessing the degree of dependency in the completion of the ADL. Individuals are classified into 6 iso-resource groups (IRGs), ranging from a total dependency to a total autonomy. The rationale behind this classification is to set the *Personalized Autonomy Allowance (PAA)*, which makes it financially oriented. Plus, the weighting of the environmental parameters is low in the IRG calculation.

Other operational models have been found in the literature, most of which focus solely on frailty and largely under look the vulnerability aspect, due to the difficulty to assess its diverse and multifactorial manifestations.

B. Existing solutions to cope with vulnerability

In [3,4], the authors addressed the isolation problem. The limitations of such ideas lie in the fact the individualistic culture is difficult to appreciate to get out of the "no stranger in my home" mentality. In [4], digital applications were developed with the aim of bringing people closer to those surrounding them. However, people who connect need to be equipped with digital tools and must be familiar with their usage. Other existing solutions, based on wearable sensors and home automation [4], monitoring systems for home-based pathological resident [5] or focused on assisting the elderly in their ADL [6], fail to consider the multifactorial sides of vulnerability in a systematic way. Most of them are also perceived by the elderly as stigmatizing.

III. PERSON-CENTRED VULNERABILITY-BASED APPROACH

The purpose of our approach is to design an adequate method capable of synthesizing the multiple facets of vulnerability. For this aim, we focus on identifying the determinants that set up a coherent view of different health perspectives: *medical, personal and environmental*.

A. ICF-inspired approach

The *ICF* was initially elaborated based on the *rainbow model*. It belongs to the *WHO's* International Classifications. *ICF* has shifted from a classification of "disease consequences" to a classification of "health components". This model might be called biopsychosocial. It is no longer limited to the functional deficiencies of the body. On the contrary, disability and functioning are viewed as outcomes of interactions between health conditions and contextual factors. Of the latter, environmental and personal factors are carried out.

B. Objectification in an accustomed environment

Among all the determinants included in the *ICF*, we have selected, from evidence-based literature, the ones which were found to be significant for leaving the habitat. This way, the determinants unrelated to this aim are not addressed, making our approach lighter while preserving its efficiency. Additional vulnerability determinants from other studies were included as their relevance has been demonstrated. All identified vulnerability determinants are consolidated in Figure 1.

1) *Personal Determinants*: For a person-centred evaluation, demographic factors are considered, in addition to socio-economic ones. The family and financial environment as well as consumption patterns and sexual interests can also significantly influence the behaviour of older people. In addition, with a closer look on the person's life path, disturbing events may be identified to be responsible of deep behavior changes.

2) *Environmental Determinants*: Being a home owner and extremely attached to the past memories limits the chance of leaving, while living in a temporary home increases it. Moreover, the disability to accomplish the ADL and the Instrumental ADL (IADL) is a major factor that pushes the elderly to take the decision of leaving. However, social support or the presence of a caregiver can defer or even eliminate this decision. The burden expressed by the helper should be considered, as it reflects the health state of the elderly. The geographic location for staying is also critical.

3) *Health Condition Determinants*: Along with the frailty characteristics defined by *Fried et al.*, the hospitalization history, pathologies, sensory and memory disorders, balance loss and pain are significant in the vulnerability assessment.

Beside the listed determinants extracted from the *ICF*, determinants not considered to be major are therefore studied in order to better understand the strategies used in the choice to leave the home. This approach leads us to explore the elements that control the process of disengagement [24]. This process requires the elderly person to adapt their life course in order to maintain their identity despite the social and biological complications.

From this chart, a set of useful parameters can be determined and continuously monitored, in a non-stigmatizing environment. This monitoring can be carried out by existing sensors. In fact, if some criteria are not measurable, but have an impact on others, the quantification could then be done on the latter. Therefore, an objective and reliable vulnerability measurement of the person could be obtained, allowing to propose early corrective activities.

IV. CONCLUSION AND PERSPECTIVES

In this work, we have thoroughly prepared a list of the vulnerability determinants in the elderly population. The uniqueness of our approach relies in the fact that these determinants are multidisciplinary. In other words, vulnerability is not seen only as a medical or biological deficit, but rather as an accumulation of environmental, medical and personal factors. Most of the identified determinants are extracted from literature and proved to be predictive of home leaving. The proposed

³AGGIR Grid

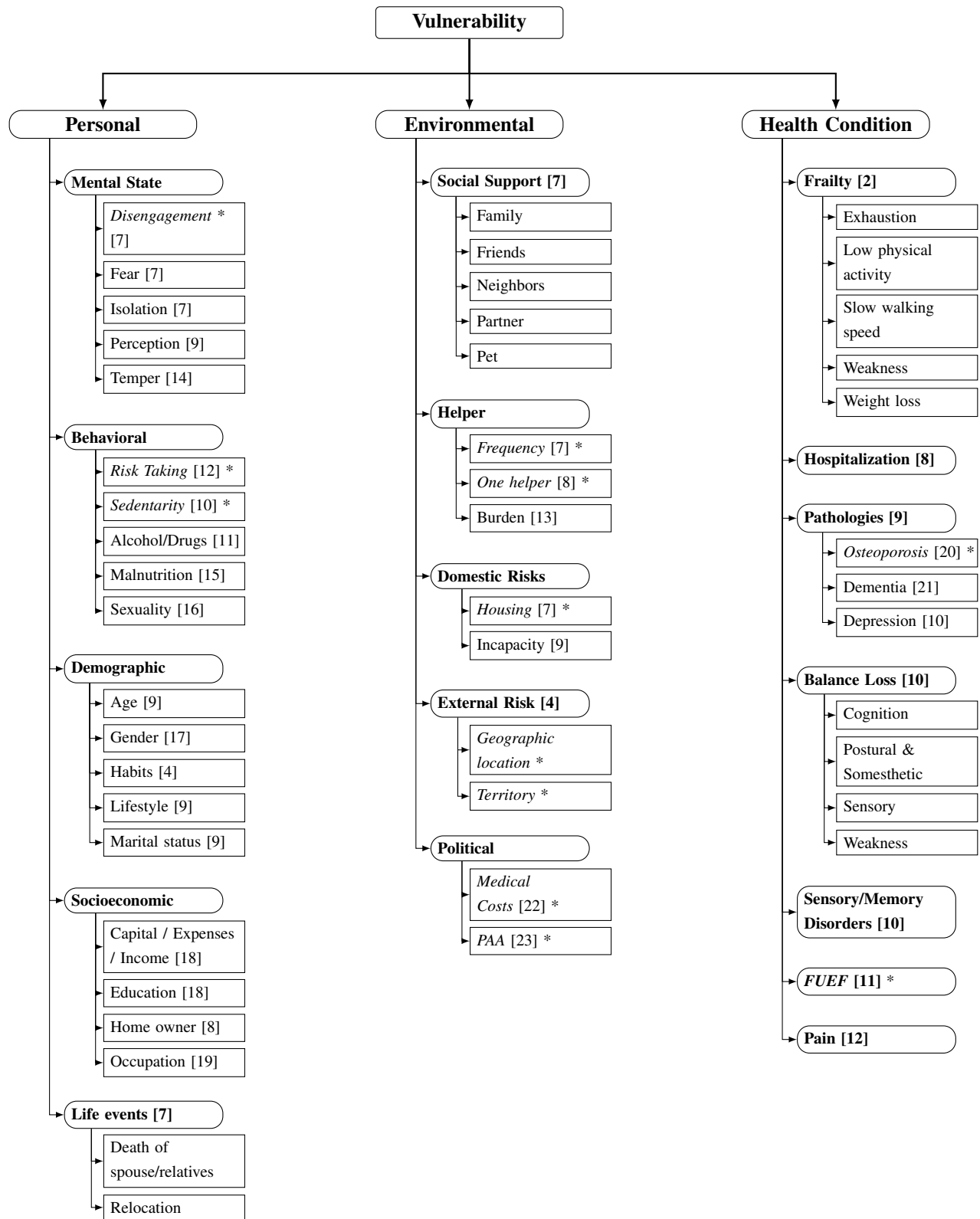


Fig. 1. Relevant vulnerability determinants derived from ICF or from other literature sources (*)

approach evolves from a group perception of vulnerability to that of an individual, taking into account his own life trajectory and making it more adapted to the heterogeneous ageing of the population. We seek to define measurable parameters that will make it possible to quantify each of the identified determinants. Therefore, assessing and monitoring their evolution can be done via ambient or even portable sensors. The collected data will be treated through *Artificial Intelligence (AI)* techniques for making early decisions.

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