


INSTITUTO DE HIGIENE E
MEDICINA TROPICAL
DESDE 1902

Universidade Nova de Lisboa
Instituto de Higiene e Medicina Tropical

eHealth's potential in providing healthcare for the elderly with risk of falling due to balance disorders, in a global health perspective

Andréa Gomes Martins Gaspar

TESE PARA A OBTENÇÃO DO GRAU DE DOUTOR EM SAÚDE INTERNACIONAL

ESPECIALIDADE DE POLÍTICAS DE SAÚDE E DESENVOLVIMENTO

FEVEREIRO, 2023

INSTITUTO DE HIGIENE E
MEDICINA TROPICAL
DESDE 1902

Universidade Nova de Lisboa
Instituto de Higiene e Medicina Tropical

eHealth's potential in providing healthcare for the elderly with risk of falling due to balance disorders, in a global health perspective

Autora: Andréa Gomes Martins Gaspar

Orientador: Prof. Doutor Luís Velez Lapão

Tese apresentada para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Saúde Internacional, especialidade em Políticas de Saúde e Desenvolvimento, nos termos do artigo 11º, alínea b, do Regulamento Geral do 3.º Ciclo de Estudos Superiores Conducentes à Obtenção do Grau de Doutor pelo IHMT/UNL, publicado no Diário da República (Regulamento n.º 474/2012 (2.ª série, n.º 223, de 19 de novembro de 2012)

SCIENTIFIC PUBLICATIONS AND COMMUNICATIONS

This thesis is based on the following papers, which are referred to in the text by their Roman numerals (I-IV):

Published papers:

I Gaspar AGM, Lapão LV. eHealth for Addressing Balance Disorders in the Elderly: Systematic Review. *J Med Internet Res*. 2021;23(4):e22215. DOI: 10.2196/22215

II Gaspar AGM, Escada P, Lapão LV. How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study. *Int J Environ Res Public Health*. 2021 Jul 11;18(14):7410. DOI: 10.3390/ijerph18147410

III Gaspar AGM, Lapão LV. A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. *Int J Environ Res Public Health*. 2022 Feb 7;19(3):1855. DOI: 10.3390/ijerph19031855

IV Gaspar AGM, Lapão LV. A utilização de um serviço de saúde digital para idosos com alterações do equilíbrio e risco de queda num contexto global. *An Inst Hig Med Trop*. 2022 Oct 22; 21:66-72.

Communications (oral and poster presentations):

- Gaspar AGM, Lapão LV. A contribuição do eHealth nos cuidados de saúde dos idosos com risco de queda por distúrbios do equilíbrio. IX Jornadas Científicas do Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa (IHMT/UNL). Lisbon, 12 December 2018 (Poster presentation).

- Gaspar AGM, Lapão LV. Inovação na prestação de cuidados ao idoso: a contribuição do eHealth nos cuidados de saúde dos idosos com risco de queda por distúrbios do equilíbrio. 5º Congresso Nacional de Medicina Tropical. Lisbon, 10-12 April 2019 (Poster presentation).

- Gaspar A, Lapão LV. The contribution of eHealth to improve fall and balance disorder care in the elderly. 12th European Public Health Conference. Marseille, 20-23 November 2019 (Oral presentation).

- Gaspar AGM, Lapão LV. Pertinência e constrangimentos do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio. X Jornadas Científicas do IHMT/UNL. Lisbon, 12 December 2019 (Poster presentation).

- Gaspar AGM, Escada P, Lapão LV. Como usar a eHealth para melhorar a prestação de cuidados médicos a idosos com distúrbios do equilíbrio? XI Jornadas Científicas do IHMT/UNL. Virtual edition, 10 December 2020 (Poster – flash oral presentation*)*

- Gaspar AGM, Escada P, Lapão LV. eHealth for elderly people with balance disorders and risk of falling. A mixed methods study. 14th European Public Health Conference 2021 in Virtual edition – 10-12 November 2021 (Poster presentation).

- Gaspar AGM, Lapão LV. Digital Monitoring Service for Elderly People with Balance Disorders: Design Science Approach. CBIS-CBTMS 2021 – XVIII Congresso Brasileiro de Informática em Saúde / 10º Congresso Brasileiro de Telemedicina e Telessaúde/ Fórum RNP 2021 – Virtual edition, 22-26 November 2021 (Oral presentation).

- Gaspar AGM, Lapão LV. Solução digital para a prestação complementar de cuidados de saúde a idosos com distúrbios do equilíbrio e risco de queda: Design Science Research Methodology. XII Jornadas Científicas do IHMT/UNL. Virtual edition, 10 December 2021 (Poster presentation).

- Gaspar AGM, Lapão LV. Saúde Global Digital e Equilíbrio do Idoso. INI de Portas Abertas – Fundação Oswaldo Cruz - FioCruz. Virtual edition, 24 March 2022 (Oral presentation).

- Gaspar AGM, Lapão LV. Solução digital na prestação complementar de cuidados de saúde a idosos com distúrbio do equilíbrio. 12º Congresso Paulista de Geriatria e Gerontologia - GERP 2022. Virtual edition, 5-9 April 2022 (Poster presentation with available video).

- Gaspar AGM, Lapão LV. "Equilíbrio": uma solução digital na prestação complementar de cuidados de saúde a idosos. 12º Congresso Paulista de Geriatria e Gerontologia - GERP 2022. Virtual edition, 5-9 April 2022 (Poster presentation with available video).

- Gaspar AGM, Lapão LV. A contribuição da MGF na elaboração e avaliação da solução digital "EQUILÍBRIO" para a prestação complementar de cuidados de saúde a idosos com distúrbios do equilíbrio e risco de queda. Update em Medicina. Virtual edition, 4-8 May 2022 (Oral presentation).

- Gaspar AGM, Lapão LV. “EQUILÍBRIO”: uma oportunidade para monitorização complementar dos distúrbios do equilíbrio. 69º Congresso Nacional da Sociedade Portuguesa de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço (SPORL-CC). Porto, 6-8 May 2022 (Oral presentation).

- Gaspar AGM, Lapão LV. Avaliação do serviço digital “EQUILÍBRIO” para prestação complementar de cuidados de saúde a idosos. 69º Congresso Nacional da Sociedade Portuguesa de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço (SPORL-CC). Porto, 6-8 May 2022 (Oral presentation).

ACKNOWLEDGMENTS

I would like to thank my supervisor Prof. Luís Lapão for his patience, knowledge, valuable comments, motivation and support of my PhD study and related research, collaborating with my academic and scientific growth.

I am grateful for the voluntary participation of the physicians and patients in this research.

Additionally, I also thank the Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa (IHMT/UNL), Regional Health Administration of Lisbon and Tejo Valey (ARS LVT) and Faculty of Science and Technology (Faculdade de Ciências e Tecnologia (FCT) da Universidade NOVA de Lisboa for supporting of the digital solution development.

I appreciate the availability and support of the implementation of the "BALANCE" digital service by Paulo Abreu, Andreia Nascimento and Mélanie Maia.

Finally, I would like to thank my family for the persistent motivation: my parents, my sister, my husband and my daughters.

RESUMO

Introdução: O processo global e progressivo de envelhecimento populacional e a vulnerabilidade a doenças crónicas, distúrbios do equilíbrio e quedas têm representado um dos principais desafios aos sistemas de saúde. Isto tem motivado o desenvolvimento de estratégias, incluindo a utilização de tecnologia na prestação de cuidados de saúde. Portugal e Cabo Verde têm acompanhado esta tendência, investindo em sistemas e tecnologias de informação. Contudo, a aplicabilidade clínica das soluções digitais no contexto do idoso com alterações do equilíbrio e risco de queda precisa ser explorada.

Objetivo: O objetivo desta investigação foi estudar, elaborar, implementar, demonstrar e avaliar uma solução digital para a prestação complementar de cuidados de saúde a idosos com alterações do equilíbrio e risco de queda no contexto português, alinhando posteriormente a sua utilização numa perspetiva global, com o exemplo de Cabo Verde.

Métodos: Utilizando *Design Science Research Methodology*, foi realizado um estudo de métodos mistos com estratégia explanatória sequencial. Inicialmente, foi disponibilizado um questionário no *website* da Ordem dos Médicos de Portugal para identificar a satisfação e constrangimentos quanto aos dados clínicos disponíveis e a relevância do *eHealth* no contexto da prestação de cuidados de saúde a idosos com distúrbio do equilíbrio. Foram conduzidas entrevistas individuais a médicos, explorando estratégias para o desenvolvimento de uma solução digital neste contexto. As sugestões contribuíram para o desenho e elaboração do serviço digital, inicialmente testado por cinco idosas e seus cuidadores, como prova de conceito. Este serviço foi avaliado por estes utilizadores e oito médicos com experiência em coordenação de serviços, através de dois grupos focais. Relativamente a Cabo Verde, foi conduzido um *Policy Dialogue Workshop* (PDW), incluindo a Direção do Hospital Central Doutor Agostinho Neto (HCDAN), para explorar o interesse e potencial utilização do serviço digital no contexto cabo-verdiano.

Resultados: A identificação de constrangimentos médicos quanto aos dados clínicos disponíveis e a verificação da relevância do *eHealth* neste contexto motivaram a elaboração de uma solução digital. Considerando as sugestões dos entrevistados, foi desenhado o serviço digital "EQUILÍBRIO" para monitorização remota, deteção precoce de agravamento clínico, atempada adequação do tratamento e maior interação médica com os doentes. As avaliações dos doentes, cuidadores e médicos foram positivas, com o reconhecimento de vários benefícios, tais como, conforto do doente, maior proximidade médico-doente e potencial redução de recursos presenciais. No caso de Cabo Verde, a Direção do HCDAN e participantes do PDW manifestaram interesse e reconheceram o potencial de utilização do serviço digital, inclusive junto a doentes mais jovens.

Conclusão: O serviço digital "EQUILÍBRIO" foi desenhado, implementado e avaliado em contexto clínico. Verificou-se um significativo potencial para aplicabilidade clínica na prestação complementar de cuidados de saúde, permitindo monitorização remota, maior interação médico-doente e participação ativa dos doentes. A implementação deste serviço em Cabo Verde representa uma oportunidade para futura investigação. O envolvimento de outros profissionais de saúde e outros países podem ser considerados como uma promissora cooperação de cuidados de saúde entre os Estados membros da Comunidade dos Países de Língua Portuguesa.

Palavras-chave: Saúde global; Idoso; Equilíbrio; *eHealth*; Saúde digital

ABSTRACT

Introduction: The global and progressive aging of the populations and vulnerability to chronic diseases, balance disorders and falls have represented one of the main challenges to health systems. This has motivated the development of strategies, including the use of technology for provision of health care. Portugal and Cape Verde have followed this trend, investing in technology-based information systems. However, the clinical applicability of these digital solutions in the context of elderly people with balance disorders and risk of falling needs to be explored.

Objective: The objective of this research was to study, develop, implement, demonstrate and evaluate a digital solution for the complementary provision of health care for elderly people with balance disorders and risk of falling in the Portuguese context, subsequently aligning its use in a global perspective, with the example of Cape Verde.

Methods: Using the Design Science Research Methodology, an explanatory sequential mixed methods study was performed. Initially, a questionnaire was made available on the website of the Portuguese General Medical Council to identify the satisfaction and difficulties with clinical data availability, and the relevance of eHealth in the context of elderly people with balance disorders. Individual interviews were carried out with physicians, exploring strategies for the development of a digital solution in this context. The suggestions contributed to the design and development of the digital service, initially tested with five elderly women and their caregivers, as a proof-of-concept. This service was evaluated through two focus groups, including these users and eight physicians with experience in coordinating services. In the case of Cape Verde, a Policy Dialogue Workshop (PDW) was carried out, including the Direction of the Hospital Central Doutor Agostinho Neto (HCDAN), to explore the interest and potential use of the digital service in the Cape Verdean context.

Results: The identification of medical constraints with availability of clinical data and the identification of the relevance of eHealth in this context encouraged the development of a digital solution. Considering the suggestions of the interviewees, the digital service "BALANCE" was designed, allowing remote monitoring, early detection of clinical deterioration, timely optimization of treatment and greater medical interaction with patients. The patient, caregiver and medical evaluations were positive, with the recognition of several benefits, such as patient comfort, closer physician-patient interaction and potential lower consumption of face-to-face resources. Regarding Cape Verde, the Direction of HCDAN and the participants of the PDW expressed interest and recognized the potential for using the digital service, including among younger patients.

Conclusion: The digital service "BALANCE" was designed, implemented and evaluated in the clinical context. There was significant potential for clinical applicability in the provision of complementary health care, allowing remote monitoring, closer physician-patient interaction and active patient participation. The implementation of this service in Cape Verde is an opportunity for future research. The involvement of other health professionals and countries could be considered as a promising health care cooperation between the member states of Community of Portuguese-Speaking Countries.

Keywords: Global health; Elderly; Balance; eHealth; Digital health

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABREVIATIONS

CPLP	In Portuguese: Comunidade dos Países de Língua Portuguesa
DSRM	Design Science Research Methodology
EIP-AHA	European Innovation Partnership on Active and Healthy Ageing
EMR	Electronic medical record
GDPR	General Data Protection Regulation
HBA	Hospital Beatriz Ângelo
HCDAN	Hospital Central Doutor Agostinho Neto
IHMT/UNL	Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa
ISQua	International Society for Quality in Health Care
IST	Information Systems and Technologies
METHIS	Multimorbidity Management Health Information System
NICE	National Institute for Health and Care Excellence
OECD	Organization for Economic Cooperation and Development
PD	Policy Dialogue
PDW	Policy Dialogue Workshop
PECS-CPLP	In Portuguese: Plano Estratégico de Cooperação em Saúde da CPLP
SPMS	In Portuguese: Serviços Partilhados do Ministério da Saúde
WHO	World Health Organization

1. INTRODUCTION

This research aimed at the study, design, implementation, demonstration and evaluation of a digital service for the complementary provision of health care for elderly people with balance disorders and risk of falling, using the Design Science Research Methodology (DSRM) as a research methodology.

The thesis is divided in three main sections.

The first section includes a pertinent state of the art, describing the challenges of global population aging and the vulnerability to the development of balance disorders and falls. The strategies to reduce this pressure placed on current health systems are described, including investment, implementing and use of digital solutions in this context. The objectives of the investigation and the DSRM activities carried out are described.

The next section "Results" includes the four published articles that resulted from the thesis work. The first is a systematic review, addressing the state of the art of digital solutions being used for elderly people with balance disorders and risk of falling. The other article describes the mixed methods study carried out in Portugal to understand how to develop the digital solution and the required functionalities. The third paper presents the implementation of the digital solution elaborated ("BALANCE" digital service), including its demonstration and evaluation in the Portuguese context. Finally, the last article includes the exploration of the potential use of the "BALANCE" digital service in Cape Verde, an island country with relevant links to Portugal, and a significant dynamism in telemedicine and progressive aging population.

The third and final section "Discussion and Conclusions" closes with the main findings, including strategic guidelines for a greater clinical applicability of "BALANCE" service in Portugal, future investigations and alignment with health policies, including the example of Cape Verde. This section ends with future research expectations.

1.1. BACKGROUND AND STATE OF THE ART

The improvement in health conditions and the increase in life expectancy in the world have led to an aging population (Eurostat, 2020; OECD, 2021; Rudnicka et al., 2020;

Telles & Borges, 2013; WHO, 2020a). However, this global population aging has often been accompanied by functional limitations or disabilities, with progressive risk of dependence in daily life activities (Amalberti et al., 2019; ISQua, 2016; Jia et al., 2019; NICE, 2016; WHO, 2017b; WHO, 2020b). Elderly people are more vulnerable to the development of chronic and degenerative diseases, balance disorders and falls with fractures and accidental death, representing challenges in the social, economic and public health context (Agrawal et al., 2019; Jaul & Barron, 2017; Kammerlind et al., 2022; Moreland et al., 2020; NICE, 2016; Salzman, 2010). Portugal and Cape Verde are following this global trend. In fact, Portuguese population is progressively getting older, implying a significant burden of chronic diseases among the elderly and poor healthy life years (Rodrigues et al., 2014; Simões et al., 2017; WHO, 2020b). The percentage of contribution of balance disorders in this context is not known, although the studies reveal an increase in its incidence (Reis et al., 2016). In relation to Portuguese-speaking countries in Africa, Cape Verde is an example of recent aging, with demographic and epidemiological transition starting to challenge the health system (República de Cabo Verde, 2017; WHO, 2019a).

1.1.1. Aging, balance disorders and falls

Although balance disorders are one of the many factors for falling and one of the most common disabilities among the elderly, various epidemiological studies reveal different prevalence, ranging from 20% to 44% (Bittar et al., 2013; Fernández et al., 2015; Jönsson et al., 2004; Kerber et al., 2017; Lin & Bhattacharyya, 2012; Neuhauser, 2016; Tinetti et al., 2000). This could be explained due to the lack of uniformity of well-defined criteria for the diagnosis, heterogeneity of study methodology, diversity of the population under study, and variability of the time of follow-up (Bösner et al., 2018; Maarsingh et al., 2010).

The balance disorders in elderly may be associated with the age-related decline in balance function (Agrawal et al., 2019; Salzman, 2010). Medication use and various clinical disorders may also be present, including cardiovascular, metabolic, neurologic, musculoskeletal, and otologic conditions (Ciorba at al., 2017; Salzman, 2010). Poor balance is frequently associated with falling (Moreland et al., 2020; Salzman, 2010). Falls

in the elderly are often underappreciated by the elderly and their families unless they cause serious injury (Maciel, 2010). It represents an important public health problem, being the main cause of accidental death in the population over 65 years old. The risk of falling increases with age, being higher in females (Maciel, 2010; Moreland et al., 2020). Data show that 28-35% of elderly (people aged 65 +) fall, leading to 20-30% injuries. After a fall, 20% of the elderly die within a year from complications of a hip fracture (WHO, 2007).

Falls lead to deterioration in quality of life, with restriction in daily life activities, reduced mobility, social isolation, increased dependence on social services and informal caregivers, and institutionalization (EIP-AHA, 2014; Moreland et al., 2020; WHO, 2007). (Figure 1).

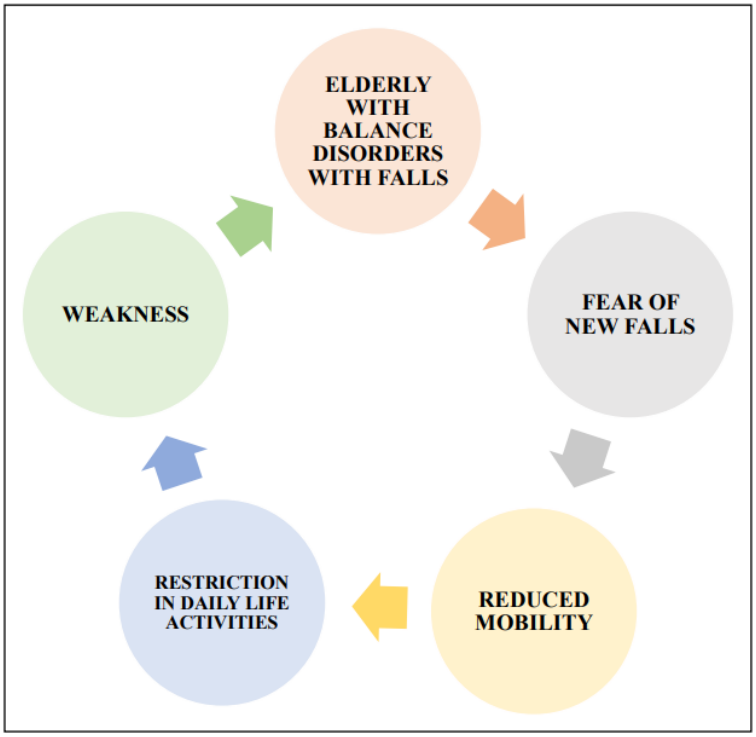


Figure 1. Falls and consequent risk of falling (Adapted from: EIP-AHA, 2014).

Over the years, balance disorders and consequent falls in elderly have progressively placed pressure on health care systems with recurrent consultations, repeated instrumental

and imaging exams, and multiple medicine use (Heinrich et al., 2010; Kerber, 2009; Kovacs et al., 2019; Maciel, 2010; Tehrani et al., 2013).

To overcome this, strategies of health policies have been recommended to achieve active and healthy aging with autonomy and independence, including person-centered model and use of Information Systems and Technologies (IST) (Amalberti et al., 2019; Blandford, 2019; Cesari et al., 2022; ISQua, 2016; Kim et al., 2017; Lapão & Dussault, 2017; Mucchi et al., 2021; Nolte et al.,2020) (Figure 2).

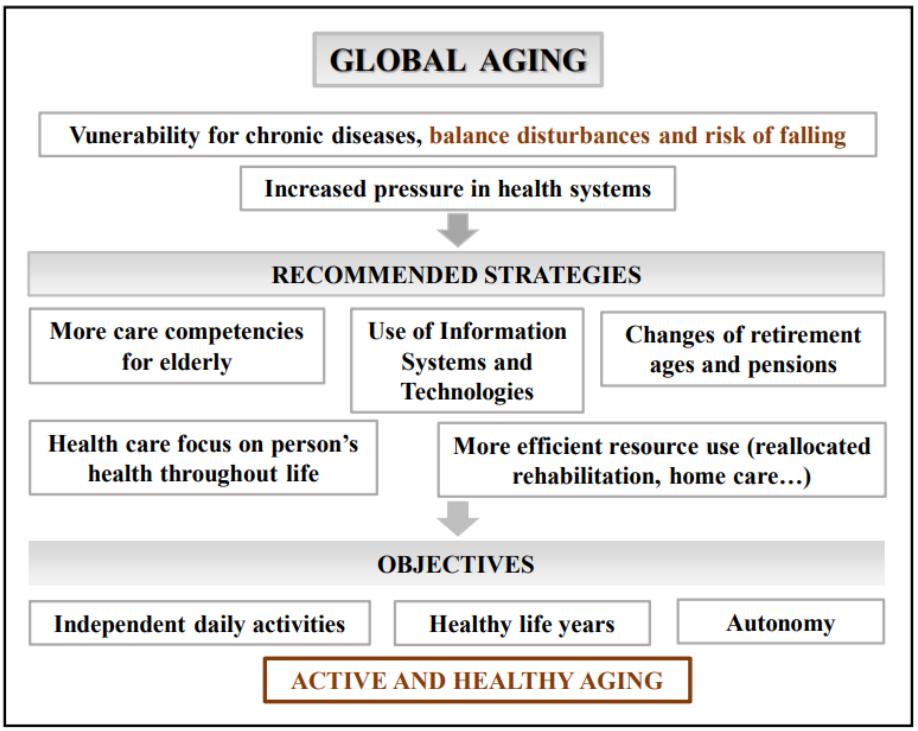


Figure 2. Strategies for a healthy aging (Adapted from: Amalberti et al., 2019)

1.1.2. Current health care model and digital health

One of the great challenges has been the implementation of effective measures with financial sustainability of the traditional model of health care delivery (Amalberti et al., 2019; Simões et al., 2017). Current healthcare systems are focused on acute disease care, unsuitable for elderly. With aging, there is a progressive need to adapt the health care model for chronic diseases and multimorbidity, motivating the active participation of the

patient or caregiver (Amalberti et al., 2019; Nolte et al., 2020; WHO, 2019b). More suitable recommendations are based on model of self-promotion of health and self-management of health and disease (Amalberti et al., 2019; Cesari et al., 2022; Nolte et al., 2020; WHO, 2019b) (Figure 3).

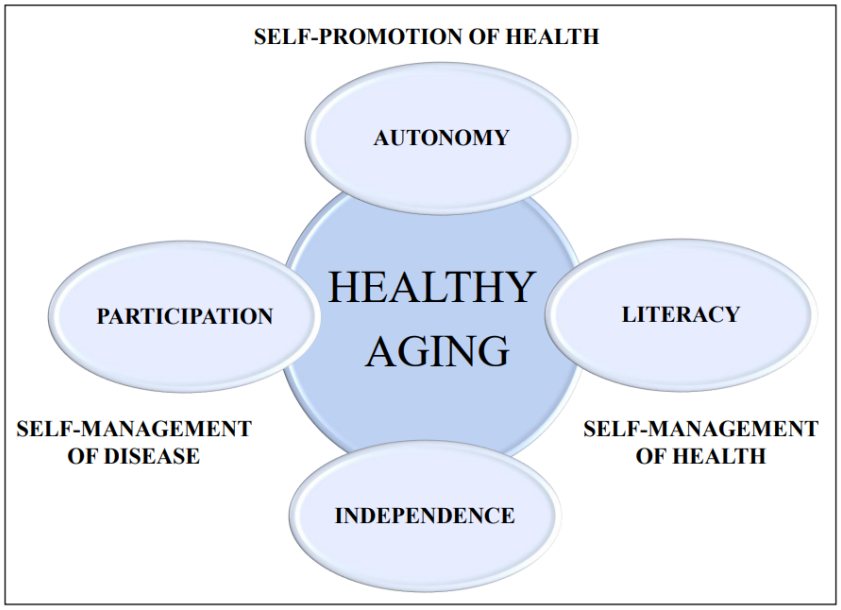


Figure 3. Suitable health care model for healthy aging (Adapted from: Cesari et al., 2022)

The elaboration, implementation and consolidation of health systems have been advocated, increasingly focused on the centrality of the citizen, with the objective of approximation, articulation and integration in health and investment in citizen literacy, including elderly (Amalberti et al., 2019; Nolte et al., 2020; WHO, 2019b).

Quality strategies in the provision of health care have been based on a greater demand for continuous professional training, quality of care and rational use of resources including the use of information systems supported by technology (Amalberti et al., 2019; Simões et al., 2017) (Figure 4).

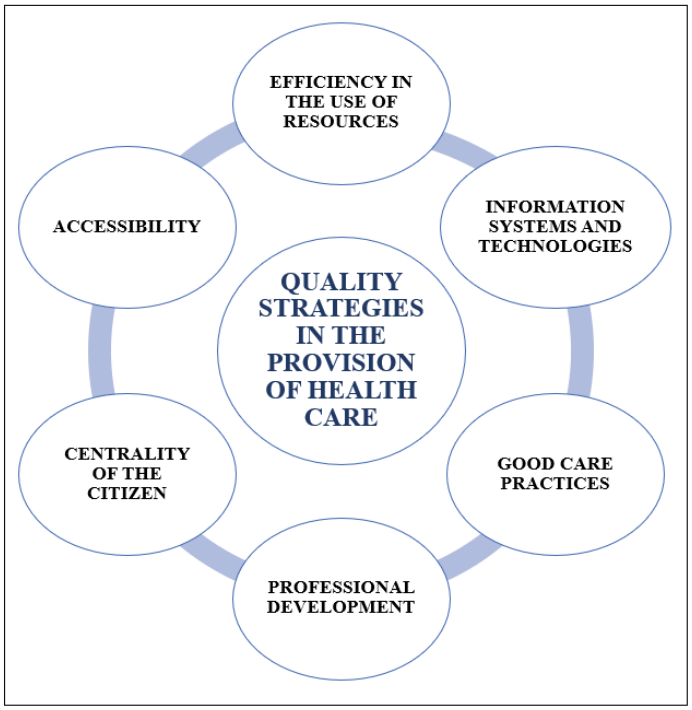


Figure 4. Quality strategies for an efficient provision of health care (Adapted from: Simões et al., 2017)

The use of IST to support a distance communication channel in the health sector has revealed the potential to improve access, reduce costs, and increase quality, promoting health and well-being (Chitungo et al., 2021; Eze et al., 2020; Hincapié et al., 2020; Lapão & Dussault, 2017). Since 2005, eHealth has been a priority strategy for the World Health Organization (WHO), promoting the access to prevention, promotion, treatment, rehabilitation and palliative care (WHO, 2005; WHO, 2016).

Many countries have progressively included digital solutions in their health policies, including the Member States of the Community of Portuguese Language Countries (Comunidade dos Países de Língua Portuguesa - CPLP) (Lapão et al., 2016). In 2017, a CPLP working group in digital health was organized for promoting and cooperation of telemedicine among these countries and creation of Portuguese digital health (CPLP, 2017a). The Strategic Plan in Health Cooperation of the Community of Portuguese-Speaking Countries 2018-2021 (Plano Estratégico de Cooperação em Saúde da CPLP-

PECS-CPLP), reinforces the importance of this cooperation between the member states, "integrating synergies in the health area" (CPLP, 2017b).

Regarding Portugal, the government has invested in digital health systems under the coordination of the Shared Services of the Ministry of Health, E.P.E., helping to mitigate inequalities of access in areas with fewer professionals in the health sector. (Portugal, Presidência do Conselho de Ministros, 2012; SPMS, 2018).

In Cape Verde, the use of eHealth services has contributed to reducing inequalities of access in the health sector, by mitigating the effect of the scarcity of qualified and qualified human resources and geography difficulties (Correia et al., 2017; Delgado et al., 2017; Latifi et al., 2014). It also has allowed remote training of health professionals, teleconsultations, international medical interaction, and strategic management of evacuations with case screening and monitoring (Azevedo et al., 2021; Beja et al., 2019; Correia et al., 2017; Lapão & Correia, 2015; Latifi et al., 2014; Maia et al., 2019).

However, this has not been enough. Satisfactory results depend not only on financial investment and the qualification of people and services, but also on the collaboration of health professionals and integration in the work organization (Lapão, 2010; Lapão & Dussault, 2017).

The digital inclusion of the elderly is possible and challenger, often requiring caregiver availability and digital training (Goldsack & Zanetti, 2020; Gordon & Crouch, 2019; Merkel & Hess, 2020; Tossaint-Schoenmakers et al., 2021). The development of user-friendly devices, adapted to the profile of the elderly, is relevant. In addition, the access of the elderly to digital devices and internet should be guaranteed (Blandford, 2019).

1.1.3. eHealth and Digital Health

In 2001, Eysenbach defined eHealth as:

> "an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." (Eysenbach, 2001, p. 1)

In February 2005, Oh et al. published their systematic review of eHealth definition and did not verified consensus about the meaning of eHealth. In May 2005, eHealth was described as "the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge and research." (WHO, 2005, p. 1)

In fact, with the progressive digital revolution in the health sector, new concepts have emerged as "… the term digital health is often used as a broad umbrella term encompassing eHealth as well as developing areas such as the use of advanced computing sciences (in the fields of big data, genomics and artificial intelligence, for example)." (WHO, 2017a, p. 1)

In 2021, WHO defined Digital Health as:

> "the field of knowledge and practice associated with the development and use of digital technologies to improve health. Digital health expands the concept of eHealth to include digital consumers, with a wider range of smart devices and connected equipment. It also encompasses other uses of digital technologies for health such as the Internet of things, artificial intelligence, big data and robotics." (WHO, 2021, p. 39)

1.1.4. Digital health care and elderly with balance disorders and risk of falling

The use of sensors has been studied to improve the data quality of tests and scales for assessment of balance and risk of falling in elderly (Bet et al., 2019; Montesinos et al., 2018). For a greater elderly adherence and motivation, balance exercises delivered through video games have been researched (Choi et al., 2017; Skjæret et al., 2016). In fact, several authors have studied the potential of digital solutions for screening, evaluation and rehabilitation of balance disorders in elderly people (Bet et al., 2019; Choi et al., 2017; Leirós-Rodríguez et al., 2019; Montesinos et al., 2018; Nguyen et al., 2018; Rucco et al., 2018; Skjæret et al., 2016; Sun & Sosnoff, 2018). However, most of the studies have included younger population as a preliminary assessment or did not describe the clinical conditions of the participants that could interfere with the outcomes (Leirós-Rodríguez et al., 2019; Nguyen et al., 2018; Rucco et al., 2018; Skjæret et al., 2016; Sun & Sosnoff, 2018). In fact, the clinical applicability of digital solutions, according to the

clinical conditions of elderly people with balance disorders and risk of falling, needed to be explored in depth.

1.2. AIM OF THESIS

The use of digital solutions has been encouraged to mitigate the aging pressure in the health system. To better understand the positive potential of digital health for a provision of care for elderly people with balance disorders and risk of falling, a conceptual model was developed (Figure 5).

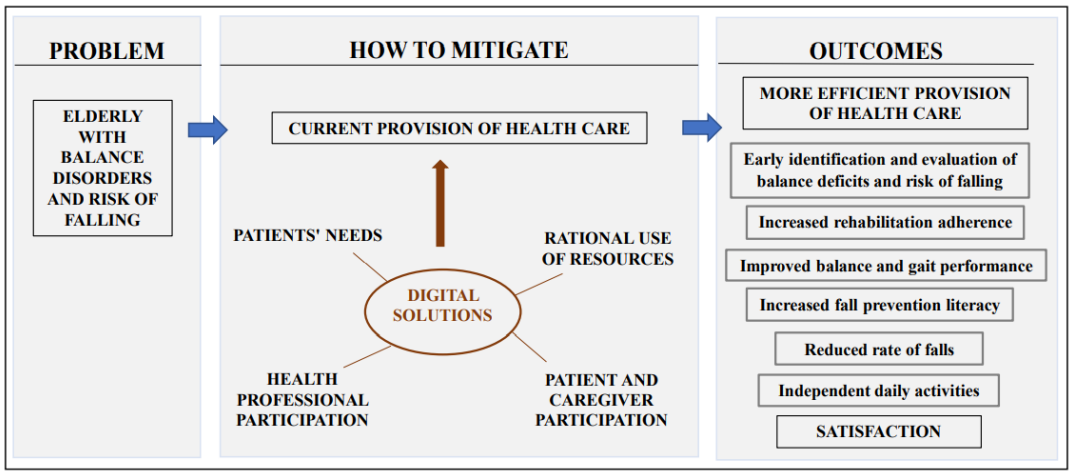


Figure 5. Conceptual model: the contribution of the use of digital solutions for elderly with balance disorders and risk of falling (Author own elaboration)

Over the years, various studies have highlighted the potential of digital devices and services to make data available, access, evaluate and treatment elderly with balance disorders and risk of falling (Bet et al., 2019; Choi et al., 2017; Leirós-Rodríguez et al., 2019; Montesinos et al., 2018; Nguyen et al., 2018; Rucco et al., 2018; Skjæret et al., 2016; Sun & Sosnoff, 2018). However, the clinical applicability needs to be further explored.

In this context, this study proposed to address several research questions: What are the medical satisfaction level and difficulties in accessing data on elderly people with balance

disorders and risk of falling in Portugal? What is the medical relevance of eHealth use in this context? How to develop an efficient digital solution for complementary provision of health care for elderly people with balance disorders and risk of falling? What is the user satisfaction with the digital solution developed for the provision of care in this context and from a global health perspective? How satisfied are the physicians with the potential of digital solution developed for the provision of care in this context and from a global health perspective? How to explore the use of this digital solution in the Cape Verdean context?

The main objective of this study was to study, develop, implement, demonstrate and evaluate a digital solution for the complementary provision of health care for elderly people with balance disorders and risk of falling in the Portuguese context, subsequently aligning its use in a global perspective, with the example of Cape Verde.

As specific objectives, it was proposed to:
-Identify and understand the medical satisfaction level and difficulties in accessing to data on health care provided to elderly people with balance disorders and risk of falling in Portugal;
-Identify and understand the medical relevance of using eHealth in this context;
-Explore how to develop an efficient digital solution for complementary provision of health care for elderly people with balance disorders and risk of falling;
-Explore user perspectives regarding the use of the digital solution developed, including benefits, restrictions, adjustment strategies, satisfaction and interest;
-Explore medical perspectives regarding the potential of the digital solution developed, including benefits, constraints, adjustment strategies, suggestions for greater clinical applicability, satisfaction and interest;
-Understand and explore the potential of using this digital solution in Cape Verde;

1.3. METHODOLOGY

Firstly, to elaborate, demonstrate and evaluate a digital solution for complementary provision of health care for elderly with balance disorders and risk of falling, a DSRM approach (Hevner et al., 2004; Peffers et al., 2007) was performed.

DSRM is methodology for conducting design science research in information systems, using criteria rigor (Hevner et al., 2004; Peffers et al., 2007). As Hevner et al. (2004) mentioned: “The result of design-science research in Information Systems is, by definition, a purposeful information technology artifact created to address an important organizational problem”. This methodology includes six steps, illustrated in Table 1.

Table 1. DSRM activities (Source: Peffers et al., 2007)

ACTIVITIES	OBJECTIVE	DEFINITION
1	Identification of the problem and motivation	Knowledge of the specific research problem and justification of the relevance of a solution
2	Definition of objectives for a solution	Identification and exploration of strategies for a suitable solution
3	Design and development of a solution	Creation of the artefact
4	Demonstration of the solution	Use of the artifact to solve the problem
5	Evaluation of the solution to solve the problem	Observation and measurement of the results of the demonstration. The researcher can go back to activity 3 for improvement of the effectiveness of the artifact or can go to activity 6 for communication of the results and improvement of the artifact in subsequent projects
6	Communication	Communication of: the problem and relevance; elaboration of the artifact; utility and effectiveness of the artifact

Information systems involve people, technological resources, and work systems. All of these factors should be considered for positive outcomes of a digital artefact (Lapão & Dussault, 2017). Considering the users' suggestions and recommendations, the development of a digital solution is potentially closer to the real needs in the field.

Secondly, regarding the recent aging population (República de Cabo Verde, 2017; WHO, 2019a) and positive telemedicine outcomes of Cape Verde (Azevedo et al., 2021; Beja et al., 2019; Correia et al., 2017; Delgado et al., 2017; Lapão & Correia, 2015; Latifi et al., 2014; Maia et al., 2019), this country was considered in this thesis as an eligible country to align with by the use of the digital solution for the complementary provision of health care for elderly people with balance disorders and risk of falling.

To understand and explore the potential use of this digital solution in Cape Verdean context, a Policy Dialogue Workshop (PDW) was conducted. The policy dialogue (PD) process can be described as "part and parcel of the policy and decision-making processes, intended to contribute to developing or implementing a policy change following a round of evidence-based discussions/workshops/consultations on a particular subject" (Rajan et al., 2015, p. 3). PD process allows span "policy-making, implementation, review and monitoring, and subsequent policy revisions" (Nabyonga-Orem et al., 2016, p. 1). However, the engagement of motivated stakeholders and knowledge of national health policies and strategic plans are critical factors for successful implementation results (Nabyonga-Orem et al., 2016).

1.4. SUMMARY OF STUDY DESIGNS

Detailed explanations of each activity are part of the articles presented in the "Results" section. However, a short summary of the methods follows.

1.4.1. Portuguese activities

Using the DSRM as a research methodology, the study was divided into six tasks carried out in Portugal (Figure 6), with later exploration in the Cape Verdean context. Each activity will be presented in the section "Results" of this thesis.

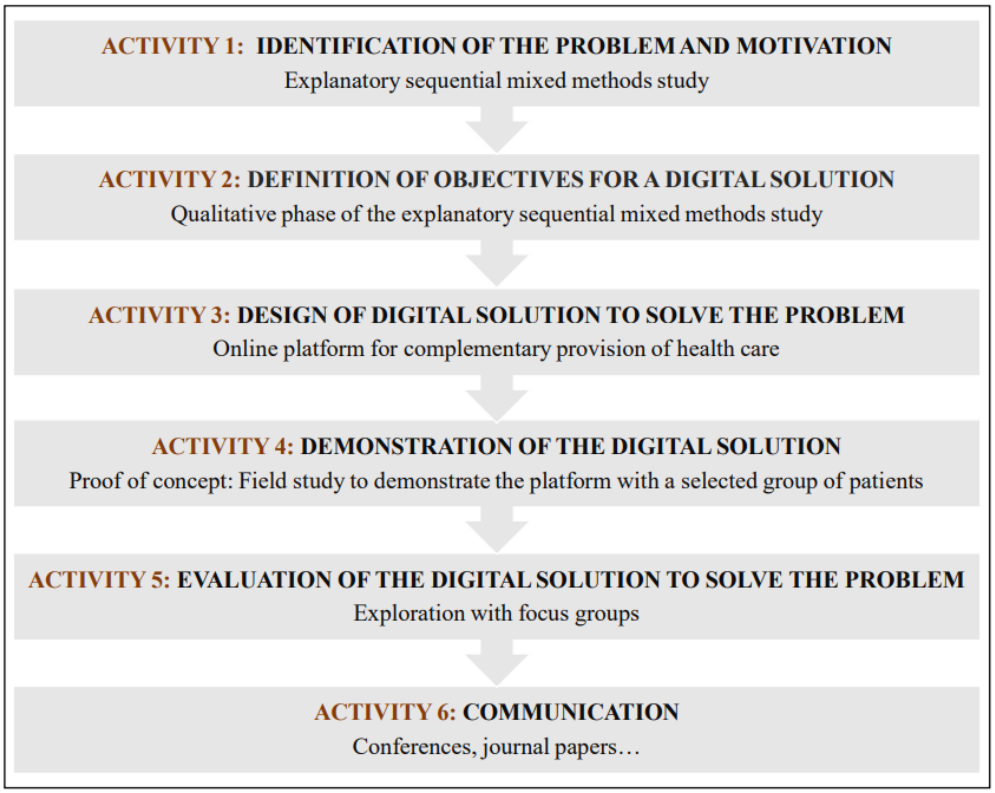


Figure 6. DSRM: Summary of the developed activities (Author own elaboration)

Activity 1: Identification of the problem

An explanatory sequential mixed methods study was performed, involving two-phase data collection. Quantitative data were initially collected and analysed, allowing planning the next qualitative phase (Creswell & Creswell, 2018).

Firstly, it was developed an open questionnaire, entitled "Health contribution to the provision of health care for the elderly at risk of falling due to balance disorders" (in the original: "*A contribuição do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio*") with 18 multiple choice questions for the identification of: a) Portuguese medical difficulties and satisfaction about clinical data in the electronic medical record (EMR) relatively to the context of healthcare provision for elderly with balance disorders and risk of falling; b) medical relevance of eHealth services in this context. The questions are presented in Appendix 4.1. From June to August 2019, the access link of the questionnaire was available through the website of the General Medical Council of Portugal. The contribution of this Entity and an illustration of the questionnaire page are presented in Appendices 4.2 and 4.3. The

questionnaire was distributed online using the survey software SurveyMonkey®. The eligible participants were specialist physicians with healthcare provision in Portugal for elderly with balance disorders and risk of falling, including family physicians, internal medicine physicians, physical medicine and rehabilitation (PMR) physicians, neurologists, otolaryngologists and physicians with competence in Geriatrics. A descriptive and exploratory statistics of the data from the questionnaires were performed (Creswell & Creswell, 2018). The software IBM SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA) was used.

Secondly, from December 2019 to April 2020, the same interviewer conducted individual semi-structured interviews, allowing to understand the results of the quantitative research. The sampling was intentional (Creswell & Creswell, 2018), including physicians with healthcare provision for elderly with balance disorders and risk of falling, coordination function in health units, and easy access by the interviewer. The participant number was defined after saturation of responses (Creswell & Creswell, 2018). A descriptive analysis of demographic data of interviewed was performed. All the interviews were manually coded and transcribed by the interviewer, allowing content analysis of interviews (Creswell & Creswell, 2018).

Activity 2: Definition of objectives for a solution

The qualitative phase of this mixed methods study (Creswell & Creswell, 2018) allowed to explore, in depth: a) how to overcome the medical difficulties about clinical data in EMR in the context of healthcare provision for elderly with balance disorders and risk of falling; (b) how to develop an efficient eHealth service to support health care in this context. The suggested strategies helped to design and develop the artefact, including audio-visual technology, and clinical and interactive data. The interview guide is presented in Paper II.

Activity 3: Design and development of the digital solution

From August to September 2020, a digital service called “BALANCE” was designed and developed to be added to the digital platform called Multimorbidity Management Health Information System (METHIS), previously tested for remote monitoring of primary

health care for patients with chronic diseases and COVID-19 infection in quarantine (Lapão et al., 2021). Eight tutorial videos were recorded and uploaded to the YouTube® platform as unlisted with restricted access, and their links were integrated to "BALANCE". Finally, until July 2021, the "BALANCE" digital service was adjusted to requirements. The draft of the design of the digital service is presented in Appendix 4.4. The research team comprised one Otolaryngologist and PhD student, two experts in digital platforms, and one professor of health information systems.

Activity 4: Demonstration of the digital solution

From August to November 2021, a proof-of-concept was performed to test the digital service "BALANCE". The proof-of-concept approach is an early intervention to demonstrate artefacts with few participants, as initial adjustments may still be required (Blokdyk, 2021).

The eligible participants were elderly patients (age of 65 years or older) with a regular balance follow-up at Hospital Beatriz Ângelo (HBA), Lisbon, Portugal. All of them had complaints of clinically decompensated balance disorder with risk of falling, confirmed with objective clinical examination findings, and instrumental exams performed for the evaluation of inner ear function. They had already completed a rehabilitation program at HBA, allowing the assessment of the patient's ability to walk without support and to perform balance rehabilitation at home. The exclusion criteria were: previous diagnosis of neurological disease, ophthalmologic pathology with severe visual acuity that does not allow to see the computer screen, clinical condition that did not allow the regular performance of physical exercises, such as decompensated cardiovascular pathology or acute infection, cognitive alteration according to the operational "cut" values for the Portuguese population of Mini-Mental State Examination (MMSE) (less than 22 points for 0 to 2 years of education, less than 24 points for 3 to 6 years of education and less than 27 points for participants with education equal to or greater than 7 years (Morgado et al., 2009), insufficient comprehensive to understand the study and limited access to the internet and computer, tablet or mobile phone. The caregivers also tested the digital service.

The protocol of the proof-of-concept is available in Appendix 4.5.

Activity 5: Evaluation of the digital solution to solve the problem

To evaluate the digital solution, two focus groups (Creswell & Creswell, 2018) were conducted, using the Zoom platform to support the meeting, due to the SARS-CoV-2 pandemic limitations.

The first focus group was conducted on 28 November 2021, including the elderly of the field study and their caregivers. Five primary thematic categories were discussed: benefits and constraints of the "BALANCE" digital service, satisfaction, strategies recommended to improve the service and interest in continuing to use the digital service.

On 5 December 2021, the same researcher conducted the second focus group, including physicians. The sample was intentional (Creswell & Creswell, 2018), including experts with healthcare provision for elderly with balance disorders and risk of falling, coordination function in public health units, and easy access by the interviewer. Six thematic categories were discussed: benefits and constraints of "BALANCE" digital service, satisfaction, recommended adjustments for this digital service, proper clinical applicability and interest in "BALANCE" digital service.

The interview guides of both focus groups are presented in Paper III.

A descriptive analysis of demographic data of the participants was performed. The focus groups were manually coded and transcribed, allowing content analysis of the data (Creswell & Creswell, 2018).

Activity 6: Communication

The communication related to the project and results of the activities were performed throughout the duration of the research and consisted in oral communications, poster presentations, papers published in conference proceedings, and three articles published in peer reviewed journals (Table 2).

Table 2. Oral and Poster communications related to the project and DSRM activities

FOCUS	TITLE	CONGRESS	PRESENTATION	PUBLISHED PAPER
Systematic review	A contribuição do eHealth nos cuidados de saúde dos idosos com risco de queda por distúrbios do equilíbrio	IX Jornadas Científicas do IHMT/UNL. Lisbon, 12 December 2018	Poster	I
	Inovação na prestação de cuidados ao idoso: a contribuição do eHealth nos cuidados de saúde dos idosos com risco de queda por distúrbios do equilíbrio	5º Congresso Nacional de Medicina Tropical. Lisbon, 10-12 April 2019	Poster	
	The contribution of eHealth to improve fall and balance disorder care in the elderly	12th European Public Health Conference. Marseille, 20-23 November 2019	Oral	
Mixed methods study	Pertinência e constrangimentos do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio (This work only included the quantitative phase of the mixed methods study)	X Jornadas Científicas do IHMT/UNL. Lisbon, 12 December 2019	Poster	II
	Como usar a eHealth para melhorar a prestação de cuidados médicos a idosos com distúrbios do equilíbrio?	XI Jornadas Científicas do IHMT/UNL. Virtual edition, 10 December 2020	Poster with flash oral presentation	
	eHealth for elderly people with balance disorders and risk of falling. A mixed methods study	14th European Public Health Conference 2021 in Virtual edition – 10-12 November 2021	Poster	
	A contribuição da MGF na elaboração e avaliação da solução digital "EQUILÍBRIO" para a prestação complementar de cuidados de saúde a idosos com distúrbios do equilíbrio e risco de queda	Update em Medicina. Virtual edition, 4-8 May 2022	Oral	
Presentation of the digital solution	Digital Monitoring Service for Elderly People with Balance Disorders: Design Science Approach	CBIS-CBTMS 2021 – XVIII Congresso Brasileiro de Informática em Saúde / 10º Congresso Brasileiro de Telemedicina e Telessaúde/ Fórum RNP 2021 – Virtual edition, 22-26 November 2021	Oral	III
	Solução digital para a prestação complementar de cuidados de saúde a idosos com distúrbios do equilíbrio e risco de queda: Design Science Research Methodology	XII Jornadas Científicas do IHMT/UNL. Virtual edition, 10 December 2021	Poster	
	Solução digital na prestação complementar de cuidados de saúde a idosos com distúrbio do equilíbrio	12º Congresso Paulista de Geriatria e Gerontologia - GERP 2022. Virtual edition, 5-9 April 2022	Poster with available video	
	"EQUILÍBRIO": uma oportunidade para monitorização complementar dos distúrbios do equilíbrio	69º Congresso Nacional da Sociedade Portuguesa de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço (SPORL-CC). Porto, 6-8 May 2022	Oral	

Proof-of-concept	"Equilíbrio": uma solução digital na prestação complementar de cuidados de saúde a idosos	12º Congresso Paulista de Geriatria e Gerontologia - GERP 2022. Virtual edition, 5-9 April 2022	Poster presentation with available video	III
Evaluation of digital solution	Avaliação do serviço digital "EQUILÍBRIO" para prestação complementar de cuidados de saúde a idosos	69º Congresso Nacional da Sociedade Portuguesa de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço (SPORL-CC). Porto, 6-8 May 2022	Oral	III
Global digital health and digital solution for elderly with balance disorders	Saúde Global Digital e Equilíbrio do Idoso	INI de Portas Abertas - Fundação Oswaldo Cruz (Fiocruz). Virtual edition, 24 March 2022	Oral	III

1.4.2. Cape Verdean activity

Due to the SARS-CoV-2 pandemic, the activity related to Cape Verde was remotely performed. In February 2022, a PDW, entitled Telemedicine and Otorhinolaryngology in Cape Verde and in a global perspective (in the original: "*Telemedicina e Otorrinolaringologia em Cabo Verde e numa perspectiva global*") was carried out via Zoom, involving health professionals, telemedicine specialists from the IHMT/UNL and the Direction of the Hospital Central Doutor Agostinho Neto (HCDAN), a public hospital in Cape Verde. The Council of this Hospital disclosed, via email, the event with the access link to its professionals. The eligible participants were specialist physicians with healthcare provision in Cape Verde for elderly with balance disorders and risk of falling, including family physicians, internal medicine physicians, neurologists, and otolaryngologists. A descriptive analysis of demographic data of the participants was performed (Creswell & Creswell, 2018). The PDW was manually transcribed, allowing content analysis of the data (Creswell & Creswell, 2018). This activity allowed to: 1) understand the potential of using the digital service "BALANCE" in Cape Verdean context; 2) explore the clinical applicability of the digital service "BALANCE" to complement health care for elderly with balance disorders and risk of falling. The article related to this activity (Paper IV) was published in a peer reviewed journal.

1.5. ETHICAL CONSIDERATIONS

The research was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Scientific Council and the Ethic Council of IHMT/UNL, Portugal and the Health Ethics Committee of HBA (Appendix 4.6).

The participants of all activities voluntarily collaborated and they were informed about: the study designation, responsible researcher and contact, objective and procedure of the study, voluntary participation, absence of risks, benefits, confidentiality and anonymity of the participant, and absence of economic compensation.

Informed consents were obtained from all subjects involved in the following activities: qualitative phase of the mixed methods study, proof-of-concept, and focus group study with patients and caregivers. The patients and caregivers also signed a document pledging not to share or publicize the videos, nor to record the videos available in the digital service. The participants received a copy of these documents. Blank informed consents are presented in Appendix 4.7.

At any time, the patients could withdraw from using the digital service. Regardless of their participation in the study, all of them were followed up with on the face-to-face consultation at HBA.

Regarding the questionnaire, interviews, and focus groups, the participants could leave the study until the submission of the online questionnaire and until one month after the date of the interview or Zoom meeting date.

The audio recording was authorized by all participants. In both focus groups, all the subjects received an automatic message authorizing the meeting's recording, from the Zoom service, after accessing the link to the meeting. The researcher asked participants to turn off the camera during the recording of the Zoom meeting, collecting only the audio. Regarding the PDW with Cape Verdean participation, a recording signal was available on the platform throughout the event.

The information of the Portuguese activities was treated confidentially. The data of the quantitative study was treated anonymously by using anonymous responses features of the software SurveyMonkey®. To guarantee confidentiality, all interviews were manually coded and transcribed by the interviewer for content analysis, omitting

information to avoid identifying respondents. All data were kept anonymous (Creswell & Creswell, 2018).

The information from the questionnaires, interviews, focus group, PDW and the audio records were kept in a safe place (external disk with access code) within the period provided by the Portuguese law (Portugal, Assembleia da República, 2019) and General Data Protection Regulation (GDPR, 2018), safeguarding the confidentiality of the information obtained.

1.6. REFERENCES

Agrawal Y, Van de Berg R, Wuyts F, Walther L, Magnusson M, Oh E, Sharpe M & Strupp M 2019, ´Presbyvestibulopathy: Diagnostic Criteria Consensus document of the classification committee of the Bárány Society´, *J. Vestib. Res.*, July, vol.29, no 4, pp. 161–170.

Amalberti R, Vincent C, Nicklin W & Braithwaite J 2019, ´Coping with more people with more illness. Part 1: The nature of the challenge and the implications for safety and quality´, *Int. J. Qual. Health Care*, March, vol.31, no 2, pp. 154–158.

Azevedo V, Latifi R, Parsikia A, Latifi F & Azevedo A 2021, ´Cabo Verde Telemedicine Program: An Update Report and Analysis of 2,442 Teleconsultations´, *Telemed. J. E. Health*, Feb, vol.27, no 2, pp.172-177.

Beja A, Correia A, Gonçalves BS, Cardoso P & Lapão LV 2019, ´Tendências e contextos de implementação de tecnologias de informação e comunicação para o reforço dos Sistemas de saúde em países de baixo e médio rendimento da CPLP: os casos de Cabo Verde, Moçambique e Guiné-Bissau´, *An. Inst. Hig. Med. Trop.*, Dec, vol.18, pp. 52-57.

Bet P, Castro PC & Ponti MA 2019, ´Fall detection and fall risk assessment in older person using wearable sensors: A systematic review´, *Int. J. Med. Inform.*, Oct, vol.130:103946, viewed 12 Feb 2020, < https://pubmed.ncbi.nlm.nih.gov/31450081/>

Bittar RS, Oiticica J, Bottino MA, Ganança FF & Dimitrov R 2013, ´Population epidemiological study on the prevalence of dizziness in the city of São Paulo´, *Braz. J. Otorhinolaryngol.*, Nov-Dec, vol.79, no 6, pp. 688-698.

Blandford A 2019, ´HCI for health and wellbeing: Challenges and opportunities´, *Int. J. Hum. Comput. Stud.*, Nov, vol.131, pp. 41–51.

Blokdyk G. Proof of Concept Poc. A Complete Guide-2020. Australia: 5STARCooks, 2021.

Bösner S, Schwarm S, Grevenrath P, Schmidt L, Hörner K, Beidatsch D, Bergmann M, Viniol A, Becker A & Haasenritter J 2018, ´Prevalence, aetiologies and prognosis of the symptom dizziness in primary care - a systematic review´, *BMC Fam. Pract.*, Feb, 19:33, viewed 12 Oct 2018, <https://doi.org/10.1186/s12875-017-0695-0>

Cesari M, Sumi Y, Han ZA, Perracini M, Jang H, Briggs A, Amuthavalli Thiyagarajan J, Sadana R & Banerjee A 2022, ´Implementing care for healthy ageing´, *BMJ Global Health,* Feb, 7(2):e0077787, viewed 10 Jul 2022, <https://gh.bmj.com/content/bmjgh/7/2/e007778.full.pdf>

Chitungo I, Mhango M, Mbunge E, Dzobo M, Musuka G & Dzinamarira T 2021, ´Utility of telemedicine in sub-Saharan Africa during the COVID-19 pandemic. A rapid review´, *Hum. Behav. Emerg. Technol.*, Dec, vol.3, no. 5, pp. 843-853.

Choi SD, Guo L, Kang D & Xiong S, 2017, ´Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review´, *Appl. Ergon.*, Nov, vol.65, pp. 570–581.

Ciorba, A, Bianchini, C, Scanelli, G, Pala M, Zurlo A & Aimoni C 2017, ´The impact of dizziness on quality-of-life in the elderly´, *Eur. Arch. Otorhinolaryngol.*, vol.274, pp. 1245–1250.

Correia A, Azevedo V & Lapão LV 2017, ´Implementation of Telemedicine in Cape Verde: Influencing Factors´, *Acta Med. Port.*, vol.30, no 4, pp. 255-262.

CPLP 2017a, *Plano Estratégico de Cooperação em Saúde da CPLP (PECS-CPLP) 2018-2021. Eixos Estratégicos, Áreas e Projetos.* CPLP, Brasília.

CPLP 2017b, *Resolução sobre o estabelecimento do Grupo de Trabalho permanente da CPLP em Telemedicina e Telessaúde.* CPLP, Brasília.

Creswell, JW & Creswell, JD. Research design. Qualitative, Quantitative, and Mixed Methods Approaches. Los Angeles: SAGE Publications, 2018.

Delgado AP, Tolentino AC & Ferrinho P 2017, ´The evolution of the medical workforce in Cape Verde since independence in 1975´, *Hum. Resour. Health*, Jan, 15(1):5, viewed 12 Oct 2018, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5242051/>

EIP-AHA 2014, *Action Groups. Achievements*. European Commission, European Union.

Eurostat 2020, *Ageing Europe - Looking at the lives of older people in the EU – 2020 Edition*. European Commission, Luxembourg.

Eysenbach G 2001, ´What is e-health?´, *J. Med. Internet Res.,* Apr-Jun, 3(2):E20, viewed 10 Jan 2019, <https://www.jmir.org/2001/2/e20/>

Eze ND, Mateus C & Hashiguchi TCO 2020, ´Telemedicine in the OECD: An umbrella review of clinical and cost-effectiveness, patient experience and implementation´, *PLoS One*, Aug, vol.15, no 8:e0237585, viewed 10 Jan 2021, <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0237585>

Fernández L, Breinbauer HA & Delano PH 2015, ´Vertigo and dizziness in the elderly´, *Front. Neurol.,* Jun, vol.6:144, viewed 10 Sep 2018, <https://doi.org/10.3389/fneur.2015.00144>

GDPR 2018, Art. 12 GDPR – Transparent Information, Communication and Modalities for the Exercise of the Rights of the Data Subject - GDPR, viewed 22 Feb 2021, <Gdpr-info.eu>

Goldsack JC & Zanetti CA 2020, ´Defining and Developing the Workforce Needed for Success in the Digital Era of Medicine´, *Digit. Biomark.* Nov, vol.4, no 1, suppl 1, pp. 136–142, viewed 10 Jan 2021, <https://doi.org/10.1159/000512382>

Gordon NP & Crouch E 2019, ´Digital information technology use and patient preferences for internet-based health education modalities: cross-sectional survey study of middle-aged and older adults with chronic health conditions´, *JMIR Aging,* Apr, vol.2(1):e12243, viewed 10 Jan 2020, <https://aging.jmir.org/2019/1/e12243/>

Heinrich S, Rapp K, Rissmann U, Becker C & König HH 2010, ´Cost of falls in old age: a systematic review´, *Osteoporos. Int.*, Jun, vol.21, no 6, pp. 891-902.

Hevner, AR von, March, S, Park, J & Ram, S 2004, ´Design science in information systems research´, *MIS Quartely*, March, vol.28, no 1, pp. 75-105.

Hincapié MA, Gallego JC, Gempeler A, Piñeros JA, Nasner D & Escobar MF 2020, ´Implementation and Usefulness of Telemedicine During the COVID-19 Pandemic: A Scoping Review´, *J. Prim. Care Community Health*, Jan-Dec, 11:2150132720980612, viewed 20 Jan 2022, <https://pubmed.ncbi.nlm.nih.gov/33300414/>.

IBM. SPSS Statistics, homepage, IBM, NY, viewed 12 Sep 2019, <https://www.ibm.com/products/spss-statistics/details>

ISQua 2016, *Health Systems and Their Sustainability: Dealing with the Impending Pressures of Ageing, Chronic and Complex Conditions, Technology and Resource Constraints.* ISQua, Dublin.

Jaul E & Barron J 2017, ´Age-Related Diseases and Clinical and Public Health Implications for the 85 Years Old and Over Population´, *Front. Public Health,* Dec, 5:335, viewed 15 Jan 2022, <https://doi.org/10.3389/fpubh.2017.00335>

Jia H, Lubetkin EI, DeMichele K, Stark DS, Zack MM & Thompson WW 2019, ´Prevalence, risk factors, and burden of disease for falls and balance or walking problems among older adults in the U.S.´, *Prev. Med.*, Sep, 126:105737, viewed 15 Jan 2020, <https://pubmed.ncbi.nlm.nih.gov/31150739/>

Jönsson R, Sixt E, Landahl S & Rosenhall U 2004, ´Prevalence of dizziness and vertigo in an urban elderly population´, *J. Vestib. Res.*, vol.14, no 1, pp. 47-52.

Kammerlind AS, Peolsson A & Johansson MM 2022, ´Dizziness in older persons at high risk of future hospitalization: prevalence, differences between those with and without dizziness, and effect of a proactive primary care intervention´, *BMC Geriatr.,* Apr, vol.22, 315, viewed 7 Jul 2022, <https://doi.org/10.1186/s12877-022-02910-1>

Kerber KA 2009, ´Vertigo and Dizziness in the Emergency Department´, *Emerg. Med. Clin. North. Am*., Feb, vol.27, no 1, pp. 39–50, viii, viewed 10 Dec 2018, <https://pubmed.ncbi.nlm.nih.gov/19218018/>

Kerber KA, Callaghan BC, Telian SA, Meurer WJ, Skolarus LE, Carender W & Burke JF 2017, ´Dizziness Symptom Type Prevalence and Overlap: A US Nationally Representative Survey´, *Am. J. Med.*, Dec, 130(12):1465;e1-1465;e9, viewed 5 March 2019, <https://doi.org/10.1016/j.amjmed.2017.05.048>

Kim K, Gollamudi SS & Steinhubl S 2017, ´Digital technology to enable aging in place´, *Exp. Gerontol.*, Feb, vol.88, pp. 25–31.

Kovacs E, Wang X & Grill E 2019, ´Economic burden of vertigo: a systematic review´, *Health Econ. Rev.*, Dec, 9(1):37, viewed 7 Feb 2020, <http://europepmc.org/abstract/MED/31883042>

Lapão LV 2010, ´O papel crítico dos sistemas de informação na saúde. Considerações no âmbito do Plano Nacional de Saúde 2011-2016´, viewed 8 April 2018, <http://pns.dgs.pt/files/2010/09/lvl.pdf>

Lapão LV & Correia A 2015, ´Improving Access to Pediatric Cardiology in Cape Verde through a Collaborative International Telemedicine service´, *Global Telehealth Studies in Health Technology and Informatics*, vol.209, pp. 51-57.

Lapão LV, Messina LA, Ungerer R & Campos F 2016, ´Roteiro estratégico para a telesaúde na CPLP: diagnóstico e prioridades para o desenvolvimento da telesaúde´, *An. Inst. Hig. Med. Trop., v*ol.15 supl 1, pp. s65-s73, viewed 2 April 2018, <https://doi.org/10.25761/anaisihmt.108>

Lapão LV & Dussault G 2017, ´The contribution of eHealth and mHealth to improving the performance of the health workforce: A review´, *Public Health Panor.*, Sep, vol.3, pp. 463–471.

Lapão, LV, Peyroteo M, Maia, M, Seixas J, Gregório J, Mira da Silva M, Heleno B & Correia JC 2021, ´Implementation of Digital Monitoring Services During the COVID-19 Pandemic for Patients with Chronic Diseases: Design Science Approach´, *J. Med. Internet Res.*, Aug, vol.23, no 8, e24181, viewed 10 Sep 2021, <https://doi.org/10.2196/24181>

Latifi R, Dasho E, Merrell RC, Lopes M, Azevedo V, Bekteshi F, Osmani KL, Qesteri O, Kucani J & Lecaj I 2014, ´Cabo Verde telemedicine program: initial results of nationwide implementation´, *Telemed. J. E. Health*, Nov, vol.20, no 11, pp.1027-1034.

Leirós-Rodríguez R, García-Soidán JL & Romo-Pérez V 2019, ´Analyzing the use of accelerometers as a method of early diagnosis of alterations in balance in elderly people: a systematic review´, *Sensors (Basel)*, Sep, vol.19, no 18:3883, viewed 1 Dec 2019, <https://www.mdpi.com/resolver?pii=s19183883>

Lin HW & Bhattacharyya N 2012, ´Balance disorders in the elderly: epidemiology and functional impact´, *Laryngoscope*, Aug, vol.122, no 8, pp.1858-1861.

Maarsingh OR, Dros J, Schellevis FG, van Weert HC, Bindels PJ & Horst HE 2010, ´Dizziness reported by elderly patients in family practice: prevalence, incidence, and clinical characteristics´, *BMC Fam. Pract.* Jan, 11:2, viewed 15 Sep 2020, <https://pubmed.ncbi.nlm.nih.gov/20064231/>

Maciel A 2010, ´Quedas em idosos: um problema de saúde pública desconhecido pela comunidade e negligenciado por muitos profissionais da saúde e por autoridades sanitárias brasileiras´, *Rev. Med. Minas Gerais*, vol.20, no 4, pp. 554-557.

Maia MR, Castela E, Pires A & Lapão LV 2019, ´How to develop a sustainable telemedicine service? A Pediatric Telecardiology Service 20 years on - an exploratory study´, *BMC Health Serv. Res.*, Sep, 19(1):681, viewed 15 Feb 2020, <https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4511-5>

Merkel S & Hess M 2020, ´The use of internet-based health and care services by elderly people in Europe and the importance of the country context: multilevel study´, *JMIR Aging.* Jun;3(1):e15491, viewed 15 Oct 2020, <https://aging.jmir.org/2020/1/e15491/>

Montesinos L, Castaldo R & Pecchia L 2018, ´Wearable inertial sensors for fall risk assessment and prediction in older adults: a systematic review and meta-analysis´, *IEEE Trans. Neural. Syst. Rehabil. Eng.*, March, vol.26, no 3, pp. 573–582.

Moreland B, Kakara R & Henry A 2020, ´Trends in Nonfatal Falls and Fall-Related Injuries Among Adults Aged ≥65 Years - United States, 2012–2018´, *Morb. Mortal. Wkly. Rep.*, Jul, vol.69, no 27, pp. 875–881.

Morgado J, Rocha CS, Maruta, C, Guerreiro, M & Martins, IP 2009, ´Novos valores normativos do Mini-Mental State Examination´, *Sinapse*, Nov, vol.9, no 2, pp. 10–16.

Mucchi L, Jayousi S, Gant A, Paoletti E & Zoppi P 2021, ´Tele-Monitoring System for Chronic Diseases Management: Requirements and Architecture´, *Int. J. Environ. Res. Public Health*, Jul, 18(14):7459, viewed 15 Oct 2021, <https://pubmed.ncbi.nlm.nih.gov/34299910/>

Nabyonga-Orem J, Dovlo D, Kwamie A, Nadege A, Guangya W & Kirigia JM 2016, ´Policy dialogue to improve health outcomes in low income countries: what are the issues and way forward?' *BMC Health Serv. Res.*, Jul, vol.16, suppl 4:217, viewed 10 Sep 2022, <https://bmchealthservres.biomedcentral.com/counter/pdf/10.1186/s12913-016-1450-2.p>

Neuhauser HK 2016, 'The epidemiology of dizziness and vertigo', *Handb. Clin. Neurol.*, vol.137, pp. 67-82.

NICE 2016, *Multimorbility: Clinical Assessment and Management*. NICE, U.K.

Nguyen H, Mirza F, Naeem MA & Baig MM 2018, ´Falls management framework for supporting an independent lifestyle for older adults: a systematic review´, *Aging Clin. Exp. Res.*, Nov, vol.30, no 11, pp. 1275–1286.

Nolte E, Merkur S & Anell A. Achieving Person-Centred Health Systems. Cambridge: University Press, 2020.

OECD 2021, *Health at a Glance 2021: OECD Indicators*. OECD, Paris.

Oh H, Rizo C, Enkin M & Jadad A 2005, ´What is eHealth (3): a systematic review of published definitions´, *J. Med. Internet. Res.*, Feb, 7(1):e1, viewed 15 Oct 2018, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550636/>

Peffers K, Tuunanen T, Rothenberger, MA & Chatterjee, S 2007, ´A design science research methodology for information systems research´, *J. Manag. Inf. Syst.*, vol.24, no 3, pp. 45–77.

Portugal, Assembleia da República. ´Lei nº 58/2019 de 8 de agosto de 2019´. *Diário da República n.º 151/2019, Série I de 2019-08-08*, pp. 3–40.

Portugal, Presidência do Conselho de Ministros, ´Resolução do Conselho de Ministros n.º 12/2012´, *Diário da República n.º 27/2012, Série I de 2012-02-07*, pp. 596 – 605.

Rajan D, Adam T, El Husseiny D, Porignon D, Ghaffar A & Schmets G 2015, *Policy dialogue: what it is and how it can contribute to evidence-informed decision-making. Briefing note*, WHO, Geneva.

Reis LR, Lameiras R, Cavilhas P & Escada P 2016, ´Epidemiologia da Vertigem na Urgência Hospitalar´, *Acta Med. Port.*, May, vol.29, no 5, pp. 326-331.

República de Cabo Verde - Ministério da Saúde e da Segurança Social – Direção Nacional da Saúde 2017, *Plano Estratégico Nacional para o Envelhecimento Ativo e Saúde do Idoso (PENEASI) Horizonte 2017-2021*.

Rodrigues TF, Martins MRO & outros. Envelhecimento e Saúde. Prioridades Políticas num Portugal em Mudança. Portugal: Instituto Hidrográfico, 2014.

Rucco R, Sorriso A, Liparoti M, Ferraioli G, Sorrentino P, Ambrosanio M & Baselice F 2018, ´Type and location of wearable sensors for monitoring falls during static and dynamic tasks in healthy elderly: a review´, *Sensors (Basel)*, May;18(5):1613, viewed 10 Dec 2018, <https://www.mdpi.com/resolver?pii=s18051613>

Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R & Grymowicz M 2020, ´The World Health Organization (WHO) approach to healthy ageing´, *Maturitas*, Sep, 139:6–11, viewed 10 Dec 2020, <https://pubmed.ncbi.nlm.nih.gov/32747042/>

Salzman B 2010, ´Gait and balance disorders in older adults´, *Am. Fam. Physician*, Jul, vol.82, no 1, pp. 61–68.

Simões J, Augusto GF, Fronteira I & Hernández-Quevedo. Portugal: Health system review. Health Systems in Transition. 2017.

Skjæret N, Nawaz A, Morat T, Schoene D, Helbostad JL & Vereijken B 2016, ´Exercise and rehabilitation delivered through exergames in older adults: An integrative review of technologies, safety and efficacy´, *Int. J. Med. Inform.*, Jan, vol.85, no 1, pp. 1–16.

SPMS 2018, *Plano Estratégico Nacional para a Telessaúde (PENTS) 2019-2022*. SPMS, Portugal.

Sun R & Sosnoff JJ 2018, ´Novel sensing technology in fall risk assessment in older adults: a systematic review´, *BMC Geriatr.*, Jan, 18:14, viewed 10 July 2018, <https://doi.org/10.1186/s12877-018-0706-6>

Tehrani ASS, Diarmuid Coughlan D, Hsieh YH, Mantokoudis G, Korley FK, Kerber KA, Frick K & Newman-Toker DE 2013, ´Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments´, *Acad. Emerg. Med.*, Jul, vol.20, no 7, pp. 689-696.

Telles JL & Borges APA 2013, ´Velhice e Saúde na Região da África Subsaariana: uma agenda urgente para a cooperação internacional´, *Ciência & Saúde Coletiva*, Dec, vol.18, no 12, pp. 3553-3562.

Tinetti ME, Williams CS & Gill TM 2000, ´Dizziness among older adults: a possible geriatric syndrome´, *Ann. Intern. Med.,* Mar, vol.32, no 5, pp. 337-344.

Tossaint-Schoenmakers R, Versluis A, Chavannes N, Talboom-Kamp E & Kasteleyn M 2021, ´The Challenge of Integrating eHealth Into Health Care: Systematic Literature Review of the Donabedian Model of Structure, Process, and Outcome´, *J. Med. Internet Res.*, May, 23(5):e27180, viewed 12 Jun 2021, <https://pubmed.ncbi.nlm.nih.gov/33970123>

WHO 2005, *Fifty-eighth World Health Assembly, Resolution WHA58.28 eHealth.* WHO, Geneva.

WHO 2007, G*lobal report on falls prevention in older age*. WHO, France.

WHO 2016, *Global diffusion of eHealth: making universal health coverage achievable. Report of the third global survey on eHealth*. WHO, Geneva.

WHO 2017a, *Document EB142/20 on mHealth*. WHO, Geneva.

WHO 2017b, *Integrated care for older people. Guidelines on community-level interventions to manage declines in intrinsic capacity.* WHO, Geneva.

WHO 2019a, *Contributions from the World Health Organization in Cabo Verde, 2016-2019 - Promoting health, keeping the world safe and serving the vulnerable.* WHO, Cabo Verde.

WHO 2019b, *Integrated care for older people (ICOPE): Guidance for person-centred assessment and pathways in primary care.* WHO, Geneva.

WHO 2020a, *Decade of Healthy Ageing. Baseline Report.* WHO, Geneva.

WHO 2020b, *Portugal-Country Case Study on the Integrated Delivery of Long-Term Care*. WHO, Copenhagen.

WHO 2021, *Global strategy on digital health 2020-2025.* WHO, Geneva.

2. RESULTS

2.1. PAPER I

Gaspar A, Lapão L. eHealth for Addressing Balance Disorders in the Elderly: Systematic Review. *J Med Internet Res.* 2021;23(4):e22215. DOI: 10.2196/22215

The register of the systematic review (PROSPERO CRD42019120774) is presented in Appendix 4.8.

Review

eHealth for Addressing Balance Disorders in the Elderly: Systematic Review

Andréa G Martins Gaspar[1,2*], MD; Luís Velez Lapão[2*], PhD

[1]Hospital Beatriz Ângelo, Lisbon, Portugal

[2]Global Health and Tropical Medicine, Instituto de Higiene e Medicina Tropical, Universidade NOVA de Lisboa, Lisbon, Portugal

[*]all authors contributed equally

Corresponding Author:
Andréa G Martins Gaspar, MD
Global Health and Tropical Medicine
Instituto de Higiene e Medicina Tropical
Universidade NOVA de Lisboa
Rua da Junqueira, 100
Lisbon, 1349-008
Portugal
Phone: 351 213 652 600
Email: andreamartinsbr@hotmail.com

Abstract

Background: The population is aging on a global scale, triggering vulnerability for chronic multimorbidity, balance disorders, and falls. Falls with injuries are the main cause of accidental death in the elderly population, representing a relevant public health problem. Balance disorder is a major risk factor for falling and represents one of the most frequent reasons for health care demand. The use of information and communication technologies to support distance healthcare (eHealth) represents an opportunity to improve the access and quality of health care services for the elderly. In recent years, several studies have addressed the potential of eHealth devices to assess the balance and risk of falling of elderly people. Remote rehabilitation has also been explored. However, the clinical applicability of these digital solutions for elderly people with balance disorders remains to be studied.

Objective: The aim of this review was to guide the clinical applicability of eHealth devices in providing the screening, assessment, and treatment of elderly people with balance disorders, but without neurological disease.

Methods: A systematic review was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement. Data were obtained through searching the PubMed, Google Scholar, Embase, and SciELO databases. Only randomized controlled trials (RCTs) or quasiexperimental studies (QESs) published between January 2015 and December 2019 were included. The quality of the evidence to respond to the research question was assessed using Joanna Briggs Institute (JBI) Critical Appraisal for RCTs and the JBI Critical Appraisal Checklist for QESs. RCTs were assessed using the Cochrane risk of bias tool. We provide a narrative synthesis of the main outcomes from the included studies.

Results: Among 1030 unduplicated articles retrieved, 21 articles were included in this review. Twelve studies explored different technology devices to obtain data about balance and risk of falling. Nine studies focused on different types of balance exercise training. A wide range of clinical tests, functional scales, classifications of faller participants, sensor-based tasks, intervention protocols, and follow-up times were used. Only one study described the clinical conditions of the participants. Instrumental tests of the inner ear were neither used as the gold-standard test nor performed in pre and postrehabilitation assessments.

Conclusions: eHealth has potential for providing additional health care to elderly people with balance disorder and risk of falling. In the included literature, the heterogeneity of populations under study, methodologies, eHealth devices, and time of follow-up did not allow for clear comparison to guide proper clinical applicability. This suggests that more rigorous studies are needed.

(J Med Internet Res 2021;23(4):e22215) doi: 10.2196/22215

KEYWORDS

balance disorders; falls; elderly; eHealth; telemedicine

Introduction

Background

Aging and Balance Disorders

The improvement of health conditions and the increase in life expectancy have led to an aging global population, although this is not always accompanied by an increase in healthy life years [1-4].

Aging is associated with functional deterioration, including in the peripheral sensory structures, thereby affecting vision, hearing, and balance [5,6]. Additionally, elderly individuals are more likely to suffer from multiple chronic conditions, which often leads to frailty with risk of falls [1-4]. Falls in elderly people represent a serious public health problem as the main cause of accidental death in this population. The risk of falling increases with age [1,7-9]. Each year, approximately one in every three elderly people experiences a serious fall. Moreover, falling can lead to deterioration of the quality of life, anxiety, depression, restriction in daily activities, decreased mobility, social isolation, increased consumption of medications, and increased dependence on medical services and informal caregivers [1,2].

Several causes of falls in the elderly population have been identified, including age, environmental factors (eg, wet paths), inappropriate clothing and shoes, incorrect behavior (eg, climbing chairs), excessive alcohol consumption, inadequate use of medications, deteriorating chronic illness, and balance disorders [1,6,10].

Various clinical conditions are associated with balance disorders in elderly people, including age-related decline in balance function (prebyvestibulopathy); medications; and cardiovascular, metabolic, musculoskeletal, neurologic, and otologic diseases [5,6].

Although dizziness and vertigo are recognized as significant factors increasing the risk of falling and are common symptoms among the elderly, epidemiological studies have revealed large variability in the prevalence of balance disorders in this population [11-13]. It is estimated that at least 30% of individuals above 60 years old suffer from vertigo and dizziness, increasing to 50% for those above 85 years old [13]. According to the 2008 National Health Interview Survey, 33 million US adults had balance disorders, 26% of whom were elderly people (above 65 years) [14]. Approximately 20% of elderly people in the United States have a balance disorder event annually [15]. In fact, dizziness is a common complaint among the elderly population and is a strong predictor of falling events with a negative impact on quality of life [16]. Poor balance is frequently associated with falling [17,18]. In particular, asymmetrical vestibular function may often contribute to falls and fractures in elderly people [19-21].

Balance disorders and consequent falls have progressively represented a burden of disease, accompanied by high costs and pressure on the social services and health care systems related to medical care. This includes repeated consultations, excessive use of diagnostic imaging, and emergency care [22-24]. For example, the first national study in the context of dizziness and vertigo in the Emergency Services of United States of America for 2011 revealed that 25.7% of patient complaints of dizziness and vertigo were associated with balance disorders. The cost was estimated at about US $768 per episode, translating to an annual national cost of US $757 million. In the same context, cardiovascular diseases (linked to 16.5% of these episodes) represented a cost of approximately US $1489 per episode for an annual cost of US $941 million. By comparison, cerebrovascular diseases only accounted for 3.1% of these episodes, but with a cost per episode of approximately US $1059 or an annual cost of US $127 million. With the progressive aging of the population, worsening of this situation is expected in the future [25]. Indeed, vertigo is already contributing to the increasing trend of health care costs, which is linked to the aging of the population [23,24].

In this scenario of global aging, the use of digital solutions has been encouraged. Moreover, the additional pressure of the current COVID-19 pandemic has motivated the broader use of eHealth technologies [26].

Digital Health Care and the Elderly

The aging trend represents a relevant challenge to both patients and their families, and to the sustainability of health care systems globally. This is linked to the goal of global health policies for achieving a more active and healthy aging society with autonomy and independence [27,28]. The provision of new health care models, including eHealth services, has been encouraged to tackle access inequities, optimize health outcomes, and ensure autonomy and social support for elderly people. The use of eHealth seems to decrease costs associated with both institutionalization and unnecessary hospital visits [27-29].

eHealth consists of the use of information and communication technologies (ICTs) to support a health care communication channel at a distance, allowing for more efficient delivery of care services with optimized resource allocation. eHealth often contributes to improving the quality of health care services, including faster access to health information, promotion of the globalization of health care, and better health outcomes [30]. The World Health Organization has also recommended eHealth to promote universal health coverage, envisaging higher health care services availability with fewer resources and larger patient interaction. To date, eHealth has been used in the management of many conditions from health literacy promotion to teleconsultations [31]. The remote access systems can actively monitor elderly people in a real-life environment, leveraging the fact that there is an increasing interest and engagement of the elderly with technology. Moreover, eHealth technologies can enhance medical-patient interactions and mitigate many care access inequities. However, digital training of elderly people and caregivers is essential [4,32-34].

Assessment and Rehabilitation for the Elderly with Balance Disorders

There are several clinical tests and functional scales, including the Timed Up and Go Test (TUGT), Unipedal Standing Test, and Berg Balance Scale, that allow for assessments of balance,

gait, and risk of falling [5,35]. The use of sensors can improve the data quality of these tests and scales [36,37]. Additionally, functional tests of the inner ear, such as videonystagmography or the Video Head Impulse Test, are essential to identify and measure balance disorder cases, including an age-related decline in balance function (prebyvestibulopathy) [6].

Personalized balance training is a relevant option for the treatment of elderly people with balance disorders and risk of falling [5]. This training consists of an exercise-based program to address an individual's specific balance disorder, with goals of increasing postural stability, improving activities of daily living, and decreasing symptoms. Balance training should be focused on the functional deficiencies identified. Therefore, a prior medical evaluation is necessary to identify the clinical conditions related to poor balance as mentioned previously [38-41]. Moreover, these clinical conditions can affect the outcomes. For example, intervention success is more difficult when the patient has a disorder of both inner ears or has limited mobility due to an osteoarticular disease [38-41]. Exercises delivered through video games can be a promising intervention to achieve greater access and adherence among elderly people [42,43].

Several reviews have addressed the potential of digital solutions to improve the clinical observation and evaluation of balance disorders, and to promote the remote balance rehabilitation of elderly people [36,37,42-47]. However, most of these reviews included studies using a younger population as a preliminary assessment [42,44-47], and the majority did not describe the clinical conditions of the participants that might interfere with the outcomes, especially in the context of balance rehabilitation. Additionally, the clinical applicability of these devices was not assessed [36,37,42-47].

Therefore, there is a gap in this field in terms of evaluating the overall applicability of digital solutions according to the clinical conditions of elderly people with balance disorders and without neurological disease.

Objectives

The aim of this review was to evaluate and guide the clinical applicability of eHealth devices in the screening, assessment, and treatment of elderly people with balance disorders but without neurological disease.

Methods

Design

This systematic review was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement [48] with the following steps: development of research questions, development of a search strategy with eligibility criteria, data selection, and qualitative analysis.

The protocol for this systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42019120774) and the complete protocol is available on the National Institute for Health Research program website.

This review focused on answering the following specific research questions, according to the PICO (Population, patient, or problem; Intervention; Control, Comparison, or Comparator; Outcome) strategy [49] (Textbox 1): (1) What are the main contributions of eHealth to elderly people with balance disorders with risk of falling? and (2) Is there any evidence that eHealth improves the quality of health care services in this context? If not, what are the reasons?

Textbox 1. Description of the PICO components.

- P (Population, Patient, Problem): Elderly people (over 60 years old) with balance disorders and risk of falling; studies with elderly people with functional limitation by neurological disease were excluded
- I (Intervention): eHealth devices for remote health education, screening, assessment, monitoring, or rehabilitation of elderly people with balance disorders with risk of falling
- C (Control, Comparison, Comparator): No intervention, paper booklet information, clinical evaluation, conservative balance training
- O (Outcome): Clinical applicability, increased fall prevention literacy, early identification and evaluation of balance deficits and risk of falling, improved balance and gait performance, reduced rate of falling, increased rehabilitation adherence, increased independence in daily activities

Definition of Concepts and Keywords used in the Search Strategy

In this study, we defined elderly people as those over 60 years of age [50]. Knudson [51] defined balance as a "person's ability to control their body position relative to some base of support." According to Agrawal et al [6], vertigo and dizziness are defined as "sensation of self-motion when no self-motion is occurring or the sensation of distorted self-motion during an otherwise normal head movement" and "sensation of disturbed or impaired spatial orientation without a false or distorted sense of motion," respectively. Falls refer to "inadvertently landing on the ground, floor or other lower level" [10]. Gait is defined as "the pattern of movement of the body during locomotion" [52].

Telemedicine is defined according to the World Health Organization Group Consultation on Health Telematics [53] as "delivery of health care services using ICT for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers." eHealth is defined according to Eysenbach [54] as:

> *an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a*

> *way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.*

Teleconsultation is defined as "synchronous or asynchronous consultation using ICT to omit geographical and functional distance" [55]. Finally, a sensor is defined as a "device that responds to a physical input of interest with a recordable functionally related output that is usually electrical or optical" [56].

Search Strategy

Articles were retrieved through searching the PubMed, Google Scholar, Embase, and SciELO databases. The search algorithm included multiple group combinations, as shown in Table 1.

Table 1. Search strategy.

Concept	Keywords
Elderly people	("elderly" OR "older" OR "aged")
Balance	("Balance" OR "balance disorder" OR "balance problem" OR "vertigo" OR "dizziness) and/or ("falls" OR "fall detection" OR "fall prevention") and/or ("gait")
Telemedicine	("Telemedicine" OR "eHealth" OR "teleconsultation" OR "technology" OR "sensor")

Selection Criteria

The inclusion criteria were randomized controlled trials (RCTs) or quasiexperimental studies (QESs) published in English between January 2015 and December 2019, studies related to use of eHealth in the context of balance and falls, and the sample was restricted to an elderly population (60 years old and above).

The exclusion criteria were: (1) review articles, brief reports, protocols, proof-of-concepts, pilot studies, conference papers, and letters to the editor; (2) studies including elderly people with a reported functional limitation due to a neurological disease; and (3) articles without an age sample reference or with participants aged below 60 years.

Screening Process and Data Extraction

First, both authors screened the papers independently, looking at titles, abstracts, and methods, and agreed about their inclusion or exclusion according to the eligibility criteria. Second, the potentially relevant papers were retrieved for full-text evaluation against the eligibility criteria. Any articles that were deemed to be questionable in the first stage were included for further evaluation in the second stage. The selection of papers was performed by checking the extracted data and risk of bias.

Outcome Measures

The main outcomes included population characteristics, balance disorder, identification of faller participants, eHealth platform and services, health benefits, and fall prevention literacy.

Risk of Bias Assessment

The quality of the evidence to respond to the research questions was independently assessed using the Joanna Briggs Institute (JBI) Critical Appraisal for Experimental Studies and JBI Critical Appraisal Checklist for Quasi-Experimental Studies tools [57]. The two researchers discussed the results of the quality appraisal, reaching a consensus in case of any divergence. The included RCTs were assessed using the Cochrane risk of bias tool [58] to evaluate the risk of internal bias for a series of domains: selection bias, performance bias, detection bias, attrition bias, and reporting bias. Disagreements were solved by consensus between the two researchers.

Data Analysis

We provide a narrative synthesis of the main outcomes from the included studies. First, the articles were categorized according to the study design. Second, the articles were categorized based on the focus of eHealth services (screening/assessment and treatment/rehabilitation) for comparison of clinical use and applicability according to digital devices.

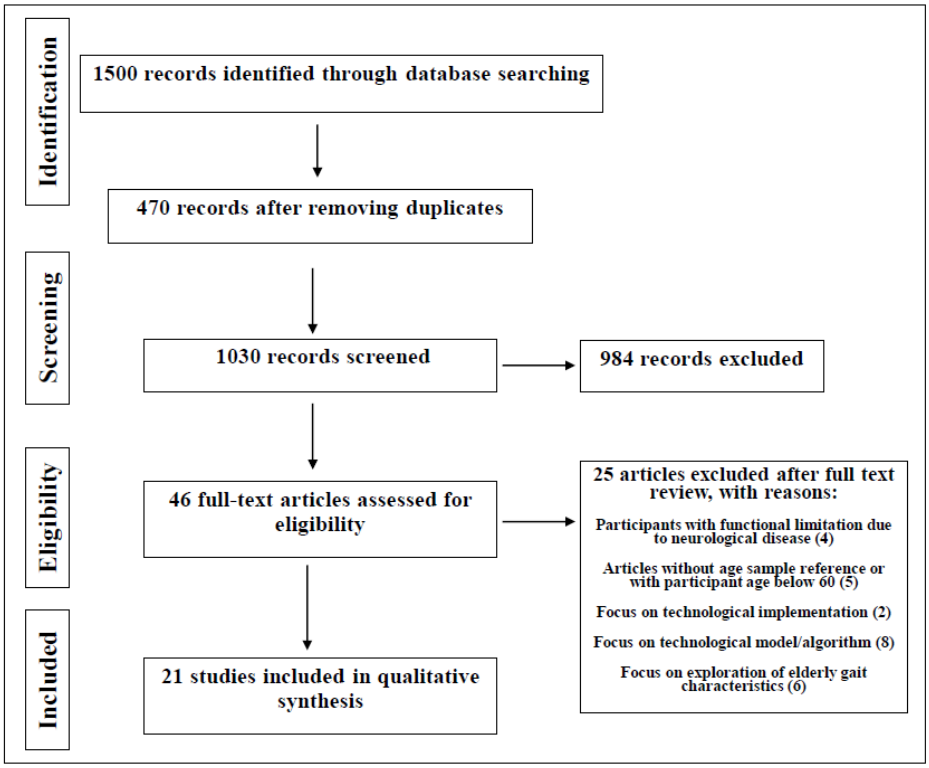
Results

Search Results

A total of 1030 unduplicated articles were identified, 984 of which were excluded after title and abstract screening. Among the 46 full-text publications assessed for eligibility, 25 articles were excluded owing to functional limitations due to neurological disease (n=4), age of participants (n=5), focus on technological implementation (n=2) or model/algorithm (n=8), and specific descriptions of elderly gait parameters (n=6).

Twenty-one articles [59-79] were ultimately included in the review (Figure 1).

Figure 1. Flow of selection for studies included and excluded in the review.



Study Design

RCT Design

Seven studies were RCTs [59-65], including one cross-over trial without a washout term [64] and one multicenter study [60].

Not all authors clearly described the randomization process [62] and the allocation concealment [62,64] (Tables 2 and 3).

The inclusion criteria were mentioned in all articles. However, the clinical conditions of the participants were only described in one study [60]. The function of the inner ear was never mentioned. Thus, the expected similarity between the control and intervention groups was not clear. This is relevant because various clinical conditions (eg, cardiovascular, metabolic, inner ear disease, medication) can interfere with the outcomes of balance rehabilitation [38-41]. Therefore, the lack of information about clinical conditions of the participants, including the lack of data about function of the inner ear, was considered as "other bias" and was a common weakness of all included RCTs (Table 3 and Figure 2). This approach led to a worse classification of the quality of these studies.

Additionally, the blinding of participants, personnel, and outcome assessment were unclear in some of these studies.

In the control and intervention groups of all RCTs, a few dropouts for medical and personal reasons were mentioned. However, this was not considered to be sufficiently relevant to have an impact on the results. Only two papers reported intention-to-treat analysis [60,63].

All outcomes were measured in a reliable manner and were considered to have been properly analyzed.

Table 2. Methodological quality of randomized controlled trials based on the Joanna Briggs Institute Critical Appraisal Checklist.

Study	Q1[a]	Q2[b]	Q3[c]	Q4[d]	Q5[e]	Q 6[f]	Q7[g]	Q8[h]	Q9[i]	Q10[j]	Q11[k]	Q12[l]	Q13[m]
Eggenberger et al [59]	Y[n]	Y	U[o]	Y	N[p]	U	Y	Y	N	Y	Y	Y	Y
Gschwind et al [60]	Y	Y	U	Y	Y	U	Y	Y	Y	Y	Y	Y	Y
Gschwind et al [61]	Y	Y	U	U	U	Y	Y	Y	N	Y	Y	Y	Y
Lim et al [62]	U	U	U	U	U	U	Y	Y	N	Y	Y	Y	Y
Oesch et al [63]	Y	Y	U	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Ozaki et al [64]	Y	U	U	U	U	U	Y	Y	N	Y	Y	Y	Y
Hong et al [65]	Y	Y	U	Y	Y	Y	Y	Y	N	Y	Y	Y	Y

[a]Question 1: Was true randomization used for assignment of participants to treatment groups?

[b]Question 2: Was allocation to treatment groups concealed?

[c]Question 3: Were treatment groups similar at the baseline?

[d]Question 4: Were participants blind to treatment assignment?

[e]Question 5: Were those delivering treatment blind to treatment assignment?

[f]Question 6: Were outcomes assessors blind to treatment assignment?

[g]Question 7: Were treatment groups treated identically other than the intervention of interest?

[h]Question 8: Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed?

[i]Question 9: Were participants analyzed in the groups to which they were randomized?

[j]Question 10: Were outcomes measured in the same way for treatment groups?

[k]Question 11: Were outcomes measured in a reliable way?

[l]Question 12: Was appropriate statistical analysis used?

[m]Question 13: Was the trial design appropriate, and any deviations from the standard randomized controlled trial design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

[n]Y: Yes.

[o]N: No.

[p]U: Unclear.

Table 3. Risk of bias for randomized controlled trials based on the modified Cochrane Collaboration tool.

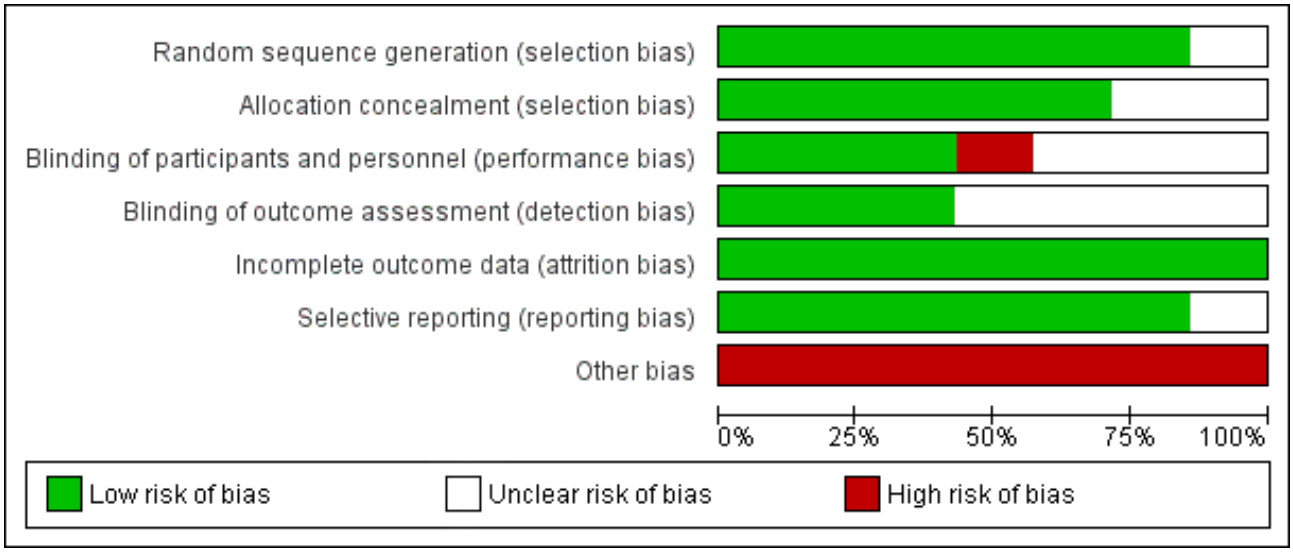
Study	Selection bias		Other bias	Reporting bias: selective reporting	Performance bias: blinding (participants and personnel)	Detection bias: blinding (outcome assessment)	Attrition bias: incomplete outcome data
	Random sequence generation	Allocation concealment					
Eggenberger et al [59]	L[a]	L	H[b]	U[c]	L	U	L
Gschwind et al [60]	L	L	H	L	L	U	L
Gschwind et al [61]	L	L	H	L	U	L	L
Lim et al [62]	U	U	H	L	U	U	L
Oesch et al [63]	L	L	H	L	H	L	L
Ozaki et al [64]	L	U	H	L	U	U	L
Hong et al [65]	L	L	H	L	L	L	L

[a]L: low risk.

[b]H: high risk.

[c]U: unclear risk.

Figure 2. Risk of bias in accordance with the authors' judgment (RevMan version 5.3.).



QES Design

Fourteen studies were QESs [66-79]; only one of these was a multicenter study [73]. Twelve of these studies used the same group of participants [66,68-77,79]. One study used two groups with different participants [67] and another had a control group and an intervention group [78]. However, the expected similarity between the groups was not clear because there was no description of the clinical conditions of the participants, including function of the inner ear. Loss to follow-up was also not mentioned for any of these studies (Table 4).

Table 4. Methodological quality of quasiexperimental studies based on the Joanna Briggs Institute Critical Appraisal Checklist.

Study	Q1[a]	Q2[b]	Q3[c]	Q4[d]	Q5[e]	Q6[f]	Q7[g]	Q8[h]	Q9[i]
Zacaria et al [66]	Y[j]	Y	Y	N[k]	Y	Y	Y	Y	Y
Hall et al [67]	Y	U[l]	Y	N	Y	Y	Y	Y	Y
Howcroft et al [68]	Y	Y	Y	N	Y	Y	Y	Y	Y
Lee et al [69]	Y	Y	Y	N	Y	Y	Y	Y	Y
Ponti et al [70]	Y	Y	Y	N	Y	Y	Y	Y	Y
Similä et al [71]	Y	Y	Y	N	Y	Y	Y	Y	Y
Shahzad et al [72]	Y	Y	Y	N	Y	Y	Y	Y	Y
Brodie et al [73]	Y	Y	Y	N	Y	Y	Y	Y	Y
Howcroft et al [74]	Y	Y	Y	N	Y	Y	Y	Y	Y
Chigateri et al [75]	Y	Y	Y	N	Y	Y	Y	Y	Y
Qiu et al [76]	Y	Y	Y	N	Y	Y	Y	Y	Y
Hiesh et al [77]	Y	Y	Y	N	Y	Y	Y	Y	Y
Maneproom et al [78]	Y	U	Y	Y	Y	Y	Y	Y	Y
Nightingale et al [79]	Y	Y	Y	N	Y	Y	Y	Y	Y

[a]Question 1: Is it clear in the study what is the "cause" and what is the "effect" (ie, there is no confusion about which variable comes first)?

[b]Question 2: Were the participants included in any similar comparisons?

[c]Question 3: Were the participants included in any comparisons receiving similar treatment/care other than the exposure or intervention of interest?

[d]Question 4: Was there a control group?

[e]Question 5: Were there multiple measurements of the outcome, both pre and post the intervention/exposure?

[f]Question 6: Was follow-up completed and if not, were differences between groups in terms of their follow-up adequately described and analyzed?

[g]Question 7: Were the outcomes of participants included in any comparisons measured in the same way?

[h]Question 8: Were outcomes measured in a reliable way?

[i]Question 9: Was appropriate statistical analysis used?

[j]Y: yes.

[k]N: no.

[l]U: unclear.

Multiple different measurements of the outcomes were used (Table 4). However, the instrumental inner ear tests were not used as the gold-standard test. This lack of comparison was considered to be a weakness of all of the included QESs. The most commonly applied tests were the TUGT and walking over different distances. One study assessed 1-week daily-life walking [73]. Only one study explored the activities of daily living [75] (Table 5).

The outcomes were considered to have been measured in a reliable manner and were properly analyzed.

Table 5. Quasiexperimental studies focused on screening/assessment.

Reference	Population and setting	Participants, N (male/female)	Technology/sensor used (location)	Completed sensor-based procedures	Comparison with fall history or a gold-standard test
Zacaria et al [66]	Hospital	38 (20/18)	WIS[a] accelerometer and gyrosensor (L2 vertebra)	TUGT[b] (sensor analysis of performance of each phase)	Classification of faller/nonfaller based on total duration for TUGT completion
Howcroft et al [68]	CDEP[c]	100 (44/56)	Wearable pressure-sensing insoles (pressure sensors-plantar); WIS, 4 triaxial accelerometers (head, pelvis, shanks)	7.62 m walk and 7.62 m walk with cognitive load (ST[d] and DT[e] gait)	Classification of faller/nonfaller based on retrospective fall occurrence
Lee et al [69]	CDEP	65 (16/49)	WIS (1 triaxial accelerometer belt around waist, pelvis, sacrum, L3-L5 vertebrae)	TUGT	Short-form BBS[f] (7 activities), TUGT
Ponti et al [70]	CDEP	36 (11/25)	WIS (1 triaxial accelerometer, waist)	ST TUGT, DT manual TUGT, DT cognitive TUGT	Faller/nonfaller based on retrospective fall occurrence, FES[g]
Similä et al [71]	Senior house/senior physical exercise group	35 (0/35)	WIS (2 accelerometers L3-L5 vertebrae, right hip)	BBS + TUGT + 4 m walk and follow-up after 1 year	Background questionnaire, interview, balance platform assessment with Kinect recording
Shahzad et al [72]	CDEP	23 (7/16)	WIS (1 triaxial accelerometer, L3-L5 vertebrae)	TUGT, STS-5[h], AST[i]	BBS
Brodie et al [73]	CDEP	96 (39/57)	Pendant sensor 3D accelerometer and barometer (sternum)	1-week daily life walking	Fall history, comparison with TUGT and 10 m walk test
Howcroft et al [74]	CDEP	75 (31/44)	Wearable pressure-sensing insoles (pressure sensor, plantar), WIS 4 triaxial accelerometers (head, pelvis, shanks)	7.62 m walk under ST, 7.62 m walk under DT (verbal-task cognitive load)	Classification of faller/ nonfaller based on prospective fall occurrence
Chigateri et al [75]	Frail elderly people from independent-living retirement homes	23 (6/17)	WIS 1 triaxial accelerometer (L5 vertebra)	TUGT, STS[j], activities of daily living	Synchronized videos with accelerometer (identification of the beginning of TUGT and of walking episode)
Qiu et al [76]	CDEP/social welfare centers	196 (0/196)	WIS 5 sensors with 3-axis-acceleration, 3-axis angular velocity, 3-axis magnetism each (low back, upper legs, lower legs)	Sensory integration test, limits of stability forward reach, STS-5, TUGT, motor function	Classification of faller based on self-reported history
Hiesh et al [77]	Healthy elderly people	30 (12/18)	Smartphone technology, 1 accelerometer (sternum)	Balance tests standing on a force plate and holding a smartphone against the chest: eyes open/closed DT, semitandem, tandem stance, single-leg stance	Comparison between force plate and smartphone data
Nightingale et al [79]	Local community centers/health care provider offices/senior centers	51 (unknown)	OptoGait system photoelectric technology	10 m walk	TUGT

[a]WIS: wearable inertial sensor.

[b]TUGT: Timed Up and Go Test.

[c]CDEP: community-dwelling elderly people.

[d]ST: single task.
[e]DT: dual task.
[f]BBS: Berg Balance Scale.
[g]FES: Fall Efficacy Scale.
[h]STS-5: Five Times Sit-to-Stand test.
[i]AST: Alternative Step Test.
[j]STS: Sit-to-Stand test.

Focus of eHealth Services

The 12 QESs were focused on screening and assessment. These studies compared the use of sensors in participants with a history of falling, or with clinical tests and functional scales [66,68-77,79] (Table 5). No instrumental test of the inner ear was performed as a gold-standard test. All RCTs [59-65] and two QESs [67,78] were focused on balance treatment or rehabilitation (Table 6). Again, no instrumental test of the inner ear was used in pre and postrehabilitation assessments.

Table 6. Studies focused on treatment/rehabilitation.

Reference	Study type	Setting and population	Participants, N (male/female)	Tested technology	Tested sensor architecture	Sensor-based procedures	Outcome measurements
Eggenberger et al [59]	RCT[a]	CDEP[b] and retirement homes	71 (25/46): dance group n=24, memory group n=22, control group n=25	VR[c] video game dancing + Impact Dance Platform treadmill walking + computer screen + training software	VR video game dancing + pressure sensitive platform, treadmill + training software	VR video game dancing with simultaneous cognitive-physical training; treadmill walking with simultaneous verbal memory training; treadmill walking (control)	Gait analysis: ST[d]/DT[e] 7.3 m walking, Short Physical Performance Battery, fall frequency, 6-minute walk test, measure of fall fear
Gschwind et al [60]	RCT	CDEP	153 (60/93): intervention group n=78, control group n=75	iStoppFalls system: computer + Google TV set top box + Microsoft Kinect + senior mobility monitor + android tablet	Kinect-based system (3D depth sensor), Senior Mobility Monitor (3D accelerometer, barometer)	16-week home-based balance exergames and muscle strength exercises + education booklet (intervention) or education booklet + usual activities (control)	Estimated risk of falling; mobility, self-care, usual activities, pain, discomfort, anxiety, depression, health questionnaires, cognitive performance, walking task, STS-5[f], TUGT[g], technology use
Gschwind et al [61]	RCT	CDEP	124 (42/82): step-mat training group n=39, Microsoft-Kinect group n=24, control group n=61	Input device, computer, USB modem, TV, exergames, Microsoft Kinect or electronic mat	Pressure-sensitive electronic mat, Kinect-based system (3D depth sensor)	Unsupervised 16-week home exercise using exergames or educational booklet about evidence-based health and fall prevention advice + usual activities (control)	Risk of falling, health and disability measure, STS-5, TUGT, cognitive performance
Hall et al [67]	QES[h]	CDEP	16 (0/16): group A n=8, group B n=8	Nintendo Wii Fit System: computer interface + monitor + Wii balance board + games Ski Slalom/ Table Tilt	*Balance* Board: force platform	Wii Fit balance test + games, followed by SOT[i] and LOS[j] test, CDP[k] (group A); SOT and LOS test, CDP, followed by Wii Fit balance test + games (group B)	Dynamic Gait Index, TUGT, gait speed
Lim et al [62]	RCT	CDEP	36 (11/25): intervention group n=18, control group n=18.	Wearable balance biofeedback (system (vibrotactile, auditory and visual biofeedback)	Biofeedback headband: 8 vibrotactile actuators, 2 bone-conducting acoustic transducers, 3 light-emitting diodes; and gyroscopes (lower back)	2-week training with real-time multimodal biofeedback of trunk sway or 2-week training without biofeedback (control)	Standing:1 leg (eyes open), feet together, firm surface and foam, tandem stance (EC[l]); self-paced 8 m walking (EC); 8 m walking with head turning; 8 tandem steps (EC)
Oesch et al [63]	RCT	Geriatric rehabilitation center	54 (29/25): intervention group n=26, control group n=28	Windows Kinect (exergame)	Kinect-based system (3D depth sensor)	10-day self-regulated training with exergames or 10-day self-regulated conventional training with instruction leaflets (control)	Adherence, motivation, enjoyment, sensor-based walking test

Reference	Study type	Setting and population	Participants, N (male/female)	Tested technology	Tested sensor architecture	Sensor-based procedures	Outcome measurements
Ozaki et al [64]	RCT	Prefrail or frail CDEP	27(7/20): intervention group n=14, control group n=13	BEAR[m] system: Stand-and-ride transport robot + wearable helmet and suspending device + software	Stand-and-ride transport robot with two inverted wheel motors	6-week based BEAR training first group or 6-week based conventional balance training first group (control)	Gait speed, tandem gait speed, functional reach test, TUGT
Hong et al [65]	RCT	CDEP	23 (0/23): intervention group n=10, control group n=13	tablet, web app, signaling server module network address translator traversal module	Web Real-Time Communication (WebRTC) technology	12-week telepresence exercise sessions or maintained lifestyle (control)	Senior fitness test, BBS[n], fall-related self-efficacy, FES[o], Fear of falling questionnaire
Maneproom et al [78]	QES	Senior housing	64 (13/51): intervention group n=32, control group n=32	robot, robot-installed fall prevention software	8-inch touchscreen installed at robot head	robot-installed fall prevention software + personal coaching + fall prevention handbook or fall prevention handbook only (control)	TUGT, BBS, fall prevention questionnaire

[a]RCT: randomized controlled trial.

[b]CDEP: community-dwelling elderly people.

[c]VR: virtual reality.

[d]ST: single task.

[e]DT: dual task.

[f]STS-5: Five Times Sit-to-Stand test.

[g]TUGT: Timed Up and Go Test

[h]QES: quasiexperimental study.

[i]SOT: Sensory Organization Test.

[j]LOS: Limits of Stability.

[k]CDP: computerized dynamic posturography.

[l]EC: eyes closed.

[m]BEAR: Balance Exercise Assist Robot.

[n]BBS: Berg Balance Scale

[o]FES: Fall Efficacy Scale.

Population Characteristics

The included studies had large differences in sample sizes, ranging from 23 to 153 participants [59-65] among RCTs and from 16 to 196 participants [66-79] among QESs. As shown in Tables 5 and 6, many studies included a small sample size that was described as a limitation.

The age range was 60-91 years for the RCTs and 60-92 years for the QESs. Most of the studies included more women than men. In four studies, only women participated [65,67,71,76]. The decision to only recruit women was explained in one study as “to avoid the influence of gender differences on risk of falling” [76]. Two studies excluded the few male participants [67,71] and the remaining article did not describe the reason for the exclusive participation of women [65]. One study did not describe the age range or the gender distribution of the participants [79].

The participants (≥60 years old) were recruited from the community [60-62,64,65,67-70,72-74,76,77], gerontology services [71,75,78], both [59,79], or at a hospital [66]. One study included participants who were referred for geriatric inpatient rehabilitation [63].

Most of the studies did not describe the characteristics of health conditions of the sample [59,62,64-66,68-72,74-77,79]. Only some authors provided quantitative data about the participants’ medication use [60,61,73,78] and their comorbidities [60,61,63,67,73,78]. One study [60] highlighted the following comorbidities of the participants: heart problems, high blood pressure, osteoporosis, lower back pain, hip pain, knee and/or leg pain, and foot pain. Two studies excluded participants with self-reported balance disorders [62,63]. Two other studies included frail or prefrail elderly adults [64,75].

Balance Disorder and Identification of Faller Participants

The included studies used functional balance tests, with or without sensors, to evaluate balance and risk of falling. An objective identification via exploration and quantification of the function of the inner ear by instrumental tests was not employed in any of the considered studies, as mentioned above.

Therefore, the presence of prebyvestibulopathy or other balance disorders was not known.

Some authors highlighted the potential of sensor-based tests in identifying early balance deficits [71] and in evaluating the risk of falling [66,72,73,76,77]. Improved balance and gait with technology-based training were mentioned in some studies [59,62,64].

The identification of faller participants based on retrospective [68,70,73,76] or prospective occurrence of falling [74] was employed to compare the technology results. The benefits of virtual training in reducing the risk of falling was also described [60,61,65,78].

No study focusing on detection of falling fully complied with the inclusion criteria of this review (RCTs or QESs, published in English between January 2015 and December 2019, restricted to the population 60 years or older).

eHealth Platform and Services

Different platforms were used for the provision of eHealth services. The main platforms identified were computer-based apps, either via the internet or mobile based platforms (Tables 5 and 6).

As mentioned above, 12 studies focused on screening or assessment [66,68-77,79] using different types (wearable inertial, wearable pressure, pendant, smartphone), quantities (range 1-5), and locations (head, sternum, lumbar vertebra, pelvis, hip, leg, shanks, foot) of sensors. Single or combined sensor-based tasks were employed. Only two studies [73,75] evaluated activities in a real-life environment (Table 5).

Nine studies explored balance rehabilitation [59-65,67,78] with different exercises and duration of training. The follow-up time was short (less than 6 months) in most of the studies, with the longest follow-up of 1 year [59]. The development of eHealth services was explored both inside and outside the laboratory environment (Table 6).

One study used a robot to provide information about training and fall prevention. However, the authors pointed out that the screen and the volume speaker were not adequate for use by elderly people [78].

The use of technical language and the presence of disabilities such as visual and hearing impairment were highlighted as the main barriers in using eHealth [78].

Health Benefits

Only one study did not report better adherence, enjoyment, motivation, and balance performance with virtual training. This was explained by the possible fragility of the sample included in the study and by the short duration of the training intervention [63].

The remaining papers emphasized the potential contribution of digital solutions to improve balance performance and risk of falling. The sensors used during balance tests improved the evaluation of balance and gait [66,68,69,71,72,79] and improved the identification of potential faller participants [70,73-77]. In addition, the use of eHealth devices for balance rehabilitation increased balance and gait performance [59,60,62,64,65,78], and reduced the risk of falling [60,61]. However, no long-term follow-up was reported. Virtual programs of falls prevention seemed to increase knowledge on the subject [78] (Table 7).

Table 7. Health benefits: conclusions from all studies.

Reference	Study type	Conclusions
Zacaria et al [66]	QES[a], screening	Single wearable sensor during TUGT[b]: an improved tool in evaluating fall risk
Howcroft et al [68]	QES, screening	Sensor-based gait assessment: potential of identification of gait changes
Lee et al [69]	QES, screening	Advantages of wearable sensor as an outside laboratory tool
Ponti et al [70]	QES, screening	Improved potential of identification of fallers with single sensor-based DT[c] TUGT
Similä et al [71]	QES, screening	Sensor-based walk test: a screening tool to identify early signs of balance deficits
Shahzad et al [72]	QES, screening	Importance of sensor-based TUGT, STS-5[d], and AST[e] on fall risk estimation
Brodie et al [73]	QES, multicenter screening	Better sensor-based daily-life gait assessment to discriminate fallers
Howcroft et al [74]	QES, screening	Sensor: potential to discriminate differences between ST[f] and DT gait and between prospective fallers and nonfallers
Chigateri et al [75]	QES, screening	Wearable accelerometer: useful for nonsedentary activity recognition and gait detection in frail older adults outside lab facilities
Qiu et al [76]	QES, screening	Potential use of wearable inertial sensor-based systems for elderly fall risk assessment
Hiesh et al [77]	QES, screening	Validity of smartphone for evaluation of postural stability and fall risk stratification in older adults
Nightingale et al [79]	QES, screening	Using Optogait system: TUGT as a tool for screening balance deficits
Eggenberger et al [59]	RCT[g], rehabilitation	Virtual reality game dancing with simultaneous cognitive-physical training and treadmill walking with simultaneous verbal memory training: potential to enhance gait variables
Gschwind et al [60]	RCT, rehabilitation	iStoppFalls program reduced physiological fall risk and improved postural sway
Gschwind et al [61]	RCT, rehabilitation	Step-mat-training and Microsoft-Kinect exergames reduced fall risks, Step-mat-training improved specific cognitive functions; neither intervention improved balance control
Hall et al [67]	QES, rehabilitation	WiiFit feasible to safely use, Ski Slalom game similar effect as computerized dynamic posturography
Lim et al [62]	RCT, rehabilitation	Balance training with biofeedback: most beneficial for the most difficult tasks but with few long-term benefits
Oesch et al [63]	RCT, rehabilitation	Superior results of conventional training with respect to adherence, enjoyment, and motivation; no difference of balance during walking between conventional and training with exergames
Ozaki et al [64]	Crossover trial without a washout term, rehabilitation	BEAR[h] training more effective for improving dynamic balance and lower extremity muscle strength
Hong et al [65]	RCT, rehabilitation	Telepresence exercise program: effective to improve balance and reduce fear of fall; no significant difference of fall efficacy between intervention (telepresence exercise sessions) and control group (maintained lifestyle)
Maneproom et al [78]	QES, rehabilitation	Robotic fall prevention program increased fall prevention knowledge, promoted exercises, and improved balance

[a]QES: quasiexperimental study.

[b]TUGT: Timed Up and Go Test.

[c]DT: dual task.

[d]STS-5: Five Times Sit-to-Stand test.

[e]AST: Alternative Step Test.

[f]ST: single task.

[g]RCT: randomized controlled trial.

[h]BEAR: Balance Exercise Assist Robot.

Fall Prevention Literacy

None of the studies explored the previous health literacy of the participants. Only two papers described the educational level of the participants [60,78].

One study compared use of a fall prevention software to a conventional handbook to evaluate the improvement of knowledge on fall prevention. Both the intervention and control groups showed improvement in knowledge, without a significant difference [78].

Discussion

Principal Findings

Population aging, and the associated vulnerability to the development of multiple chronic pathologies and balance disorders, have motivated research and the implementation of new strategies for the provision of health care. eHealth devices have been studied to help assess balance and gait performance, risk of falling in and outside a laboratory setting, and to perform in-home balance rehabilitation. In this review, we confirmed the potential of eHealth to complement the health care of elderly people. However, most of these studies were not designed to provide clinical guidelines.

Despite growing interest about this subject in the last 20 years, we decided to focus on studies published in the last 5 years (RCTs and QESs), taking into consideration both continuous advances in technological innovation and the opportunity to apply new clinical applications in balance disorder and risk of falling for the elderly population.

Unlike other reviews, our eligibility criteria ruled out many initially retrieved articles, especially studies with participants under 60 years old, those without reporting the age of participants, or with participants having a functional limitation due to neurologic disease. Therefore, only 21 articles fully complied with the requirements of this review [59-79].

Except for one study [63], the others showed the potential of eHealth to evaluate balance assessment and risk of falling of elderly people and to promote balance training. The eHealth devices allowed collecting additional information about the balance, gait, and risk of falling of elderly people, and to monitor their daily activities.

In particular, eHealth seems to provide an opportunity for increasing medical-patient interactions and to reduce access inequities [30]. In 1996, Viierre et al [80] had already mentioned the potential of eHealth in this field: “remote medical diagnosis and treatment facilities could make the few vestibular disorder specialists much more available to patients.” However, as observed in other reviews [36,37,42-47], the differences in methodologies and of variables included in the studies did not allow for a proper comparison to guide clinical applicability.

First, there was a broad range of sample sizes, which were generally quite small (ranging from 16 to 196 participants). A small sample of participants is considered a limitation for extrapolating the results, especially for the exploration of risk of falling.

Second, there were missing data about the clinical conditions of the participants. Except for one study [60], several volunteers were recruited from the community and were defined as “healthy” elderly people only based on a self-reported assessment. There were also participants recruited from geriatric services without reference to their clinical conditions. Despite the exclusion of participants with self-reported balance disorders in two studies [62,63], we consider that the exclusion rules should be more rigorous and based on objective data such as instrumental inner ear tests. We have to take into consideration that elderly people can have instability due to many conditions, including the normative aging process, and therefore the outcomes from a balance rehabilitation intervention could be sensitive to these differences [38-41].

Third, different research methodologies were used for screening and assessment. We observed a wide range of clinical tests, functional scales, faller classifications, and sensor-based tasks among the included studies. The lack of homogeneity of these variables limited an appropriate comparison among the studies. Moreover, functional inner ear tests were not used as the gold-standard test. We consider this as a weakness common to all studies.

Fourth, different types of sensors were used for screening and assessment. Similar to the findings of other reviews [36,37,44-47], the studies employed mainly accelerometers, with variations in both number and body location.

Fifth, as observed previously [42,43], studies focusing on treatment and rehabilitation used different devices, training durations, and follow-up times. Some authors employed supervised training. In one study, this was used a telepresence-based exercise platform [65]. Others employed in-home self-regulated exercises training [61], thereby avoiding the need for participants to travel to the rehabilitation center. None of the studies described pre and postintervention data about the function of the inner ear. The studies did not verify the long-term effect of training, especially with respect to fall occurrence. Only two studies explored a sensor used in real-life activities [73,75], which is relevant since it allowed for a better evaluation of the remote interaction and monitoring of daily activities.

Additionally, we observed a constraint related to the use of devices that are not fully adequate to match the abilities of elderly people [78]. We also highlight the importance of providing a better definition of the eHealth user profile to improve adherence.

Future studies in this field should consider the above topics as a starting point, as well as for health policy implementations on eHealth apps for elderly people with balance disorders.

The use of eHealth can play an important role as a complementary method to provide health care services, encouraging health promotion and patient participation, as well as allowing for the remote management of balance disorders.

Recommendations

Based on this review, we can provide the following recommendations to improve studies and applications of eHealth for preventing fall risk in the elderly population.

First, this review highlights the need for further research on the use of eHealth devices in proper clinical settings. This represents an opportunity to be explored, reaching out to elderly people with balance and risk of falling.

Second, despite several efforts to explore balance among the elderly, there is still a need for better characterization and description of the health condition of the population under study. In particular, we recommend future studies to include the results of functional tests of the inner ear as a gold-standard test or for comparison of the outcome before and after remote balance rehabilitation. Most of the interventions were developed with only functional balance tests. Future studies should also focus on the real-life environment, allowing for additional information of the daily activities among elderly participants.

Third, a longer follow-up time is important to evaluate the long-term benefits of eHealth tools on the balance performance and risk of falling of elderly people.

Finally, the eHealth devices should be user-friendly to improve adherence among elderly people.

Limitations

This review was limited to articles written in the English language and available on the PubMed, Google Scholar, Embase, and SciELO databases for the last 5 years; therefore, it is possible that relevant studies were missed.

Conclusions

The inclusion of eHealth services can play a critical role for the better provision of health care to elderly people with a balance disorder and risk of falling. The differences in populations, methodologies, eHealth devices, and follow-up times of the included studies did not allow for a clear comparison between results, therefore limiting the possibility of obtaining valid guidance for clinical applicability. More rigorous studies are recommended.

Acknowledgments

This work was partially supported by Fundação para a Ciência e a Tecnologia (FCT) for funds to Global Health and Tropical Medicine (GHTM) (UID/04413/2020 to LVL).

Conflicts of Interest

None declared.

References

1. Action plan on specific action on innovation in support of personalized health management, starting with a falls prevention initiative. European Innovation Partnership on Active and Healthy Ageing (EIP-AHA). 2013. URL: https://ec.europa.eu/eip/ageing/library/action-plan-specific-action-innovation-support-personalized-health-management-starting-falls_en.html [accessed 2020-01-05]
2. Global strategy and action plan on ageing and health. World Health Organization. 2017. URL: https://www.who.int/ageing/WHO-GSAP-2017.pdf?ua=1 [accessed 2020-01-05]
3. Health at a glance 2019 - OECD INDICATORS. Organization for Economic Co-operation and Development (OECD). URL: https://oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2019_4dd50c09-en [accessed 2020-05-17]
4. Ageing Europe - Looking at the lives of older people in the EU. Eurostat - Statistics Explained. 2020. URL: https://ec.europa.eu/eurostat/statistics-explained/index.php/Ageing_Europe_-_looking_at_the_lives_of_older_people_in_the_EU [accessed 2020-11-29]
5. Salzman B. Gait and balance disorders in older adults. Am Fam Physician 2010 Jul 01;82(1):61-68 [FREE Full text] [Medline: 20590073]
6. Agrawal Y, Van de Berg R, Wuyts F, Walther L, Magnusson M, Oh E, et al. Presbyvestibulopathy: Diagnostic Criteria Consensus document of the classification committee of the Bárány Society. J Vestib Res 2019;29(4):161-170. [doi: 10.3233/VES-190672] [Medline: 31306146]
7. WHO global report on falls prevention in older age. World Health Organization. 2007. URL: https://www.who.int/ageing/publications/Falls_prevention7March.pdf [accessed 2020-01-05]
8. Berry SD, Miller RR. Falls: epidemiology, pathophysiology, and relationship to fracture. Curr Osteoporos Rep 2008 Dec;6(4):149-154 [FREE Full text] [doi: 10.1007/s11914-008-0026-4] [Medline: 19032925]
9. Haagsma JA, Olij BF, Majdan M, van Beeck EF, Vos T, Castle CD, et al. Falls in older aged adults in 22 European countries: incidence, mortality and burden of disease from 1990 to 2017. Inj Prev 2020 Oct;26(Supp 1):i67-i74. [doi: 10.1136/injuryprev-2019-043347] [Medline: 32111726]
10. Integrated care for older people Guidelines on community-level interventions to manage declines in intrinsic capacity. World Health Organization Institutional Repository for Information Sharing. 2017. URL: https://apps.who.int/iris/handle/10665/258981 [accessed 2020-01-05]

11. Neuhauser H. The epidemiology of dizziness and vertigo. Handb Clin Neurol 2016;137:67-82. [doi: 10.1016/B978-0-444-63437-5.00005-4] [Medline: 27638063]
12. Wojtczak R, Narożny W, Kuczkowski J, Siebert J. Epidemiology of dizziness in northern Poland - The first Polish neurootologic survey of the general population. Ann Agric Environ Med 2017 Sep 21;24(3):502-506. [doi: 10.5604/12321966.1228401] [Medline: 28954498]
13. Fernández L, Breinbauer HA, Delano PH. Vertigo and dizziness in the elderly. Front Neurol 2015;6:144. [doi: 10.3389/fneur.2015.00144] [Medline: 26167157]
14. Kerber KA, Callaghan BC, Telian SA, Meurer WJ, Skolarus LE, Carender W, et al. Dizziness symptom type prevalence and overlap: A US nationally representative survey. Am J Med 2017 Dec;130(12):1465.e1-1465.e9. [doi: 10.1016/j.amjmed.2017.05.048] [Medline: 28739195]
15. Lin HW, Bhattacharyya N. Balance disorders in the elderly: epidemiology and functional impact. Laryngoscope 2012 Aug;122(8):1858-1861. [doi: 10.1002/lary.23376] [Medline: 22645067]
16. Maarsingh OR, Dros J, Schellevis FG, van Weert HC, Bindels PJ, Horst HEVD. Dizziness reported by elderly patients in family practice: prevalence, incidence, and clinical characteristics. BMC Fam Pract 2010 Jan 11;11:2 [FREE Full text] [doi: 10.1186/1471-2296-11-2] [Medline: 20064231]
17. Gillespie LD, Robertson MC, Gillespie WJ, Sherrington C, Gates S, Clemson LM, et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 2012 Sep 12(9):CD007146. [doi: 10.1002/14651858.CD007146.pub3] [Medline: 22972103]
18. Ekvall Hansson E, Magnusson M. Vestibular asymmetry predicts falls among elderly patients with multi-sensory dizziness. BMC Geriatr 2013 Jul 22;13:77 [FREE Full text] [doi: 10.1186/1471-2318-13-77] [Medline: 23875891]
19. Kristinsdottir EK, Jarnlo GB, Magnusson M. Asymmetric vestibular function in the elderly might be a significant contributor to hip fractures. Scand J Rehabil Med 2000 Jun;32(2):56-60. [Medline: 10853718]
20. Kristinsdottir EK, Nordell E, Jarnlo GB, Tjäder A, Thorngren KG, Magnusson M. Observation of vestibular asymmetry in a majority of patients over 50 years with fall-related wrist fractures. Acta Otolaryngol 2001 Jun;121(4):481-485. [Medline: 11508508]
21. Baldursdottir B, Petersen H, Jonsson PV, Mogensen B, Whitney SL, Ramel A, et al. Sensory impairments and wrist fractures: A case-control study. J Rehabil Med 2018 Feb 13;50(2):209-215 [FREE Full text] [doi: 10.2340/16501977-2312] [Medline: 29271981]
22. Heinrich S, Rapp K, Rissmann U, Becker C, König HH. Cost of falls in old age: a systematic review. Osteoporos Int 2010 Jun;21(6):891-902. [doi: 10.1007/s00198-009-1100-1] [Medline: 19924496]
23. Kerber KA. Vertigo and dizziness in the emergency department. Emerg Med Clin North Am 2009 Feb;27(1):39-50 [FREE Full text] [doi: 10.1016/j.emc.2008.09.002] [Medline: 19218018]
24. Kovacs E, Wang X, Grill E. Economic burden of vertigo: a systematic review. Health Econ Rev 2019 Dec 27;9(1):37 [FREE Full text] [doi: 10.1186/s13561-019-0258-2] [Medline: 31883042]
25. Saber Tehrani AS, Coughlan D, Hsieh YH, Mantokoudis G, Korley FK, Kerber KA, et al. Rising annual costs of dizziness presentations to U.S. emergency departments. Acad Emerg Med 2013 Jul;20(7):689-696. [doi: 10.1111/acem.12168] [Medline: 23859582]
26. Bhaskar S, Bradley S, Chattu VK, Adisesh A, Nurtazina A, Kyrykbayeva S, et al. Telemedicine across the Globe-Position Paper from the COVID-19 Pandemic Health System Resilience PROGRAM (REPROGRAM) International Consortium (Part 1). Front Public Health 2020;8:556720. [doi: 10.3389/fpubh.2020.556720] [Medline: 33178656]
27. Gammon D, Berntsen GKR, Koricho AT, Sygna K, Ruland C. The chronic care model and technological research and innovation: a scoping review at the crossroads. J Med Internet Res 2015 Feb 06;17(2):e25 [FREE Full text] [doi: 10.2196/jmir.3547] [Medline: 25677200]
28. Kim K, Gollamudi SS, Steinhubl S. Digital technology to enable aging in place. Exp Gerontol 2017 Feb;88:25-31. [doi: 10.1016/j.exger.2016.11.013] [Medline: 28025126]
29. Global Observatory of eHealth. Global diffusion of eHealth: Making universal health coverage achievable: Report of the third Global Observatory on eHealth. World Health Organization. 2016. URL: https://apps.who.int/iris/bitstream/handle/10665/252529/9789241511780-eng.pdf;jsessionid=4857CD1FAD00D6536337F2868A07FD81?sequence=1#page=16 [accessed 2019-11-07]
30. Lapão L, Dussault G. The contribution of eHealth and mHealth to improving the performance of the health workforce: a review. Public Health Panorama.: World Health Organization Regional Office for Europe; 2017. URL: https://apps.who.int/iris/handle/10665/325262 [accessed 2019-11-07]
31. eHealth at WHO. World Health Organization. 2019 Dec 3. URL: https://www.who.int/ehealth/about/en/ [accessed 2019-12-03]
32. Gordon NP, Crouch E. Digital information technology use and patient preferences for internet-based health education modalities: cross-sectional survey study of middle-aged and older adults with chronic health conditions. JMIR Aging 2019 Apr 04;2(1):e12243 [FREE Full text] [doi: 10.2196/12243] [Medline: 31518291]
33. Merkel S, Hess M. The use of internet-based health and care services by elderly people in Europe and the importance of the country context: multilevel study. JMIR Aging 2020 Jun 03;3(1):e15491 [FREE Full text] [doi: 10.2196/15491] [Medline: 32490837]

34. Ammenwerth E, Duftschmid G, Al-Hamdan Z, Bawadi H, Cheung NT, Cho K, et al. International comparison of six basic eHealth indicators across 14 countries: an eHealth benchmarking study. Methods Inf Med 2020 Dec;59(S 02):e46-e63 [FREE Full text] [doi: 10.1055/s-0040-1715796] [Medline: 33207386]
35. Yelnik A, Bonan I. Clinical tools for assessing balance disorders. Neurophysiol Clin 2008 Dec;38(6):439-445. [doi: 10.1016/j.neucli.2008.09.008] [Medline: 19026963]
36. Montesinos L, Castaldo R, Pecchia L. Wearable inertial sensors for fall risk assessment and prediction in older adults: a systematic review and meta-analysis. IEEE Trans Neural Syst Rehabil Eng 2018 Mar;26(3):573-582. [doi: 10.1109/TNSRE.2017.2771383] [Medline: 29522401]
37. Bet P, Castro PC, Ponti MA. Fall detection and fall risk assessment in older person using wearable sensors: A systematic review. Int J Med Inform 2019 Oct;130:103946. [doi: 10.1016/j.ijmedinf.2019.08.006] [Medline: 31450081]
38. Moreira Bittar RS, Bovino Pedalini ME, Oiticica Ramalho J, Yoshimura R. Critical analysis of vestibular rehabilitation outcome according to dizziness etiology. Braz J Otorhinolaryngol 2007 Nov;73(6):760-764. [doi: 10.1016/s1808-8694(15)31172-1]
39. Han BI, Song HS, Kim JS. Vestibular rehabilitation therapy: review of indications, mechanisms, and key exercises. J Clin Neurol 2011 Dec;7(4):184-196 [FREE Full text] [doi: 10.3988/jcn.2011.7.4.184] [Medline: 22259614]
40. Lacour M, Bernard-Demanze L. Interaction between vestibular compensation mechanisms and vestibular rehabilitation therapy: 10 recommendations for optimal functional recovery. Front Neurol 2014;5:285. [doi: 10.3389/fneur.2014.00285] [Medline: 25610424]
41. Rossi-Izquierdo M, Gayoso-Diz P, Santos-Pérez S, Del-Río-Valeiras M, Faraldo-García A, Vaamonde-Sánchez-Andrade I, et al. Vestibular rehabilitation in elderly patients with postural instability: reducing the number of falls-a randomized clinical trial. Aging Clin Exp Res 2018 Nov;30(11):1353-1361. [doi: 10.1007/s40520-018-1003-0] [Medline: 30008159]
42. Skjæret N, Nawaz A, Morat T, Schoene D, Helbostad JL, Vereijken B. Exercise and rehabilitation delivered through exergames in older adults: An integrative review of technologies, safety and efficacy. Int J Med Inform 2016 Jan;85(1):1-16. [doi: 10.1016/j.ijmedinf.2015.10.008] [Medline: 26559887]
43. Choi SD, Guo L, Kang D, Xiong S. Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review. Appl Ergon 2017 Nov;65:570-581. [doi: 10.1016/j.apergo.2016.10.013] [Medline: 27825723]
44. Sun R, Sosnoff JJ. Novel sensing technology in fall risk assessment in older adults: a systematic review. BMC Geriatr 2018 Jan 16;18(1):14 [FREE Full text] [doi: 10.1186/s12877-018-0706-6] [Medline: 29338695]
45. Rucco R, Sorriso A, Liparoti M, Ferraioli G, Sorrentino P, Ambrosanio M, et al. Type and location of wearable sensors for monitoring falls during static and dynamic tasks in healthy elderly: a review. Sensors (Basel) 2018 May 18;18(5):1613 [FREE Full text] [doi: 10.3390/s18051613] [Medline: 29783647]
46. Nguyen H, Mirza F, Naeem MA, Baig MM. Falls management framework for supporting an independent lifestyle for older adults: a systematic review. Aging Clin Exp Res 2018 Nov;30(11):1275-1286. [doi: 10.1007/s40520-018-1026-6] [Medline: 30196346]
47. Leirós-Rodríguez R, García-Soidán JL, Romo-Pérez V. Analyzing the use of accelerometers as a method of early diagnosis of alterations in balance in elderly people: a systematic review. Sensors (Basel) 2019 Sep 09;19(18):3883 [FREE Full text] [doi: 10.3390/s19183883] [Medline: 31505828]
48. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med 2009 Jul 21;6(7):e1000100 [FREE Full text] [doi: 10.1371/journal.pmed.1000100] [Medline: 19621070]
49. O'Connor D, Green S, Higgins JPT. Chapter 5: Defining the review questiondeveloping criteria for including studies. In: Higgins JPT, Green S, editors. Cochrane Handbook of Systematic Reviews of Intervention. Version 5.1.0 (updated March 2011). London, UK: The Cochrane Collaboration; 2011.
50. Active ageing: a policy framework. World Health Organization. 2002. URL: https://www.who.int/ageing/publications/active_ageing/en/ [accessed 2019-11-05]
51. Knudson D. Fundamentals of Biomechanics. 2nd edition. New York: Springer; 2007.
52. Rosso AL, Studenski SA, Chen WG, Aizenstein HJ, Alexander NB, Bennett DA, et al. Aging, the central nervous system, and mobility. J Gerontol A Biol Sci Med Sci 2013 Nov;68(11):1379-1386 [FREE Full text] [doi: 10.1093/gerona/glt089] [Medline: 23843270]
53. A health telematics policy in support of WHO's Health-for-all strategy for global health development: report of the WHO Group Consultation on Health Telematics, 11-16 December, Geneva, 1997. World Health Organization. 1998. URL: https://apps.who.int/iris/handle/10665/63857 [accessed 2021-04-15]
54. Eysenbach G. What is e-health? J Med Internet Res 2001;3(2):E20 [FREE Full text] [doi: 10.2196/jmir.3.2.e20] [Medline: 11720962]
55. Deldar K, Bahaadinbeigy K, Tara SM. Teleconsultation and clinical decision making: a systematic review. Acta Inform Med 2016 Jul 16;24(4):286-292 [FREE Full text] [doi: 10.5455/aim.2016.24.286-292] [Medline: 27708494]
56. Jones DP. Biomedical Sensors. New York: Momentum Press; 2010.
57. Critical appraisal tools. The Joanna Briggs Institute. URL: https://jbi.global/critical-appraisal-tools [accessed 2019-01-05]

58. Julian PT Higgins, Jelena Savovic, Matthew J Page, Jonathan AC Sterne on behalf of the ROB2 Development Group. Revised Cochrane risk-of-bias tool for randomized trials (Rob2). URL: https://sites.google.com/site/riskofbiastool/welcome/rob-2-0-tool/current-version-of-rob-2 [accessed 2019-01-05]
59. Eggenberger P, Theill N, Holenstein S, Schumacher V, de Bruin ED. Multicomponent physical exercise with simultaneous cognitive training to enhance dual-task walking of older adults: a secondary analysis of a 6-month randomized controlled trial with 1-year follow-up. Clin Interv Aging 2015;10:1711-1732 [FREE Full text] [doi: 10.2147/CIA.S91997] [Medline: 26604719]
60. Gschwind YJ, Eichberg S, Ejupi A, de Rosario H, Kroll M, Marston HR, et al. ICT-based system to predict and prevent falls (iStoppFalls): results from an international multicenter randomized controlled trial. Eur Rev Aging Phys Act 2015;12:10 [FREE Full text] [doi: 10.1186/s11556-015-0155-6] [Medline: 26865874]
61. Gschwind YJ, Schoene D, Lord SR, Ejupi A, Valenzuela T, Aal K, et al. The effect of sensor-based exercise at home on functional performance associated with fall risk in older people - a comparison of two exergame interventions. Eur Rev Aging Phys Act 2015;12:11 [FREE Full text] [doi: 10.1186/s11556-015-0156-5] [Medline: 26865875]
62. Lim SB, Horslen BC, Davis JR, Allum JHJ, Carpenter MG. Benefits of multi-session balance and gait training with multi-modal biofeedback in healthy older adults. Gait Posture 2016 Jun;47:10-17. [doi: 10.1016/j.gaitpost.2016.03.017] [Medline: 27264396]
63. Oesch P, Kool J, Fernandez-Luque L, Brox E, Evertsen G, Civit A, et al. Exergames versus self-regulated exercises with instruction leaflets to improve adherence during geriatric rehabilitation: a randomized controlled trial. BMC Geriatr 2017 Mar 23;17(1):77 [FREE Full text] [doi: 10.1186/s12877-017-0467-7] [Medline: 28330455]
64. Ozaki K, Kondo I, Hirano S, Kagaya H, Saitoh E, Osawa A, et al. Training with a balance exercise assist robot is more effective than conventional training for frail older adults. Geriatr Gerontol Int 2017 Nov;17(11):1982-1990. [doi: 10.1111/ggi.13009] [Medline: 28295912]
65. Hong J, Kong H, Yoon H. Web-based telepresence exercise program for community-dwelling elderly women with a high risk of falling: randomized controlled trial. JMIR Mhealth Uhealth 2018 May 28;6(5):e132 [FREE Full text] [doi: 10.2196/mhealth.9563] [Medline: 29807877]
66. Zakaria NA, Kuwae Y, Tamura T, Minato K, Kanaya S. Quantitative analysis of fall risk using TUG test. Comput Methods Biomech Biomed Engin 2015;18(4):426-437. [doi: 10.1080/10255842.2013.805211] [Medline: 23964848]
67. Hall CD, Clevenger CK, Wolf RA, Lin JS, Johnson TM, Wolf SL. Feasibility of a low-cost, interactive gaming system to assess balance in older women. J Aging Phys Act 2016 Jan;24(1):111-118. [doi: 10.1123/japa.2014-0184] [Medline: 26181324]
68. Howcroft J, Kofman J, Lemaire ED, McIlroy WE. Analysis of dual-task elderly gait in fallers and non-fallers using wearable sensors. J Biomech 2016 May 03;49(7):992-1001. [doi: 10.1016/j.jbiomech.2016.01.015] [Medline: 26994786]
69. Lee C, Sun T, Jiang B, Choi V. Using wearable accelerometers in a community service context to categorize falling behavior. Entropy 2016 Jul 13;18(7):257 [FREE Full text] [doi: 10.3390/e18070257]
70. Ponti M, Bet P, Oliveira CL, Castro PC. Better than counting seconds: Identifying fallers among healthy elderly using fusion of accelerometer features and dual-task Timed Up and Go. PLoS One 2017;12(4):e0175559 [FREE Full text] [doi: 10.1371/journal.pone.0175559] [Medline: 28448509]
71. Similä H, Immonen M, Ermes M. Accelerometry-based assessment and detection of early signs of balance deficits. Comput Biol Med 2017 Jun 01;85:25-32. [doi: 10.1016/j.compbiomed.2017.04.009] [Medline: 28432935]
72. Shahzad A, Ko S, Lee S, Lee J, Kim K. Quantitative assessment of balance impairment for fall-risk estimation using wearable triaxial accelerometer. IEEE Sensors J 2017 Oct 15;17(20):6743-6751. [doi: 10.1109/jsen.2017.2749446]
73. Brodie MA, Coppens MJ, Ejupi A, Gschwind YJ, Annegarn J, Schoene D, et al. Comparison between clinical gait and daily-life gait assessments of fall risk in older people. Geriatr Gerontol Int 2017 Nov;17(11):2274-2282. [doi: 10.1111/ggi.12979] [Medline: 28176431]
74. Howcroft J, Lemaire ED, Kofman J, McIlroy WE. Dual-task elderly gait of prospective fallers and non-fallers: a wearable-sensor based analysis. Sensors (Basel) 2018 Apr 21;18(4):1275 [FREE Full text] [doi: 10.3390/s18041275] [Medline: 29690496]
75. Chigateri NG, Kerse N, Wheeler L, MacDonald B, Klenk J. Validation of an accelerometer for measurement of activity in frail older people. Gait Posture 2018 Oct;66:114-117. [doi: 10.1016/j.gaitpost.2018.08.024] [Medline: 30172217]
76. Qiu H, Rehman RZU, Yu X, Xiong S. Application of wearable inertial sensors and a new test battery for distinguishing retrospective fallers from non-fallers among community-dwelling older people. Sci Rep 2018 Nov 05;8(1):16349 [FREE Full text] [doi: 10.1038/s41598-018-34671-6] [Medline: 30397282]
77. Hsieh KL, Roach KL, Wajda DA, Sosnoff JJ. Smartphone technology can measure postural stability and discriminate fall risk in older adults. Gait Posture 2019 Jan;67:160-165. [doi: 10.1016/j.gaitpost.2018.10.005] [Medline: 30340129]
78. Maneeprom N, Taneepanichskul S, Panza A, Suputtitada A. Effectiveness of robotics fall prevention program among elderly in senior housings, Bangkok, Thailand: a quasi-experimental study. Clin Interv Aging 2019;14:335-346. [doi: 10.2147/CIA.S182336] [Medline: 30863027]
79. Nightingale CJ, Mitchell SN, Butterfield SA. Validation of the Timed Up and Go Test for assessing balance variables in adults aged 65 and older. J Aging Phys Act 2019 Apr 01;27(2):230-233. [doi: 10.1123/japa.2018-0049] [Medline: 30117359]

80. Viirre E. Vestibular telemedicine and rehabilitation. Applications for virtual reality. Stud Health Technol Inform 1996;29:299-305. [Medline: 10163763]

Abbreviations

ICT: information and communication technologies
JBI: Joanna Briggs Institute
QES: quasiexperimental study
RCT: randomized controlled trial
TUGT: Timed Up and Go Test

Edited by R Kukafka; submitted 08.07.20; peer-reviewed by L Barbosa, H Wang, J Howcroft; comments to author 17.11.20; revised version received 10.01.21; accepted 25.02.21; published 28.04.21

Please cite as:
Gaspar AGM, Lapão LV
eHealth for Addressing Balance Disorders in the Elderly: Systematic Review
J Med Internet Res 2021;23(4):e22215
URL: https://www.jmir.org/2021/4/e22215
doi: 10.2196/22215
PMID:

2.2. PAPER II

Gaspar AGM, Escada P, Lapão LV. How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study. *Int J Environ Res Public Health*. 2021 Jul 11;18(14):7410. DOI: 10.3390/ijerph18147410

International Journal of
Environmental Research and Public Health

MDPI

Article

How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study

Andréa Gomes Martins Gaspar [1,2,*,†], Pedro Escada [3] and Luís Velez Lapão [1,†]

[1] Instituto de Higiene e Medicina Tropical (IHMT), Universidade NOVA de Lisboa (UNL), 1349-008 Lisbon, Portugal; luis.lapao@ihmt.unl.pt
[2] Hospital Beatriz Ângelo, 2674-514 Lisbon, Portugal
[3] Hospital Egas Moniz, 1349-019 Lisbon, Portugal; pedroalbertoescada@gmail.com
* Correspondence: andreamartinsbr@hotmail.com
† These authors contributed equally to this work.

Abstract: This study aimed to identify relevant topics for the development of an efficient eHealth service for elderly people with balance disorders and risk of falling, based on input from physicians providing healthcare to this patient group. In the quantitative part of the study, an open multiple-choice questionnaire was made available on the website of the Portuguese General Medical Council to assess the satisfaction with electronic medical records regarding clinical data available, the time needed to retrieve data and the usefulness of the data. Of the 118 participants, 55% were dissatisfied/very dissatisfied with data availability and 61% with the time spent to access and update data related to the focused patient group. Despite this negative experience, 76% considered future e-Health solutions as pertinent/very pertinent. Subsequently, these findings were further explored with eight semi-structured interviews. The physicians confirmed the reported dissatisfactions and pointed out the lack of comprehensive data and system interoperability as serious problems, causing inefficient health services with an overlap of emergency visits and uncoordinated diagnostics and treatment. In addition, they discussed the importance of camera and audio monitoring to add significant value. Our results indicate considerable potential for e-Health solutions, but substantial improvements are crucial to achieving such future solutions.

Keywords: balance disorders; falls; elderly care; eHealth; mixed methods

Citation: Gaspar, A.G.M.; Escada, P.; Lapão, L.V. How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7410. https://doi.org/10.3390/ijerph18147410

Academic Editors: Irene Torres-Sanchez and Marie Carmen Valenza

Received: 23 May 2021
Accepted: 8 July 2021
Published: 11 July 2021

1. Introduction

1.1. The Burden of an Ageing Population: Portugal and the World

As is observed in other health systems [1–7], Portugal's increasing life expectancy in recent decades has not been followed by an increase in healthy life years [4,6]. The prevalence of chronic diseases, comorbidities, disabilities and falls have increased with aging [1–7]. In fact, there are many causes for elderly people's falls to happen, including age, environmental factors, inappropriate clothing and shoes, risky behavior, medications, and balance disorders [1,7–9].

Elderly falls represent an important public health problem, being the main cause of accidental death in the population over 65 years of age [1,8–10]. Although Portugal has one of the lowest rates of fall-related mortality in the elderly population of the Western European region, this issue has received attention from the Portuguese government [11].

The burden of aging with balance disorders and falls, and the insufficient access to healthcare data by health professionals, have led to additional medical visits, overdiagnosis, repeated diagnostic tests and multiple prescriptions [12–15]. This misuse of healthcare provision is costlier and unsustainable for the current healthcare provision model and considered unsuitable for responding to elderly population demand [4,12–15]. In order to

relieve this pressure, new strategies have been recommended, including person-centered health systems and the utilization of devices and systems supported by Information Systems and Technologies (IST) [2,5,16] (Figure 1).

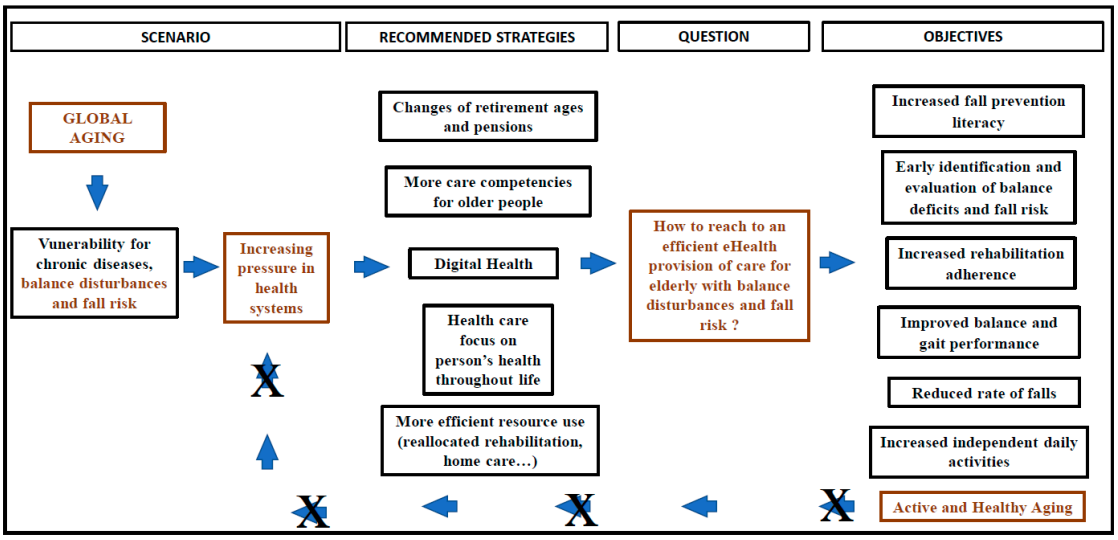


Figure 1. eHealth Framework for the elderly with balance disorders care provision. (Authors own elaboration).

These healthcare solutions have revealed the potential to provide quality health services with complete, interoperable data in near real-time [17–20], and eHealth services with the engagement of patients and families for self and remote management of chronic conditions and prevention of risky behaviors [2,20–22]. Indeed, many researchers have studied the potential of digital sensors to identify early balance deficit and identify fallers among elderly people, improving the data quality of clinical tests and functional scales as the Timed Up and Go Test (TUGT) and the Berg Balance Scale [23–29]. Other researchers have evaluated the benefits of eHealth devices in balance training, reducing the risk of falling [29–31]. The eHealth services seem to have the potential to be a complementary method for preventive monitoring of falls, telerehabilitation, and monitoring of effective rehabilitation for elderly with balance disorder and risk of falling [23–31], aligned with the eHealth definition: "*an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology*" [32]. However, there are still constraints to be overcome: technological obsolescence; unsuitable technological devices; regulation, standardization, auditing, inspection and quality control; lack of interoperability; health professional resistance; low organizational capability for new ways of working and organization; shortage of digital training [33–38]. In Europe, both the skill development in old age and the aging of younger generations of technology users have led to a growing number of elderly people able to use health and care services online, although to a lesser extent in Portugal [39].

1.2. Portugal and the Strategies Supported by IST

To build up a shared ecosystem of health information, the Portuguese Ministry of Health created an Electronic Health Record (EHR) called "Sclínico," which is unfortunately not yet available in all health units of the Portuguese National Health Service (NHS) [40]. More recently, another digital service was made available on the NHS' digital platform to allow the sharing of clinical information between all levels of health care and to promote the interaction between the citizen and the family health unit [40]. In addition, the Portuguese elderly people can use the current telephone and digital service of the NHS Call

Center, known as "SNS 24," which is responsible for the triage of first-level emergencies and guiding the population about health problems [40]. Another NHS telephone service, known as Senior Proximity Project, was implemented to identify the risks and needs of elderly people to reduce morbidity and promote more autonomy and health literacy [41]. Several public health units have provided retinal examination by teleradiology, teleconsultation, telediagnostic-telepathology, telemonitoring of cardiac and pulmonary diseases and telerehabilitation of osteoarticular disease of shoulder and knee [40]. Additionally, the electronic prescription system and the treatment guide for the user have allowed patients, including elderly people with chronic diseases, to obtain their medication without ever going to a health care unit [40].

However, in recent reviews [23–31], it was pointed out that the clinical applicability of eHealth devices and services in screening, assessing and treating elderly people with balance disorders and the risk of falling in Portugal is still unknown. Therefore, we aim at studying how to obtain an efficient eHealth service for the provision of care for elderly people with balance disorders and the risk of falling.

The purposes of this explanatory sequential mixed methods approach [42] were: (a) to identify and understand how to overcome the medical difficulties about availability of clinical data in the electronic medical record (EMR) relatively to the context of healthcare provision for elderly with balance disorders and risk of falling; (b) to know and understand the medical relevance about eHealth services to support health care for elderly people with balance disorders and risk of falls; (c) to understand how to develop an efficient eHealth service to support health care for elderly people with balance disorders and risk of falls.

The increasing interest of elderly people in medical digital devices and the eHealth potential to enhance health promotion and physician–patient interaction to mitigate care access inequities and to allow remote management of balance disorders and risk of falling are opportunities that should be further explored for active and healthy aging [29]. This could be viewed as an opportunity to mitigate the aging pressure in the health systems.

2. Materials and Methods

2.1. Study Design

From June to August 2019, the authors performed a quantitative observational descriptive study [42] to identify the difficulties about clinical data and the relevance of eHealth (Figure 2).

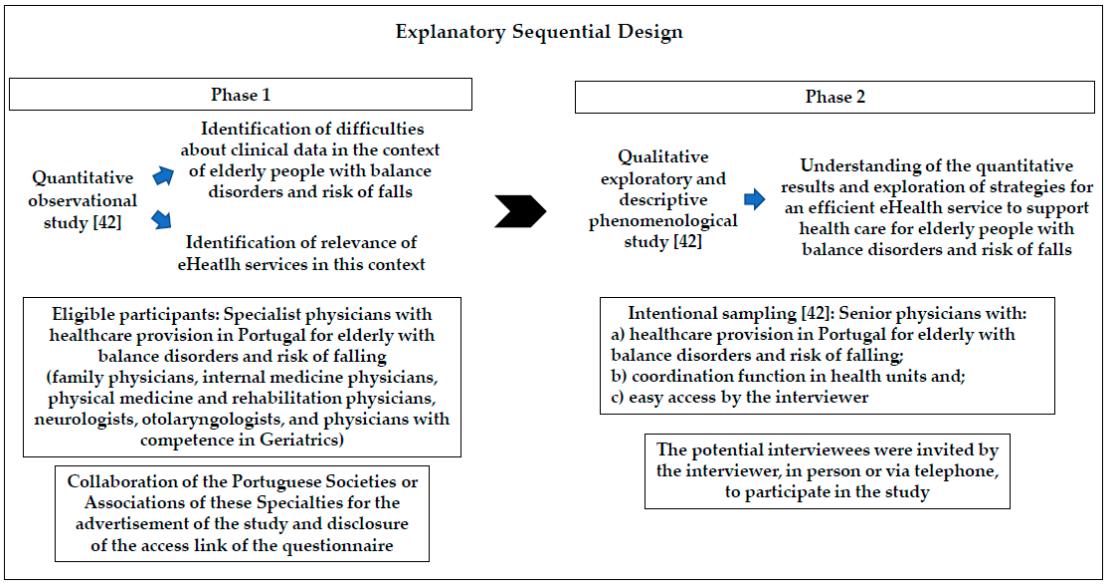


Figure 2. Design of the mixed methods study performed.

This first phase aimed at responding to the following specific research questions: "Do physicians have difficulties accessing current clinical data in EMR relatively to the context of healthcare provision for elderly with balance disorders and risk of falling?"; "In this context, what is the medical satisfaction level with the use (e.g., time spent to access and fill in clinical data) and quality (e.g., availability of sufficient and understandable clinical data) of the current clinical data in the electronic medical record (EMR)?", and "Could eHealth services be relevant to improve healthcare?".

From December 2019 to April 2020, a qualitative exploratory and descriptive phenomenological study [42] was performed to understand the quantitative results and how to obtain an efficient eHealth service to support health care for elderly people with balance disorders and risk of falls. This second phase explored the following research questions: "What are the medical difficulties related with current clinical data in the context of health care provision for elderly with balance disorders and risk of falling?"; "What strategies can be implemented to improve clinical data?"; "What do you think about the contribution of eHealth?"; "How can an eHealth service be suitable? What are the necessary strategies? What difficulties must be overcome?".

2.2. Materials

The questionnaire, entitled "Health contribution to the provision of health care for the elderly at risk of falling due to balance disorders" (in the original: "A contribuição do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio") was developed with 18 multiple choice questions [42]. It included sociodemographic data of the participants, availability of data in the EMR and relevance of eHealth in the context of health care for the elderly with balance disorder and risk of falling. Except for the demographic questions, alternative responses on quantity, frequency and evaluation were used, and a non-response ("Do not know/Do not answer") was provided [42] (see Table A1). The usability, technical functionality and time to complete the questionnaire were tested. The access link was available through the website of the Portuguese General Medical Council (Ordem dos Médicos de Portugal), the entity that regulates medical practice in Portugal (https://ordemdosmedicos.pt/inquerito-a-contribuicao-do-ehealth-na-prestacao-de-cuidados-de-saude-ao-idoso/ (accessed on 25 June 2019)). The information regarding this open survey was provided online. The eligible participants were specialist physicians who provide healthcare in Portugal for the elderly with balance disorders and risk of falling, including family physicians, internal medicine physicians, physical medicine and rehabilitation (PMR) physicians, neurologists, otolaryngologists and physicians with competence in Geriatrics. For the advertisement of the study and disclosure of the access link of the questionnaire, the authors requested, via email, the collaboration of the Portuguese Society of Physical Medicine and Rehabilitation, Portuguese Association of General and Family Medicine, Portuguese Society of Internal Medicine, Center for Geriatric Studies of the Portuguese Society of Internal Medicine, Portuguese Society of Otorhinolaryngology and Portuguese Otoneurology Association. The Portuguese Society of Neurology was also contacted through this institution's website. The questionnaire was distributed online using the survey software SurveyMonkey® [43]. Each question was made available in turn, with the possibility of returning to the previous questions. All questions had one mandatory answer [44]. During the study time, the IP address of the participants was used to eliminate potential duplicate responses from the same user [44].

Regarding the qualitative study, the same interviewer (one of the authors) conducted individual semi-structured interviews [42]. Four primary thematic categories were discussed: current clinical data in the context of health provision for elderly with balance disorders and risk of falling (i.e., understanding of quantitative results), interventions to improve the clinical data, understanding of eHealth relevance pointed out by physicians in the quantitative research, and strategies to improve the use of eHealth services (see Table A2). The sampling was intentional [42], with a purposeful search for physicians

with: (a) healthcare provision for elderly with balance disorders and risk of falling; (b) coordination function in health units and; (c) easy access by the interviewer. The potential interviewees were invited by the interviewer, in person or via telephone, to participate in the study. The participant number was defined after saturation or redundancy of responses; that is, the sampling process was completed when no new information emerged from the new interviews [42]. Respecting the anonymous participation of the quantitative study, the interviewer did not ask if the interviewee had participated in the previous study.

2.3. Data Analysis

Firstly, to determine the quantitative frequency tables [42], a descriptive and exploratory statistics of the data from the questionnaires were performed. The software IBM SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA) was used [45]. Secondly, a descriptive analysis of demographic data [42] of interviewed was performed. All the interviews were manually coded and transcribed by the interviewer, allowing content analysis of interviews [42]. For a better comprehension of the quotes, the authors entered words in round brackets.

2.4. Ethical Considerations

The survey's aim was clearly identified in both the website of the Portuguese General Medical Council and on the SurveyMonkey® link [SURVEY PREVIEW MODE] A contribuição do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio Survey (surveymonkey.com, accessed on 25 June 2019). The physicians could voluntarily participate and leave the study until the submission of the questionnaire. The information of the quantitative study was treated confidentially and anonymously by using respondent e-mails confidentiality and anonymous responses features of the software SurveyMonkey® [43].

Regarding the interviews, the participants signed a consent form and received a copy of this and information about the study. They could leave the study until one month after the interview's date. The audio recording was authorized by the participants. To guarantee confidentiality, all interviews were manually coded. The transcriptions omitted information to avoid identifying respondents. All data were kept anonymous [42]. The information from the questionnaires and interviews and the audio records were kept in a safe place (external disk with access code) within the period provided by the Portuguese law [46], always safeguarding the confidentiality of the information obtained.

3. Results

3.1. First Phase: Quantitative Research

The online questionnaire had a total of 118 responses. This represents 1% of the total universe of 12,214 [47] family physicians, internal medicine physicians, PMR physicians, neurologists and otolaryngologists registered in Portugal (Table 1).

Table 1. Study quantitative: Demographic data of the participants. PMR: physical medicine and rehabilitation.

Demographic Data/Specialty	Family Physician	Internal Medicine Physician	PMR Physician	Neurologist	Otolaryngologist	Total
Physician number according to Portuguese General Medical Council—year 2019 [47]	7451	2847	691	549	676	12,214
Number of participants of the study according to specialty (%)	18 (15.3%)	46 (39.0%)	5 (4.2%)	4 (3.4%)	45 (38.1%)	118 (100%)

Table 1. *Cont.*

Demographic Data/Specialty	Family Physician	Internal Medicine Physician	PMR Physician	Neurologist	Otolaryngologist	Total
Participation according to specialty total number of physicians (%)	18/7451 (0.2%)	46/2847 (1.6%)	5/691 (0.7%)	4/549 (0.7%)	45/676 (6.7%)	118/12 214 (1.0%)
Participant's gender (M/F)	3/15	15/31	3/2	1/3	24/21	46/72
Participant age $\leq$ 50 years old/Total physician number age $\leq$ 50 years old [a]	15/2390	34/1299	5/271	3/234	30/233	87/4427
Participant age >51 years old/Total physician number age > 51 years old [a]	3/5061	12/1548	0/420	1/315	15/443	31/7787
Regional Health Administration of Portugal						
-North	2	13	1	0	8	24
-Center	0	7	1	0	12	20
-Lisbon and Tejo Valey	16	19	3	4	22	64
-Alentejo	0	3	0	0	1	4
-Algarve	0	4	0	0	2	6
-Madeira	0	0	0	0	0	0
-Azores	0	0	0	0	0	0
Main job—Public sector	17	43	4	4	29	97
Main job—Private sector	1	3	1	0	16	21

[a] According to Portuguese General Medical Council ("Ordem dos Médicos de Portugal")—year 2019 [47].

There was no duplicate response found with the same IP address. A relevant proportion of the respondent activity was directed to provide care to elderly people in the context studied. About the elderly people observed by physicians, 19% of the participants said that their monthly appointment time was more than 50% occupied with elderly patients with balance disorders, while 9% of physicians had their monthly appointment time more than 50% occupied with elderly patients with complaints related to consequent falls. A total of 86% of the physicians recognized the relevance of data about the previous provision of health care to the elderly with balance disorders and risk of falling. However, A total of 43% of all physicians responded that they need to access data from previous care consultations for elderly patients with balance disorder and risk of falling in more than half of cases. The majority of the participants (84%) had access to this information through the hospital or health center electronic medical record. Most respondents (60%) reported that more than half of the medical consultation time had been spent on IST-related activities. Moreover, 50% of participants were dissatisfied or very dissatisfied with the use of IST (e.g., usefulness, quality) in the context of balance disorders and the risk of falling in the elderly.

3.1.1. Socio-Demographic Participant Data

Most of the participants were female, accounting for 72 responses (61%). Younger physicians adhered more to the study: most participants (74%) had 50 years old or less. Although 64% of the eligible physicians were over 50 years old (7787 out of 12,214), the participants over 50 years old represented only 26% (31 out of 118) of the responses.

About 39% of the participants were specialists in Internal Medicine, 38% in Otolaryngology, 15% were family physicians, 4% PMR physicians, and 3% were neurologists. Only 4% were enrolled in the College of Competence in Geriatrics. Comparing the numbers, the family physicians had weak participation (18 out of 7451 family physicians), although being the specialty most represented among the eligible physicians.

Most physicians (82%) had the main job in public healthcare units, and 54% were from the larger Portuguese health region, the Lisbon and Tejo Valey (LTV) Regional Health Administration. (Table 1)

3.1.2. Difficulties and Medical Satisfaction Level Related to Current Clinical Data in the EMR (Electronic Medical Registration)

61% of all respondents were dissatisfied or very dissatisfied with the time spent accessing clinical data in the EMR, rising to 65% when considering only professionals who have the main job in a public healthcare institution. Regarding the availability of sufficient and understandable clinical data in the EMR, 55% of the physicians revealed dissatisfaction or a lot of dissatisfaction, with values of 59% for public health professionals as their main job. Again, 61% of all participants also expressed dissatisfaction or great dissatisfaction with time spent to fill in new data in the EMR, reaching 64% among professionals with the main job in a public health institution (Table 2).

Table 2. Questionnaire: Satisfaction degree with clinical data in the EMR—Context of health care provision for elderly with balance disorders and risk of falling.

Satisfaction Degree/Specialty	Family Physician	Internal Medicine Physician	PMR Physician	Neurologist	Otolaryngologist	Total
Time to data access (public and private main job)						
-S	1	12	3	1	25	42 (36%)
-D	17	34	1	3	17	72 (61%)
-Others	0	0	1	0	3	4 (3%)
TOTAL	18	46	5	4	45	118 (100%)
Time to data access (public main job)						
-S	1	11	3	1	15	31 (32%)
-D	16	32	0	3	12	63 (65%)
-Others	0	0	1	0	2	3 (3%)
TOTAL	17	43	4	4	29	97 (100%)
Sufficient/understandable data (public and private main job)						
-S	3	18	3	1	25	50 (42%)
-D	15	27	2	3	18	65 (55%)
-Others	0	1	0	0	2	3 (3%)
TOTAL	18	46	5	4	45	118 (100%)
Sufficient/understandable data (public main job)						
-S	3	16	3	1	15	38 (39%)
-D	14	26	1	3	13	57 (59%)
-Others	0	1	0	0	1	2 (2%)
TOTAL	17	43	4	4	29	97 (100%)
Time to fill data (public and private main job)						
-S	2	13	2	0	22	39 (33%)
-D	16	29	3	4	20	72 (61%)
-Others	0	4	0	0	3	7 (6%)
TOTAL	18	46	5	4	45	118 (100%)

Table 2. *Cont.*

Satisfaction Degree/Specialty	Family Physician	Internal Medicine Physician	PMR Physician	Neurologist	Otolaryngologist	Total
Time to fill data (public main job)						
-S	2	12	2	0	13	29 (30%)
-D	15	27	2	4	14	62 (64%)
-Others	0	4	0	0	2	6 (6%)
TOTAL	17	43	4	4	29	97 (100%)

S: Satisfied or very satisfied. D: Dissatisfied or very dissatisfied. Others: Did not use or Did not answer or Did not know.

3.1.3. Relevance of the Use of eHealth

The possibility of using eHealth for elderly patients with balance disorder and risk of falling was considered pertinent or very pertinent by 76% of all physicians and also by professionals with public healthcare as the main job. Regarding the medical specialties with more than 30 responses, 72% (33 out of 46) and 82% (37 out of 45) of internal medicine physicians and otolaryngologists, respectively, considered remote services as pertinent or very pertinent. If we consider only the participants of Internal Medicine and Otolaryngology working in the public sector as their main job, the percentages remain at 72% (31 out of 43) and rise to 86% (25 out of 29), respectively (Table 3).

Table 3. Questionnaire: Relevance degree about the use of eHealth in the context of care provision for the elderly with balance disorders and the risk of falling.

Relevance of eHealth/Specialty	Family Physician	Internal Medicine Physician	PMR Physician	Neurologist	Otolaryngologist	Total
Public and private main job						
-Pertinent	13	33	5	2	37	90 (76%)
-No pertinent	2	3	0	1	3	9 (8%)
-Indifferent	2	5	0	0	3	10 (8%)
-Others	1	5	0	1	2	9 (8%)
TOTAL	18	46	5	4	45	118 (100%)
Public main job						
-Pertinent	12	31	4	2	25	74 (77%)
-No pertinent	2	3	0	1	1	7 (7%)
-Indifferent	2	4	0	0	2	8 (8%)
-Others	1	5	0	1	1	8 (8%)
TOTAL	17	43	4	4	29	97 (100%)

Others: Did not answer or Did not know.

3.2. Second phase: Qualitative Research

The same interviewer conducted a total of seven face-to-face semi-structured interviews and one semi-structured interview by mobile phone due to coronavirus pandemic limitations. This interview phase was limited to senior physicians who provided healthcare to the elderly, with different training in technology and medical experience.

3.2.1. Socio-Demographic Participant Data

Five male and three female physicians, aged 47–66 years old, participated in the study. Two were family physicians, two internal medicine physicians, one neurologist and three otolaryngologists. All of them were either graduated or senior consultants. Six

physicians were coordinators in their public health units, and two were coordinators of private otoneurology units. One physician was from the Regional Health Administration of the center (Center) of Portugal, and the others were from Lisbon and Tejo Valey (LTV) (Table 4).

Table 4. Study qualitative: Socio-demographic data of the participants and interview features.

Participant	Gender	Age	Specialty	Regional Health Administration of Portugal	Main Job	Interview	Audio Recording
1	M	59	Otolaryngology	LTV	Public sector	Face-to-face	Y
2	M	55	Neurology	LTV	Public sector	Face-to-face	Y
3	M	53	Internal Medicine	LTV	Public sector	Face-to-face	Y
4	M	59	Internal Medicine	LTV	Public sector	Face-to-face	Y
5	M	47	Family Medicine	LTV	Public sector	Face-to-face	Y
6	F	66	Family Medicine	Center	Public sector	Face-to-face	Y
7	F	49	Otolaryngology	LTV	Private sector	Face-to-face	Y
8	F	55	Otolaryngology	LTV	Private sector	Mobile phone	Y

M: Male; F: Female; LTV: Lisbon and Tejo Valey.

3.2.2. Content Analysis

As mentioned previously, four primary thematic categories were discussed. Twelve subthemes emerged from data analysis (Table 5).

Table 5. Thematic categories of the qualitative research.

Thematic Categories
1. Current clinical data in the context of health provision for elderly with balance disorders and risk of falling: understanding of the medical dissatisfaction identified in the quantitative research
1.1. Availability
1.2. Barriers
2. Interventions to improve the clinical data
2.1. Interoperability of computer health systems
2.2. New work organization
3. eHealth contribution in this context: understanding of the relevance observed in the quantitative research
3.1. eHealth benefits
4. Strategies to improve eHealth services for a more effective healthcare provision
4.1. Clinical and interactive data
4.2. Audiovisual technology
4.3. eHealth management
4.4. Security of eHealth use
4.5. Motivation and training of patient
4.6. Caregiver involvement
4.7. Medical training

The interviewees pointed out some misuse of healthcare provision by the elderly people in Portugal, meaning using above what is necessary of emergency visits, drug therapies and complementary diagnostic tests: *The elderly Portuguese population has no specific education on how to access healthcare services properly* (Participant 5). They also agreed on the need to access complete data: . . . *the elderly people often represent complex patients* . . . *the intervention* . . . *requires multiple specialties* . . . (Participant 1).

Relative to the medical dissatisfaction with available clinical data identified in the quantitative research, all interviewees highlighted the lack of a comprehensive data set and the lack of interoperability of computer systems: *We* (Physicians) *get to know more or less the drugs that are prescribed* . . . *We don't know more* . . . (Participant 4); *I have asked them* (family physicians) *to send me information. So, I can get a sense of what is going on with the patient.* (Participant 8); *... the data records are, sometimes, incomplete, they are not very explicit* (Participant 1); *The computer systems* . . . *have great incompatibilities with each other.* . . . *because the operating systems are different, or because the internet browser is different.* (Participant 5).

Some interventions to improve clinical data were pointed out: more investments in the interoperability of health information systems and in the organization of work with time for remote interaction and consultation: *Medicine will have to be a Medicine of shared information.* (Participant 1); *We should have some time allocated for this* (remote consultations). *So that we can keep our head on it and we will be really effective*. (Participant 4). Regarding the use of eHealth services for elderly people with balance disorders and the risk of falling, only Interviewee 2 questioned its proper applicability, justifying the doubts due to his lack of experience: . . . *I don't know how this* (remote health care provision) *is done at a distance* . . . *I don't even see myself doing a thing like that* . . . *I think the physician-patient relationship is something that is impossible to be computerized.* (Participant 2). The other physicians, similar to most of the participants of the quantitative research, considered the eHealth contribution to be beneficial: . . . *it* (eHealth) *could be a great help because vertigo has many decompensations* . . . (and) *they* (patients) *are afraid of being* . . . *without connection to the physician.* (Participant 7).

The interviewees pointed out the potential benefits of eHealth as a complementary channel to healthcare: rational use of resources with lower pressure on hospital resources, more healthcare access, better communication between medical specialties, closer physician–patient relation and more participation of patient and caregiver at home. However, they only agreed with the eHealth use for a follow-up consultation. The age was not considered a limitation for eHealth use. About the improvement of the use of eHealth services, the interviewees mentioned the need for more discussions to address the essential parameters for remote interaction and the need for involving eHealth system managers and programmers: . . . *it is crucial the collaboration between the technology and those responsible for the technology* . . . (Participant 6). In addition, the need for availability of clinical and interactive data and the motivation for human involvement were mentioned.

As essential strategies, the participants considered the inclusion of medications in use, the analyzes and imaging tests, and the registration of activities of daily living [48]. The use of questionnaires, calendars and graphics of trends on the occurrence of balance disorders and falls, supported by physician and patient's records, was also considered as a closer way of managing the disease: . . . *simple questions like "Have you had a fall last year?", "Was there any injury? Yes, are you afraid of falling due to this injury?* (Participant 5); . . . *interactive questionnaires* . . . *, for example, in the recurrent vertigo* . . . *to have documented how many episodes* . . . *what kind of triggers* . . . (Participant 7). Warning messages for adverse effects of medications or falls were classified as beneficial. The availability of individual balance exercises with a checklist and the possibility of uploading patient videos for clinical follow-up were other issues discussed: . . . *the patient could record what they are feeling, for example, eye movements and then they uploaded the recording* . . . *We* (physicians) *could include some exercises on the platform* . . .

The interviewees mentioned the relevance of camera and audio for monitoring of balance rehabilitation and closer interaction, especially in cases of gait assessment and depression: . . . *a phone call is one thing. If there is a camera it may even allow you* (physician) *to see, for example, the patient's gait* . . . (Participant 3); . . . *to monitor through videos, through cameras, as long as the patient gives his consent, of course* . . . (Participant 7).

The eHealth service management by a physician was considered essential: *When there are changes* (in the health), *the physician can also be consulted.* (Participant 3); . . . *always a physician*. (Participant 7).

In addition, the security of using eHealth was discussed: . . . what type of password one (physician) should use . . . encrypted . . . addressed to the clinical team with security code (Participant 5).

The participants also referred to the relevance of active motivation and involvement of patient and caregiver in disease prevention and control: . . . *Patients cannot continue to think that the responsibility of their health belongs to the physician . . . the patients have to be involved and responsible for their health* . . . (Participant 7); . . . *we often think that our elderly people do not have the ability to manage new technologies . . . but we can have a caregiver who can contact us remotely* . . . (Participant 5) Finally, the investment in medical awareness and eHealth training was highlighted, allowing better physician involvement: . . . *this is a work to be done in medical education . . . after some time of implementation* (of medical education), *I am convinced that it* (eHealth) *will be the future of medicine* . . . (Participant 1).

4. Discussion

A mixed-methods study was performed to know how to develop an efficient eHealth service for the provision of care for elderly people with balance disorders and the risk of falling, i.e., the research problem. Our findings revealed negative experiences with EMR, contributing to a misuse of the health care system. Despite this, the highlighted relevance of eHealth in this matter is an incentive for the development of future solutions.

Unfortunately, we had a low response number in the quantitative research, as described in other studies [49,50]. This limited the comparison between the specialties and between public or private health provision groups. Despite this, we could confirm the presence of constraints regarding the data availability in Portugal. We observed medical dissatisfaction with the information systems in general. In total, 50% of the participants of our study were dissatisfied or very dissatisfied with the current usefulness and quality of IST in the context of balance disorders and the risk of falling in the elderly. The physicians were dissatisfied or very dissatisfied with available data in EMR and time spent to access and update clinical data. According to the interviews, the incomplete or not understandable information about medical consultations and the lack of integration of clinical data between the health units have contributed to the misuse of healthcare provisions by elderly people, with multiple consultations, repeated prescriptions, polypharmacy and increasing costs that could be minimized with an appropriate digital service. These limitations and consequent costs have been reported by other authors [4,12–15]. The participants pointed out the need for investments in the interoperability of health information systems and in the organization of work to overcome this situation, as previously proposed in other studies [19–21]. In fact, data are essential for healthcare provision, monitoring of population health status and decision making. To reach real-time universal data in healthcare, interoperability issues should be addressed.

As in previous studies [2,5,16], our findings also confirmed the relevance of the use of eHealth services. However, the current way of working and interacting with patients should be restructured, including dedicated time to interact digitally with patients. eHealth can be leveraged as a complementary method to provide healthcare services, including preventive monitoring of falls and telerehabilitation with evaluation and monitoring of balance diseases and falls. For the interviewed participants, the remote consultation or management should be only for follow-up consultations, and it cannot fully replace the face-to-face clinical evaluations. As mentioned by Catan et al. [34], face-to-face consulta-

tions reduce anxiety whenever people need a physician. Only one interviewed revealed skepticism about digital solutions due to the lack of eHealth clinical experience. Several studies have already revealed the influence of limited knowledge about telemedicine on the perception of the potential of eHealth [19,35].

Finally, we confirmed the need for improvement of eHealth services for a more effective healthcare provision. The qualitative research allowed exploring interventions to achieve an efficient eHealth service to support healthcare for elderly people with balance disorders and risk of falling. Several suggestions were pointed out: the inclusion of complete clinical data, the possibility for interactive communication, message alerts and remote availability of balance exercises. Camera and audio were considered essential elements for closer interaction, allowing remote viewing of the gait, as well as the balance exercises performed. All the parameters should be aligned between technology experts and physicians to design suitable technological services. eHealth services and devices should be user-friendly and suitable for both the health professional and for the patient.

For the participants, the physician emerged as the main manager of eHealth service, but not necessarily the only one [51]. As in other studies [35,37], physicians also highlighted the need for investment for confidentiality and security of data. This should always be ensured. Relatively to human resources, strategies to motivate, educate and train the elderly patient and caregiver were also discussed. Self-care and self-management of health and disease (e.g., promotion of health and prevention of disease) should be further encouraged [2,5,16]. The need for health professional awareness and training to use all of the potential of digital solutions were mentioned, including the investment in professional health education. Thus, the potential of digital health could be widely used with motivated and trained human resources [2,20]. The Portuguese health system should be adjusted to tackle aging demand, overcoming the constraints of the EHR and the lack of interoperability of the information systems. The implementation of a universal digital health coverage system supported by comprehensive digital tools with camera and audio resources can better contribute to active and healthy aging [52] with more efficient management of health care for elderly with balance disorder and risk of falling. The design and the development of a balance disorder-related remote service, with the recommended functionalities, is an opportunity worth to be explored. The strategies identified and discussed in this study will be fed into a Design Science [50] process to design and implement a future eHealth service for a more effective provision of healthcare for elderly with balance disorders at a distance.

Limitations

Regarding the participants of the web-based questionnaire, we should acknowledge possible selection biases [53] of the quantitative research. Despite the intention to recruit physicians of different specialties, a small participant size was observed as in other online studies. This made it difficult to compare the results between specialties and to know if there is a difference between the public or private health provision groups. Another consideration, already highlighted in other web-based surveys, is the age of the respondents. Most participants of this research were younger physicians who seem to have more technological resources and online interests and to be more receptive to web-based questionnaires. In addition, the higher percentage of responses from otolaryngologists can be explained by their focus of interest in inner ear diseases that can promote balance disorders. The family physicians had weak participation (only 18 out of 7451), although this specialty represented most of the eligible participants. Due to the reduced or null number of responses from geographically more remote areas (e.g., Azores), we could not analyze and, in the second phase of the mixed methods study, explore more deeply the data of these participants that could most benefit from the potential of eHealth.

Additionally, the multiple-choice questions of the questionnaire allowed an easier analysis, but this approach did not allow the inclusion and discussion of supplementary opinions of the respondents.

Relatively to the qualitative research, the sampling was intentional. The last interview was conducted via mobile phone due to the limitation of the coronavirus pandemic.

The population targeted in both studies was limited to physicians with the provision of outpatient health care to the elderly in Portugal.

All these facts limited the generalizability of the findings.

5. Conclusions

Despite significant obstacles in existing digital solutions, 76% of the Portuguese physicians included in this study considered future e-Health services as highly relevant for complementary healthcare for elderly people with balance disorders and the risk of falling. The use of eHealth services comprised of digital technologies such as cameras, sensors and audio monitoring may reinforce such solutions. Additionally, these services may represent considerable potential for reducing the excess of emergency visits, and the overlap of drug therapies and diagnostic procedures and improved treatment. This may increase both health care efficiency and quality and contribute to relieving pressure in the escalating health care costs. However, significant constraints regarding the current availability of clinical data in EHR care systems were described. The insufficient quality of both available data in EMR and in the time needed to access such data and to register new clinical data was stated. We would like to highlight that our study group's description of incomplete, or not understandable, information about medical consultations and the lack of integration of clinical data indicate serious challenges to overcome. More research about this topic is also required to further enhance the knowledge about the use of digital tools in this field of health care.

Author Contributions: Conceptualization, A.G.M.G. and L.V.L.; methodology, A.G.M.G. and L.V.L.; formal analysis, A.G.M.G. and L.V.L.; investigation, A.G.M.G. and L.V.L.; data curation, A.G.M.G.; writing—original draft preparation, A.G.M.G., P.E. and L.V.L.; writing—review and editing, A.G.M.G., P.E. and L.V.L.; funding acquisition, L.V.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was partially supported by Fundação para a Ciência e a Tecnologia (FCT) for funds to Global Health and Tropical Medicine (GHTM) (UID/04413/2020 to LVL).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Scientific Council and the Ethics Council of Instituto de Higiene e Medicina Tropical of Universidade NOVA de Lisboa, Portugal (date of approval: 21 September 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the qualitative study.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author, AGMG.

Acknowledgments: Portuguese General Medical Council (Ordem dos Médicos), for the approval and availability of the link on the website of the Institution; Portuguese Societies and Associations who contributed to the dissemination of the link with the partners.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table A1. Quantitative study: answer choices of the questionnaire.

Number Question	Subject	Answer Choices
Q1	Sex	Male Female
Q2	Age	= or <30 31–40 41–50 51–60 = or >61
Q3	Specialty	Physical Medicine and Rehabilitation General and Family Medicine Internal Medicine Otorhinolaryngology Neurology
Q4	Competence in Geriatrics	Yes No
Q5	Main job	Personalized public health care unit Family health unit Public hospital Hospital in public-private partnership University hospital Private health unit
Q6	Regional Health Administration	North Center Lisbon and Tejo Valey Alentejo Algarve Madeira Azores
Q7	Monthly frequency of health care provision for elderly with balance disorders	= or <25% 26 a 50% 51 a 75% =or >76% Do not answer/Do not know
Q8	Monthly frequency of health care provision for elderly with consequent falls	= or <25% 26 a 50% 51 a 75% = or >76% Do not answer/Do not know
Q9	Need to access data from previous care consultations of elderly people with balance disorders and risk of falling	= or <25% 26 a 50% 51 a 75% = or >76% Do not answer/Do not know
Q10	Access to data from previous care consultations for elderly people with balance disorders and risk of falling	Clinical paper process Electronic medical record (EMR) Paper information provided by the patient Do not answer/Do not know

Table A1. *Cont.*

Number Question	Subject	Answer Choices
Q11	Relevance of data about previous health care to the elderly with balance disorders and risk of falling for a new provision of healthcare in this context	Never Rarely Sometimes Often Always Do not answer/Do not know
Q12	Estimated time spent on Information Systems and Technologies (IST)-related activities	= or >76% 51 a 75% 26 a 50% = or <25% Do not use Do not answer/Do not know
Q13	General usefulness of clinical data in the EMR	Excellent Very good Good Bad Very bad Do not use Do not answer/Do not know
Q14	Satisfaction with time spent to access clinical data, in the EMR, from previous care consultations for elderly people with balance disorders and risk of falling	Very dissatisfied Dissatisfied Satisfied Very Satisfied Do not use Do not answer/Do not know
Q15	Satisfaction with availability of sufficient and understandable clinical data, in the EMR, from previous care consultations for elderly people with balance disorders and risk of falling	Very dissatisfied Dissatisfied Satisfied Very Satisfied Do not use Do not answer/Do not know
Q16	Satisfaction with time spent to fill-in new data, in the EMR, related to the provision of health care to the elderly with balance disorders and risk of falling	Very dissatisfied Dissatisfied Satisfied Very Satisfied Do not use Do not answer/Do not know
Q17	General satisfaction with the use of IST (usefulness, quality) in the context of elderly with balance disorders and risk of falling	Very dissatisfied Dissatisfied Satisfied Very Satisfied Do not use Do not answer/Do not know
Q18	Relevance of eHealth in the context of elderly with balance disorders and risk of falling	Very relevant Relevant No difference Irrelevant Very irrelevant Do not answer/Do not know

Appendix B

Table A2. Qualitative study: Interview guide.

Thematic Categories	Questions
Current clinical data in Portugal	"What are the medical difficulties related with current clinical data in the context of health care provision for elderly with balance disorders and risk of falling?"
Interventions to improve the clinical data	What strategies can be implemented to improve clinical data?
eHealth contribution	"What do you think about the contribution of eHealth?"
Strategies to improve the use of eHealth services	How can eHealth services be suitable? What are the necessary strategies? What difficulties must be overcome?

References

1. European Innovation Partnership on Active and Healthy Ageing (EIP-AHA). Action Plan on Specific Action on Innovation in Support of Personalized Health Management, Starting with a Falls Prevention Initiative. 2013. Available online: https://ec.europa.eu/eip/ageing/library/action-plan-specific-action-innovation-support-personalized-health-management-starting-falls_en.html (accessed on 15 January 2020).
2. The International Society for Quality in Health Care (ISQua). Health Systems and Their Sustainability: Dealing with the Impending Pressures of Ageing, Chronic and Complex Conditions, Technology and Resource Constraints. Whitepaper. 2016. Available online: https://isqua.org/resources-blog/resources?page=1&search=Health%20Systems%20and%20their%20Sustainability&date_range_start=&date_range_end= (accessed on 15 January 2020).
3. National Institute for Health and Care Excellence (NICE). Multimorbility: Clinical Assessment and Management. 2016. Available online: https://www.nice.org.uk/guidance/ng56 (accessed on 15 January 2020).
4. Simões, J.; Augusto, G.F.; Fronteira, I.; Hernández-Quevedo, C. Portugal: Health system review. *Health Syst. Transit.* **2017**, *19*, 1–184. Available online: http://www.healthobservatory.eu (accessed on 17 January 2020).
5. Amalberti, R.; Vincent, C.; Nicklin, W.; Braithwaite, J. Coping with more people with more illness. Part 1: The nature of the challenge and the implications for safety and quality. *Int. J. Qual. Health Care* **2019**, *31*, 154–158. [CrossRef] [PubMed]
6. OECD. *Health at a Glance 2019: OECD Indicators*; OECD Publishing: Paris, France, 2019. [CrossRef]
7. European Union. Ageing Europe—Looking at the Lives of Older People in the EU. 2020. Available online: https://ec.europa.eu/eurostat (accessed on 26 November 2020).
8. Salzman, B. Gait and balance disorders in older adults. *Am. FAM Physician* **2010**, *82*, 61–68. [PubMed]
9. Health Evidence Network (HEN)—WHO. What are the Main Risk Factors for Falls Amongst Older People and What are the Most Effective Interventions to Prevent These Falls? 2004. Available online: http://www.euro.who.int/document/E82552.pdf (accessed on 20 October 2020).
10. Ha, V.A.T.; Nguyen, T.N.; Nguyen, T.X.; Nguyen, H.T.T.; Nguyen, T.T.H.; Nguyen, A.T.; Pham, T.; Thanh Vu, H.T. Prevalence and Factors Associated with Falls among Older Outpatients. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4041. [CrossRef]
11. Haagsma, J.A.; Olij, B.F.; Majdan, M.; van Beeck, E.F.; Vos, T.; Castle, C.D.; Dingels, Z.V.; Fox, J.T.; Hamilton, E.B.; Liu, Z.; et al. Falls in older aged adults in 22 European countries: Incidence, mortality and burden of disease from 1990 to 2017. *INJ Prev.* **2020**, *26*, i67–i74. [CrossRef] [PubMed]
12. Kerber, K.A. Vertigo and Dizziness in the Emergency Department. *Emerg. Med. Clin. N. Am.* **2009**, *27*, 39–50. [CrossRef]
13. Heinrich, S.; Rapp, K.; Rissmann, U.; Becker, C.; König, H.H. Cost of falls in old age: A systematic review. *Osteoporos. Int.* **2010**, *21*, 891–902. [CrossRef]
14. Tehrani, A.S.S.; Coughlan, D.; Hsieh, Y.H.; Mantokoudis, G.; Korley, F.K.; Kerber, K.A.; Frick, K.D.; Newman-Toker, D.E. Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments. *Acad. Emerg. Med.* **2013**, *20*, 689–696. [CrossRef] [PubMed]
15. Reis, L.; Lameiras, R.; Cavilhas, P.; Escada, P. Epidemiology of Vertigo on Hospital Emergency. *Acta Med. Port.* **2016**, *29*, 326–331. [CrossRef]
16. Nolte, E.; Merkur, S.; Anell, A. *Achieving Person-Centred Health Systems*; Cambridge University Press: Cambridge, UK, 2020; pp. 1–396.
17. Winter, A.; Takabayashi, K.; Jahn, F.; Kimura, E.; Engelbrecht, R.; Haux, R.; Honda, M.; Hübner, U.H.; Inoue, S.; Kohl, C.D.; et al. Quality Requirements for Electronic Health Record Systems. A Japanese-German Information Management Perspective. *Methods Inf. Med.* **2017**, *56*, e92–e104.
18. Ammenwerth, E.; Duftschmid, G.; Al-Hamdan, Z.; Bawadi, H.; Cheung, N.T.; Cho, K.H.; Goldfarb, G.; Gülkesen, K.H.; Harel, N.; Kimura, M.; et al. International Comparison of Six Basic eHealth Indicators Across 14 Countries: An eHealth Benchmarking Study. *Methods Inf. Med.* **2020**, *59*, e46–e63. [PubMed]

19. Lapão, L.V.; Dussault, G. The contribution of eHealth and mHealth to improving the performance of the health workforce: A review. *Public Health Panorama.* **2017**, *3*, 463–471.
20. Blandford, A. HCI for health and wellbeing: Challenges and opportunities. *Int J. Hum. Comput. Stud.* **2019**, *131*, 41–51. [CrossRef]
21. World Health Organization (WHO). mHealth Use of Appropriate Digital Technologies for Public Health—EB142/20. 2017. Available online: https://apps.who.int/gb/ebwha/pdf_files/EB142/B142_20-en.pdf (accessed on 15 January 2020).
22. Uei, S.L.; Kuo, Y.M.; Tsai, C.H.; Kuo, Y.L. An Exploration of Intent to Use Telehealth at Home for Patients with Chronic Diseases. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1544. [CrossRef]
23. Sun, R.; Sosnoff, J.J. Novel sensing technology in fall risk assessment in older adults: A systematic review. *BMC Geriatr.* **2018**, *18*, 14. [CrossRef] [PubMed]
24. Rucco, R.; Sorriso, A.; Liparoti, M.; Ferraioli, G.; Sorrentino, P.; Ambrosanio, M.; Baselice, F. Type and Location of Wearable Sensors for Monitoring Falls during Static and Dynamic Tasks in Healthy Elderly: A Review. *Sensors* **2018**, *18*, 1613. [CrossRef] [PubMed]
25. Nguyen, H.; Mirza, F.; Naeem, M.A.; Baig, M.M. Falls management framework for supporting an independent lifestyle for older adults: A systematic review. *Aging Clin. Exp. Res.* **2018**, *30*, 1275–1286. [CrossRef]
26. Leirós-Rodríguez, R.; García-Soidán, J.L.; Romo-Pérez, V. Analyzing the Use of Accelerometers as a Method of Early Diagnosis of Alterations in Balance in Elderly People: A Systematic Review. *Sensors* **2019**, *19*, 3883. [CrossRef]
27. Montesinos, L.; Castaldo, R.; Pecchia, L. Wearable Inertial Sensors for Fall Risk Assessment and Prediction in Older Adults: A Systematic Review and Meta-Analysis. *IEEE Trans. Neural Syst. Rehabil. Eng.* **2018**, *26*, 573–582. [CrossRef]
28. Bet, P.; Castro, P.C.; Ponti, M.A. Fall detection and fall risk assessment in older person using wearable sensors: A systematic review. *Intern. J. Med. Inform.* **2019**, *130*, 103946. [CrossRef]
29. Gaspar, A.G.M.; Lapão, L.V. eHealth for Addressing Balance Disorders in the Elderly: Systematic Review. *J. Med. Internet Res.* **2021**, *23*, e22215. [CrossRef] [PubMed]
30. Skjæret, N.; Nawaz, A.; Morat, T.; Schoene, D.; Helbostad, J.L.; Vereijken, B. Exercise and rehabilitation delivered through exergames in older adults: An integrative review of technologies, safety and efficacy. *Int. J. Med. Inf.* **2016**, *85*, 1–16. [CrossRef] [PubMed]
31. Choi, S.D.; Guo, L.; Kang, D.; Xiong, S. Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review. *Appl. Erg.* **2017**, *65*, 570–581. [CrossRef]
32. Eysenbach, G. What is e-health? *J. Med. Internet Res.* **2001**, *3*, E20. [CrossRef]
33. Poenaru, C.; Poenaru, E.; Vinereanu, D. Current Perception of Telemedicine in an EU Country. *Maedica* **2014**, *9*, 367–374.
34. Catan, G.; Espanha, R.; Mendes, R.V.; Toren, O.; Chinitz, D. Health information technology implementation—Impacts and policy considerations: A comparison between Israel and Portugal. *ISR J. Health Policy Res.* **2015**, *4*, 41. [CrossRef]
35. Ayatollahi, H.; Sarabi, F.Z.P.; Langarizadeh, M. Clinicians' Knowledge and Perception of Telemedicine Technology. *Perspect Health Inf. Manag.* **2015**, *12*, 1c.
36. Radhakrishnan, K.; Xie, B.; Berkley, A.; Kim, M. Barriers and Facilitators for Sustainability of Tele-Homecare Programs: A Systematic Review. *Health Serv. Res.* **2016**, *51*, 48–75. [CrossRef]
37. Albarraka, A.I.; Mohammedb, R.; Almarshoudc, N.; Almujalli, L.; Aljaeed, R.; Altuwaijiri, S.; Albohairy, T. Assessment of physician's knowledge, perception and willingness of telemedicine in Riyadh region, Saudi Arabia. *J. Infect. Public Health* **2021**, *14*, 97–102. [CrossRef]
38. Wynn, R.; Gabarron, E.; Johnsen, J.K.; Traver, V. Special Issue on E-Health Services. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2885. [CrossRef] [PubMed]
39. Gil, H. The elderly and the digital inclusion: A brief reference to the initiatives of the European union and Portugal. *MOJ Gerontol. Ger.* **2019**, *4*, 213–221. [CrossRef]
40. SPMS, Portuguese National Centre of Telehealth (CNTS). National Strategic Telehealth Plan (PENTS) 2019–2022. Available online: https://www.spms.min-saude.pt/wp-content/uploads/2019/11/PENTS_Tradu%C3%A7%C3%A3o.pdf (accessed on 15 February 2021).
41. SPMS. SNS 24 Projeto Proximidade Senior. Available online: https://www.spms.min-saude.pt/pesquisa-geral/?_sf_s=idoso (accessed on 15 August 2020).
42. Creswell, J.W.; Creswell, J.D. Research design. In *Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed.; SAGE Publications Inc.: Los Angeles, CA, USA, 2018.
43. SurveyMonkey. Available online: https://help.surveymonkey.com/articles/en_US/kb/How-do-I-make-surveys-anonymous (accessed on 15 January 2019).
44. Eysenbach, G. Improving the quality of Web surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J. Med. Internet Res.* **2004**, *6*, e34. [CrossRef]
45. IBM. SPSS Statistics. Available online: https://www.ibm.com/products/spss-statistics/details (accessed on 12 September 2019).
46. Assembleia da República. Lei nº 58/2019 de 8 de Agosto de 2019. Diário da República n.º 151/2019, Série I de 2019-08-08. 3-40. Available online: https://data.dre.pt/eli/lei/58/2019/08/08/p/dre (accessed on 22 February 2021).
47. Ordem dos Médicos de Portugal. Estatísticas 2019. Available online: https://ordemdosmedicos.pt/wp-content/uploads/2020/01/ESTATISTICAS_ESPECIALIDADES_2019.pdf (accessed on 17 July 2020).

48. WHO. Active Ageing, A Policy Framework. A Contribution of the WHO to the Second United Nations World Assembly on Ageing, Madrid, Spain, April, 2002. Available online: https://extranet.who.int/agefriendlyworld/wp-content/uploads/2014/06/WHO-Active-Ageing-Framework.pdf (accessed on 17 January 2020).
49. Aitken, C.; Power, R.; Dwyer, R. A very low response rate in an on-line survey of medical practitioners. *Aust. N. Z. J. Public Health* **2008**, *32*, 288–289. [CrossRef] [PubMed]
50. Lapão, L.V.; Da Silva, M.M.; Gregório, J. Implementing an online pharmaceutical service using design science research. *BMC Med. Inform. Decis. Mak.* **2017**, *17*, 1–4. [CrossRef] [PubMed]
51. Lapão, L.V.; Pisco, L. Primary health care reform in Portugal, 2005–2018: The future and challenges of coming of age. *Cad. Saude Publica* **2019**, *35* (Suppl. 2), e00042418.
52. Liotta, G.; Canhão, H.; Cenko, F.; Cutini, R.; Vellone, E.; Illario, M.; Kardas, P.; Poscia, A.; Sousa, R.D.; Palombi, L.; et al. Active Ageing in Europe: Adding Healthy Life to Years. *Front. Med.* **2018**, *5*. [CrossRef]
53. Eysenbach, G.; Wyatt, J. Using the Internet for surveys and health research. *J. Med. Internet Res.* **2002**, *4*, E13. [CrossRef] [PubMed]

2.3. PAPER III

Gaspar AGM, Lapão LV. A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. *Int J Environ Res Public Health*. 2022 Feb 7;19(3):1855. DOI: 10.3390/ijerph19031855

International Journal of
Environmental Research and Public Health

MDPI

Article

A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach

Andréa Gomes Martins Gaspar [1,2,*,†] and Luís Velez Lapão [1,†]

[1] Instituto de Higiene e Medicina Tropical (IHMT), Universidade NOVA de Lisboa (UNL), 1349-008 Lisbon, Portugal; luis.lapao@ihmt.unl.pt
[2] Hospital Beatriz Ângelo, 2674-514 Lisbon, Portugal
* Correspondence: andreamartinsbr@hotmail.com
† These authors contributed equally to this work.

Abstract: In this study, a design science research methodology was used aiming at designing, implementing and evaluating a digital health service to complement the provision of healthcare for elderly people with balance disorders and risk of falling. An explanatory sequential mixed methods study allowed to identify and explore the dissatisfaction with electronic medical records and the opportunity for using digital health solutions. The suggested recommendations helped to elaborate and develop "BALANCE", a digital service implemented on the METHIS platform, which was recently validated for remote monitoring of chronic patients in primary healthcare. "BALANCE" provides clinical and interactive data, questionnaire pre and post-balance rehabilitation, tutorial videos with balance exercises and patient-recorded videos of the exercises. This digital service was demonstrated, including five elderly patients with clinical recommendations for balance rehabilitation at home. Finally, the authors conducted two focus groups with the participants and their caregivers as well as with physicians. The focus groups aimed at exploring their satisfaction level, needs of adjustment in the "BALANCE" service and strategies for applicability. The digital healthcare service evaluation revealed a significant potential for clinical applicability of this digital solution for elderly people with balance disorders and risk of falling.

Keywords: balance disorders; falls; healthy ageing; elderly care; eHealth; digital health

Citation: Gaspar, A.G.M.; Lapão, L.V. A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. *Int. J. Environ. Res. Public Health* **2022**, *19*, 1855. https://doi.org/10.3390/ijerph19031855

Academic Editors: Diana Castilla, Carlos Suso-Ribera, Sabrina Cipolletta and U. Rajendra Acharya

Received: 27 December 2021
Accepted: 5 February 2022
Published: 7 February 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

In most countries, the life expectancy growth rate has not been met by an increase in healthy life years [1–5]. With ageing, a growing prevalence of multiple comorbidities, chronic diseases, balance disorders and falls affecting the independence of the elderly has been observed [6–11]. However, healthy ageing does not mean disease-free. Even in the presence of disease, healthy ageing means living well with the disease under control and with functional ability, which is seldom observed [3]. The dearth of healthy ageing among the elderly has led to inappropriate use of physical and human resources, to multiple medical visits, diagnosis tests and treatments [11–13]. The ageing process has challenged the sustainability of the healthcare systems, including the Portuguese health system [1,5]. To address this, several approaches have been suggested, such as person-centered health systems and use of digital devices [2,3,14–18] (Figure 1).

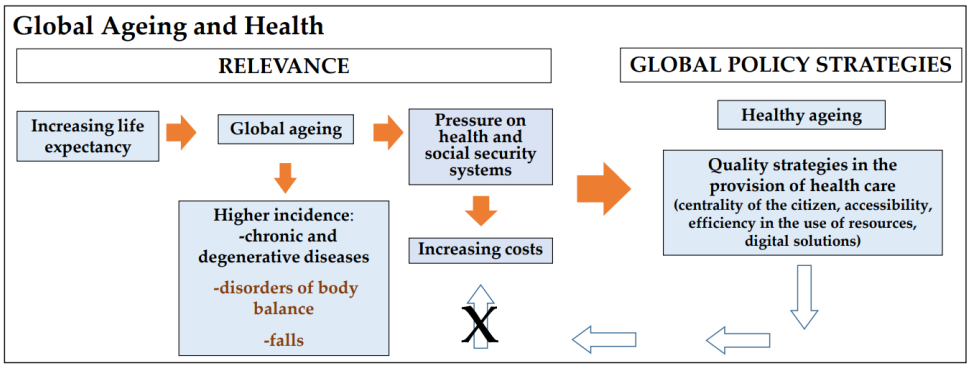


Figure 1. Strategies for a sustainable ageing (Authors' own elaboration).

Several studies have explored the potential of digital health solutions to assess and monitor the elderly with balance disorders and risk of falling. The heterogeneity of populations, methodologies of study, eHealth devices and services as well as time of follow-up have not allowed for clear comparisons. Therefore, the actual clinical applicability of these solutions still needs to be further explored [19–21]. In this study, we aimed to design, develop, implement and evaluate the use of a digital health service for the complementary provision of care for the elderly with balance disorders and risk of falling.

2. Materials and Methods

2.1. Study Design and Materials

Using Design Science Research Methodology (DSRM) [22], a digital service for the remote management and monitoring of elderly people with balance disorders and risk of falling was designed, implemented, demonstrated and evaluated (Figure 2).

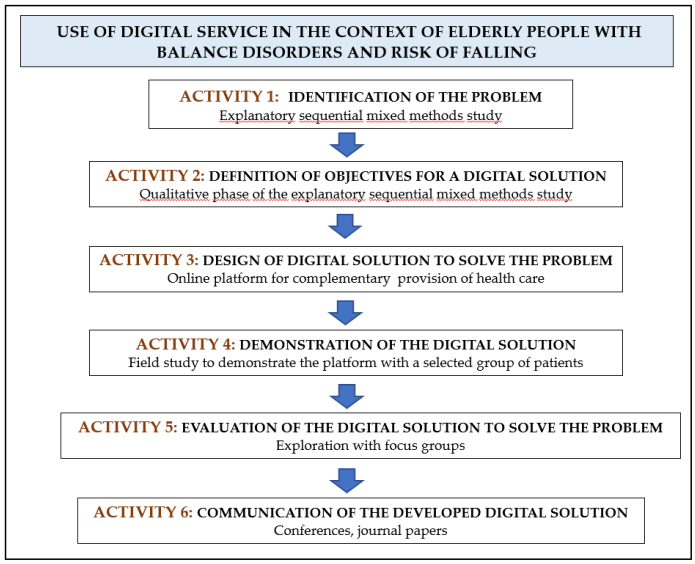


Figure 2. DSRM activities and tasks. Activities 1 and 2 were already published [23].

An explanatory sequential mixed methods study [23] was previously performed. This study identified the clinical practice difficulties, the relevance of using digital solutions and the strategic options to develop a digital service targeting this profile of patients (Activities 1 and 2 of the DSRM). First, we elaborated and adapted an open questionnaire with 18 multiple choice questions, available through the website of the General Medical Council of Portugal (Activity 1). Second, one of the authors conducted semi-structured interviews for better understanding of the results obtained from the quantitative study

and to explore how to develop an efficient digital service to support healthcare (Activity 2). The eligible participants were specialist physicians focused on healthcare provision in Portugal for the elderly with balance disorders and risk of falling [23].

Based on the results obtained in the previous mixed methods study, especially the recommendations, the "BALANCE" digital service was conceived and designed, as an online service to provide balance care services (Activity 3). The purpose of the digital service had been defined to provide complementary care for elderly people with balance disorders and risk of falling, allowing a closer physician–patient interaction and encouraging a more active participation of the patients and caregivers. From August to September 2020, we designed an online service, called "BALANCE", following the otoneurologic clinical approach of patients with balance disorders [24]: clinical data, clinical examination findings, instrumental test findings, treatment and the Dizziness Handicap Inventory (DHI) questionnaire [25], a validated self-reported questionnaire that quantifies the impact of dizziness on daily life, pre and post- rehabilitation program. From October 2020 to April 2021, "BALANCE" digital service was implemented and integrated into the digital platform, METHIS (Multimorbidity Management Health Information System) [26], a web-based platform with three relational databases using PostgreSQ and fully integrated with Zoom (Zoom Inc). The platform METHIS was recently validated for providing remote monitoring services for chronic patients in primary healthcare [26]. For better patient guidance, eight tutorial videos were recorded by the first author (consultant physician), performing the specific balance exercises. The videos were uploaded to the YouTube® platform as unlisted with restricted access, and their links were integrated to "BALANCE". Finally, until July 2021, the "BALANCE" digital service was adjusted to requirements. One otorhinolaryngologist, two experts in digital platforms and one professor of health information systems collaborated in the development and implementation of this digital service.

To demonstrate the "BALANCE" digital service (Activity 4 of DSRM), we performed a proof-of-concept study [27] from August to November 2021. A set of patients was followed at the Otorhinolaryngology and Head and Neck Surgery Service of Hospital Beatriz Ângelo (HBA). They were invited to participate, respecting the following inclusion criteria: (a) age of 65 years or older; (b) complaints of clinically decompensated balance disorder with risk of falling, confirmed with objective clinical examination findings; (c) instrumental tests performed to assess inner ear function, such as videonystagmography or cervical vestibular evoked myogenic potentials, allowing for prescribing balance exercises according to the clinical condition; and (d) balance rehabilitation indication for patient with clinically decompensated balance disorder; each participant performed vestibular rehabilitation at HBA, which allowed the assessment of the patient's ability to walk without support and he/she would have the capacity to perform the balance exercises at home. We excluded patients with the following conditions: (a) neurological pathology diagnosis at the time of the inclusion in the study, such as a neurodegenerative disease; (b) ophthalmological pathology diagnosis with severe visual acuity that did not allow one to see the computer screen; (c) osteoarticular pathology diagnosis with reduced mobility of the lower limbs; (d) a clinical condition that did not allow the regular performance of physical exercises, such as decompensated cardiovascular pathology or acute infection; (e) a cognitive alteration according to the Mini-Mental State Examination (MMSE), using operational "cut" values for the Portuguese population, elderly individuals with less than 22 points for 0 to 2 years of education, less than 24 points for 3 to 6 years of education and less than 27 points for participants with education equal to or greater than 7 years were all excluded [28]; (f) insufficient comprehensive to understand the study; and g) limited access to the internet. All selected participants provided an email address for later access to the digital platform and to receive a automatically-generated password. The patients and caregivers also received individual instructions by the consultant physician, via a Zoom teleconsultation, on how to access and operate the platform.

After the proof-of-concept study, we conducted two focus groups [29] using the Zoom platform (due to the SARS-CoV-2 pandemic limitations) to discuss and explore the benefits, constraints, adjustment requirements, new strategies for clinical applicability of the "BALANCE" service and the satisfaction level (Activity 5 of the DSRM). On 28 November 2021, the main researcher conducted a focus group with the participants of the proof-of-concept study and their caregivers, that is, the proof-of-concept users of the "BALANCE" digital service. Five primary thematic categories were discussed: benefits and constraints of the "BALANCE" service, satisfaction, strategies suggested and interest in continuing to use the platform (Appendix A). The link, identity number and password of the meeting were sent to the participants, via an asynchronous message system provided by the digital platform. On 5 December 2021, the same researcher conducted a focus group with physician experts in healthcare provision for elderly people with balance disorders and risk of falling. The sample was intentional [29], with a purposeful search for physicians with the following characteristics: (a) providing care for the elderly with balance disorders and risk of falling; (b) coordinating function in public health units; and (c) being easily accessible to the interviewer. The potential participants were invited by the interviewer, in person or via mobile phone. All physicians received a specific message, via multimedia messaging service (MMS), WhatsApp or email, with information about the study and audio recording, link, an identification number and password for the Zoom meeting. Before the discussion was initiated, the researcher showed a summary of the project with the main results of the various activities carried out and showed the functionalities of "BALANCE". Six thematic categories were covered: benefits and constraints of "BALANCE" digital service, satisfaction, recommended adjustments for the "BALANCE" digital service, proper clinical applicability and interest in this digital care service (Appendix A).

Finally, we disseminated the results of these activities in oral communications, posters and papers published in conference proceedings (Activity 6). Two papers were already published in peer reviewed journals [21,23].

2.2. Data Analysis

We performed a descriptive analysis of demographic data of all participants in the different activities [29].

The information of the interviews and focus groups was manually coded and transcribed by the interviewer, allowing for content analysis to be carried out [29]. We entered words in round brackets, enabling a better comprehension of the quotes.

2.3. Ethical Considerations

The participants of the proof-of-concept study received a copy of the signed consent form referring to the participation in the demonstration study and in the focus group on the satisfaction of the digital solution. The patients also signed a document pledging not to share or publicize the videos nor to record the videos available in the study.

The interviewees and the participants of the focus groups were informed that they could leave the study up until one month after the interview or Zoom meeting date. At any time, the patients could withdraw from using the digital platform. Regardless of their participation in the study, all of them were followed up with on the face-to-face consultation at HBA.

Audio of interviews was recorded upon authorization from the participants. In both focus groups, all the participants received an automatic message authorizing the meeting's recording, from the Zoom service, after accessing the link to the meeting. The researcher asked participants to turn off the camera during the recording of the Zoom meeting, since the objective was only to collect the audio.

All the information was treated confidentially. The interviews and meetings were manually coded and transcribed by the interviewer for content analysis. The transcrip-

tions omitted information to avoid identifying participants. All data were kept anonymous [29]. The information and audio records were kept in a safe place (external disk with access code) within the period provided by the Portuguese law [30] and General Data Protection Regulation (GDPR) [31], safeguarding the confidentiality of the information obtained at all times.

The participant engagement in the activities was voluntary.

3. Results

Firstly, the previous mixed methods study confirmed a dissatisfaction with the current medical data relative to the elderly with balance disorders and risk of falling as well as the dissatisfaction with lack of system interoperability, which led to multiple emergency visits and uncoordinated diagnostics and treatments. We also verified there was an opportunity to explore a digital solution in this context, as most physicians considered this strategy relevant [23]. The recommendations from the interviews (e.g., inclusion of clinical data recorded by either the patient or the caregiver, interactive questionnaires and calendars on care episodes and triggering factors for deterioration of balance disorders and falls, availability of tutorial videos with balance exercises and possibility of uploading patient videos for clinical follow-up) helped to define the objectives and design the "BALANCE" digital service for a complementary provision of healthcare.

3.1. Design of a Digital Solution to Solve the Problem

The results of the design of "BALANCE" digital service were a set of functionalities following both medical and patient requirements enabled to define both medical and patient profiles:

(a) Quick access to balance deterioration or recent fall data;
(b) Provide tutorial videos with specific balance exercises (1. Walk; 2. Walk turning the head to the right and to the left; 3. Walk lifting your legs; 4. Walk lifting the legs and turning the head to the right and to the left; 5. Walk with legs progressively apart. Video A—Moving target with motionless head; Video B—Moving head with motionless target; Video C—Moving head and target);
(c) Regular monitoring and adjustment of vestibular exercises.

3.1.1. Medical Profile

The physician could register the patient data on the platform and create an individual clinical record. By clicking on "BALANCE" service, the following set of six functionalities are available:

(a) Balance monitoring (i.e., access to clinical data): the SOAP framework [32] was used, with a checklist and free-text, with the following: Subjective (complaints: vertigo, unsteadiness, difficulty walking at home or outside, need for crutches or canes to walk, falls, triggers, hearing loss or tinnitus); Objective clinical examination findings (gait, otoscopy, clinical and instrumental examination, Time Up and Go Test (TUGT), Berg Balance Scale (BBS), Tinetti Performance e-Oriented Mobility Assessment (POMA), cochleovestibular instrumental exams, imaging exams and blood tests); Assessment based on the information collected in the previous two sections, with the summary of the salient points; Plan (treatment: medication and balance rehabilitation);
(b) Patient balance deterioration records: the physician could identify an eventual clinical deterioration and triggers, with a checklist and free-text structure data recorded by the patient from home;
(c) Patient's fall records: the physician could be alerted of an eventual episode of falling, triggers and consequences, with a checklist and free-text data recorded by the patient;
(d) Dizziness Handicap Inventory (DHI) [25]: the physician could access the 25-item questionnaire and the final score, automatically summed;

(e) Balance rehabilitation prescription: the physician could also provide additional information with free-text;
(f) Patient record about exercises performed: the physician could monitor the daily frequency of the balance exercises performed and access a possible video link uploaded by the patient with exercises performed.

3.1.2. Patient Profile

After the registration on the platform by the physician, the patient received, via email, an automatic individual password (unknown to the physician). After logging in, the participant was able to forward messages to the assistant physician and access "BALANCE". By clicking on this, the following set of five functionalities become available:

(a) Patient balance deterioration records: the patient or caregiver could record a recent deterioration of the balance. This information, either with checklist and free-text, can also be visible in the medical profile;
(b) Patient's fall records: the patient or caregiver can record the episodes of falling; this information, checklist and free-text, can be also visible in the medical profile;
(c) DHI questionnaire [25]: to be completed before and after the balance rehabilitation program; the final score can be automatically summed and is visible in the medical profile;
(d) Recorded tutorial videos with balance exercises: each one presents instructions on the exercise to be performed, allowing for viewing in slow motion and at normal speed of the exercise;
(e) Patient record about exercises performed with checklist structure: the patient can upload a recorded video link of other exercises performed. This information can also be visible in the medical profile. At any time, both physician and participants can send or receive messages with questions or comments, enabling a more dynamic physician–patient interaction. All data are processed with security, respecting the General Data Protection Regulation rules.

3.2. Demonstration of the Digital Solution

3.2.1. Participants

Since we used a proof-of-concept approach as an initial intervention to demonstrate the "BALANCE" service, only a small set of participants was included: five female patients, aged 70–83 years old, with a regular balance follow-up at Hospital Beatriz Ângelo (HBA), Lisbon, Portugal (Table 1). One participant, a male patient aged 86 years old, withdrew from the study, stating that he depended on his daughter's support and that she no longer had the time to access the platform. In fact, no data was filled on the platform about this participant. However, the patient had been followed at HBA, with face-to-face consultation, as were the other participants.

Table 1. Socio-demographic data of the participants in the proof-of-concept.

Patient	Patient Gender	Patient Age	Education Level (Years of Schooling)	MMSE * Score	Caregiver Gender	Caregiver Age	Caregiver Education Level (Years of Schooling)
1	F	70	6	30	F	72	4
2	F	71	+7	28	-	-	-
3	F	80	6	27	F	58	+7
4	F	83	4	24	F/F	38/59	+7/+7
5	F	83	+7	30	F	53	+7

* MMSE: Mini-Mental State Examination.

All the patients reported initial complaints about clinically decompensated balance disorders and instrumental exams performed for the evaluation of inner ear function. Additionally, three patients usually used nearby furniture as support to maintain balance during gait. One participant often needed this support and another used it, mainly in low-light environments or with uneven floors to prevent falls. They had already completed a rehabilitation program at HBA and had indicated they were carrying out balance rehabilitation at home. None of them were revealed to have a cognitive disorder according to the Mini-Mental State Examination (MMSE), considering the operational "cut" values for the Portuguese population [28]. Participant 1, after inclusion in the study, was evaluated for suspected Lewi Body disease. However, her MMSE score was 27/30, hence the reason why the researchers chose to keep her in the study.

3.2.2. Remote Monitoring

On a daily basis, each patient was remotely monitored for clinical conditions. The physician contacted each of them at least four times during the study (Figure 3).

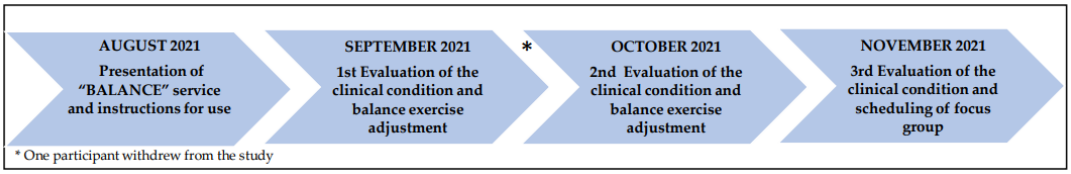


Figure 3. Description of the remote contact schedule.

In the first step of the study, the patients (or the caregivers) were individually trained on how to access (via a secure and unique link) and use the "BALANCE" service. This training was performed via Zoom due to the SARS-CoV-2 pandemic limitations. During the screen sharing, all the functionalities, including the videos with balance exercises, were shown and an email with instructions about exercise frequency was sent. According to the clinical condition and limitation, each patient received personalized instructions about the balance exercises. We also asked them to complete the pre-questionnaire (DHI). About a month later, we called each patient by mobile phone, to establish how his clinical condition was and the constraints with balance exercises. Accordingly, we adjusted the balance rehabilitation schema, including more or fewer exercises. The instructions were sent by email. The second individual evaluation, both via Zoom and available on the platform (for future reference), allowed us to re-evaluate the clinical condition and re-adjust the balance exercises. Finally, during November 2021, we re-evaluated the clinical condition and asked the patients and caregivers, via mobile phone, to complete the post-questionnaire (DHI). We also invited them to participate in the focus group.

3.2.3. Participant and Caregiver Registration in the Digital Platform "BALANCE"

Despite vertigo complaints by four of the patients, only two caregivers actually registered this information on the platform (Table 2).

Table 2. Patient and caregiver registration.

Patient	Complaints of Difficulty with Exercise Performance (Platform Message)	Complains of Clinical Deterioration (Telephone or Zoom)	Record of Clinical Deterioration on the Platform	Complains of Falls (Telephone or Zoom)	Record of Falls on the Platform	DHI Score Pre Rehabilitation	DHI Score Post Rehabilitation	Record of Balance Exercises Performed	Upload of Video with Exercises Performed
1	Sometimes	Sometimes	Not filled	No	Not filled	Not filled	Not filled	Not filled	No
2	No	Once	Once	No	Not filled	24	13	Not filled	No
3	Several times	No	Not filled	No	Not filled	68	56	Incomplete 27 days	No
4	No	Once	Not filled	No	Not filled	28	16	Not filled	No
5	Several times	Once	Once	No	Not filled	90	Not filled	Incomplete 20 days	No

These records motivated an additional medical contact with the patients, via mobile phone, to better evaluate their conditions and to intervene as early as possible. No fall was recorded during this period. Only two caregivers registered and reported the exercises being performed for less than a month. However, they sent emails about their parents' limitations with balance exercises, expecting some support from the interaction that is possible through the digital platform. The patient with the elderly caregiver had no record registered on the platform. No patient or caregiver sent an individual video with exercises performed, as requested by the consultant physician. Nevertheless, the comparison between pre and post DHI score already revealed some benefits of the balance exercises. This information was sent, via email, as positive feedback to participants, motivating them to continue performing the balance exercises.

3.3. Evaluation of the Digital Solution to Solve the Problem

3.3.1. Focus Group Socio-Demographic Participant Data

A researcher (and first author) conducted a focus group with five patients and five caregivers, all involved in the proof-of-concept study. This information is available in Table 1.

A week later, the same researcher conducted the other focus group with eight physicians who provided healthcare to the elderly in Portugal, having different technology knowledge and experience. Seven participants had coordination positions or were ex-coordinators of their own specialty in their health units, and one was an ex-coordinator of a medical residency in a public health unit in Portugal (Table 3).

Table 3. Socio-demographic data of the physicians.

Physician	Gender	Age	Specialty	Regional Health Administration of Portugal
1	M	49	Family Medicine	LTV
2	F	68	Family Medicine	Center
3	M	59	Internal Medicine	LTV
4	F	60	Internal Medicine	LTV
5	M	58	Otorhinolaryngology	LTV
6	M	59	Otorhinolaryngology	North
7	M	61	Otorhinolaryngology	LTV
8	M	68	Otorhinolaryngology	Center

M: Male; F: Female; LTV: Lisbon and Tejo Valey.

3.3.2. Focus group-Content Analysis

In the focus group with the participants of the proof-of-concept study, five primary thematic categories were discussed. From the data analysis, 11 subthemes emerged. Additionally, six other thematic categories were discussed in the focus group with physicians. From data analysis, 15 subthemes emerged (Table 4).

Table 4. Thematic categories of the focus groups.

Thematic Categories	Focus Group: Patients and Caregivers	Focus Group: Physicians
1. Benefits of "BALANCE" digital service	1.1. Patient comfort 1.2. Closer physician-patient interaction anywhere 1.3. Availability of tutorial videos with balance exercises	1.1. Patient comfort 1.2. Closer physician-patient interaction 1.3. Lower consumption of face-to-face resources 1.4. Patient motivation and adhesion
2. Constraints regarding the use of "BALANCE" digital service	2.1. Patient profile 2.2. Presentation screen on the mobile phone 2.3. Lack of time to record the exercises performed	2.1. Patient profile 2.2. Resistance of healthcare professionals 2.3. Lack of working time by healthcare professionals
3. Satisfaction with "BALANCE" digital service functionalities	3.1. Satisfaction level	3.1. Satisfaction level
4. Suggested strategies to improve "BALANCE" digital service	4.1. Presentation screen of "BALANCE" 4.2. Recorded videos with more identifiable exercises 4.3. Adjustment of interactive data relatively to performed balance exercises	4.1. Inclusion of automatic tools—objective data of performed balance exercises
5. Suggested strategies for new clinical applicability of "BALANCE" digital service	-	5.1. Working hours organization 5.2. Involvement of other health professionals 5.3. Interoperability

		5.4. Funding and continuity of the use of digital solution
		5.5. Recognition of the hierarchy
6. Interest in using "BALANCE" digital service	6.1. Interest in maintaining the use	6.1. Recognized interest in using "BALANCE" digital service

All physicians recognized the increased importance of telemedicine, especially in recent days: *The* (SARS-CoV-2) *pandemic has changed many things … therefore, we have to look for new solutions* (Physician 7)*; … the pandemic brought bad things but it also brought good things, namely in telemedicine* (Physician 4); *It might be an opportunity for eHealth*... (Physician 5); *The new tools* (telemedicine) *allow you to reach more people* (Physician 1); *It…* (telemedicine) *requires us… to review everything* (clinical file) *and with that we are even more prepared* (with more quality of data) *to the consultation* (Physician 5); *There is no doubt that Portugal is ageing badly…* (so) *we have many people who would benefit … and caregivers can (also) benefit in the future* (as they are getting older) (Physician 3).

In fact, both groups of interviewees mentioned many benefits from using the "BALANCE" digital service. They pointed out the patient comfort: *I had to go* (to the hospital) *by public transport or my daughter would take me* (to the hospital) *most of the time. And so* (with the platform)*, it is not necessary* (Patient 2); *It increases the comfort… the safety of the elderly …*(Physician 2). The benefit of closer physician–patient interaction was also mentioned in both focus groups: *I think it was the best...the interaction with the physician... and really the physician was able to answer almost immediately… (*Caregiver: Patient 5); *…to keep therapy* (balance rehabilitation) *at home, with all this help, it is fantastic* (Physician 8); *It increases… the connection with the health professional* (Physician 2)*; I am fully convinced that, with this type of strategy, we can help our patients … Basically, what they (patients) need is a close and frequent monitoring … physician available … to guide them through their difficulties* (Physician 5). The patients and caregivers also highlighted the medical involvement: *The physician* (i.e., the researcher) *is a person very concerned about us… in the other day, what I had was not even related to balance disorder...and the physician called anyway, worried to know if I was alright* (Patient 2)*; … really the physician answered almost immediately* (Caregiver: Patient 5). The availability of tutorial videos with balance exercises was highly praised: *The* (recorded videos) *are very good… They help to remember* (the exercises) (Caregiver: Patient 5). This availability of videos also allowed caregivers to understand the exercises and create strategies to make their family members less dependent: *My mother watched the videos. To avoid forgetting, we wrote down what should be done...* (Caregiver: Patient 4); *The videos motivated the realization of exercises outside the home, even in an unstable surface. I memorized most of them...even when I was walking on the street...I was doing them* (the exercises) *... normal path or in the sand. It was amazing. I think this gave me greater security* (Patient 2)*;... she* (the mother) *was even doing* (balance exercises) *in the market...* (Caregiver: Patient 4). The potential lower use of face-to-face resources was also mentioned: *Perhaps it* (digital solution) *will consume less face-to-face resources, with some people proactivity*. (Physician 1); *I think it is interesting … the patients can share their own difficulties and abilities through a mobile phone, a webcam...* (Physician 8). Moreover, the interviewees highlighted the potential for better patient motivation and adhesion to the therapy: *I want to thank. I think this* (digital platform) *is facilitating, even though it may seem like an obligation* (doing the exercises), *it encourages and serves even for us* (caregivers)*,… as we are going there* (we are getting older) (Caregiver: Patient 3); *Strategies like this can allow … greater adherence of patients to therapy* (Physician 3)*;...if they* (patients) *are at home and they have the perception that Andréa Gaspar* (the name of the reseacher, for example) *is able to assist them, to give recommendations, to know what difficulties they were facing... they become more interested... even if Andréa Gaspar, or whoever, is doing the* (remote) *monitoring and asks how many hours* (the patient) *has spent on*

the couch, they will probably spend fewer hours on the couch and practice the (balance) *exercises recommended than if they do not have any support or if they have support from caregivers who usually do not know how to provide this type of support* (Physician 8*).* In fact, the importance of carrying out balance exercises was recognized: *I think it's important to do* (balance exercises)*... sometimes doing more...sometimes doing less* (Caregiver: Patient 4).

However, some of the interviewees pointed out possible constraints in both focus groups, for example the user profile definitions: *People reached presbyvertigo* (prebivestibulopathy) *sooner than digital resources arrived. There are technical difficulties for this* (use of telemedicine by the elderly) (Physician 8); *We can use* (digital solution) *only with patients, with some differentiation. I think this is the big issue with this tool* (Physician 7). However, this point of view was not held by all physicians: *It is a mistake for us to think that elderly are completely averse and incompetent to use electronic resources. I think that these people are sometimes available to experiment...especially when they use it for their interest... namely, in their own health.* (Physician 5); *There are many people who can benefit from this project with the proper training of their caregivers, even those who consider themselves info-excluded* (Physician 1). In fact, all participating caregivers recognized the existence of their elderly family members' limitations on the use of "BALANCE" digital service: *My mom couldn't do that* (use the digital solution) … (Caregiver: Patient 5); *Of course, I have no difficulty at using the* (digital) *platform... But to apply it to elderly people, … it's not easy* (Caregiver: Patient 3). About this, Patient 1 mentioned: *I have been doing* (the exercises) *according to what the physician explained to me* (all participants received, via email, individual instructions with the recommended exercises and videos). *I never saw the videos* (during balance rehabilitation). After sharing the computer screen, her caregiver, who is her 72-year-old husband, said: *Yes, the physician* (the researcher) *has already presented this to me. She* (the physician) *already has presented it at the beginning* (in the first meeting, via Zoom, to explain how to use of the digital platform)*... … I simply forgot about it*. The caregivers of patients 3 and 4 also highlighted their difficulty with using "BALANCE" digital service on the mobile phone: *On the computer it's easie*r (the use of the digital solution) *than on the mobile phone.* The lack of time to record the balance exercises performed was another constraint pointed out*: …the daily record of exercises... we do not always have the computer on …* (Caregiver: Patient 3). The potential resistance of healthcare professionals as a constraint for clinical applicability of the "BALANCE" digital service was also mentioned*: …there will be some difficulties in terms of human resources...* (Participant 4); *It will always cost in the beginning of the process, when there is something new, there is always some resistance...* (Physician 7); *I often hear… that consultation of Otorhinolaryngology has to be a face-to-face consultation at all times... I think this is not true... the literature and articles...they have already demonstrated that it is not true... I know there is great resistance to change... It is necessary to have people … to demonstrate that we have to accept other alternatives and that they are useful* (Physician 5). The physicians also considered the lack of time as another barrier for clinical applicability of this digital solution: *It* (the use of this digital platform*) is an advantage that… must be compensated with specific time for this… my doubts are what time we* (physicians) *have to do this* (remote) *monitoring… …time must be allocated for this purpose* (Physician 5).

Despite not having seen the available tutorial videos, Patient 1 was motivated and performed the exercises according to email instructions and rated the remote physician–patient interaction 20 out of 20 values (on a scale from 0 to 20 points, 20 points for the best rating of level of satisfaction). Relative to the other participants of the proof-of-concept study, all caregivers rated the digital platform with 20 points, except for the caregiver of Patient 4. She rated it with 19 points, recommending specific adjustment on the available services: *There are* (in the digital platform) *items that we don't use and then it gets a little more confusing.* (Caregiver: Patient 4). In fact, these "items" were part of the METHIS platform, related to the follow-up of patients with chronic pathology in primary healthcare. Another suggestions pointed out was the recording of the videos without protective equipment: *I think that, in the future, if it is possible to record without the protective equipment it would help more to be able to see the whole face… in the* (videos of) *walking, it would also be possible to better*

identify (the exercises) (Caregiver: Patient 4). Actually, these videos were recorded with the researcher using individual protective equipament due to the SARS-CoV-2 pandemic. The recording of balance exercises performed was another point to be changed, avoiding the daily recording of exercises performed. When asked if there was a need to add more functionalities in the "BALANCE" *digital* service, the patients and caregivers did not agree: *It* (the digital platform) *couldn't be much more complex* (to use)…(Caregiver: Patient 5). When asked whether puppet-animated videos could be used, patients and caregivers stated that recorded videos should only include people as models, such as the recorded videos added on the platform.

Regarding medical satisfaction on using the platform, only Physician 6 revealed some dissatisfaction with the digital service: *It is not clear enough in the information provided that the systems allows the physician to assess the patient's evolution*. He suggested the adjustment of the "BALANCE" digital service with the inclusion of automatic tools: *… to analyze the videos* (sent by patients)*... creating alerts… so that the physician can intervene and make corrections in the patient's rehabilitation process*. Other strategies for a better clinical applicability were discussed. For example, the restructuring of working hours were discussed: *Everything is possible, as long as there is a willingness…* (Physician 7);*... make the activity* (of the digital solution) *accountable as medical production* (within working hours)*… so that physicians and other professionals could have time for these activities* (Physician 5); *It is important to integrate into the schedule* (of health professionals*), it is not beyond the schedule... If not, it is something* that *becomes a volunteer and the volunteer is temporary* (Physician 2). The use of the digital solution by other health professionals was also suggested: *If we can generalize this tool* (digital solution), *not only with the support of caregivers but also with the support of nurses...* (Physician 1). The interoperability was also remembered as an issue: *this is a tool that we can use, as long as the interoperability with other tools is guaranteed …* (Physician 1). They also discussed the importance of funding and continuity of digital solutions not only at the regional level but also at the national level, with the recognition of the hierarchy: *I will try to give you my experience... from two studies* (with telemedicine) *… I tried to keep elderly people at home with a better quality of life and they were not institutionalized. The biggest problem…. It was its end...I think the elderly have already lost a lot… in their lives. And when we give them a better quality of life, when we increase their ability to be at home... when we provide better caregivers* (with training of caregivers*)… we can't have an end* (of the study). *I think that...they* (projects) *have to include more Ministries to be more sustainable...* (Physician 2).

Physician 6 also highlighted the importance of the involvement and integration of several professionals in designing and implementing digital solutions: *... these things only gain with exchange between the various centers...because we all learn together.*

All the physicians considered the digital platform as interesting and agreed with the potential of the digital solution as a complementary healthcare provision: *This project is interesting and it can move forward… and no longer just a study* (Physician 6); *There is undoubtedly a large percentage of patients who could benefit* (from the "BALANCE" digital service) (Physician 3).

All patients expressed their willingness to continue using the digital platform. One participant justified: *And if we* (patients), *from time to time, need to see the videos* (with the balance exercises) … *it's better* (Patient 2).

4. Discussion

The systematic review [21] previously identified the lack of valid guidance of digital devices for a better clinical provision of healthcare in the context of elderly people with balance disorders and risk of falling [19,20]. Thus, to address and study this issue, DSRM [22] was used to design and integrate the "BALANCE" digital service to the platform METHIS [29], as suggested by strategies previously discussed in the explanatory sequential mixed methods study [23]. The "BALANCE" digital service was demonstrated and evaluated with a set of patients. We verified that there is an important potential for clinical

applicability of this digital solution for the elderly with balance disorders and risk of falling.

The identification and exploration of the digital medical constraints relative to healthcare provision in this context, and the recommended strategies allowed us to elaborate the "BALANCE" digital care service. This digital solution allowed to: (a) upload and access clinical data, in checklist format and free-text structure, according to the SOAP model; (b) upload and access interactive data, in checklist format and free-text structure, allowing closer physician–patient interaction, complementary remote monitoring, early detection of clinical deterioration and adjustment of recommended balance exercises; (c) access the final score of the DHI questionnaire completed by the patient and compare the results before and after carrying out the balance exercises; (d) access tutorial videos with balance exercises in slow motion and at normal speed, for a better patient orientation. No video recorded demonstrating patients' performances while carrying out the exercise was uploaded onto the platform, which could not have allowed for the physician's "real-time" assessment.

Both participants and caregivers' engagement in the demonstration of the "BALANCE" digital service was verified, as well as encouraging their elderly family members and teaching them how to access the exercise videos. Despite the 72-year-old caregiver not having accessed the videos as instructed, the patient was carrying out the exercises according to the medical remote interaction (Figure 3). This revealed the motivation of this patient and the limitation of the use of digital technology by an elderly patient and elderly caregiver, which had already been discussed in both focus groups. Instead of using the messaging functionality via the "BALANCE" digital service, this caregiver requested the physician's email as a form of rapid contact, revealing the need for more intense digital training to use the platform. The patients and caregivers highlighted the medical involvement with quick response to their questions. In fact, the involvement of patients, caregivers and healthcare professionals is one key point for the success of digital interactive solutions [33,34].

Using focus groups, we explored the potential contributions, constraints for clinical applicability, satisfaction and strategies to improve the digital solution. In fact, digital health end-user experience is important, listening and engaging with patient, family members, caregivers, health professionals and policymakers to improve the implementation of digital solutions in clinical contexts [3,34,35].

As observed in other studies [14,15,17,36], the participants of the two focus groups highlighted several benefits of a digital rehabilitation service: comfort, closer physician–patient interaction anywhere, the potential for patient's motivation and engagement with self-care. Additionally, the availability of the tutorial videos with balance exercises was considered as a positive factor, allowing patients to remember the exercises and motivating them to exercise, including outside the home. These videos also allowed caregivers to understand the recommended exercises. In fact, the advantages of internet based balance rehabilitation with videos had been already pointed out [36]. However, we also performed remote daily monitoring, allowing for additional physician–patient interaction in case of uploaded data regarding clinical deterioration.

However, according to the literature [37–41], some remaining constraints for the clinical applicability of digital devices have been discussed: limitations of elderly people in accessing and using technologies, need for previous digital training and caregiver support. In fact, the caregivers' deep involvement and training were essential in our study as was reported in previous research [33,34].

Unfortunately, in our study, even the caregivers had difficulty in using the "BALANCE" digital service on the mobile phone support, pointing to the need for future adjustments. The digital devices must be adequate to match the abilities of this population as highlighted by other researchers [33,38,42].

The caregiver's unavailability to upload daily data about exercises performed is another issue that needs to be considered. The suggested inclusion of automatic tools to objectively analyze patient's videos may add value (and usability) to the platform "BALANCE".

As already identified [5,33,37], the lack of investment in long-term care services, including digital solutions, and of alignment with public health policies, were other constraints discussed.

All the patients and caregivers revealed interest with this remote physician–patient interaction and asked for extension of the "BALANCE" digital service use. The motivation for physical activity is a well-defined public health policy for healthy ageing [43,44] and with the "BALANCE" digital service, we are motivating this in a clinical way.

All the physicians also recognized the potential of the "BALANCE" digital service to be used as a complementary healthcare provision, once the interoperability and the restructuring of work processes are guaranteed [41].

Face-to-face physician–patient interaction will always be important. However, several researchers have observed a gradual path for the medical specialties to learn how to reach their patients remotely and benefit from it [45–47].

Our study allowed us to design and develop, using a scientifically-based approach, the "BALANCE" digital service, a digital supporting system that could add value for complementary treatment, and optimize and maintain opportunities for elderly people with functional ability within their communities. Again, we can also consider that these systems could support the training and preparing of caregivers for their roles, promoting active ageing and proactively using a digital solution. There is always an additional effort to understand and implement innovative technologies, but it is necessary to establish implementation strategies to overcome this challenge.

Limitations

Regarding the eligible health professionals, this project only included physicians. In future studies, we must consider the participation of other professionals with healthcare provision for the elderly with balance disorders and risk of falling. The sampling of the all those interviewed was intentional, and the focus groups were conducted remotely via Zoom due to SARS-CoV-2 pandemic limitations.

Relative to the patients, we included participants without diagnosed neurologic disease. In fact, patients with balance disorders and neurologic diseases could benefit from the "BALANCE" digital service. However, future researchers could evaluate whether constraints with the use of this digital solution by neurological patients would be greater.

Because we performed a proof-of-concept study, only one physician (the researcher) and five patients, followed up at HBA and participated in the demonstration of the digital solution. Additionally, the follow-up time was only three months. However, after this initial intervention, we are planning to carry out a future study with a longer follow-up and a representative sample, considering the suggestions of the focus groups.

Finally, only the participants of the proof-of-concept study and the invited physicians evaluated the "BALANCE" digital service. In fact, managers and digital developers must also be involved in the evaluation of digital health solutions [33,48].

Multicenter studies with a longer follow-up could provide more information on usability, acceptability, adherence and impact of the "BALANCE" digital service.

5. Conclusions

Using DSRM, we designed, implemented and demonstrated "BALANCE", a digital service for complementary care provision for elderly people with balance disorders and risk of falling. We explored the benefits, constraints, necessary adjustments and satisfaction. We verified a significant potential for clinical applicability of this digital solution.

However, involvement of patients, caregivers and healthcare professionals, interoperability of digital solutions and reorganization of work activities are key points for future clinical applicability. Additional studies are required to include these aspects.

Author Contributions: Conceptualization, A.G.M.G. and L.V.L.; methodology, A.G.M.G. and L.V.L.; formal analysis, A.G.M.G. and L.V.L.; investigation, A.G.M.G. and L.V.L.; data curation, A.G.M.G.; writing—original draft preparation, A.G.M.G. and L.V.L.; writing—review and editing, A.G.M.G. and L.V.L.; funding acquisition, L.V.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was partially supported by Fundação para a Ciência e Tecnologia (FCT) for funds to Global Health and Tropical Medicine (GHTM) (UID/04413/2020 to LVL).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Scientific Council and the Ethic Council of Instituto de Higiene e Medicina Tropical da Universidade NOVA de Lisboa, Portugal (date of approval: 21 September 2018) and the Health Ethics Committee of Hospital Beatriz Ângelo (date of approval: 4 January 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the following activities: qualitative phase of the mixed methods study, proof of concept and patient focus group study.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author A.G.M.G.

Acknowledgments: The digital solution development had the support of the Instituto de Higiene e Medicina Tropial (IHMT) da Universidade NOVA de Lisboa, Regional Health Administration of Lisbon and Tejo Valey (ARS LVT) and Faculty of Science and Technology (Faculdade de Ciências e Tecnologia (FCT) da Universidade NOVA de Lisboa. We would like to thank Paulo Abreu, Andreia Nascimento and Mélanie Maia for supporting the implementation of the "BALANCE" digital service.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table A1. Focus group with patients and caregivers: Interview guide.

Thematic Categories	Questions
Benefits of "BALANCE" service	"In your opinion, was this digital service beneficial?Why?"
Constraints relatively the digital service	"Did you have difficulty using this digital service?" If yes, what were the difficulties"
Satisfaction	"What is your level of satisfaction regarding the use of the "BALANCE" service?"
Strategies to improve the digital service	"What would you recommend to improve this service?"
Interest in maintaining the use	"Would you like to continue using the "BALANCE" service?"

Table A2. Focus group with physicians: Interview guide.

Thematic Categories	Questions
Benefits of "BALANCE" service	"What do you think about the benefits of this digital service for the provision of complementary healthcare for elderly people with balance disorders and risk of falling?"

Constraints regarding the use of "BALANCE" service	"What is your opinion about the constrains/limitations regarding this service?"
Medical satisfaction with "BALANCE" service functionalities	"How satisfied are you with the potential of this digital service?"
Suggested strategies to adjust "BALANCE" service	"What strategies can be implemented to improve BALANCE service?"
Suggested strategies for clinical applicability	"How can "BALANCE" service be suitable for clinical applicability?"
Interest in the "BALANCE" service	"In your opinion, is there interest in this digital complementary health service?"

References

1. World Health Organization (WHO). Regional Office for Europe. Portugal-Country Case Study on the Integrated Delivery of Long-Term Care. 2020. Available online: https://www.euro.who.int/__data/assets/pdf_file/0004/426388/05_PORT-CountryRep_WEB.pdf (accessed on 10 August 2021).
2. WHO Regional Office for Europe. Age-Friendly Environments in Europe. A Handbook of Domains for Policy Action. 2017. Available online: https://apps.who.int/iris/bitstream/handle/10665/334251/9789289052887-eng.pdf (accessed on 10 August 2021).
3. World Health Organization (WHO). Decade of Healthy Ageing. Baseline Report. 2020. Available online: https://www.who.int/publications/i/item/9789240017900 (accessed on 11 October 2021).
4. Rudnicka, E.; Napierała, P.; Podfigurna, A.; Męczekalski, B.; Smolarczyk, R.; Grymowicz, M. The World Health Organization (WHO) approach to healthy ageing. *Maturitas* **2020**, *139*, 6–11. https://doi.org/10.1016/j.maturitas.2020.05.018.
5. OECD. *Health at a Glance 2021: OECD Indicators*; OECD Publishing: Paris, France, 2021. https://doi.org/10.1787/ae3016b9-en.
6. Fernández, L.; Breinbauer, H.A.; Delano, P.H. Vertigo and Dizziness in the Elderly. *Front. Neurol.* **2015**, *6*, 144. https://doi.org/10.3389/fneur.2015.00144.
7. Nguyen, H.; Moreno-Agostino, D.; Chua, K.C.; Vitoratou, S.; Prina, A.M. Trajectories of healthy ageing among older adults with multimorbidity: A growth mixture model using harmonised data from eight ATHLOS cohorts. *PLoS ONE* **2021**, *16*, e0248844. https://doi.org/10.1371/journal.pone.0248844.
8. Casani, A.P.; Gufoni, M.; Capobianco, S. Current Insights into Treating Vertigo in Older Adults. *Drugs Aging* **2021**, *38*, 655–670. https://doi.org/10.1007/s40266-021-00877-z.
9. Ha, V.A.T.; Nguyen, T.N.; Nguyen, T.X.; Nguyen, H.T.T.; Nguyen, T.T.H.; Nguyen, A.T.; Pham, T.; Thanh Vu, H.T. Prevalence and Factors Associated with Falls among Older Outpatients. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4041. https://doi.org/10.3390/ijerph18084041.
10. Coto, J.; Alvarez, C.L.; Cejas, I.; Colbert, B.M.; Levin, B.E.; Huppert, J.; Rundek, T.; Balaban, C.; Blanton, S.H.; Lee, D.J.; et al. Peripheral vestibular system: Age-related vestibular loss and associated deficits. *J. Otol.* **2021**, *16*, 258–265. https://doi.org/10.1016/j.joto.2021.06.001.
11. Zhang, R.; Liu, B.; Bi, J.; Chen, Y. Relationship Between Chronic Conditions and Balance Disorders in Outpatients with Dizziness: A Hospital-Based Cross-Sectional Study. *Med. Sci. Monit*. **2021**, *27*, e928719. Feb 21. https://doi.org/10.12659/MSM.928719.
12. Florence, C.S.; Bergen, G.; Atherly, A.; Burns, E.; Stevens, J.; Drake, C. Medical Costs of Fatal and Nonfatal Falls in Older Adults. *J. Am. Geriatr. Soc.* **2018**, *66*, 693–698. https://doi.org/10.1111/jgs.15304.
13. Kovacs, E.; Wang, X.; Grill, E. Economic burden of vertigo: A systematic review. *Health Econ. Rev.* **2019**, *9*, 27. https://doi.org/10.1186/s13561-019-0258-2.
14. Lapão, L.V.; Dussault, G. The contribution of eHealth and mHealth to improving the performance of the health workforce: A review. *Public Health Panor.* **2017**, *3*, 463–471.
15. Uei, S.L.; Kuo, Y.M.; Tsai, C.H.; Kuo, Y.L. An Exploration of Intent to Use Telehealth at Home for Patients with Chronic Diseases. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1544. https://doi.org/10.3390/ijerph14121544.
16. Olsen, C.F.; Bergland, A.; Bye, A.; Debesay, J.; Langaas, A.G. Crossing knowledge boundaries: Health care providers' perceptions and experiences of what is important to achieve more person-centered patient pathways for older people. *BMC Health Serv. Res.* **2021**, *21*, 310. https://doi.org/10.1186/s12913-021-06312-8.
17. Wynn, R.; Gabarron, E.; Johnsen, J.K.; Traver, V. Special Issue on E-Health Services. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2885. https://doi.org/10.3390/ijerph17082885.
18. Mucchi, L.; Jayousi, S.; Gant, A.; Paoletti, E.; Zoppi, P. Tele-Monitoring System for Chronic Diseases Management: Requirements and Architecture. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7459. https://doi.org/10.3390/ijerph18147459.

19. Leirós-Rodríguez, R.; García-Soidán, J.L.; Romo-Pérez, V. Analyzing the Use of Accelerometers as a Method of Early Diagnosis of Alterations in Balance in Elderly People: A Systematic Review. *Sensors* **2019**, *19*, 3883. https://doi.org/10.3390/s19183883.
20. Choi, S.D.; Guo, L.; Kang, D.; Xiong, S. Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review. *Appl. Ergon.* **2017**, *65*, 570–581. https://doi.org/10.1016/j.apergo.2016.10.013.
21. Gaspar, A.G.M.; Lapão, L.V. eHealth for Addressing Balance Disorders in the Elderly: Systematic Review. *J. Med. Internet Res.* **2021**, *23*, e22215. https://doi.org/10.2196/22215.
22. Peffers, K.; Tuunanen, T.; Rothenberger, M.A.; Chatterjee, S. A design science research methodology for information systems research. *J. Manag. Inf. Syst.* **2007**, *24*, 45–77. https://doi.org/10.2753/MIS0742-1222240302.
23. Gaspar, A.G.M.; Escada, P.; Lapão, L.V. How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7410. https://doi.org/10.3390/ijerph18147410.
24. Brandt, T.; Dieterich, M.; Strupp, M. *Vertigo and Dizziness: Common Complaints*, 2nd ed.; Springer: Berlin/Heidelberg, Germany, 2014; ISBN-10:085729590X, ISBN-13: 978-0857295903.
25. Jacobson, G.P.; Newman, C.W. The development of the Dizziness Handicap Inventory. *Arch. Otolaryngol. Head Neck Surg.* **1990**, *116*, 424–427. https://doi.org/10.1001/archotol.1990.01870040046011.
26. Lapão, L.V.; Peyroteo, M.; Maia, M.; Seixas, J.; Gregório, J.; Mira da Silva, M.; Heleno, B.; Correia, J.C. Implementation of Digital Monitoring Services During the COVID-19 Pandemic for Patients with Chronic Diseases: Design Science Approach. *J. Med. Internet Res.* **2021**, *26*, 23, e24181. https://doi.org/10.2196/24181.
27. Blokdyk, G. *Proof of Concept Poc. A Complete Guide-2020*; 5STARCooks Brendale, Australia, Edition Paperback; 2021; 304p, ISBN-10:0655930612, ISBN-13:978-0655930617.
28. Morgado, J.; Rocha, C.S.; Maruta, C.; Guerreiro, M.; Martins, I.P. Novos valores normativos do Mini-Mental State Examination. *Sinapse* **2009**, *9*, 10–16.
29. Creswell, J.W.; Creswell, J.D. Research design. In *Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed.; SAGE Publications Inc.: Los Angeles, CA, USA, 2018.
30. Assembleia da República. Lei nº 58/2019 de 8 de Agosto de 2019. Diário da República n.º 151/2019, Série I de 2019-08-08. 3–40. Available online: https://data.dre.pt/eli/lei/58/2019/08/08/p/dre (accessed on 22 February 2021).
31. General Data Protection Regulation. Art. 12 GDPR–Transparent Information, Communication and Modalities for the Exercise of the Rights of the Data Subject-General Data Protection Regulation (GDPR). Available online: Gdpr-info.eu (accessed on 22 February 2021).
32. Pearce, P.F.; Ferguson,L.A.; George, G.S.; Langford, C.A. The essential SOAP note in an EHR age. *Nurse Pract.* **2016**, *41*, 29–36. https://doi.org/10.1097/01.NPR.0000476377.35114.d7.
33. Goldsack, J.C.; Zanetti, C.A. Defining and Developing the Workforce Needed for Success in the Digital Era of Medicine. *Digit. Biomark.* **2020**, 4,:136-142. https://doi.org/10.1159/000512382.
34. Tossaint-Schoenmakers, R.; Versluis, A.; Chavannes, N.; Talboom-Kamp, E.; Kasteleyn, M. The Challenge of Integrating eHealth Into Health Care: Systematic Literature Review of the Donabedian Model of Structure, Process, and Outcome. *J. Med. Internet Res.* **2021**, *23*, e27180. https://doi.org/10.2196/27180.
35. Kim, H.S.; Kwon, I.H.; Cha, W.C. Future and Development Direction of Digital Healthcare. *Healthc. Inform. Res.* **2021**, *27*, 95–101. https://doi.org/10.4258/hir.2021.27.2.95.
36. van Vugt, V.A.; van der Wouden, J.C.; Essery, R.; Yardley, L.; Twisk, J.W.; van der Horst, H.E.; Maarsingh, O.R. Internet based vestibular rehabilitation with and without physiotherapy support for adults aged 50 and older with a chronic vestibular syndrome in general practice: Three armed randomised controlled trial. *BMJ* **2019**, *367*, l5922. https://doi.org/10.1136/bmj.l5922.
37. Orton, M.; Agarwal, S.; Muhoza, P.; Vasudevan, L.; Vu, A. Strengthening Delivery of Health Services Using Digital Devices. *Glob. Health Sci. Pract.* **2018**, *6*, S61–S71. https://doi.org/10.9745/GHSP-D-18-00229.
38. Ricciardi, W.; Pita Barros, P.; Bourek, A.; Brouwer, W.; Kelsey, T.; Lehtonen, L. How to govern the digital transformation of health services. *Eur. J. Public Health* **2019**, *29*, 7–12. https://doi.org/10.1093/eurpub/ckz165.
39. Jun, W. A Study on the Current Status and Improvement of the Digital Divide among Older People in Korea. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3917. https://doi.org/10.3390/ijerph17113917.
40. Heponiemi, T.; Jormanainen, V.; Leemann, L.; Manderbacka, K.; Aalto, A.M.; Hyppönen, H. Digital Divide in Perceived Benefits of Online Health Care and Social Welfare Services: National Cross-Sectional Survey Study. *J. Med. Internet Res.* **2020**, *22*, e17616. https://doi.org/10.2196/17616.
41. Trenerry, B.; Chng, S.; Wang, Y.; Suhaila, Z.S.; Lim, S.S.; Lu, H.Y.; Oh, P.H. Preparing Workplaces for Digital Transformation: An Integrative Review and Framework of Multi-Level Factors. *Front. Psychol.* **2021**,12, 620766. https://doi.org/10.3389/fpsyg.2021.620766.
42. Raja, M.; Bjerkan, J.; Kymre, I.G.; Galvin, K.T.; Uhrenfeldt, L. Telehealth and digital developments in society that persons 75 years and older in European countries have been part of: A scoping review. *BMC Health Serv. Res.* **2021**, *21*, 1157. https://doi.org/10.1186/s12913-021-07154-0.
43. Sowa, A.; Tobiasz-Adamczyk, B.; Topór-Mądry, R.; Poscia, A.; la Milia, D.I. Predictors of healthy ageing: Public health policy targets. *BMC Health Serv. Res.* **2016**, *16*, 289. https://doi.org/10.1186/s12913-016-1520-5.
44. Bechtold, U.; Stauder, N.; Fieder, M. Let's Walk It: Mobility and the Perceived Quality of Life in Older Adults. *Int. J. Environ. Res. Public Health* **2021**,18,11515. https://doi.org/10.3390/ijerph182111515.

45. Cohen, A.B.; Nahed, B.V. The Digital Neurologic Examination. *Digit. Biomark.* **2021**, *5*, 114–126. https://doi.org/10.1159/000515577.
46. Barreto, R.G.; Yacovino, D.A.; Cherchi, M.; Nader, S.N.; Teixeira, L.J.; Silva, D.A.D.; Verdecchia, D.H. The Role of the Smartphone in the Diagnosis of Vestibular Hypofunction: A Clinical Strategy for Teleconsultation during the COVID-19 Pandemic and Beyond. *Int. Arch. Otorhinolaryngol.* **2021**, *25*, e602–e609. https://doi.org/10.1055/s-0041-1736340.
47. da Fonseca, M.H.; Kovaleski, F.; Picinin, C.T.; Pedroso, B.; Rubbo, P. E-Health Practices and Technologies: A Systematic Review from 2014 to 2019. *Healthcare* **2021**, *9*, 1192. https://doi.org/10.3390/healthcare9091192.
48. Karpathakis, K.; Libow, G.; Potts, H.W.W.; Dixon, S.; Greaves, F.; Murray, E. An Evaluation Service for Digital Public Health Interventions: User-Centered Design Approach. *J. Med. Internet Res.* **2021**, *8*, e28356. https://doi.org/10.2196/28356.

2.4. PAPER IV

Gaspar AGM, Lapão LV. A utilização de um serviço de saúde digital para idosos com alterações do equilíbrio e risco de queda num contexto global. *An Inst Hig Med Trop*. 2022 Oct 22; 21:66-72.

Artigo original

A utilização de um serviço de saúde digital para idosos com alterações do equilíbrio e risco de queda num contexto global

The use of a digital health service for elderly people with balance disorders and risk of falling in a global context

L'utilisation d'un service de santé numérique pour les personnes âgées avec troubles de l'équilibre et risques de chute dans un contexte global

Andréa G. Martins Gaspar
Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Lisboa, Portugal.
Serviço de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço, Hospital Beatriz Ângelo, Loures, Lisboa, Portugal.

Luís Velez Lapão
Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Lisboa, Portugal.

Resumo

Introdução: O envelhecimento a nível global e a vulnerabilidade para o desenvolvimento de doenças crónicas estão a desafiar a sustentabilidade dos sistemas de saúde, inclusive dos países em transição demográfica e epidemiológica, como Cabo Verde. Uma das recomendações globais para aliviar esta pressão é o uso da saúde digital.
Objetivos: Compreender e explorar o potencial de utilização do serviço digital "EQUILÍBRIO" para a prestação complementar de cuidados de saúde a idosos com alterações de equilíbrio e risco de queda em Cabo Verde.
Materiais e métodos: Em fevereiro de 2022, realizou-se um Workshop de Policy Dialogue, via Zoom, incluindo o Conselho da Administração do Hospital Central Doutor Agostinho Neto.
Resultados: Com a análise do conteúdo do Workshop, verificaram-se o interesse e o potencial de utilização do serviço digital "EQUILÍBRIO", previamente testado e avaliado em contexto clínico português. Contudo, para a sua aplicabilidade clínica, foi reconhecida a necessidade de tempo para a reestruturação do trabalho e alocação dos profissionais de saúde e envolvimento dos doentes.
Conclusão: A futura implementação do serviço digital "EQUILÍBRIO" em Cabo Verde é uma oportunidade de investigação, permitindo uma estreita cooperação entre Portugal e Cabo Verde na conjuntura do envelhecimento. Poderá ser um promissor exemplo de cooperação de cuidados de saúde entre os Estados-membros da Comunidade dos Países de Língua Portuguesa.

Palavras-chave: Saúde global, Idoso, Equilíbrio, Queda, eHealth, Telemedicina, Saúde digital, Cabo Verde

Abstract

Introduction: Global aging and the vulnerability to the development of chronic diseases are challenging the sustainability of health systems, including countries in demographic and epidemiological transition, such as Cape Verde. One of the global recommendations to alleviate this pressure is the use of digital health.
Objectives: Understand and explore the potential of using the digital service "BALANCE" to provide complementary health care for elderly people with balance disorders and risk of falling in Cape Verde.
Materials and methods: In February 2022, a Policy Dialogue Workshop was carried out, via Zoom, including the Board of Directors of Hospital Central Doutor Agostinho Neto.
Results: With the analysis of the Workshop's content, the interest and potential of using the digital service "BALANCE", previously tested and evaluated in a Portuguese clinical context, were verified. However, for its clinical applicability, the need for time for the restructuring of work and allocation of health professionals and patient involvement was recognized.

https://doi.org/10.25761/anaisihmt.430

Conclusion: The future implementation of the digital service "BALANCE" in Cape Verde is an opportunity for research, allowing a close cooperation between Portugal and Cape Verde in the context of aging. It could be a promising example of health care cooperation between the member states of the Community of Portuguese-Speaking Countries.

Keywords: Global health; Elderly, Balance, Falls, eHealth, Digital health, Telemedicine, Cape Verde

Résumé

Introduction: Le vieillissement mondial et la vulnérabilité au développement des maladies chroniques remettent en question la pérennité des systèmes de santé, y compris dans les pays en transition démographique et épidémiologique, comme le Cap-Vert. L'une des recommandations mondiales pour atténuer cette pression est l'utilisation de la santé numérique.
Objectifs: Comprendre et explorer le potentiel d'utilisation du service numérique "ÉQUILIBRE" pour fournir des soins de santé complémentaires aux personnes âgées avec troubles de l'équilibre et risques de chute au Cap-Vert.
Matériels et méthodes: En février 2022, un atelier de dialogue politique a été organisé, via Zoom, avec le Conseil d'Administration de l'Hôpital Central Doutor Agostinho Neto.
Résultats: Avec l'analyse du contenu de l'atelier, l'intérêt et le potentiel d'utilisation du service numérique "ÉQUILIBRE", préalablement testé et évalué dans un contexte clinique portugais, ont été vérifiés. Cependant, pour son applicabilité clinique, le besoin de temps pour la restructuration du travail et l'affectation des professionnels de la santé et l'implication des patients a été reconnu.
Conclusion: La future implantation du service numérique "ÉQUILIBRE" au Cap-Vert est une opportunité de recherche, permettant une coopération étroite entre le Portugal et le Cap-Vert dans le contexte du vieillissement. Il pourrait s'agir d'un exemple prometteur de coopération en matière de soins de santé entre les États membres de la Communauté des pays de langue portugaise.

Mots-clés: Santé globale, Personne âgée, Équilibre, Chute, eHealth, Santé numérique, Telemedicine, Cap Vert

Introdução

O envelhecimento e a sua suscetibilidade para o desenvolvimento de doenças crónicas, multimorbilidade, alterações do equilíbrio e risco de queda têm pressionado os atuais sistemas de saúde, inclusive nos países em transição demográfica e epidemiológica [1-4]. De facto, vários estudos confirmam o progressivo aumento global na prestação de cuidados de saúde a idosos com distúrbios do equilíbrio e consequentes quedas [1-4].

Neste contexto de cuidados associados ao envelhecimento, a utilização da saúde digital pode representar uma das estratégias para mitigar a sua pressão nos sistemas de saúde. Desde 2005, a Organização Mundial da Saúde tem incentivado a implementação e o uso global de Sistemas e Tecnologias de Informação para apoiar o setor de saúde [5,6] Progressivamente, muitos governos têm incluído soluções digitais em suas políticas de saúde. No entanto, diversos países africanos ainda apresentam alguns constrangimentos ao uso digital, como recursos materiais insuficientes, resistência dos profissionais de saúde, barreira cultural e linguística, coordenação deficiente, analfabetismo digital, falta de financiamento, inacessibilidade digital e falta de interoperabilidade, restringindo o pleno uso do potencial das soluções digitais [7,8].

Por outro lado, a trajetória da República de Cabo Verde tem sido diferente, com resultados mais positivos [9,10]. Este país da África Subsariana, Estado membro da Comunidade dos Países de Língua Portuguesa (CPLP), é constituído por 10 ilhas e vários ilhéus mais pequenos, com cerca de meio milhão de habitantes que também estão a envelhecer progressivamente, embora com uma taxa de envelhecimento inferior à dos países europeus [11]. Cabo Verde tem um sistema de saúde organizado na promoção dos cuidados primários [12], contudo com alguma escassez de profissionais de saúde em áreas especializadas [13].

Por exemplo, a base de dados cabo-verdiana do ano de 2014 identificou 401 médicos, com apenas 272 médicos em atividade [13]. Destes, apenas 1 era especialista em Medicina de Família, 15 em Medicina Interna, 1 em Neurologia e 4 em Otorrinolaringologia, ou seja, um total de 21 médicos especialistas com prestação de cuidados de saúde a doentes com alterações do

equilíbrio [13]. Assim, neste contexto, o número de médicos para o atendimento ao idoso pode não ser suficiente.

Para mitigar os constrangimentos geográficos e a insuficiência de recursos humanos, Cabo Verde tem incentivado o uso da saúde digital [13-16]. De facto, este país é um dos primeiros utilizadores da saúde digital na África [17], com uma rede de telemedicina bem integrada. Em 2012, o Governo cabo-verdiano avançou para a implementação de um programa nacional de telemedicina com a cooperação da República da Eslovénia e da *International Virtual e-Hospital Foundation*, utilizando a estratégia *Initiate-Build-Operate-Transfer* [14,18]. Esta cooperação auxiliou na compra, entrega e integração de recursos tecnológicos nas nove ilhas habitadas e na formação de profissionais de saúde [14]. Desde 2014, o programa de telemedicina é gerido pelo Ministério da Saúde de Cabo Verde, que em 2015 criou o primeiro Centro Nacional de Telessaúde na CPLP [10], alinhando-se com as estratégias de saúde digital desta organização de países lusófonos [19-21].

Com o investimento em saúde digital, a formação remota de profissionais de saúde tem aumentado o acesso aos cuidados de saúde. Os centros de telemedicina cabo-verdianos também têm proporcionado interação médica com teleconsultas, melhor gestão das evacuações dos doentes e cooperação com instituições internacionais, reduzindo custos [9,10,22,23]. Em 2013, foram registadas 62 teleconsultas. Com motivação e trabalho contínuos, foram contabilizadas, em 2019, um total de 786 teleconsultas de diferentes especialidades, distribuídas pelos diversos centros de telemedicina [24]. No entanto, estes dados publicados não discriminaram os números relacionados à prestação de cuidados de saúde a idosos com distúrbios do equilíbrio e risco de queda [24].

O presente trabalho tem como objetivos compreender e explorar o potencial de utilização do serviço digital "EQUILÍBRIO" e a sua aplicabilidade para a prestação complementar de cuidados a idosos com alterações do equilíbrio e risco de queda no contexto global, considerando o contexto cabo-verdiano. Utilizando a *Design Science Research Methodology* (DSRM) [25], uma das abordagens utilizadas para o desenvolvimento de serviços de informação, este serviço digital foi previamente desenhado, elaborado, demonstrado e avaliado no contexto clínico português, com resultados positivos [26,27]. O serviço digital "EQUILÍBRIO" permite monitorização remota complementar, síncrona ou assíncrona, com deteção precoce da deterioração do equilíbrio ou quedas, ajuste oportuno do tratamento e interação médico-doente mais próxima [27].

Materiais e métodos

Desenho do estudo

No dia 10 de fevereiro de 2022, realizou-se um *Workshop de Policy Dialogue*. Metodologicamente, tratou-se de um estudo fenomenológico exploratório, qualitativo e descritivo [28] com os objetivos de: 1) compreender o potencial de utilização do serviço digital "EQUILÍBRIO" no contexto cabo-verdiano; 2) explorar a aplicabilidade clínica deste serviço digital neste contexto.

Materiais

Foi desenhado e realizado o *Workshop* "Telemedicina e Otorrinolaringologia em Cabo Verde e numa perspectiva global", via plataforma Zoom, com duração de 90 minutos, envolvendo profissionais de saúde, especialistas em telemedicina do Instituto de Higiene e Medicina Tropical (IHMT) e o Conselho de Administração do Hospital Central Doutor Agostinho Neto (HCDAN), unidade de saúde pública com prestação de cuidados especializados na capital de Cabo Verde. O Conselho deste Hospital divulgou para os seus profissionais, via email, o evento com o *link* de acesso. Os participantes elegíveis foram os médicos especialistas com prestação de cuidados de saúde em Cabo Verde para idosos com distúrbios do equilíbrio e risco de queda, incluindo médicos de família, médicos de medicina interna, neurologistas e otorrinolaringologistas.

Análise

As informações do *Workshop* foram transcritas manualmente por um dos autores, permitindo a análise de conteúdo [28]. Foram inseridas palavras entre parênteses curvos, possibilitando uma melhor compreensão das citações.

Considerações éticas

A participação no *Workshop* foi voluntária, com autorização para a gravação de áudio. A informação e os registos áudio foram guardados em local seguro (disco externo com código de acesso) dentro do prazo previsto pela Lei Portuguesa [29].

Resultados

Workshop de Policy Dialogue

- Dados sociodemográficos

Os dados demográficos dos atores chave, ou seja, participantes com intervenção ativa, como apresentação, comentário e discussão, no *Workshop* estão descritos na Tabela 1.

Tabela 1. Dados sociodemográficos dos participantes com intervenção ativa no *Workshop*

Ator Chave	Género	Profissão	País
AC1	M	Gestor e Membro do Conselho da Administração do HCDAN	Cabo Verde
AC2	M	Especialista em Saúde digital (um dos autores)	Portugal
AC3	F	Otorrinolaringologista no HCDAN	Cabo Verde
AC4	F	Otorrinolaringologista (um dos autores)	Portugal
AC5	M	Médico e Membro do Conselho da Administração do HCDAN	Cabo Verde

M: Masculino F: Feminino

Registou-se também a presença de mais 6 participantes (profissionais do HCDAN), dos quais não se recolheu informação sociodemográfica.

- Análise do conteúdo

Durante o *Workshop* foram discutidas três categorias temáticas. Da análise do conteúdo, emergiram sete subtemas (Tabela 2).

Tabela 2. Categorias temáticas do *Workshop*

Categorias temáticas
1. Saúde Digital 1.1. Cabo Verde 1.2. O potencial da saúde global e cooperação mútua na CPLP
2. Utilização do serviço digital "EQUILÍBRIO" 2.1. Interesse dos atores chave 2.2. Potencial para melhorar o acesso
3. Aplicabilidade clínica do serviço digital "EQUILÍBRIO" no HCDAN 3.1.Reorganização do trabalho 3.2.Envolvimento dos profissionais de saúde 3.3.Envolvimento dos doentes

Inicialmente, um dos membros do Conselho da Administração do HCDAN destacou a importância na temática do workshop, revelando abertura para a implementação de novas soluções digitais: … (há um) *programa estratégico do hospital para a transformação digital como forma de promover a inovação no contexto hospitalar… em que a inovação traz vantagens quer do ponto de vista competitivo, mas também a nível da gestão… como forma de promover a mudança e trazer melhorias dos indicadores do hospital e, consequentemente, dos indicadores do país* (AC1).

A relevância da telemedicina em Cabo Verde também foi destacada: *A telemedicina faz parte do componente da inovação da saúde focando na questão da tecnologia para a saúde. Estamos num país em que dependemos das estruturas hospitalares centrais, em que temos nove ilhas praticamente habitadas, em que a maior parte delas não dispõe de um hospital de referência. Então, a teleconsulta é uma forma de garantir acesso aos cuidados de saúde para a população* (AC1). E um pouco da evolução da telemedicina foi explicada: *O nosso centro de telemedicina foi inaugurado em 2013.Tivemos uma evolução muito satisfatória da evolução dos atendimentos. Iniciámos com 112 casos. Neste momento, já ultrapassamos mais de mil consultas através de telemedicina. Uma média anual de mais de 600 consultas nos últimos 6 anos. No ano 2021, apesar da pandemia, tivemos um aumento substancial. Isto também ocorreu devido a medidas estruturais que o hospital* (HCDAN) *teve que implementar, como forma de garantir os cuidados de saúde às pessoas que estão mais dispersas… A otorrinolaringologia é uma das especialidades que mais se beneficiou da telemedicina…* (permitindo) *acesso equitativo a cuidados especializados nesta área* (AC1).

A seguir, três palestrantes fizeram exposições, com duração de 20 minutos cada.

Inicialmente, foi apresentado o potencial da Saúde Digital para uma interação mais estreita entre os países membros da CPLP: …*aproveitar as parcerias estratégicas… um potencial enorme com quase 300 milhões de pessoas… pode ser intermutável.* Adicionalmente, os benefí-

cios foram apontados: *…mitigar a falta de recursos humanos,* (promover a) *educação à distância,* (ajudar a gestão das) *evacuações,* (melhorar) *a ligação entre investigação e hospitais…* (AC2). A necessidade da abordagem multidisciplinar também foi mencionada: *…um trabalho combinado…* (incluindo também) *técnico de saúde, informáticos, gestores, decisores políticos…* (AC2).

A seguir, a palestrante seguinte confirmou a importância da adoção e uso da telemedicina em Cabo Verde, principalmente a nível das teleconsultas e evacuações, mitigando os constrangimentos geográficos e a escassez de recursos humanos deste país, principalmente com a pandemia por SARS_CoV-2: *…com a pandemia, não temos muitos voos* (de avião) *… a telemedicina tem sido uma mais valia para a nossa especialidade* (Otorrinolaringologia) (AC3). A telemedicina também tem promovido uma mais estreita articulação entre os cuidados de saúde primários e os hospitalares: (Como houve) *doentes crónicos sem atendimento, a fila de espera aumentou para pedido de consulta.* (Desta forma) *houve mais teleconsultas, mais orientação aos clínicos gerais, mais exames realizados* (fora do hospital) *e os doentes vinham* (ao HCDAN) *só para a cirurgia* (já com exames pré-operatórios realizados) (AC3).

Finalmente, a última apresentação focou-se no envelhecimento e na oportunidade do uso do serviço digital "EQUILÍBRIO" no contexto cabo-verdiano: *…a ideia é ter um envelhecimento ativo… saudável* (AC4). Nesta intervenção, a abordagem DSRM utilizada para sua elaboração e o desenvolvimento deste serviço digital foram apresentados. Foram mencionadas as funcionalidades disponíveis do serviço "EQUILÍBRIO", assim como os seus pontos relevantes: *"… a monitorização remota complementar, deteção precoce da deterioração do equilíbrio ou quedas, ajuste do tratamento e interação médico-doente mais próxima"* (AC4). Os resultados da demonstração do serviço, realizada no contexto português, foram apresentados. A seguir, foram divulgadas as avaliações realizadas pelos utilizadores (idosos e cuidadores) do serviço digital e por médicos portugueses com experiência em coordenação de unidades de saúde: *…tivemos mesmo um resultado muito positivo* (com a utilização do serviço digital "EQUILÍBRIO") *… permitindo uma interação mais próxima entre o médico e o doente…a disponibilidade dos vídeos tutoriais…a possibilidade de menos recursos presenciais…* (AC4).

Após a intervenção dos palestrantes, iniciou-se a discussão entre os participantes do *Workshop*, permitindo entender e explorar o potencial do serviço digital "EQUILIBRIO" para a prestação complementar de cuidados de saúde a idosos com risco de queda por alterações do equilíbrio no contexto cabo-verdiano, podendo configurar: *uma oportunidade de cooperação* (entre Portugal e Cabo Verde) (AC2).

Questionada a aplicabilidade clínica concreta do "EQUILÍBRIO" no HCDAN, um dos médicos destacou, como constrangimento à sua breve utilização, alguma dificuldade no recrutamento de idosos com perturbações do equilíbrio, uma vez que o atual foco de cuidados ao idoso tem sido a abordagem da perda auditiva. Outro obstáculo destacado foi a deficiência de recursos humanos na área da saúde cabo-verdiana, restringindo a alocação de profissionais de saúde especificamente para a monitorização digital de idosos no contexto das alterações do equilíbrio. No entanto, os médicos cabo-verdianos e o Conselho de Administração do HCDAN reconheceram o potencial do serviço digital "EQUILIBRIO" e manifestaram interesse em utilizá-lo, solicitando algum tempo para o recrutamento de idosos e para organização de trabalho: *É possível implementar. Tem que inventariar e identificar os doentes… e organizar o serviço* (AC5). Adicionalmente, o Conselho de Administração e os médicos do HCDAN revelaram também interesse na inclusão de doentes mais jovens para a utilização do serviço digital "EQUILÍBRIO".

Discussão

Para compreender e explorar o potencial de utilização do serviço de saúde digital "EQUILÍBRIO", no âmbito da prestação complementar de cuidados a idosos com alterações do equilíbrio e risco de queda em Cabo Verde, foi realizado um *Workshop* incluindo profissionais de saúde e o Conselho de Administração do HCDAN. Verificou-se um interesse no desenvolvimento de medidas que levem à sua aplicabilidade clínica, constituindo uma oportunidade de implementação no contexto cabo-verdiano.

A análise do conteúdo da informação proveniente do *Workshop* inicialmente permitiu perceber a importância da saúde digital em Cabo Verde, país com restrição de recursos humanos na área da saúde, mas com uma telemedicina integrada e progressivamente amadurecida. De facto, dos países africanos, Cabo Verde tem se destacado com resultados positivos na gestão da prestação de cuidados e das evacuações, educação à distância e cooperação entre as unidades de saúde, com menos custos [9,10,18,22-24]. Contudo, ao alargar o foco da saúde digital a outros países de língua portuguesa, pode-se pensar no seu significativo potencial de coope-

ração envolvendo milhões de pessoas em processo de envelhecimento. Estas soluções podem mitigar a pressão da senilidade nos sistemas de saúde, permitindo que poucos profissionais de saúde interajam remotamente com muitos doentes ou outros profissionais de saúde [30]. Entretanto, deve-se considerar a sua função complementar, e não substitutiva, na prestação de cuidados de saúde [26,31].

Com o foco na divulgação e alargamento da utilização do serviço digital "EQUILÍBRIO", a outros países de língua portuguesa em envelhecimento, também foram explorados o interesse, potencial de utilização e aplicabilidade clínica no contexto de Cabo Verde.

Foi possível confirmar o interesse dos médicos participantes e da Administração do HCDAN para acrescentar ao seu portfólio de serviços a utilização de um serviço digital no contexto das alterações do equilíbrio, corroborando a relevância atribuída à saúde digital em Cabo Verde. Adicionalmente, como já ressaltado na literatura [32], foi referida uma maior necessidade do uso da telemedicina em Cabo Verde durante a pandemia por SARS-CoV-2, tendo sido considerada como *…uma mais valia…* (AC3) na Otorrinolaringologia, por exemplo. Contudo, não há disponibilidade de dados discriminando esta maior demanda da prestação de cuidados de saúde consoante o contexto, como por exemplo, idosos com alterações do equilíbrio.

Verificou-se também o potencial da utilização do serviço digital "EQUILÍBRIO" no contexto clínico cabo-verdiano, tendo sido sugerida a participação de doentes mais jovens com alterações do equilíbrio e risco de queda.

Contudo, para a aplicabilidade clínica deste serviço digital, foi solicitado tempo, permitindo a reestruturação do trabalho e envolvimento dos profissionais de saúde e dos doentes nesta prestação digital de cuidados de saúde. Tais condições já têm sido apontadas na literatura como cruciais para o uso pleno das soluções digitais [26,27].

A implementação do serviço digital "EQUILÍBRIO" em Cabo Verde, para a prestação complementar de cuidados de saúde a idosos com alterações do equilíbrio e risco de queda, é uma oportunidade de investigação. Poderá configurar uma promissora cooperação de cuidados de saúde entre Portugal e Cabo Verde no contexto do envelhecimento. Adicionalmente, poderá representar mais uma contribuição para a consolidação de uma Saúde Digital entre os Estados-membros da CPLP, uma interação digital previamente discutida e aspirada para um universo de cerca de 300 milhões de pessoas [19-21].

Limitações

Devido à pandemia por SARS-CoV-2, o presente estudo foi desenvolvido à distância.

A divulgação do *Workshop* foi realizada, via email, pelo Conselho de Administração do Hospital Central Doutor Agostinho Neto (HCDAN), não incluindo as outras Unidades de Saúde de Cabo Verde.

Nesta fase inicial, a participação médica foi priorizada. Contudo, futuramente, o envolvimento dos outros profissionais de saúde deverá ser considerado. A inclusão de outros hospitais em Cabo Verde também deverá ser ponderada.

Conclusões

No contexto da prestação de cuidados de saúde a idosos com alterações de equilíbrio e risco de queda, realizou-se um *Workshop* para compreender e explorar o potencial de utilização do serviço digital "EQUILÍBRIO", tendo como exemplo Cabo Verde. Verificaram-se interesse, potencial de utilização do serviço "EQUILÍBRIO" e necessidade de reestruturação do trabalho e alocação de recursos humanos para a sua aplicabilidade clínica. A implementação deste serviço digital em Cabo Verde é uma oportunidade de investigação no âmbito do envelhecimento e da saúde global, podendo permitir uma mais próxima interação entre as unidades de saúde de Cabo Verde e Portugal. Poderá estreitar a cooperação de cuidados de saúde entre os Estados-membros da Comunidade dos Países de Língua Portuguesa.

Agradecimentos

Os autores agradecem a divulgação, participação e disponibilidade do Conselho de Administração do Hospital Central Doutor Agostinho Neto no *Workshop* "Telemedicina e Otorrinolaringologia em Cabo Verde e numa perspectiva global". Igualmente agradecem a utilização da plataforma digital METHIS, co-financiada pelo programa Research4COVID-19, da Fundação para a Ciência e Tecnologia, que suportou o serviço digital "EQUILÍBRIO".

Bibliografia:

[1] Jaul E, Barron J. Age-Related Diseases and Clinical and Public Health Implications for the 85Years Old and Over Population. Front Public Health. 2017; 5:335. doi:10.3389/fpubh.2017.00335. [Consultado em 15 de janeiro de 2022]. Disponível em: https://doi.org/10.3389/fpubh.2017.00335

[2] Jia H, Lubetkin EI, DeMichele K, Stark DS, Zack MM, Thompson WW. Prevalence, risk factors, and burden of disease for falls and balance or walking problems among older adults in the U.S. Prev Med. 2019; 126:105737. doi: 10.1016/j.ypmed.2019.05.025. [Consultado em 15 de janeiro de 2022]. Disponível em: https://pubmed.ncbi.nlm.nih.gov/31150739/

[3] Moreland B, Kakara R, Henry A. Trends in Nonfatal Falls and Fall-Related Injuries Among Adults Aged ≥65 Years - United States, 2012–2018. Morb Mortal Wkly Rep. 2020; 69(27):875–881.

[4] Telles JL, Borges APA. Velhice e Saúde na Região da África Subsaariana: uma agenda urgente para a cooperação internacional. Ciência & Saúde Coletiva. 2013; 18(12):3553-3562.

[5] World Health Organization (WHO). Resolution WHA58.28. 2005. [Consultado em 12 de abril de 2022]. Disponível em: http://apps.who.int/iris/bitstream/10665/20378/1/WHA58_28-en.pdf?ua=1

[6] WHO - Global Observatory of eHealth. Global diffusion of eHealth: Making universal health coverage achievable. 2016. [Consultado em 12 de abril de 2022]. Disponível em: http://apps.who.int/iris/bitstream/10665/252529/1/9789241511780-eng.pdf?ua=1#page=16

[7] Dodoo JE, Al-Samarraie H, Alsswey A. The development of telemedicine programs in Sub-Saharan Africa: Progress and associated challenges. Health Technol (Berl). 2021; 1-14.

[8] Chitungo I, Mhango M, Mbunge E, Dzobo M, Musuka G, Dzinamarira T. Utility of telemedicine in sub-Saharan Africa during the COVID-19 pandemic. A rapid review. Hum Behav Emerg Technol. 2021; 3(5): 843-853.

[9] Beja A, Correia A, Gonçalves BS, Cardoso P, Lapão LV. Tendências e contextos de implementação de tecnologias de informação e comunicação para o reforço dos Sistemas de saúde em países de baixo e médio rendimento da CPLP: os casos de Cabo Verde, Moçambique e Guiné-Bissau. An Inst Hig Med Trop. 2019; 18:52-57.

[10] Azevedo V, Latifi R, Parsikia A, Latifi F, Azevedo A. Cabo Verde Telemedicine Program: An Update Report and Analysis of 2,442 Teleconsultations. Telemed J E Health. 2021; 27(2):172-177.

[11] WHO. Contributions from the World Health Organization in Cabo Verde, 2016-2019 - Promoting health, keeping the world safe and serving the vulnerable. 2019. [Consultado em 17 de abril de 2022]. Disponível em: Contributions_of_the_World Health_Organization_in_Cabo_Verde_2016-2019 (1).pdf (who.int)

[12] Barros FPC, Lapão LV. A efetivação do direito universal à saúde: os casos de Portugal, Brasil e Cabo Verde. An Inst Hig Med Trop. 2016; 15:89-100.

[13] Delgado AP, Tolentino AC, Ferrinho P. The evolution of the medical workforce in Cape Verde since independence in 1975. Hum Resour Health. 2017; 15(1):5. doi: 10.1186/s12960-017-0180-9. [Consultado em 12 de outubro de 2018]. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5242051/

[14] Latifi R, Dasho E, Merrell RC, Lopes M, Azevedo V, Bekteshi F, Osmani KL, Qesteri O, Kucani J, Lecaj I. Cabo Verde telemedicine program: initial results of nationwide implementation. Telemed J E Health. 2014; 20(11):1027-34.

[15] Correia A, Azevedo V, Lapão LV. A Implementação da Telemedicina em Cabo Verde: Fatores Influenciadores. Acta Med Port. 2017; 30(4):255-262.

[16] Delgado AP, Martins AS, Ferrinho P. Medical Training Experience and Expectations Regarding Future Medical Practice of Medical Students at the University of Cape Verde. Acta Med Port. 2017; 30(10):699-703.

[17] Olu O, Muneene D, Bataringaya JE, Nahimana MR, Ba H, Turgeon Y, Karamagi HC, Dovlo D. How Can Digital Health Technologies Contribute to Sustainable Attainment of Universal Health Coverage in Africa? A Perspective. Front Public Health. 2019; 7:341. doi:10.3389/fpubh.2019.00341. [Consultado em 12 abril de 2022]. Disponível em: https://www.frontiersin.org/articles/10.3389/fpubh.2019.00341/full

[18] Republic of Slovenia. Ministry of Foreign Affairs. Evaluation of projects of telemedicine and e-health network in Cabo Verde for the period 2011–2017. 2018. [Consultado em 12 abril de 2022]. Disponível em: Telemedicine_and_e-health_project_evaluation_Final_report.pdf (gov.si)

[19] Lapão LV, Messina LA, Ungerer R, Campos F. Roteiro estratégico para a telessaúde na CPLP: diagnóstico e prioridades para o desenvolvimento da telessaúde. An Inst Hig Med Trop. 2016; 15(supl1):s65-s73.

[20] Comunidade dos Países de Língua Portuguesa (CPLP). Carta da Cidade da Praia: I Reunião de Telemedicina e Telessaúde da CPLP. 2017 [Consultado em 12 de setembro de 2019. Disponível em: https://www.cnts.min-saude.pt/2017/09/19/i-reuniao-de-telemedicina-e-telessaude-da-cplp/

[21] CPLP. Plano Estratégico de Cooperação em Saúde da CPLP (PECS-CPLP - 2018-2021) - Eixos Estratégicos, Áreas e Projetos [Internet]. CPLP - Comunidade de Países de Lingua Portuguesa; 2018. [Consultado em 10 abril de 2022]. Disponível em: https://www.cplp.org/id-2370.aspx

[22] Lapão LV, Correia A. Improving Access to Pediatric Cardiology in Cape Verde through a Collaborative International Telemedicine service. Global Telehealth Studies in Health Technology and Informatics. 2015; 209:51-57.

[23] Maia MR, Castela E, Pires A, Lapão LV. How to develop a sustainable telemedicine service? A Pediatric Telecardiology Service 20 years on - an exploratory study. BMC Health Serv Res. 2019; 19(1):681. doi:10.1186/s12913-019-4511-5. [Consultado em 15 de fevereiro de 2020]. Disponível em: https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4511-5

[24] Ministério da Saúde e da Segurança Social da República de Cabo Verde. Relatório Estatístico 2019. 2020. [Consultado em 12 abril de 2022]. Disponível em: Relatório Estatístico 2019.pdf

[25] Peffers K, Tuunanen T, Rothenberger MA, Chatterjee S. A design science research methodology for information systems research. J Manag Inf Syst. 2007; 24:45-77.

[26] Gaspar AGM, Escada P, Lapão LV. How Can We Develop an Efficient eHealth Service for Provision of Care for Elderly People with Balance Disorders and Risk of Falling? A Mixed Methods Study. Int. J. Environ. Res. Public Health 2021, 18, 7410. [Consultado em 15 agosto de 2021]. Disponível em: https://doi.org/10.3390/ijerph18147410

[27] Gaspar AGM, Lapão LV. A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. Int J Environ Res Public Health. 2022; 19(3):1855. doi: 10.3390/ijerph19031855. [Consultado em 13 de abril de 2022]. Disponível em: https://pubmed.ncbi.nlm.nih.gov/35162877/

[28] Creswell JW, Creswell JD. Research design. In Qualitative, Quantitative, and Mixed Methods Approaches, 5th ed.; SAGE Publications Inc.: Los Angeles, CA, USA, 2018.

[29] Assembleia da República. Lei nº 58/2019 de 8 de agosto de 2019. Diário da República n.º 151/2019, Série I de 2019-08-08. 3–40. [Consultado em 17 abril de 2019]. Disponível em: https://data.dre.pt/eli/lei/58/2019/08/08/p/dre

[30] Viirre E. Vestibular telemedicine and rehabilitation. Applications for virtual reality. Stud Health Technol Inform. 1996; 29:299–305.

[31] Catan G, Espanha R, Mendes RV, Toren O, Chinitz D. Health information technology implementation—Impacts and policy considerations: A comparison between Israel and Portugal. ISR J. Health Policy Res. 2015; 4:41. doi: 10.1186/s13584-015-0040-9. [Consultado em 12 outubro de 2018]. Disponível em: https://pubmed.ncbi.nlm.nih.gov/26269740/

[32] WHO. The European Health Report 2021 - Taking stock of the health-related Sustainable Development Goals in the COVID-19 era with a focus on leaving no one behind. 2022. [Consultado em 10 abril de 2022]. Disponível em: 9789289057547-eng.pdf

Conflitos de interesse:

Os autores declaram que não existem conflitos de interesse relacionados com o presente artigo.

3. DISCUSSION AND CONCLUSIONS

3.1. DISCUSSION

The burden of global aging with clinical conditions as balance disorders and risk of falling has motivated research into how digital health can contribute for an adjusted provision of health care. However, the use in the clinical context has not yet been explored. In this context, the DSRM was used to conceive, design, develop, implement, demonstrate and evaluate the digital service "BALANCE". This implementation was done, considering the Portuguese clinical context, and focussed on the remote management of elderly people with balance disorders and risk of falling. The evaluation revealed positive outcomes for clinical applicability, motivating research in a global perspective. The exploration of the interest and potential use of the digital service "BALANCE" in the clinical context of Cape Verde also revealed positive results and an opportunity for future study, enabling innovation in current healthcare provision.

3.1.1. Summing up the results and discussion

PAPER I

Population aging and its vulnerability to chronic diseases and balance disorders with falls has challenged the sustainability of the current health care model. In fact, balance disorder has become a public health concern. Several studies have pointed to the progressive global increase in the provision of health care, leading to the use of multiple and inadequate resources (Heinrich et al., 2010; Kerber, 2009; Kerber et al., 2017; Kovacs et al., 2019; Maciel, 2010; Tehrani et al., 2013).

To mitigate this specific burden of disease with expenses related to care, the health policies have recommended the implementation and use of the digital health, providing new opportunities to improve the quality of services and the rational use of resources (Amalberti et al., 2019; Kim et al., 2017; Lapão, 2010; Mucchi et al., 2021). However, the clinical use of digital devices and services are still in its earlier developments and under investigation.

To evaluate and guide the clinical applicability of eHealth devices in the screening, assessment, and treatment of elderly people with balance disorders and without

neurological disease, a systematic review was performed. As described in literature (Bet et al., 2019; Choi et al., 2017; Leirós-Rodríguez et al., 2019; Montesinos et al., 2018; Nguyen et al., 2018; Rucco et al., 2018; Skjæret et al., 2016; Sun and Sosnoff, 2018), the heterogeneity of the sample sizes, clinical conditions of the elderly under study, methodologies, and follow-up times of the included studies restricted the scope of a guideline for clinical settings. In fact, most of the included studies neither described the clinical conditions of the participants nor the instrumental tests of the inner ear, which could interfere with the results. Additionally, as most of the included studies are from high-income countries, it is not possible to evaluate the use of eHealth devices for elderly people with balance disorders in low-income or middle-income countries.

In conclusion, the systematic review (Paper I) both shown the need for digital services development and supported the challenged for a broader exploration of the clinical applicability of digital solutions in this context, as verified in previous literature.

PAPER II

Using DSRM (Hevner et al., 2004; Peffers et al., 2007), a scientifically-based approach for the development, demonstration and evaluation of a digital service, the thesis was developed over the years, step by step, including various activities. The research involved several professionals: experts in digital platforms and specialist physicians who provide healthcare in Portugal for the elderly with balance disorders and risk of falling, including family physicians, internal medicine physicians, physical medicine and rehabilitation physicians, neurologists, otolaryngologists and physicians with competence in Geriatrics, with differentiated training in technology and information technology.

Initially, the phase quantitative of the mixed methods study (Creswell & Creswell, 2018) (Activity 1) was performed. As observed in other studies (Aitken et al., 2008; Lapão et al., 2017), a low response number was verified. However, the responses allowed identifying medical dissatisfaction with the information systems in general, including time spent in digital use and comprehensive data. Additionally, future eHealth services were considered highly relevant for complementary healthcare for elderly people with balance disorders and the risk of falling, encouraging the development of a digital solution to adjust and rationalize the use of resources with lower costs, as described in Paper II.

With the qualitative phase of the mixed methods study (Creswell & Creswell, 2018) (Activity 2), the quantitative results were discussed in depth, including the participation of coordinating physicians of health units (one Neurologist, two Family Physicians, two Internal Medicine Physicians, and three Otolaryngologists). As mentioned in other studies (Heinrich et al., 2010; Kerber, 2009; Nolte et al., 2020; Tehrani et al., 2013), poor access to data on previous care provision and the lack of integration of clinical data between the health units were highlighted, partially justifying the recurrent and multiple use of resources. Strategies for an efficient digital solution were also explored, such as the inclusion of interactive data and audio-visual technology, time allocation of digital work, investment in suitable technology and system interoperability, patient motivation and training, caregiver involvement, and health professional training. In fact, positive outcomes of digital health also depend on qualification and collaboration of health professionals (Goldsack & Zanetti, 2020; Lapão, 2010). The relevance of the physician as the main manager of eHealth service was also discussed, as described in Paper II.

The recommendations (Activity 2) allowed to guide the elaboration of the digital solution requirements for complementary health care for elderly with balance disorders and consequent risk of falling (Activity 3).

PAPER III

Previous medical suggestions, explored in the qualitative phase of the mixed methods study (Activity 2), contributed to the design and elaboration of the digital service "BALANCE" (Activity 3), as described in Paper III. The options of this service were developed according to the clinical approach of patients with balance disorders (Brandt et al, 2014): clinical information, clinical and instrumental assessment data, pre and post rehabilitation DHI (Dizziness Handicap Inventory) questionnaire (Jacobson & Newman, 1990) and treatment. This digital service was integrated into the METHIS digital platform, already used for the remote monitoring of patients with chronic pathologies (Lapão et al, 2021). Eight tutorial videos with rehabilitation exercises were recorded and up-loaded to the digital service. The medical and patient profiles are presented in Appendix 4.9.

"BALANCE" service became clinically available after months of interaction between the main researcher (Otolaryngologist), two experts in digital platforms, and one professor of health information systems. As verified in literature (Goldsack & Zanetti, 2020; Karpathakis et al., 2021), the involvement of eHealth system managers and programmers was also pointed out as crucial during the qualitative study of the mixed methods study.

Using the proof-of-concept study (Blokdyk, 2021) to initially test the digital service, five elderly women, with balance disorders and indication to maintain vestibular rehabilitation at home, used "BALANCE" digital service for three months (Activity 4). They and their caregivers could interact with the main researcher (their physician), allowing remote monitoring, early detection of clinical deterioration, timely adjustment of treatment, greater physician-patient interaction, and active patient and caregiver participation.

To evaluate the satisfaction level of the service digital, two focus groups (Creswell & Creswell, 2018) were conducted, involving the participants engaged with the proof-of-concept study, and invited physicians with experience in coordinating public health units (two Family Physicians, two Internal Medicine Physicians, and four Otolaryngologists) (Activity 5). These explorations allowed to evaluate and address how to adjust, improve the functioning of "BALANCE" service in the clinical context, with greater engagement from patients, caregivers and healthcare professionals. In fact, the concept of health care quality is subjective and can be interpreted in different ways, encompassing effective, safe, culture of excellence, and desired outcomes (Allen-Duck et al., 2017). One of the methods to determine the perceptions of quality is to make the user as a participatory element in the health services, and not just an observer.

The patient and caregiver perspectives allowed to explore the satisfaction level, understanding the benefits (patient comfort, closer physician-patient interaction, availability of tutorial videos with balance exercises), constraints (elderly profile as a digital user, presentation screen on the mobile phone, lack of time to record the exercises performed), suggestions for improvement (adjustment to the "BALANCE" interface, record of videos with more identifiable exercises, adjustment of interactive data relatively to performed balance exercise) and interest in maintaining the use of "BALANCE" service. Additionally, medical perspectives were also explored, such as benefits (patient comfort, closer physician-patient interaction, lower consumption of face-to-face

resources, patient motivation and adhesion), constraints (patient profile, resistance of healthcare professionals, lack of working time for digital use), strategies for clinical applicability (working reorganization with dedicated time to interact digitally with patients, involvement of other health professionals, interoperability, funding and continuity of the use of digital solution, recognition of the hierarchy), and interest in using "BALANCE" service. Only one physician pointed-out some dissatisfaction with this digital service, suggesting the inclusion of automatic tools to support the collection of data of performed balance exercises. In fact, knowledge about the difficulties can help to improve awareness and invest in technological training in health.

As discussed in the two focus groups, the use of technology in health care can still be considered a barrier, especially for those who do not master the technology. The profile of elderly is a challenge to be overcome (Scott Kruse et al., 2018). However, more and more, elderly people are experienced and motivated to use technology and, as possible, the digital inclusion of the elderly should be encouraged. Moreover, caregiver involvement could contribute to their training, promoting active ageing and proactively using a digital solution, as observed in this study.

Additionally, digital services and devices should be user-friendly and suitable for both the health professional and for the patient (Raja et al., 2021; Ricciardi et al., 2019). The suggestions to adjust "BALANCE", as such exercise registration frequency, will be considered.

In conclusion, the evaluations revealed positive outcomes for clinical applicability, motivating its dissemination and exploration to other Portuguese-speaking countries as for example Cape Verde.

PAPER IV

Cape Verde, a country with both progressive aging population (WHO, 2019) and matured digital culture with sustained positive results, including remote management of care and evacuations, distance education and digital cooperation between health units (Azevedo et al., 2021; Beja et al., 2019; Lapão & Correia, 2015; Maia et al., 2019), was chosen to align with the use of "BALANCE" service. In fact, IHMT/UNL is an institution that promotes research in global health, especially in the CPLP context (Carvalho et al., 2018).

A PDW was performed to understand and explore the potential use of the digital health service "BALANCE" in Cape Verde, including health professionals and the Board of Directors of HCDAN, a hospital with specialized health care in the nation's capital. This PDW embraced the Fair Research Partnerships principles, ensuring that IHMT/UNL-HCDAN partnership on health research was carried out in a symmetrical way, and addressing HCDAN precise needs and sustainability (Carvalho et al., 2018).

It was possible to confirm the interest and the potential of using the digital service "BALANCE" in the Cape Verdean context. Additionally, the inclusion of younger patients with balance disorders and risk of falling was discussed. However, for the clinical applicability of this digital service, proper time was requested, allowing the restructuring of the work and involvement of health professionals and patients in this digital provision of health care. Such conditions have already been pointed out in the literature as crucial for the full use of digital solutions (Catan et al., 2015; Goldsack & Zanetti, 2020; Orton et al., 2018; Radhakrishnan et al., 2016; Scott Kruse et al., 2018; Tossaint-Schoenmakers et al., 2021; Trenerry et al., 2021; Wynn et al., 2020).

From the author's knowledge, this PDW was the first intervention for remote health care focusing on the elderly with balance disorders and risk of falling in Cape Verde.

In conclusion, according with the PDW participants, the implementation of the digital service "BALANCE" for complementary health care for elderly people with balance disorders and risk of falling in Cape Verde is a research possibility. The use of this digital service could contribute to approach the health care between Portugal and Cape Verde in the context of population aging. In the global perspective, it could be an opportunity to strength the cooperation between the State members of CPLP, a universe of about 300 million people (CPLP, 2017; Lapão et al., 2016;).

3.1.2. Implications for practice and policy

The positive Portuguese outcomes sustained a significant potential for clinical applicability of "BALANCE" service, allowing to reach patients with more difficult face-to-face access, especially elderly people who depend on caregivers for their displacement to a health unit. In fact, a digital service can leverage health care, as Viierre et al. (1996) had already mentioned: "remote medical diagnosis and treatment facilities could make

the few vestibular disorder specialists much more available to patients". This should be considered by health policy decision makers, including countries facing recent demographic and epidemiological transition.

In line with this multiplication concept, the potential of using the "BALANCE" service in Cape Verde were also explored during a PDW, trying to overcome the shortage of health professionals and geographic constraints (Delgado et al., 2017). The Cape Verdean stakeholders, including the Direction of HCDAN, confirmed the interest in using this digital service, requiring time for work organization. As Nabyonga-Orem et al. (2016) highlighted, the results of the PD process can allow the development and implementation of health policies and plans. Additionally, "BALANCE" service could strength the health care cooperation between Portugal and Cape Verde in the context of aging.

Naturally, face-to-face physician–patient interaction will always be important. The use of "BALANCE" service for the complementary provision of care for elderly population with balance disorder and risk of falling can play a strategic role, improving access, empowering patients and caregivers, maintaining elderly people with functional ability within their communities, and promoting improvement in the quality of health and well-being. Nevertheless, the needed financial investment, collaboration of health professionals, allocation in work methodology and interoperability should be considered.

For efficiency and low costs reasons, this project scientifically described and explored the use of a digital solution, raising awareness among health professionals. It allowed clarifying the opinions of participants, exploring the complexity of related factors. It also allowed to respond to the need for a quick decision, such as policy planning actions to promote and enhance digital knowledge and training, including a global perspective.

In the context of International Health, this thesis identified the need to adjust health care for the elderly population with balance disorders and risk of falling, highlighting the relevance of implementing digital health as a strategy to respond to the challenge of aging. Additionally, the exploration of the interest and potential of use of the digital service "BALANCE" in Cape Verde allowed a closer international cooperation between researchers, research institutions and health units. This project represents an opportunity of mutual provision of health care for elderly population, contributing for the consolidation of a digital health between the Portuguese-speaking countries and

overcoming geographical distances. The dissemination of the results can contribute to the formulation of health policies and the organization of responses with the mobilization of the necessary and adequate resources.

3.2. LIMITATIONS

The limitations of this thesis were already discussed in the papers presented in "Results" section.

Relatively to the Portuguese activities, some limitations were verified. Of the health professionals who provide care to elderly people with balance disorders and risk of falling, only physicians participated in this project. Regarding the respondents of the online questionnaire, it is important to consider the possibility of selection biases (Eysenbach & Wyatt, 2002): small participant size and more participation of younger physicians. The multiple-choice questions of the questionnaire did not allow the inclusion of opinions of the respondents. The demonstration of the digital service was restricted to one physician (the researcher) and five elderly people, without diagnosed neurological disease, and previously followed at only one Hospital Unit in Lisbon. The follow-up time was only three months. Relatively to the qualitative researches, the sampling was intentional (Creswell & Creswell, 2018). The last individual interview and the focus groups were conducted remotely due to SARS-CoV-2 pandemic limitations. Only the participants of the proof-of-concept study and the invited physicians evaluated the "BALANCE" service. However, managers and digital developers should also be considered in the evaluation of digital solutions (Goldsack & Zanetti, 2020; Karpathakis et al., 2021).

Regarding the Cape Verdean context, the PDW was conducted remotely due to the SARS-CoV-2 pandemic. This was promoted and sent, via email, by the Board of Directors of HCDAN. It did not include the other Health Units of Cape Verde. The participation of physicians related with the case in study was prioritized.

3.3. FUTURE RESEARCH EXPECTATIONS

The use of "BALANCE" service for the complementary provision of care for elderly with balance disorder and risk of falling can be further explored in a Portuguese multicentre

context with a longer follow-up, providing more information on usability, acceptability, adherence and impact of this digital service. Eventually, a clinical trial could be designed and implemented.

The involvement of more patients, including neurologic patients, could be considered. Future researchers could evaluate whether constraints with the use of this digital solution by neurological patients would be greater. Being more ambitious, a clinical trial could also be planned using the digital platform.

Once the "BALANCE" digital service had been successfully applied to the challenging profile of the elderly, younger age patients can also enjoy it more easily.

Other health professionals who provide care to elderly people with balance disorders and risk of falling could be included, promoting integrated health care. In addition, a closer interaction between primary and hospital care could be achieved.

This digital service could be aligned with the provision of health care in other Portuguese-speaking countries, for example, integrating the services provided by *Centro Nacional de Telemedicina* in Cape Verde.

3.4. REFERENCES

Aitken C, Power R & Dwyer R 2008, 'A very low response rate in an on-line survey of medical practitioners', *Aust. N. Z. J. Public Health*, Jun, vol.32, no 3, pp. 288–289.

Allen-Duck A, Robinson JC & Stewart MW 2017, 'Healthcare Quality: A Concept Analysis', *Nurs. Forum*, Oct, vol.52, no 4, pp. 377-386.

Amalberti R, Vincent C, Nicklin W & Braithwaite J 2019, ´Coping with more people with more illness. Part 1: The nature of the challenge and the implications for safety and quality´, *Int. J. Qual. Health Care*, March, vol.31, no 2, pp. 154–158.

Azevedo V, Latifi R, Parsikia A, Latifi F & Azevedo A 2021, ´Cabo Verde Telemedicine Program: An Update Report and Analysis of 2,442 Teleconsultations´, *Telemed. J. E. Health*, Feb, vol.27, no 2, pp.172-177.

Beja A, Correia A, Gonçalves BS, Cardoso P & Lapão LV 2019, ´Tendências e contextos de implementação de tecnologias de informação e comunicação para o reforço dos Sistemas de saúde em países de baixo e médio rendimento da CPLP: os casos de Cabo Verde, Moçambique e Guiné-Bissau´, *An. Inst. Hig. Med. Trop.,* Dec, vol.18, pp. 52-57.

Bet P, Castro PC & Ponti MA 2019, ´Fall detection and fall risk assessment in older person using wearable sensors: A systematic review´, *Int. J. Med. Inform.,* Oct, vol.130:103946, viewed 12 Feb 2020, < https://pubmed.ncbi.nlm.nih.gov/31450081/>

Blokdyk G. Proof of Concept Poc. A Complete Guide-2020. Australia: 5STARCooks, 2021.

Brandt T, Dieterich M & Strupp M. Vertigo and Dizziness: Common Complaints. Germany: Springer, 2014.

Carvalho A, Hartz Z & Ferrinho P 2018, *Research Fairness Initiative Report*, Instituto de Higiene e Medicina Tropical, Portugal.

Catan G, Espanha R, Mendes RV, Toren O & Chinitz D 2015, 'Health information technology implementation—Impacts and policy considerations: A comparison between Israel and Portugal', *ISR. J. Health Policy Res.*, Aug;4:41, viewed 12 Oct 2018, <https://pubmed.ncbi.nlm.nih.gov/26269740/>

Choi SD, Guo L, Kang D & Xiong S 2017, ´Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review´, *Appl. Ergon.*, Nov, vol.65, pp. 570–581.

CPLP 2017, *Plano Estratégico de Cooperação em Saúde da CPLP (PECS-CPLP) 2018-2021. Eixos Estratégicos, Áreas e Projetos.* CPLP, Brasília.

Creswell, JW & Creswell, JD. Research design. Qualitative, Quantitative, and Mixed Methods Approaches. Los Angeles: SAGE Publications, 2018.

Delgado AP, Soares Martins A & Ferrinho P 2017, ´Medical Training Experience and Expectations Regarding Future Medical Practice of Medical Students at the University of Cape Verde´, *Acta Med. Port.*, Oct, vol.30, no 10, pp. 699-703.

Eysenbach G & Wyatt J 2002, ´Using the Internet for surveys and health research´, *J. Med. Internet Res.*, 4:E13, viewed 15 Nov 2018, <https://pubmed.ncbi.nlm.nih.gov/12554560>

Goldsack JC & Zanetti CA 2020, ´Defining and Developing the Workforce Needed for Success in the Digital Era of Medicine´ *Digit. Biomark.* Nov, vol.4, no 1, suppl 1, pp. 136–142, viewed 10 Jan 2021, <https://doi.org/10.1159/000512382>

Heinrich S, Rapp K, Rissmann U, Becker C & König HH 2010, ´Cost of falls in old age: a systematic review´, *Osteoporos. Int.*, Jun, vol.21, no 6, pp. 891-902.

Hevner, AR von, March, S, Park, J & Ram, S 2004, ´Design science in information systems research´, *MIS Quartely*, March, vol.28, no 1, pp. 75-105.

Jacobson GP & Newman CW 1990, The development of the Dizziness Handicap Inventory. *Arch. Otolaryngol. Head Neck Surg.*, Apr, vol.116, no 4, pp. 424–427.

Karpathakis K, Libow G, Potts HWW, Dixon S, Greaves F & Murray E, 2021, 'An Evaluation Service for Digital Public Health Interventions: User-Centered Design Approach', *J. Med. Internet Res*., Sep;23(9):e28356, viewed 10 Nov 2021, <https://pubmed.ncbi.nlm.nih.gov/34494965>

Kerber KA 2009, ´Vertigo and Dizziness in the Emergency Department´, *Emerg. Med. Clin. North. Am.*, Feb, vol.27, no 1, pp. 39–50, viii, viewed 10 Dec 2018, <https://pubmed.ncbi.nlm.nih.gov/19218018/>

Kerber KA, Callaghan BC, Telian SA, Meurer WJ, Skolarus LE, Carender W & Burke JF 2017, ´Dizziness Symptom Type Prevalence and Overlap: A US Nationally Representative Survey´, *Am. J. Med*, Dec, 130(12):1465;e1-1465;e9, viewed 5 March 2019, <https://doi.org/10.1016/j.amjmed.2017.05.048>

Kim K, Gollamudi SS & Steinhubl S 2017, ´Digital technology to enable aging in place´, *Exp. Gerontol.*, Feb, vol.88, pp. 25–31.

Kovacs E, Wang X & Grill E 2019, ´Economic burden of vertigo: a systematic review´, *Health Econ. Rev.*, Dec, 9(1):37, viewed 7 Feb 2020, <http://europepmc.org/abstract/MED/31883042>

Lapão LV 2010, ´O papel crítico dos sistemas de informação na saúde. Considerações no âmbito do Plano Nacional de Saúde 2011-2016´, viewed 8 April 2018, <http://pns.dgs.pt/files/2010/09/lvl.pdf>

Lapão LV & Correia A 2015, ´Improving Access to Pediatric Cardiology in Cape Verde through a Collaborative International Telemedicine service´, *Global Telehealth Studies in Health Technology and Informatics*, vol.209, pp. 51-57.

Lapão LV, Messina LA, Ungerer R & Campos F 2016, ´Roteiro estratégico para a telesaúde na CPLP: diagnóstico e prioridades para o desenvolvimento da telesaúde´, *An. Inst. Hig. Med. Trop., v*ol.15 supl 1, pp. s65-s73, viewed 2 April 2018, <https://doi.org/10.25761/anaisihmt.108>

Lapão LV, Da Silva MM & Gregório J 2017, 'Implementing an online pharmaceutical service using design science research', *BMC Med. Inform. Decis. Mak.* Mar, 27;17(1):31., viewed 7 Feb 2020, <https://pubmed.ncbi.nlm.nih.gov/28347304/>

Lapão, LV, Peyroteo M, Maia, M, Seixas J, Gregório J, Mira da Silva M, Heleno B & Correia JC 2021, ´Implementation of Digital Monitoring Services During the COVID-19 Pandemic for Patients with Chronic Diseases: Design Science Approach´, *J. Med. Internet Res.* Aug, vol.23, no 8, e24181, viewed 10 Sep 2021, <https://doi.org/10.2196/24181>

Leirós-Rodríguez R, García-Soidán JL & Romo-Pérez V 2019, ´Analyzing the use of accelerometers as a method of early diagnosis of alterations in balance in elderly people: a systematic review´, *Sensors (Basel)*, Sep, vol.19, no 18:3883, viewed 1 Dec 2019, <https://www.mdpi.com/resolver?pii=s19183883>

Maciel A 2010, ´Quedas em idosos: um problema de saúde pública desconhecido pela comunidade e negligenciado por muitos profissionais da saúde e por autoridades sanitárias brasileiras´, *Rev. Med. Minas Gerais*, vol.20, no 4, pp. 554-557.

Maia MR, Castela E, Pires A & Lapão LV 2019, ´How to develop a sustainable telemedicine service? A Pediatric Telecardiology Service 20 years on - an exploratory study´, *BMC Health Serv. Res.*, Sep, vol.19, no 1:681, viewed 15 Feb 2020, <https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4511-5>

Montesinos L, Castaldo R & Pecchia L 2018, ´Wearable inertial sensors for fall risk assessment and prediction in older adults: a systematic review and meta-analysis´, *IEEE Trans. Neural. Syst. Rehabil. Eng.* March, vol.26, no 3, pp. 573–582.

Mucchi L, Jayousi S, Gant A, Paoletti E & Zoppi P 2021, ´Tele-Monitoring System for Chronic Diseases Management: Requirements and Architecture´, *Int. J. Environ. Res. Public Health*, Jul, 18(14):7459, viewed 15 Oct 2021, <https://pubmed.ncbi.nlm.nih.gov/34299910/>

Nabyonga-Orem J, Dovlo D, Kwamie A, Nadege A, Guangya W & Kirigia JM 2016, ´Policy dialogue to improve health outcomes in low income countries: what are the issues and way forward?' *BMC Health Serv. Res.*, Jul, vol.16, suppl 4:217, viewed 10 Sep 2022, <https://bmchealthservres.biomedcentral.com/counter/pdf/10.1186/s12913-016-1450-2.p>

Nguyen H, Mirza F, Naeem MA & Baig MM 2018, ´Falls management framework for supporting an independent lifestyle for older adults: a systematic review´, *Aging Clin. Exp. Res.*, Nov, vol.30, no 11, pp. 1275–1286.

Nolte E, Merkur S & Anell A. Achieving Person-Centred Health Systems. Cambridge: University Press, 2020.

Orton M, Agarwal S, Muhoza P, Vasudevan L & Vu A 2018, 'Strengthening Delivery of Health Services Using Digital Devices', *Glob. Health Sci. Pract.*, Oct, vol.6 suppl 1, pp. s61-s71, viewed 15 Oct 2021, < https://pubmed.ncbi.nlm.nih.gov/30305340/>

Peffers K, Tuunanen T, Rothenberger, MA & Chatterjee, S 2007, ´A design science research methodology for information systems research´, *J. Manag. Inf. Syst.*, vol.24, no 3, pp. 45–77.

Radhakrishnan K, Xie B, Berkley A & Kim M 2016, 'Barriers and Facilitators for Sustainability of Tele-Homecare Programs: A Systematic Review', *Health Serv. Res.*, Feb, vol.51, no 1, pp. 48–75.

Raja M, Bjerkan J, Kymre IG, Galvin KT & Uhrenfeldt L 2021, 'Telehealth and digital developments in society that persons 75 years and older in European countries have been part of: A scoping review', *BMC Health Serv. Res.*, Oct, 21(1):1157, viewed 8 Dec 2021, < https://pubmed.ncbi.nlm.nih.gov/34696789>

Ricciardi W, Pita Barros P, Bourek A, Brouwer W, Kelsey T & Lehtonen L 2019, 'How to govern the digital transformation of health services', *Eur J Public Health*, Oct, vol.29 suppl3, pp. s7-s12.

Rucco R, Sorriso A, Liparoti M, Ferraioli G, Sorrentino P, Ambrosanio M & Baselice F 2018, ´Type and location of wearable sensors for monitoring falls during static and dynamic tasks in healthy elderly: a review´, *Sensors (Basel)*, May;18(5):1613, viewed 10 Dec 2018, <https://www.mdpi.com/resolver?pii=s18051613>

Scott Kruse C, Karem P, Shifflett K, Vegi L, Ravi K & Brooks M 2018, 'Evaluating barriers to adopting telemedicine worldwide: A systematic review', *J. Telemed. Telecare*, Jan, vol.24, no 1, pp. 4-12.

Skjæret N, Nawaz A, Morat T, Schoene D, Helbostad JL & Vereijken B 2016, ´Exercise and rehabilitation delivered through exergames in older adults: An integrative review of technologies, safety and efficacy´, *Int. J. Med. Inform.*, Jan, vol.85, no 1, pp. 1–16.

Sun R & Sosnoff JJ 2018, ´Novel sensing technology in fall risk assessment in older adults: a systematic review´, *BMC Geriatr.*, Jan, 18:14, viewed 10 July 2018, <https://doi.org/10.1186/s12877-018-0706-6>

Tehrani ASS, Diarmuid Coughlan D, Hsieh YH, Mantokoudis G, Korley FK, Kerber KA, Frick K & Newman-Toker DE 2013, ´Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments´, *Acad. Emerg. Med.*, Jul, vol.20, no 7, pp. 689-696.

Tossaint-Schoenmakers R, Versluis A, Chavannes N, Talboom-Kamp E & Kasteleyn M 2021, ´The Challenge of Integrating eHealth Into Health Care: Systematic Literature Review of the Donabedian Model of Structure, Process, and Outcome´, *J. Med. Internet Res.*, May, 23(5):e27180, viewed 12 Jun 2021, <https://pubmed.ncbi.nlm.nih.gov/33970123>

Trenerry B, Chng S, Wang Y, Suhaila ZS, Lim SS, Lu HY & Oh PH 2021, 'Preparing Workplaces for Digital Transformation: An Integrative Review and Framework of Multi-Level Factors', *Front. Psychol.*, Mar;12:620766, viewed 10 Feb 2022, <https://pubmed.ncbi.nlm.nih.gov/33833714/>

Viirre E 1996, 'Vestibular telemedicine and rehabilitation. Applications for virtual reality', *Stud. Health Technol. Inform.*, vol.29, pp. 299–305.

WHO 2019, *Contributions from the World Health Organization in Cabo Verde, 2016-2019 - Promoting health, keeping the world safe and serving the vulnerable.* WHO, Cabo Verde.

Wynn R, Gabarron E, Johnsen, JK & Traver V 2020, 'Special Issue on E-Health Services', *Int. J. Environ. Res. Public Health*, Apr;17(8):2885, viewed 10 July 2022, <https://pubmed.ncbi.nlm.nih.gov/32331273/>

3.5. CONCLUSIONS

Using a scientific approach, the “BALANCE” service was designed, tested and evaluated in a Portuguese clinical context, revealing relevant potential to complement the provision of health care to the elderly with balance disorders and risk of falling. The results shown that this digital service can allow early detection of deterioration of clinical condition, timely adjustment of the treatment, closer physician-patient interaction and active participation of patients and caregivers. For broader clinical applicability, it is relevant to ensure the involvement of patients, caregivers and health professionals, investment in interoperability, and allocation of working hours to the digital provision of health care. The implementation of this digital service in Cape Verde is both a clinical and a research opportunity, approaching the health care between Portugal and Cape Verde in the context of population aging. The engagement of other health professionals and the alignment with other Portuguese-speaking countries should be considered.

4. APPENDICES

4.1. QUESTIONNAIRE – ACTIVITY 1

Question Title
1. Género
- ○ Masculino
- ○ Feminino

Question Title
2. Idade
- ○ Igual ou menor 30 anos
- ○ 31 - 40 anos
- ○ 41 - 50 anos
- ○ 51 - 60 anos
- ○ Igual ou maior 61 anos

Question Title
3. É especialista em:
- ○ Medicina Física e de Reabilitação
- ○ Medicina Geral e Familiar
- ○ Medicina Interna
- ○ Neurologia
- ○ Otorrinolaringologia

Question Title
4. Está inscrito no Colégio da Competência em Geriatria?
- ○ Sim
- ○ Não

Question Title
5. Trabalha num/ numa … (se trabalhar em mais de uma, considerar a unidade onde tem o seu emprego principal)
- ○ Unidade de Cuidados de Saúde Personalizados
- ○ Unidade de Saúde Familiar
- ○ Hospital Público
- ○ Hospital em Parceria Público-Privada
- ○ Hospital Universitário
- ○ Consultório / Clínica Privada / Hospital Privado

Question Title

6. A qual Administração Regional de Saúde (ARS) pertence a Unidade de Saúde na qual trabalha? (se trabalhar em mais de uma, considerar a unidade onde tem seu emprego principal)

- ○ Norte
- ○ Centro
- ○ Lisboa e Vale do Tejo
- ○ Alentejo
- ○ Algarve
- ○ Região Autónoma da Madeira
- ○ Região Autónoma dos Açores

Question Title

7. De todos os doentes IDOSOS observados por si, com que frequência mensal presta cuidados de saúde no contexto das alterações do equilíbrio?

- ○ Igual ou inferior a 25%
- ○ Entre 26 e 50%
- ○ Entre 51 e 75%
- ○ Igual ou superior a 76%
- ○ Não responde / Não sabe

Question Title

8. De todos os doentes IDOSOS observados por si, com que frequência mensal presta cuidados de saúde no contexto das QUEDAS por alterações do equilíbrio?

- ○ Igual ou inferior a 25%
- ○ Entre 26 e 50%
- ○ Entre 51 e 75%
- ○ Igual ou superior a 76%
- ○ Não responde / Não sabe

Question Title

9. Nas suas consultas, com que frequência você tem NECESSIDADE de dados clínicos (anamnese, observação, tratamento) relativos a prestações anteriores de cuidados ao idoso com alterações do equilíbrio e consequente risco de queda?

- ○ Igual ou inferior a 25%
- ○ Entre 26 e 50%
- ○ Entre 51 e 75%
- ○ Igual ou superior a 76%
- ○ Não responde / Não sabe

Question Title

10. Nas suas consultas, em que formato acede a estes dados, na maior parte das vezes?

- ○ Processo clínico em papel
- ○ Processo clínico suportado por Sistemas e Tecnologias de Informação
- ○ Informação em papel disponibilizada pelo doente
- ○ Não responde / Não sabe

Question Title

11. Em que medida a disponibilidade de dados relativos a prestações ANTERIORES de cuidados de saúde no âmbito das alterações do equilíbrio no idoso e consequente risco de queda faz diferença ou não na sua prestação de cuidados neste contexto?

- ○ Nunca
- ○ Raramente
- ○ Poucas vezes
- ○ Frequentemente
- ○ Sempre
- ○ Não responde / Não sabe

Question Title

12. DURANTE A CONSULTA qual a sua percepção sobre a percentagem de tempo da consulta que dedica a usar os Sistemas e Tecnologias de Informação?

- ○ Igual ou mais de 76%
- ○ Entre 51 e 75%
- ○ Entre 26 e 50%
- ○ Igual ou menos de 25%
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

13. Como classifica a utilidade dos dados obtidos da sua Unidade de Saúde, com Sistemas e Tecnologias de Informação?

- ○ Excelente
- ○ Muito boa
- ○ Boa
- ○ Má
- ○ Muito má
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

14. Em que medida está satisfeito/a ou insatisfeito/a acerca do TEMPO DESPENDIDO PARA ACEDER dados de Sistemas e Tecnologias de Informação da sua Unidade de Saúde, relativos a prestações anteriores de cuidados de saúde no contexto das perturbações do equilíbrio no idoso e consequente risco de queda?

- ○ Muito insatisfeito/a
- ○ Insatisfeito/a
- ○ Satisfeito/a
- ○ Muito satisfeito/a
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

15. Em que medida está satisfeito/a ou insatisfeito/a acerca da DISPONIBILIDADE DE DADOS SUFICIENTES E COMPREENSÍVEIS de Sistemas e Tecnologias de Informação da sua Unidade de Saúde, relativos a prestações anteriores de cuidados de saúde no contexto das perturbações do equilíbrio no idoso e consequente risco de queda?

- ○ Muito insatisfeito/a
- ○ Insatisfeito/a
- ○ Satisfeito/a
- ○ Muito satisfeito/a
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

16. Em que medida está satisfeito/a ou insatisfeito/a acerca do TEMPO DESPENDIDO PARA PREENCHER novos dados de Sistemas e Tecnologias de Informação na sua Unidade de Saúde, relativos à prestação de cuidados de saúde no contexto das perturbações do equilíbrio no idoso e consequente risco de queda?

- ○ Muito insatisfeito/a
- ○ Insatisfeito/a
- ○ Satisfeito/a
- ○ Muito satisfeito/a
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

17. No geral em que medida está satisfeito/a ou insatisfeito/a acerca do uso de Sistemas e Tecnologias de Informação no contexto das perturbações do equilíbrio no idoso e consequente risco de queda?

- ○ Muito insatisfeito/a
- ○ Insatisfeito/a
- ○ Satisfeito/a
- ○ Muito satisfeito/a
- ○ Não utiliza
- ○ Não responde / Não sabe

Question Title

18. Em que medida considera que a utilização de soluções à distância (eHealth ou telemedicina) no contexto das perturbações do equilíbrio no idoso e consequente risco de queda é, ou poderá ser, pertinente no seu trabalho?

- ○ Muito pertinente
- ○ Pertinente
- ○ Não faz diferença
- ○ Impertinente
- ○ Muito impertinente
- ○ Não responde / Não sabe

4.2. CONTRIBUTION OF THE GENERAL MEDICAL COUNCIL OF PORTUGAL – ACTIVIY 1 (QUANTITATIVE STUDY)

De: andrea27 andrea <andreamartinsbr@hotmail.com>
Enviado: quinta-feira, 25 de outubro de 2018 13:57
Para: omcne@omcne.pt
Cc: Luís Lapão
Assunto: COLABORAÇÃO OM - INVESTIGAÇÃO DRA. ANDRÉA GASPAR

Boa tarde,
Exmo. Presidente do Conselho Nacional da Ordem dos Médicos
Sr. Bastonário Dr. José Miguel Ribeiro de Castro Guimarães

Sou médica do Serviço de ORL do Hospital Beatriz Ângelo e aluna do doutoramento em Saúde Internacional, Especialidade em Políticas de Saúde e Desenvolvimento do Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa.

No âmbito de um estudo integrado na tese do meu doutoramento, venho solicitar a colaboração da Ordem do Médicos para realizar uma investigação sobre o tema "Potencial do *eHealth* na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspectiva de saúde global". Será fundamental a disponibilidade dos *emails* da população em estudo, conforme carta em anexo, ou como alternativa, a colaboração da Ordem dos Médicos no envio do questionário

Encaminho todos os documentos necessários para a vossa apreciação.

Fico a aguardar a vossa confirmação relativamente à receção dos anexos e a vossa resposta.

Desde já agradeço a vossa atenção.

Com os melhores cumprimentos,

Andréa Gomes Martins Gaspar – OM 40858

COLABORAÇÃO PARA ESTUDO DOUTORAMENTO - mb / 2018 / 17528 / N44526

Maria João <maria.joao@ordemdosmedicos.pt>
Qui, 27/12/2018 15:49
Para: andreamartinsbr@hotmail.com <andreamartinsbr@hotmail.com>

Exma. Senhora Dr.ª Andréa Gomes Martins Gaspar,

Por deliberação do Conselho Nacional desta Ordem a colaboração que podemos prestar no âmbito da investigação que está a desenvolver consiste na disponibilização, no site da Ordem dos Médicos, o link para o inquérito que pretende levar a cabo.

Não facultamos os endereços de correio eletrónico dos médicos, já que de acordo com o artigo 7.º do Estatuto da Ordem dos Médicos, tais dados não são públicos.

Assim, caso considere útil, solicitamos que nos remeta o link do inquérito para que o mesmo fique disponível no site desta Ordem. Nesta hipótese, agradecemos ainda que nos informe qual o prazo durante o qual o referido link deverá ficar online.

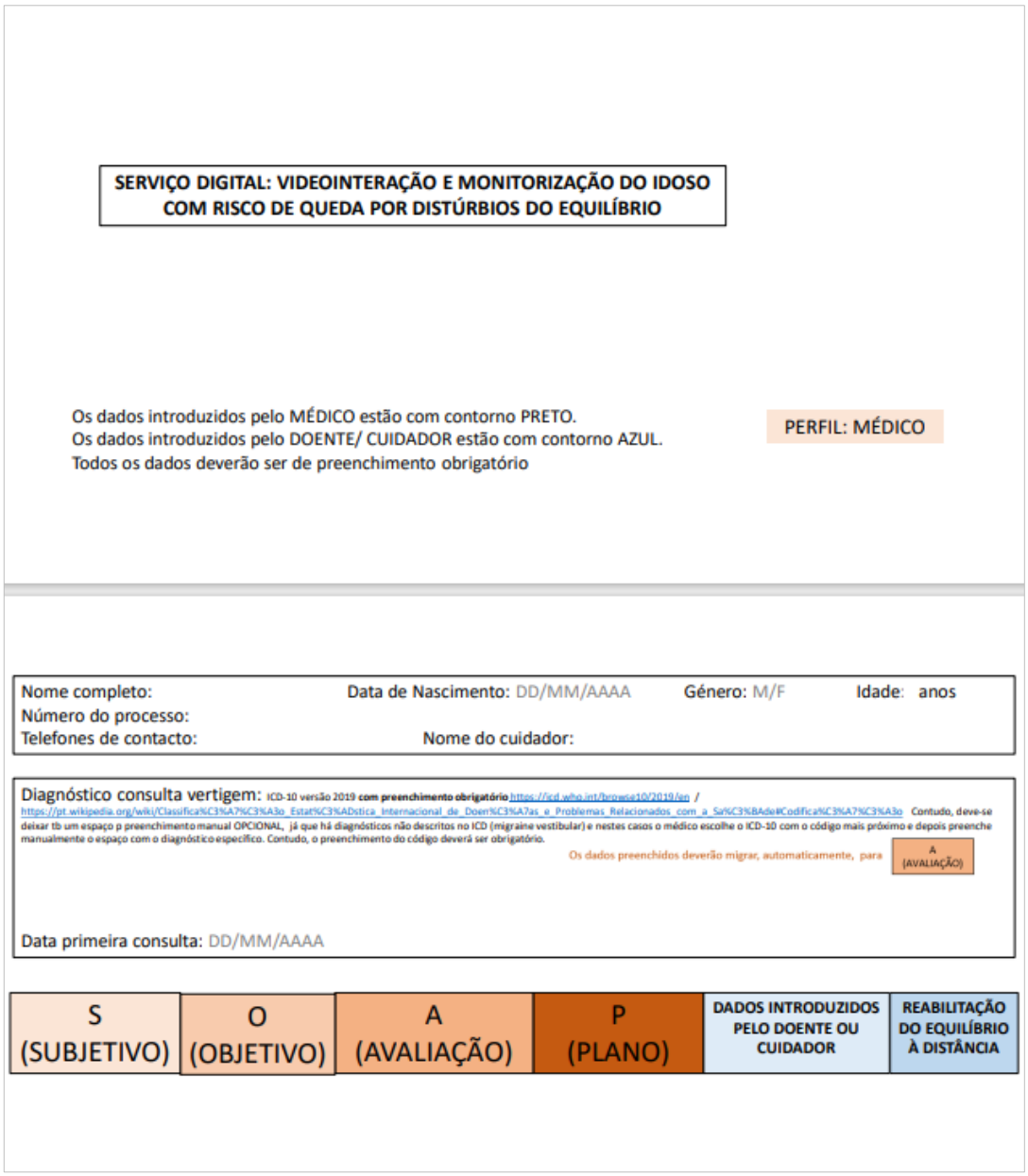
Com os melhores cumprimentos,

A Secretária do Conselho Nacional da Ordem dos Médicos

Dra. Maria de Lurdes Gandra

4.3. ILLUSTRATION OF THE QUESTIONNAIRE PAGE AVAILABLE THROUGH WEBSITE OF THE GENERAL MEDICAL COUNCIL OF PORTUGAL (ACTIVITY 1)

4.4. DRAFT OF THE DESIGN OF THE DIGITAL SERVICE - ACTIVITY 3



SERVIÇO DIGITAL: VIDEOINTERAÇÃO E MONITORIZAÇÃO DO IDOSO COM RISCO DE QUEDA POR DISTÚRBIOS DO EQUILÍBRIO

Os dados introduzidos pelo MÉDICO estão com contorno PRETO.
Os dados introduzidos pelo DOENTE/ CUIDADOR estão com contorno AZUL.
Todos os dados deverão ser de preenchimento obrigatório

PERFIL: MÉDICO

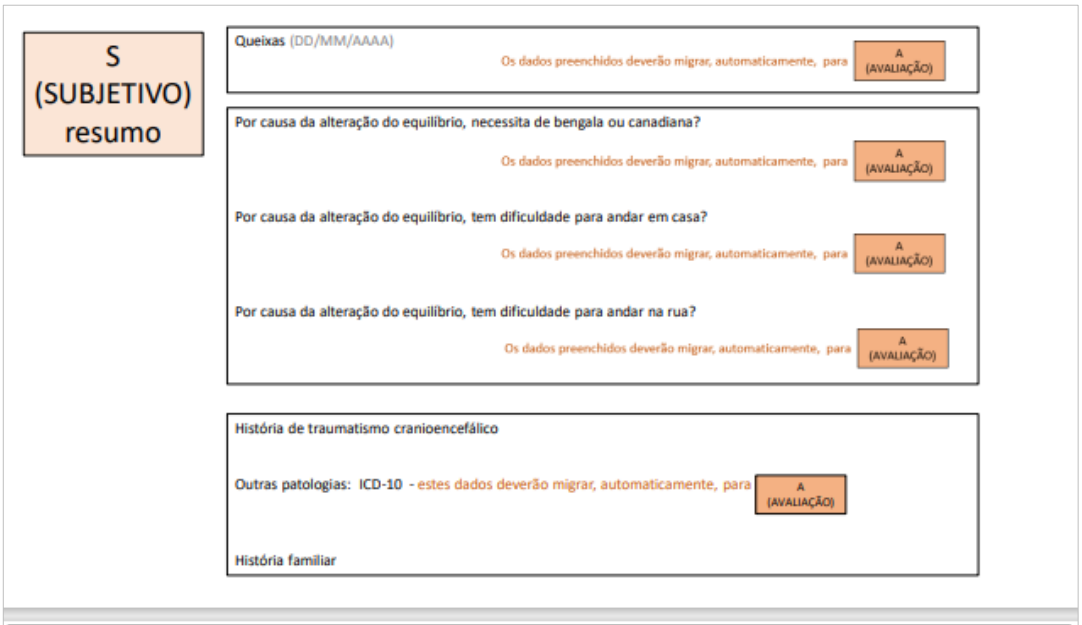
Nome completo: Data de Nascimento: DD/MM/AAAA Género: M/F Idade: anos
Número do processo:
Telefones de contacto: Nome do cuidador:

Diagnóstico consulta vertigem: ICD-10 versão 2019 **com preenchimento obrigatório** https://icd.who.int/browse10/2019/en / https://pt.wikipedia.org/wiki/Classifica%C3%A7%C3%A3o_Estat%C3%ADstica_Internacional_de_Doen%C3%A7as_e_Problemas_Relacionados_com_a_Sa%C3%BAde#Codifica%C3%A7%C3%A3o Contudo, deve-se deixar tb um espaço p preenchimento manual OPCIONAL, já que há diagnósticos não descritos no ICD (migraine vestibular) e nestes casos o médico escolhe o ICD-10 com o código mais próximo e depois preenche manualmente o espaço com o diagnóstico específico. Contudo, o preenchimento do código deverá ser obrigatório.

Os dados preenchidos deverão migrar, automaticamente, para A (AVALIAÇÃO)

Data primeira consulta: DD/MM/AAAA

S (SUBJETIVO)	O (OBJETIVO)	A (AVALIAÇÃO)	P (PLANO)	DADOS INTRODUZIDOS PELO DOENTE OU CUIDADOR	REABILITAÇÃO DO EQUILÍBRIO À DISTÂNCIA



Queixas: Quando carregar no item "queixas", aparecerão as opções abaixo para serem assinaladas. Depois, o item "queixas" revelará apenas o que foi assinalado. sim Estes dados deverão migrar automaticamente p AVALIAÇÃO

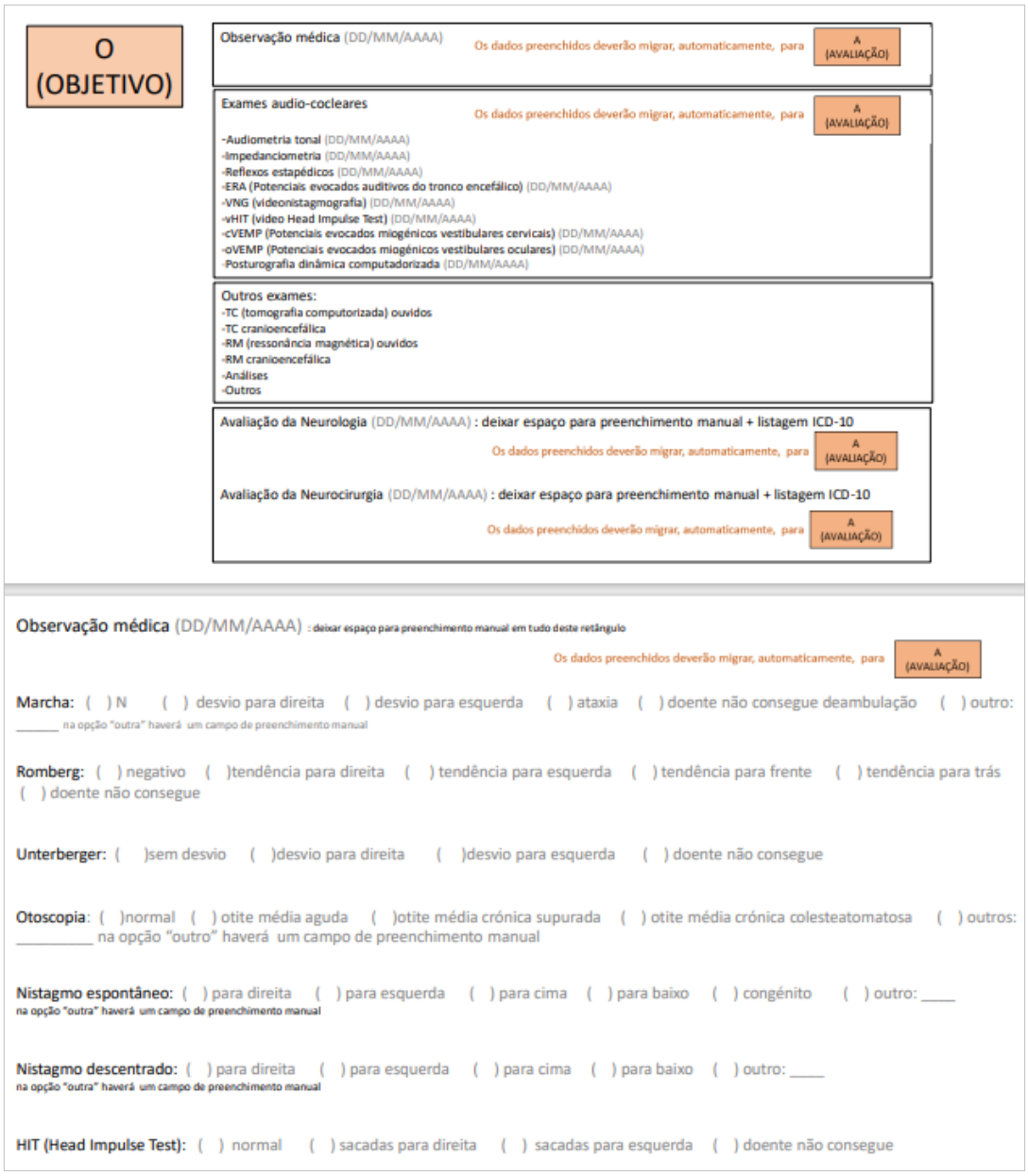
- vertigem
- tontura
- instabilidade
- desvio da marcha: ( ) para direita ( ) para esquerda ( ) sem lado preferencial
- número de quedas no último ano: 0-50 quedas última queda: 0-365 dias (nesta opção "última queda", a introdução de nova data de queda recente não deveria apagar a data da queda anterior. Seria mais uma data acrescentada de forma q qdo virmos o este item tenhamos já todas as datas disponíveis, sem precisar carregar em nada).
- hipoacusia: ( ) OD (ouvido direito) ( ) OE (ouvido esquerdo) ( ) bilateral
- acufeno: ( ) OD (ouvido direito) ( ) OE (ouvido esquerdo) ( ) bilateral
- cefaleia
- náuseas
- vómitos
- sudorese
- cinetose
- outros: _____na opção "outros" haverá um campo de preenchimento manual

Por causa da alteração do equilíbrio, necessita de bengala ou canadiana? ( ) não ( ) sim Estes dados deverão migrar automaticamente p AVALIAÇÃO
Por causa da alteração do equilíbrio, tem dificuldade para andar em casa?( ) não ( ) sim Estes dados deverão migrar automaticamente p AVALIAÇÃO
Por causa da alteração do equilíbrio, tem dificuldade para andar na rua? ( ) não ( ) sim Estes dados deverão migrar automaticamente p AVALIAÇÃO

História de traumatismo cranioencefálico: ( ) N ( ) S (DD/MM/AAAA) nesta opção "História de traumatismo cranioencefálico", a introdução de nova data mais recente não deveria apagar a data anterior. Apenas seria mais uma data acrescentada de forma q qdo virmos o este item tenhamos já todas as datas disponíveis, sem precisar carregar em nada).

Outras patologias: https://icd.who.int/browse10/2019/en /
https://pt.wikipedia.org/wiki/Classifica%C3%A7%C3%A3o_Estat%C3%ADstica_Internacional_de_Doen%C3%A7as_e_Problemas_Relacionados_com_a_Sa%C3%BAde#Codifica%C3%A7%C3%A3o - Estes dados deverão migrar automaticamente p AVALIAÇÃO

História familiar: ( ) doença de Mènière ( ) enxaqueca ( ) outros:_____deixar espaço p preenchimento manual



Observação médica (DD/MM/AAAA) : deixar espaço para preenchimento manual em tudo deste retângulo

Os dados preenchidos deverão migrar, automaticamente, para A (AVALIAÇÃO)

Marcha: ( ) N ( ) desvio para direita ( ) desvio para esquerda ( ) ataxia ( ) doente não consegue deambulação ( ) outro: _____ na opção "outra" haverá um campo de preenchimento manual

Romberg: ( ) negativo ( )tendência para direita ( ) tendência para esquerda ( ) tendência para frente ( ) tendência para trás ( ) doente não consegue

Unterberger: ( )sem desvio ( )desvio para direita ( )desvio para esquerda ( ) doente não consegue

Otoscopia: ( )normal ( ) otite média aguda ( )otite média crónica supurada ( ) otite média crónica colesteatomatosa ( ) outros: _____ na opção "outro" haverá um campo de preenchimento manual

Nistagmo espontâneo: ( ) para direita ( ) para esquerda ( ) para cima ( ) para baixo ( ) congénito ( ) outro: ____
na opção "outra" haverá um campo de preenchimento manual

Nistagmo descentrado: ( ) para direita ( ) para esquerda ( ) para cima ( ) para baixo ( ) outro: ____
na opção "outra" haverá um campo de preenchimento manual

HIT (Head Impulse Test): ( ) normal ( ) sacadas para direita ( ) sacadas para esquerda ( ) doente não consegue

Head Shaking Test: ( ) normal ( ) monofásico: batidas para direita ( ) monofásico: batidas para esquerda ( ) bifásico ( ) doente não consegue

Oculomotricidade: ( ) sacadas alteradas ( ) perseguição alterada ( ) provas optocinéticas alteradas ( ) doente não consegue

Prova de Hallpike:
à direita: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) doente não consegue

à esquerda: : ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) doente não consegue

Prova de Mc Clure:
à direita: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) doente não consegue

à esquerda: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) doente não consegue

Outros: _____ na opção "outros" haverá um campo de preenchimento manual

EXAMES AUDIO-COCLEARES Os dados preenchidos deverão migrar, automaticamente, para A (AVALIAÇÃO)

-Audiometria tonal (DD/MM/AAAA) : possibilidade de carregar exames em pdf
OD (ouvido direito)
( ) normal
( ) perda auditiva: tipo ( ) condutiva ( ) sensorioneural ( ) mista
grau ( ) ligeiro ( ) moderado ( ) profundo ( ) severo ( ) cofose

OD (ouvido esquerdo)
( ) normal
( ) perda auditiva: tipo ( ) condutiva ( ) sensorioneural ( ) mista
grau ( ) ligeiro ( ) moderado ( ) profundo ( ) severo ( ) cofose

-Timpanograma (DD/MM/AAAA) :
OD (ouvido direito)
( ) normal
( ) tipo Ar (rigidez)
( ) tipo Ad
( ) tipo B
( ) tipo C

OD (ouvido esquerdo)
( ) normal
( ) tipo Ar
( ) tipo Ad
( ) tipo B
( ) tipo C

-Reflexos estapédicos (DD/MM/AAAA) :
Ipsilateral:
Ouvido direito: ( ) presente ( ) ausente
Ouvido esquerdo: ( ) presente ( ) ausente

Contralateral:
Ouvido direito: ( ) presente ( ) ausente
Ouvido esquerdo: ( ) presente ( ) ausente

-ERA (potenciais evocados auditivos do tronco encefálico) (DD/MM/AAAA) :
( ) exame normal
( ) exame com as seguintes alterações:
ouvido direito: ( ) latências aumentadas ( ) sem curvas
ouvido esquerdo: ( ) latências aumentadas ( ) sem curvas
relação das ondas I / V anormal ( )
intervalo interaural I-V aumentado ( )
outros: _____deixar espaço para preenchimento manual

-VNG (videonistagmografia) (DD/MM/AAAA) possibilidade de carregar exames em pdf
( ) exame normal
( ) exame com as seguintes alterações: **(quando carregar neste item, aparecerão os seguintes campos a serem preenchidos, caso estejam alterados):**
( ) Nistagmo espontâneo: ( ) para direita ( ) para esquerda ( ) para cima ( ) para baixo ( ) congénito ( ) outro: _____ na opção "outra" haverá um campo de preenchimento manual

( ) Nistagmo descentrado: ( ) para direita ( ) para esquerda ( ) para cima ( ) para baixo ( ) outro: ___campo de preenchimento manual

( ) Oculomotricidade: ( ) sacadas alteradas ( ) perseguição alterada ( ) provas optocinéticas alteradas ( ) outro:_____ deixar espaço para preenchimento manual

VNG (continuação):

( ) Prova de Hallpike:
à direita: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual

à esquerda: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual

( ) Prova de Mc Clure:
à direita: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) não efectuada

à esquerda: ( ) nistagmo geotrópico ( ) nistagmo apogeotrópico ( ) nistagmo horizontal geotrópico ( ) nistagmo horizontal apogeotrópico ( ) nistagmo vertical com batidas para cima ( ) nistagmo vertical com batidas para baixo ( ) outros: _____ deixar espaço para preenchimento manual ( ) não efectuada

( ) Head Shaking Test: ( ) monofásico: batidas para direita ( ) monofásico: batidas para esquerda ( ) bifásico ( ) batidas verticais

( ) Provas cinéticas: ( ) preponderância direcional _____ deixar espaço para preenchimento manual ( ) ganho anormal ( ) outro _____ deixar espaço para preenchimento manual

VNG (continuação):

( ) Provas calóricas
( ) hiporreflexia vestibular ( ) direita ( ) esquerda _____ % (deixar espaço para preenchimento manual)
( ) hiperreflexia vestibular _____ (deixar espaço para preenchimento manual)
( ) arreflexia vestibular ( ) direita ( ) esquerda ( ) bilateral a _____graus C (deixar espaço para preenchimento manual)
( ) invertidas _____ (deixar espaço para preenchimento manual)
( ) pervertidas _____ (deixar espaço para preenchimento manual)
( ) não efectuadas

( ) Outros: _____ (deixar espaço para preenchimento manual)

( ) Teste vibratório: ( ) positivo

-vHIT (video Head Impulse Test) (DD/MM/AAAA)

( ) exame normal

( ) exame com as seguintes alterações:

( ) CSCL (canal semicircular lateral) direito: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) CSCL esquerdo: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) CSSP (canal semicircular posterior) direito: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) CSCP esquerdo: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) CSCS (canal semicircular superior) direito: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) CSCS esquerdo: ( ) sacadas corretivas tipo covert ( ) sacadas corretivas tipo overt ( ) diminuição do valor médio do ganho

( ) Assimetria de ganho alterada nos planos: ( ) CSCL _____% ( ) CSCP _____% ( ) CSCS ____%

( ) outros: _____ (deixar espaço para preenchimento manual)

-cVEMP (Potenciais evocados miogénicos vestibulares cervicais) (DD/MM/AAAA)
( ) exame normal
( ) exame com as seguintes alterações:
( ) ouvido direito: ( ) sem curvas ( ) curvas amplas ( ) latências aumentadas
( ) ouvido esquerdo: ( ) sem curvas ( ) curvas amplas ( ) latências aumentadas
( ) comparação P13-N23 aumentada entre os ouvidos: _____% deixar espaço para preenchimento manual
( ) outros: _____deixar espaço para preenchimento manual

-oVEMP (Potenciais evocados miogénicos vestibulares oculares) (DD/MM/AAAA)
( ) exame normal
( ) exame com as seguintes alterações:
( ) ouvido direito: ( ) sem curvas ( ) curvas amplas ( ) latências aumentadas
( ) ouvido esquerdo: ( ) sem curvas ( ) curvas amplas ( ) latências aumentadas
( ) comparação N10-P15 aumentada entre os ouvidos: _____% deixar espaço para preenchimento manual
( ) outros: _____deixar e
spaço para preenchimento manual

-Posturografia dinâmica computorizada:
( ) exame normal
( ) exame com as seguintes alterações:
-análise composta do equilíbrio: score____ deixar espaço para preenchimento manual
-análise sensorial com alteração(ções) do (s) componente(s): ( ) somatossensorial ( ) visual ( ) vestibular
- estratégia _____ deixar espaço para preenchimento manual
- centro de gravidade: ( )desvio para direita ( )desvio para esquerda ( )desvio para frente ( )desvio para trás
- outros: _____ deixar espaço para preenchimento manual

Outros exames:
TC (tomografia computorizada) ouvidos (DD/MM/AAAA) :_____ deixar espaço para preenchimento manual

TC cranioencefálica (DD/MM/AAAA) : _____deixar espaço para preenchimento manual

RM (ressonância magnética) ouvidos (DD/MM/AAAA) : _____ deixar espaço para preenchimento manual

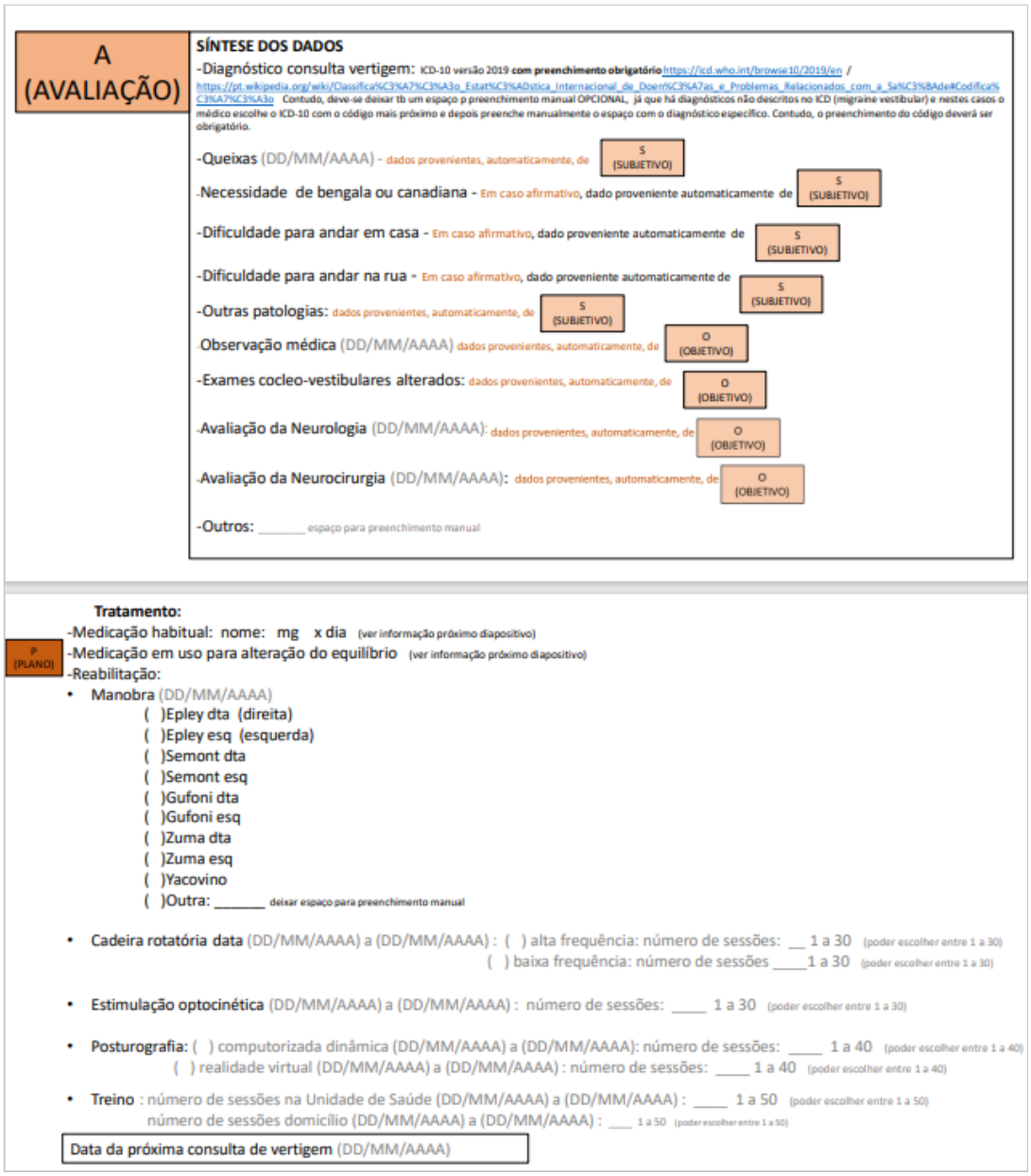
RM cranioencefálica (DD/MM/AAAA) : _____ deixar espaço para preenchimento manual

Análises (DD/MM/AAAA) : _____deixar espaço para preenchimento manual

Outros (DD/MM/AAAA) : _____ deixar espaço para preenchimento manual

Avaliação da Neurologia (DD/MM/AAAA) : deixar espaço para preenchimento manual + listaeem o selecionar ICD-10
Os dados preenchidos deverão migrar, automaticamente, para A (AVALIAÇÃO)

Avaliação da Neurocirurgia (DD/MM/AAAA) : deixar espaço para preenchimento manual + listagem p selecionar ICD-10
Os dados preenchidos deverão migrar, automaticamente, para A (AVALIAÇÃO)



A (AVALIAÇÃO)

SÍNTESE DOS DADOS

-Diagnóstico consulta vertigem: ICD-10 versão 2019 **com preenchimento obrigatório** https://icd.who.int/browse10/2019/en / https://pt.wikipedia.org/wiki/Classifica%C3%A7%C3%A3o_Estat%C3%ADstica_Internacional_de_Doen%C3%A7as_e_Problemas_Relacionados_com_a_Sa%C3%BAde#Codifica%C3%A7%C3%A3o Contudo, deve-se deixar tb um espaço p preenchimento manual OPCIONAL, já que há diagnósticos não descritos no ICD (migraine vestibular) e nestes casos o médico escolhe o ICD-10 com o código mais próximo e depois preenche manualmente o espaço com o diagnóstico específico. Contudo, o preenchimento do código deverá ser obrigatório.

-Queixas (DD/MM/AAAA) - dados provenientes, automaticamente, de S (SUBJETIVO)

-Necessidade de bengala ou canadiana - Em caso afirmativo, dado proveniente automaticamente de S (SUBJETIVO)

-Dificuldade para andar em casa - Em caso afirmativo, dado proveniente automaticamente de S (SUBJETIVO)

-Dificuldade para andar na rua - Em caso afirmativo, dado proveniente automaticamente de S (SUBJETIVO)

-Outras patologias: dados provenientes, automaticamente, de S (SUBJETIVO)

-Observação médica (DD/MM/AAAA) dados provenientes, automaticamente, de O (OBJETIVO)

-Exames cocleo-vestibulares alterados: dados provenientes, automaticamente, de O (OBJETIVO)

-Avaliação da Neurologia (DD/MM/AAAA): dados provenientes, automaticamente, de O (OBJETIVO)

-Avaliação da Neurocirurgia (DD/MM/AAAA): dados provenientes, automaticamente, de O (OBJETIVO)

-Outros: _____ espaço para preenchimento manual

P (PLANO)

Tratamento:

-Medicação habitual: nome: mg x dia (ver informação próximo diapositivo)

-Medicação em uso para alteração do equilíbrio (ver informação próximo diapositivo)

-Reabilitação:

- Manobra (DD/MM/AAAA)
  - ( )Epley dta (direita)
  - ( )Epley esq (esquerda)
  - ( )Semont dta
  - ( )Semont esq
  - ( )Gufoni dta
  - ( )Gufoni esq
  - ( )Zuma dta
  - ( )Zuma esq
  - ( )Yacovino
  - ( )Outra: _____ deixar espaço para preenchimento manual

- Cadeira rotatória data (DD/MM/AAAA) a (DD/MM/AAAA) : ( ) alta frequência: número de sessões: __ 1 a 30 (poder escolher entre 1 a 30)
  ( ) baixa frequência: número de sessões ____1 a 30 (poder escolher entre 1 a 30)

- Estimulação optocinética (DD/MM/AAAA) a (DD/MM/AAAA) : número de sessões: ____ 1 a 30 (poder escolher entre 1 a 30)

- Posturografia: ( ) computorizada dinâmica (DD/MM/AAAA) a (DD/MM/AAAA): número de sessões: ____ 1 a 40 (poder escolher entre 1 a 40)
  ( ) realidade virtual (DD/MM/AAAA) a (DD/MM/AAAA) : número de sessões: ____ 1 a 40 (poder escolher entre 1 a 40)

- Treino : número de sessões na Unidade de Saúde (DD/MM/AAAA) a (DD/MM/AAAA) : ____ 1 a 50 (poder escolher entre 1 a 50)
  número de sessões domicílio (DD/MM/AAAA) a (DD/MM/AAAA) : ___ 1 a 50 (poder escolher entre 1 a 50)

Data da próxima consulta de vertigem (DD/MM/AAAA)

diapositivo, apenas, informacional: como obter lista de medicamentos

Tratamento:
-Medicação habitual: nome: mg x dia
http://app10.infarmed.pt/prontuario/index.php

-Medicação em uso para alteração do equilíbrio: item 2.7 do prontuário médico on line (antieméticos e antivertiginosos)

http://m.infarmed.pt/Prontuario/Indice.aspx?t=i&c=46

DADOS INTRODUZIDOS PELO DOENTE OU CUIDADOR

Este resumo é para usar apenas se as informações dos 2 próximos diapositivos não couberem numa mesma página

Calendário agravamento do equilíbrio

Calendário queda

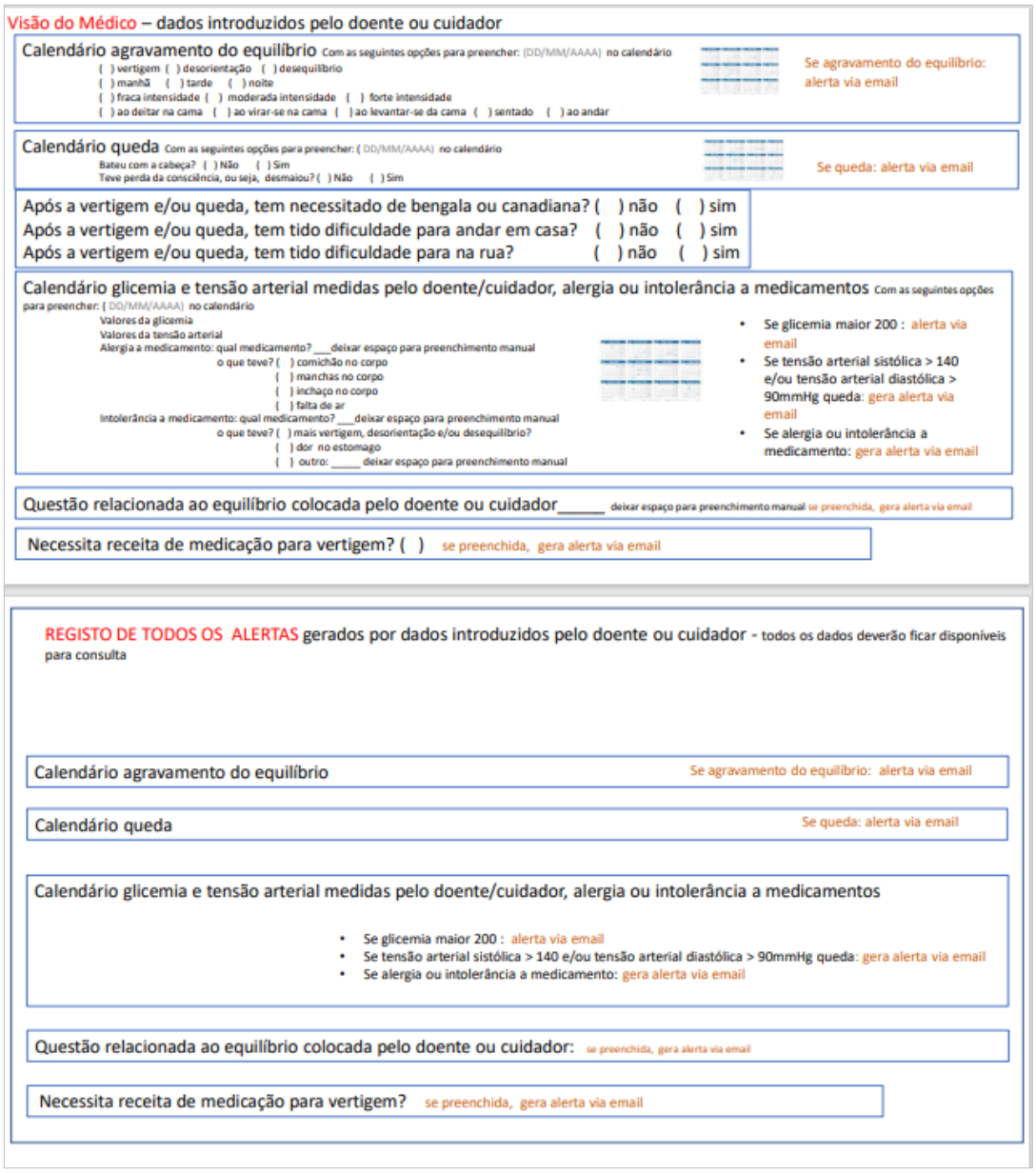
Após a vertigem e/ou queda, tem necessitado de bengala ou canadiana? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para andar em casa? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para na rua? ( ) não ( ) sim

Calendário glicemia e tensão arterial medidas pelo doente/cuidador, alergia ou intolerância a medicamentos

Questão relacionada ao equilíbrio colocada pelo doente ou cuidador:

Necessita receita de medicação para vertigem?

Registo de todos os alertas


Visão do Médico – dados introduzidos pelo doente ou cuidador
Calendário agravamento do equilíbrio Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
( ) vertigem ( ) desorientação ( ) desequilíbrio
( ) manhã ( ) tarde ( ) noite
( ) fraca intensidade ( ) moderada intensidade ( ) forte intensidade
( ) ao deitar na cama ( ) ao virar-se na cama ( ) ao levantar-se da cama ( ) sentado ( ) ao andar
Se agravamento do equilíbrio: alerta via email
Calendário queda Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
Bateu com a cabeça? ( ) Não ( ) Sim
Teve perda da consciência, ou seja, desmaiou? ( ) Não ( ) Sim
Se queda: alerta via email
Após a vertigem e/ou queda, tem necessitado de bengala ou canadiana? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para andar em casa? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para na rua? ( ) não ( ) sim
Calendário glicemia e tensão arterial medidas pelo doente/cuidador, alergia ou intolerância a medicamentos Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
Valores da glicemia
Valores da tensão arterial
Alergia a medicamento: qual medicamento? ___deixar espaço para preenchimento manual
o que teve? ( ) comichão no corpo
( ) manchas no corpo
( ) inchaço no corpo
( ) falta de ar
Intolerância a medicamento: qual medicamento? ___deixar espaço para preenchimento manual
o que teve? ( ) mais vertigem, desorientação e/ou desequilíbrio?
( ) dor no estomago
( ) outro: _____ deixar espaço para preenchimento manual
Se glicemia maior 200 : alerta via email
Se tensão arterial sistólica > 140 e/ou tensão arterial diastólica > 90mmHg queda: gera alerta via email
Se alergia ou intolerância a medicamento: gera alerta via email
Questão relacionada ao equilíbrio colocada pelo doente ou cuidador_____ deixar espaço para preenchimento manual se preenchida, gera alerta via email
Necessita receita de medicação para vertigem? ( ) se preenchida, gera alerta via email
REGISTO DE TODOS OS ALERTAS gerados por dados introduzidos pelo doente ou cuidador - todos os dados deverão ficar disponíveis para consulta
Calendário agravamento do equilíbrio Se agravamento do equilíbrio: alerta via email
Calendário queda Se queda: alerta via email
Calendário glicemia e tensão arterial medidas pelo doente/cuidador, alergia ou intolerância a medicamentos
Se glicemia maior 200 : alerta via email
Se tensão arterial sistólica > 140 e/ou tensão arterial diastólica > 90mmHg queda: gera alerta via email
Se alergia ou intolerância a medicamento: gera alerta via email
Questão relacionada ao equilíbrio colocada pelo doente ou cuidador: se preenchida, gera alerta via email
Necessita receita de medicação para vertigem? se preenchida, gera alerta via email

REABILITAÇÃO DO EQUILÍBRIO À DISTÂNCIA

SOFTWARE EXERCÍCIOS DISPONÍVEIS

formato mp4 – espaço para suportar até 30 vídeos

Calendário exercícios com as seguinte opções:
dias / meses / ano
turno manhã, tarde e/ou noite número do exercício (1, 2, 3... até 50)

Cada vez que o doente fizer algum exercício, o doente deverá marcar na agenda : dia, mês e ano , turno manhã, tarde e/ou noite pelo doente e número do exercício (1, 2, 3 ... até 50)

Upload da Gravação dos exercícios formato MP4

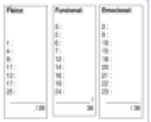
Resultados do questionário Dizziness Handicap Inventory (DHI)

Pré reabilitação (DD/MM/AAAA) : se possível, o computador soma os itens
Pós reabilitação (DD/MM/AAAA) : se possível, o computador soma os itens

Possibilidade de preenchimento após outras reabilitações

Atenção: todos os 25 itens do questionário deverão ser de preenchimento obrigatório pelo doente

(informação dos resultados no próximo diapositivo)



Este diapositivo tem apenas caráter informativo, em relação aos resultados do questionário *Dizziness Handicap Inventory* (DHI), preenchido pelos doentes

Cada pergunta com a sua pontuação é agrupada conforme abaixo: (perguntas 1, 4, 8...são da componente física)... só visível isto pelo medico!!!!

Física:	Funcional:	Emocional:
1 : 4 : 8 : 11 : 13 : 17 : 25 :	3 : 5 : 6 : 7 : 12 : 14 : 16 : 19 : 24 :	2 : 9 : 10 : 15 : 18 : 20 : 21 : 22 : 23 :
_____ / 28	_____ / 36	_____ / 36

O computador apresentará estes resultados, inclusive com a soma total _____/ 100

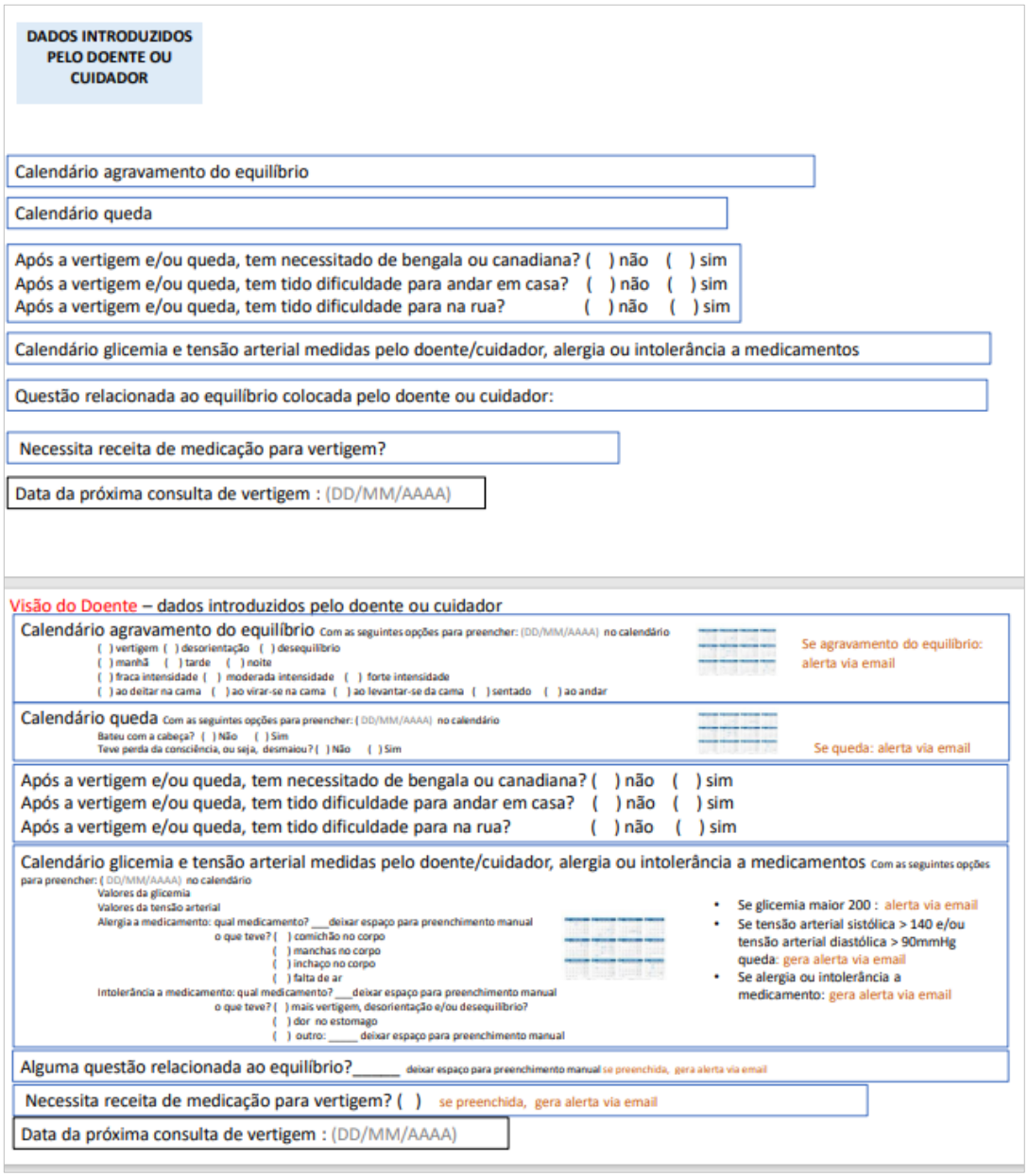
SERVIÇO DIGITAL: VIDEOINTERAÇÃO E MONITORIZAÇÃO DO IDOSO COM RISCO DE QUEDA POR DISTÚRBIOS DO EQUILÍBRIO

PERFIL: DOENTE/ CUIDADOR

Os dados introduzidos pelo MÉDICO estão com contorno PRETO.
Os dados introduzidos pelo DOENTE/ CUIDADOR estão com contorno AZUL.

Nome completo:	Data de Nascimento: DD/MM/AAAA	Género: M/F	Idade:
Número do processo:			
Telefones de contacto:	Nome do cuidador:		

DADOS INTRODUZIDOS PELO DOENTE OU CUIDADOR	EXERCÍCIOS DISPONÍVEIS	QUESTIONÁRIOS: PREENCHIMENTO ANTES DO INÍCIO DO PROTOCOLO DOS EXERCÍCIOS E APÓS


DADOS INTRODUZIDOS PELO DOENTE OU CUIDADOR
Calendário agravamento do equilíbrio
Calendário queda
Após a vertigem e/ou queda, tem necessitado de bengala ou canadiana? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para andar em casa? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para na rua? ( ) não ( ) sim
Calendário glicemia e tensão arterial medidas pelo doente/cuidador, alergia ou intolerância a medicamentos
Questão relacionada ao equilíbrio colocada pelo doente ou cuidador:
Necessita receita de medicação para vertigem?
Data da próxima consulta de vertigem : (DD/MM/AAAA)
Visão do Doente – dados introduzidos pelo doente ou cuidador
Calendário agravamento do equilíbrio Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
( ) vertigem ( ) desorientação ( ) desequilíbrio
( ) manhã ( ) tarde ( ) noite
( ) fraca intensidade ( ) moderada intensidade ( ) forte intensidade
( ) ao deitar na cama ( ) ao virar-se na cama ( ) ao levantar-se da cama ( ) sentado ( ) ao andar
Se agravamento do equilíbrio: alerta via email
Calendário queda Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
Bateu com a cabeça? ( ) Não ( ) Sim
Teve perda da consciência, ou seja, desmaiou? ( ) Não ( ) Sim
Se queda: alerta via email
Após a vertigem e/ou queda, tem necessitado de bengala ou canadiana? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para andar em casa? ( ) não ( ) sim
Após a vertigem e/ou queda, tem tido dificuldade para na rua? ( ) não ( ) sim
Calendário glicemia e tensão arterial medidas pelo doente/cuidador, alergia ou intolerância a medicamentos Com as seguintes opções para preencher: (DD/MM/AAAA) no calendário
Valores da glicemia
Valores da tensão arterial
Alergia a medicamento: qual medicamento? ___deixar espaço para preenchimento manual
o que teve? ( ) comichão no corpo
( ) manchas no corpo
( ) inchaço no corpo
( ) falta de ar
Intolerância a medicamento: qual medicamento? ___deixar espaço para preenchimento manual
o que teve? ( ) mais vertigem, desorientação e/ou desequilíbrio?
( ) dor no estomago
( ) outro: ____ deixar espaço para preenchimento manual
Se glicemia maior 200 : alerta via email
Se tensão arterial sistólica > 140 e/ou tensão arterial diastólica > 90mmHg queda: gera alerta via email
Se alergia ou intolerância a medicamento: gera alerta via email
Alguma questão relacionada ao equilíbrio?_____ deixar espaço para preenchimento manual se preenchida, gera alerta via email
Necessita receita de medicação para vertigem? ( ) se preenchida, gera alerta via email
Data da próxima consulta de vertigem : (DD/MM/AAAA)

EXERCÍCIOS DISPONÍVEIS

SOFTWARE EXERCÍCIOS DISPONÍVEIS

formato mp4 – espaço para suportar até 30 vídeos

Calendário exercícios com as seguinte opções:
dias / meses / ano
turno manhã, tarde e/ou noite número do exercício (1, 2, 3... até 50)

Cada vez que o doente fizer algum exercício, o doente deverá marcar na agenda : dia, mês e ano , turno manhã, tarde e/ou noite pelo doente e número do exercício (1, 2, 3 ... até 50)

Upload da Gravação dos exercícios formato MP4

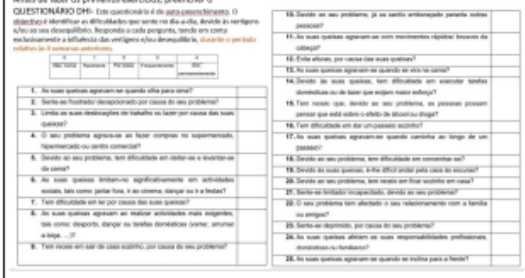
QUESTIONÁRIOS: PREENCHIMENTO ANTES DO INÍCIO DO PROTOCOLO DOS EXERCÍCIOS E APÓS

Os questionários pré e pós reabilitação estão em *Word* assim como a tabela dos resultados.

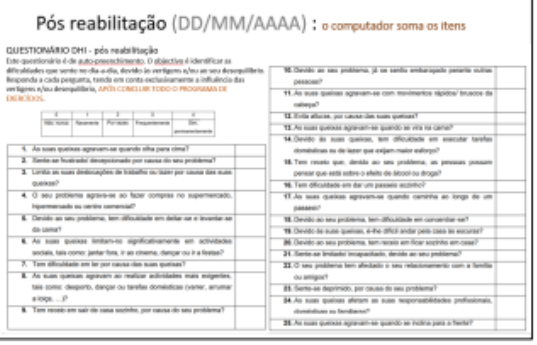
Questionário Dizziness Handicap Inventory (DHI) – disponível no Word : questionário pré e pós reabilitação

Pré reabilitação (DD/MM/AAAA) : o computador soma os itens

Atenção: todos os 25 itens deverão ser de preenchimento obrigatório – ver os 2 próximos diapositivos



Pós reabilitação (DD/MM/AAAA) : o computador soma os itens



Este diapositivo é, apenas, de caráter informativo. Os resultados do preenchimento do questionário DHI deverão migrar para

Estes resultados ficarão APENAS VISÍVEIS para o MÉDICO.

-Todos os 25 itens deverão ser de preenchimento obrigatório.

-Os valores (0 a 4), atribuídos a cada um dos 25 itens, deverão transitar de forma automática para a tabela dos resultados respeitando cada pergunta (exemplo: o valor atribuído à pergunta 1, deverá migrar para a componente FÍSICA. O da pergunta 23 para a EMOCIONAL…).

-No final, os valores de cada componente deverão ser somados automaticamente e estar expostos , inclusive o score total.

Esta tabela deverá aparecer apenas para o médico!

Incapacidades:

Física	Funcional	Emocional
	3.	2.
	5.	9.
1.	6.	10.
4.	7.	15.
8.	12.	18.
11.	14.	20.
13.	16.	21.
17.	19.	22.
25.	24.	23.
/28	/36	/36
Total	/100	

4.5. PROTOCOL OF THE PROOF-OF-CONCEPT – ACTIVITY 4

PROOF-OF-CONCEPT STUDY

STUDY: "eHealth's potential in providing healthcare for the elderly with risk of falling due to balance disorders, in a global health perspective"

MAIN RESEARCHER: Andréa Gomes Martins Gaspar, physician and researcher at Global Health and Tropical Medicine (GHTM), Institute of Hygiene and Tropical Medicine, Universidade Nova de Lisboa, Rua da Junqueira 100, 1349-008, Lisbon, Portugal. Email: andreamartinsbr@hotmail.com

OBJECTIVES: To monitor and evaluate the use of eHealth services in health care for the elderly at risk of falling due to balance disorders.

STUDY: During the face-to-face consultation, the patient and their caregivers will be invited to participate and receive all information about the study. If they accept to participate, the patients will initially respond to the Mini–Mental State Examination (MMSE) to exclude cognitive impairment. Once cognitive impairment is excluded, they will have to sign the informed consent and provide an email address for later access to the digital service, allowing clinical monitoring of their balance, audio-visual interaction with the researcher and access to exercises to improve balance. The participants will receive, through the email, a unique and non-transferable password. The patients and caregivers will also receive instructions on how to access and operate the digital service. They will be able to fill out a questionnaire about balance, access demonstration videos of balance exercises (prescribed by the researcher), ask questions, report worsening of the clinical condition or fall, and upload videos of their exercises. At least, one audio-visual interaction will be scheduled, in real time with the researcher, using the digital service. The access to the digital service will be made available free of charge, through a link, for a period of 3 months.

Subsequently, the researcher will conduct a focus group with the patients and their caregivers on the use of this digital service. The voice recording will be carried out in agreement with the participants. Only the investigators will know about the identities of the respondents. Interview transcripts will omit information that could identify respondents. The information obtained and the voice recordings will be kept in a safe place by the researchers, within the period established by Portuguese law, respecting the confidentiality of the information obtained. The group interview will not exceed 60 minutes.

PARTICIPANTS: Patients, followed at the Otorhinolaryngology and Head and Neck Surgery Service of Hospital Beatriz Ângelo (HBA), will be invited to participate, respecting the following inclusion criteria:

(a) age of 65 years or older;

(b) complaints of clinically decompensated balance disorder with risk of falling, confirmed with objective clinical examination findings;

(c) instrumental tests performed to assess inner ear function, such as videonystagmography or cervical vestibular evoked myogenic potentials, allowing for prescribing balance exercises according to the clinical condition;

(d) balance rehabilitation indication for patient with clinically decompensated balance disorder;

(e) the patients should have undergone balance rehabilitation at the HBA, allowing the assessment of the patient's ability to walk without support;

(f) capacity to perform the balance exercises at home.

Exclusion criteria:

(a) neurological pathology diagnosis at the time of the inclusion in the study, such as a neurodegenerative disease;

(b) ophthalmological pathology diagnosis with severe visual acuity that did not allow one to see the computer screen;

(c) osteoarticular pathology diagnosis with reduced mobility of the lower limbs;

(d) a clinical condition that did not allow the regular performance of physical exercises, such as decompensated cardiovascular pathology or acute infection;

(e) a cognitive alteration according to the Mini-Mental State Examination (MMSE), using operational "cut" values for the Portuguese population, elderly individuals with less than 22 points for 0 to 2 years of education, less than 24 points for 3 to 6 years of education and less than 27 points for participants with education equal to or greater than 7 years were all excluded (Morgado J, Rocha CS, Maruta, C, Guerreiro, M & Martins, IP 2009, ´Novos valores normativos do Mini-Mental State Examination´, *Sinapse*, Nov, vol.9, no 2, pp. 10–16).

PARTICIPATION: Voluntary participation. At any time, the participant may withdraw from using the digital service. Regarding the focus group, the participant may withdraw up to one month after the date of the group interview without any consequences, just needing to contact the principal investigator.

DURATION: The duration of balance rehabilitation will depend on each clinical case. However, the maximum time for using the digital service for this study will be 3 months, from the beginning of its use (date of receipt of the password).

RISKS: There are no risks related to the participation in this study.

2

BENEFITS: This study may help to improve the functioning of technological support in this health area as well as improve the clinical follow-up of these patients. The results may be published in scientific journals and presented at scientific conferences.

CONFIDENTIALITY: All information collected will be treated confidentially and anonymously. The identification of participants will not be revealed in any report or publication.

FINANCIAL COMPENSATION: The participation in this study will not be remunerated and will not require any payment from the participants.

INFORMED CONSENT: The participants will receive a copy of the signed consent form referring to the participation in the proof-of-concept study and focus group. They will sign a document pledging not to share or publicize the videos nor to record the videos available in the digital service.

4.6. APPROVAL OF THE HEALTH ETHICS COMMITTEE OFHOSPITAL BEATRIZ ÂNGELO – ACTIVITY 4 (PROOF-OF-CONCEPT)

HOSPITAL BEATRIZ ÂNGELO

Exma. Senhora

Dr.ª Andréa Gomes Martins Gaspar

Médica do Serviço de Otorrinolaringologia do Hospital Beatriz Ângelo

Loures, 10 de janeiro de 2019

***N/Ref.ª** 2828/2019_MJHNO*

Correio eletrónico e PMP

***Estudo HBA n.º** 0357*

Assunto: "Potencial do ehealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspetiva de saúde global"

Exma. Senhora Dr.ª Andréa Gaspar,

No seguimento da submissão a este Hospital do estudo melhor identificado em epígrafe, no qual V. Exa. participa na qualidade de Investigador Principal, temos o prazer de informar que a Comissão de Ética para a Saúde (CES) do HBA, considera asseguradas as questões éticas relacionadas com a realização do estudo, pelo que, deliberou a sua aprovação em reunião do dia 04 de janeiro do corrente ano.

Com os nossos melhores cumprimentos,

A Presidente da Comissão de Ética para a Saúde do HBA

Maria João Heitor

SGHL – Sociedade Gestora do Hospital de Loures, SA
Avenida Carlos Ferreira de Almeida, 3 | 2674-514 Loures | Portugal
T. +351 219 847 200 | F. +351 219 847 209
geral@hbeatrizangelo.pt
Capital Social: 2.313.000 Euros | Registo do C.R.C. de Lisboa e Contribuinte n.º 503 217 605

4.7. BLANK INFORMED CONSENT FORM

4.7.1. Individual interviews - Activity 2

TERMO DE CONSENTIMENTO INFORMADO

ESTUDO: "Potencial do *eHealth* na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspectiva de saúde global"

INVESTIGADORA PRINCIPAL: Dra. Andréa Gomes Martins Gaspar, investigadora do Global Health and Tropical Medicine (GHTM), Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Rua da Junqueira 100, 1349-008, Lisboa, Portugal Contacto: Email – andreamartinsbr@hotmail.com

PROPÓSITO DO ESTUDO
Este estudo tem como objetivos descrever e entender as vantagens e dificuldades do uso de Sistemas e Tecnologias de Informação (STI) na prestação de cuidados de saúde ao idoso com risco de queda por perturbações do equilíbrio.

PROCEDIMENTO DO ESTUDO
Está a ser convidado para participar neste estudo devido a sua prática clínica relativa à prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio.

Se concordar, a investigadora irá realizar uma entrevista individual sobre a utilização do e-*HEALTH* neste contexto. Se concordar, haverá gravação áudio. Haverá também perguntas para caracterizar o conjunto de participantes, como género, idade, área e anos de especialidade médica.

A entrevista será codificada para assegurar a confidencialidade, atribuindo-se código a cada um dos participantes de forma que apenas os investigadores terão conhecimento sobre as identidades dos respondentes. As transcrições omitirão informações que possam identificar os respondentes. As informações obtidas e os registos áudio serão guardados em local seguro pelos investigadores, no prazo previsto pela lei, sempre salvaguardando a confidencialidade da informação obtida

A entrevista não deverá ultrapassar 40 minutos.

PARTICIPAÇÃO VOLUNTÁRIA E LIBERDADE PARA DESISTIR
É totalmente sua a decisão de participar ou não, sem quaisquer prejuízos. Caso decida participar, é importante que saiba que pode desistir até um mês após a data da entrevista sem qualquer tipo de consequência para si, necessitando apenas entrar em contacto com a investigadora principal. Antes de decidir, pode pedir todos os esclarecimentos que considere necessários.

RISCOS
Não há riscos relacionados à sua participação neste estudo.

BENEFÍCIOS
A sua participação neste estudo ajudará a ajustar e melhorar o funcionamento dos STI nesta temática. Os resultados deste estudo poderão ser publicados em revistas científicas e apresentados em congressos científicos.

CONFIDENCIALIDADE
Todas as informações recolhidas serão tratadas de forma confidencial e anónima: a sua identificação nunca será revelada em nenhum relatório ou publicação.

COMPENSAÇÃO
A participação neste estudo não é remunerada nem exige qualquer pagamento de sua parte.

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Declaro ter lido e compreendido o presente documento. Tive oportunidade de esclarecer quaisquer dúvidas sobre este estudo.

Concordo livremente em participar neste estudo, tendo sido informado dos objetivos e procedimentos do estudo, do anonimato e confidencialidade dos dados e de que tenho direito de recusar ou cessar a minha participação até um mês após a data da entrevista, sem qualquer prejuízo pessoal.

Compreendo que não existem riscos pela participação e nem remuneração económica.

Pelo presente documento declaro que aceito de livre vontade participar no estudo.

_____

Nome e assinatura do participante – data

_____

Nome e assinatura da investigadora – data

(Eu, abaixo assinado, expliquei completamente ao participante as informações relevantes deste estudo e forneci-lhe cópia deste consentimento assinada e datada).

Este documento é composto de duas páginas e feito em duplicado: uma via para a pessoa que consente, outra para a investigadora.

4.7.2. Patient participation - Activities 4 and 5

TERMO DE CONSENTIMENTO INFORMADO

ESTUDO: "Potencial do *eHealth* na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspectiva de saúde global"

INVESTIGADORA PRINCIPAL: Dra. Andréa Gomes Martins Gaspar, investigadora do Global Health and Tropical Medicine (GHTM), Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Rua da Junqueira 100, 1349-008, Lisboa, Portugal Contacto: Email – andreamartinsbr@hotmail.com

PROPÓSITO DO ESTUDO
Este estudo tem como objetivos descrever e compreender a satisfação da utilização de Sistemas e Tecnologias de Informação nos cuidados de saúde ao idoso com risco de queda por alterações do equilíbrio.

PROCEDIMENTO DO ESTUDO
Está a ser convidado para participar neste estudo devido ao risco de queda por alterações do equilíbrio.

Se concordar poderá utilizar um sistema de informação indolor que permitirá monitorização clínica do seu equilíbrio à distância. Este sistema tecnológico será fornecido gratuitamente a si durante o período de estudo. Posteriormente, a investigadora irá realizar uma entrevista juntamente com outros participantes e/ou seus cuidadores sobre a utilização deste sistema tecnológico. Se concordar, haverá gravação de voz. Haverá também perguntas para conhecer o sexo, idade e grau de escolaridade dos participantes.

Para assegurar a confidencialidade da entrevista será atribuído código a cada um dos participantes de forma que apenas os investigadores terão conhecimento sobre as identidades dos respondentes. As transcrições das entrevistas omitirão informações que possam identificar os respondentes. As informações obtidas e os registos de voz serão guardados em local seguro pelos investigadores, no prazo previsto pela lei, respeitando a confidencialidade da informação obtida.

A entrevista de grupo não deverá ultrapassar 60 minutos.

PARTICIPAÇÃO VOLUNTÁRIA E LIBERDADE PARA DESISTIR
É totalmente sua a decisão de participar ou não, sem quaisquer prejuízos. Caso decida participar, a qualquer momento pode desistir da utilização do sistema de informação tecnológico para monitorização clínica do seu equilíbrio à distância. Também é importante que saiba que pode desistir até um mês após a data da entrevista de grupo sem qualquer tipo de consequência para si, necessitando apenas entrar em contacto com a investigadora principal. Antes de decidir, pode pedir todos os esclarecimentos que considere necessários.

RISCOS
Não há riscos relacionados à sua participação neste estudo.

BENEFÍCIOS
A sua participação neste estudo poderá ajudar a melhorar o funcionamento do suporte tecnológico nesta área de saúde.
Os resultados deste estudo poderão ser publicados em revistas científicas e apresentados em congressos científicos.

CONFIDENCIALIDADE
Todas as informações recolhidas serão tratadas de forma confidencial e anónima: a sua identificação nunca será revelada em nenhum relatório ou publicação.

COMPENSAÇÃO
A participação neste estudo não é remunerada nem exige qualquer pagamento de sua parte.

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Declaro ter lido e compreendido o presente documento. Tive oportunidade de esclarecer quaisquer dúvidas sobre este estudo.

Concordo livremente em participar neste estudo, tendo sido informado dos objetivos e procedimentos do estudo, do anonimato e confidencialidade dos dados e de que tenho direito de recusar ou cessar a qualquer momento a utilização do sistema de informação tecnológico para monitorização clínica do meu equilíbrio à distância. Também tenho o direito de recusar ou cessar a minha participação na entrevista de grupo até um mês após a data da entrevista, sem qualquer prejuízo pessoal.

Compreendo que não existem riscos pela participação e nem remuneração económica.

Pelo presente documento declaro que aceito de livre vontade participar no estudo.

_____

Nome e assinatura do participante – data

_____

Nome e assinatura da investigadora – data

(Eu, abaixo assinado, expliquei completamente ao participante as informações relevantes deste estudo e forneci-lhe cópia deste consentimento assinada e datada).

Este documento é composto de duas páginas e feito em duplicado: uma via para a pessoa que consente, outra para a investigadora.

ESTUDO: “Potencial do eHealth na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspectiva de saúde global”

Eu, comprometo-me a NÃO partilhar e/ou divulgar os vídeos e a NÃO fazer gravação dos vídeos disponíveis no estudo.

_____

_____

4.7.3. Caregiver participation- Activities 4 and 5

TERMO DE CONSENTIMENTO INFORMADO

ESTUDO: "Potencial do *eHealth* na prestação de cuidados de saúde ao idoso com risco de queda por distúrbios do equilíbrio numa perspectiva de saúde global"

INVESTIGADORA PRINCIPAL: Dra. Andréa Gomes Martins Gaspar, investigadora do Global Health and Tropical Medicine (GHTM), Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Rua da Junqueira 100, 1349-008, Lisboa, Portugal Contacto: Email – andreamartinsbr@hotmail.com

PROPÓSITO DO ESTUDO

Este estudo tem como objetivos descrever e entender a satisfação da utilização de Sistemas e Tecnologias de Informação nos cuidados de saúde ao idoso com risco de queda por alterações do equilíbrio.

PROCEDIMENTO DO ESTUDO

Está a ser convidado para participar neste estudo devido ao risco de queda do idoso que está sob os seus cuidados.

Se o idoso que está sob os seus cuidados concordar, ele poderá utilizar um sistema de informação tecnológico indolor que permitirá monitorização médica do seu equilíbrio à distância. Este sistema tecnológico será fornecido gratuitamente durante o período de estudo.

Na qualidade de cuidador, a sua opinião sobre a utilização deste sistema tecnológico será importante. Desta forma, a investigadora irá realizar uma entrevista conjuntamente com outros participantes e/ou seus cuidadores sobre o uso deste sistema tecnológico. Se concordar, haverá gravação de voz. Haverá também perguntas para conhecer o sexo, idade e grau de escolaridade dos participantes.

Para assegurar a confidencialidade da entrevista será atribuído código a cada um dos participantes de forma que apenas os investigadores terão conhecimento sobre as identidades dos respondentes. As transcrições das entrevistas omitirão informações que possam identificar os respondentes. As informações obtidas e os registos de voz serão guardados em local seguro pelos investigadores, no prazo previsto pela lei, respeitando a confidencialidade da informação obtida.

A entrevista de grupo não deverá ultrapassar 60 minutos.

PARTICIPAÇÃO VOLUNTÁRIA E LIBERDADE PARA DESISTIR

É totalmente sua a decisão de participar ou não, sem quaisquer prejuízos. Caso decida participar, é importante que saiba que pode desistir até um mês após a data da entrevista de grupo sem qualquer tipo de consequência para si, necessitando apenas entrar em contacto com a investigadora principal. Antes de decidir, pode pedir todos os esclarecimentos que considere necessários.

RISCOS
Não há riscos relacionados à sua participação neste estudo.

BENEFÍCIOS
A sua participação neste estudo poderá ajudar a ajustar e melhorar o funcionamento do suporte tecnológico neste assunto.
Os resultados deste estudo poderão ser publicados em revistas científicas e apresentados em congressos científicos.

CONFIDENCIALIDADE
Todas as informações recolhidas serão tratadas de forma confidencial e anónima: a sua identificação nunca será revelada em nenhum relatório ou publicação.

COMPENSAÇÃO
A participação neste estudo não é remunerada nem exige qualquer pagamento de sua parte.

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Declaro ter lido e compreendido o presente documento. Tive oportunidade de esclarecer quaisquer dúvidas sobre este estudo.

Concordo livremente em participar neste estudo, tendo sido informado dos objetivos e procedimentos do estudo, do anonimato e confidencialidade dos dados e de que tenho direito de recusar ou cessar a minha participação até um mês após a data da entrevista de grupo, sem qualquer prejuízo pessoal.

Compreendo que não existem riscos pela participação e nem remuneração económica.

Pelo presente documento declaro que aceito de livre vontade participar no estudo.

_____

Nome e assinatura do participante – data

_____

Nome e assinatura da investigadora – data

(Eu, abaixo assinado, expliquei completamente ao participante as informações relevantes deste estudo e forneci-lhe cópia deste consentimento assinada e datada).

Este documento é composto de duas páginas e feito em duplicado: uma via para a pessoa que consente, outra para a investigadora.

4.8. REGISTER OF THE SYSTEMATIC REVIEW - PROSPERO

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Citation

Andréa Gaspar, Luís Lapão. Is eHealth ready for addressing disturbances of balance in the elderly? Review of the literature. PROSPERO 2019 CRD42019120774 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019120774

Review question

What have been the contributions of eHealth to older people with balance disorders with fall risk?

Is there any evidence that eHealth improves the quality of health care services in this context? If it does not, what are the reasons?

Searches

Electronic bibliographic databases: PubMed, Google Scholar and SciELO
Multiple group combinations: "balance" , "falls", "detection", "risk", "gait", "elderly", "eHeatth", "assessment", "applications", "behaviour"

English language journals or reports published in the last 5 years (2015-2019)

Types of study to be included

Inclusion criteria: studies related to use of eHealth in the context of balance/ fall in elderly (over 60)
Exclusion criteria: studies with inclusion of older people with functional limitation by neurological disease

Condition or domain being studied

Balance disturbances with fall risk in elderly people - contribution of eHealth for education, screening, assessment, and treatment.

Participants/population

Elderly people (over 60).

Intervention(s), exposure(s)

eHealth contribution to balance disorders with fall risk in the elderly.

Comparator(s)/control

None.

Context

Clinical setting.

Main outcome(s)

Population characteristics, study methodology, balance identification, fall identification, ehealth plataforms and services, benefits, ehealth literacy, clinical use, costs.

Measures of effect

Additional outcome(s)

None

Data extraction (selection and coding)

Both researches will screen independently titles and abstracts from the identified records. The full text of potentially eligible articles will be retrieved and independently assessed by both authors. In case of unsure of any record, full text will be retrieved and assessed. discrepancies will be resolved through discussion, if necessary with a third person.

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

The authors will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Risk of bias (quality) assessment [1 change]

The researchers will access and review independently the records. They will check for the risk of bias and extracted data.

The included full text papers should be assessed for eligibility by both researchers. Disagreements will be resolved by discussion between the two. If necessary, a third person will be involved.

The quality of the evidence for the research question will be independently assessed using the Critical Appraisal Checklist for Experimental Studies (Joanna Briggs Institute, 2017) and the Critical Appraisal Checklist for Quasi-Experimental Studies (Joanna Briggs Institute, 2017). The two researchers will discuss the results of the quality appraisal to reach a consensus in case of any divergence. The results of this assessment will be used to form part of the narrative synthesis.

The included randomized controlled trials will be assessed using the Cochrane risk of bias tool to assess the risk of internal bias for a series of domains: selection bias, performance bias, detection bias, attrition bias, and reporting bias. Disagreements will be solved by discussion between the two researchers. If necessary, a third person will be engaged.

Strategy for data synthesis [1 change]

The researchers will provide a narrative synthesis of the findings from the included studies: population, type of methodology, balance disorder identification, fall identification, eHealth platforms, eHealth services, benefits, eHealth literacy, clinical use, and costs.

The quality assessment on study methodology of the included studies will be assessed using the Critical Appraisal Checklist for experimental Studies (Joanna Briggs Institute, 2017) and the Critical Appraisal Checklist for Quasi-experimental Studies (Joanna Briggs Institute, 2017). The two researchers will discuss the results of the quality appraisal to reach a consensus in case of any disagreement. The results of this quality assessment will be used to form part of the narrative synthesis.

Analysis of subgroups or subsets

Analysis of eHealth platform (computer applications, telephone services, internet or mobile plataform).
Analysis of eHealth services (education, screening/ assessment, rehabilitation).

Contact details for further information

Andréa Gaspar
andreamartinsbr@hotmail.com

Organisational affiliation of the review

Instituto de Higiene e Medicina Tropical da Universidade NOVA de Lisboa
andreamartinsbr@hotmail.com

Review team members and their organisational affiliations

Dr Andréa Gaspar. Instituto de Higiene e Medicina Tropical da Universidade NOVA de Lisboa
Dr Luís Lapão. Instituto de Higiene e Medicina Tropical da Universidade NOVA de Lisboa

Type and method of review

Intervention, Methodology, Narrative synthesis, Prevention, Service delivery, Systematic review

Anticipated or actual start date

01 January 2019

Anticipated completion date

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

28 February 2019

Funding sources/sponsors
GHTM

Conflicts of interest

Language
English

Country
Portugal

Stage of review [2 changes]

Review Completed published

Details of final report/publication(s) or preprints if available [3 changes]

Gaspar AGM, Lapão LV. eHealth for Addressing Balance Disorders in the Elderly: Systematic Review. J Med Internet Res 2021;23(4):e22215. doi: 10.2196/22215 PMID: 33908890

URL:
https://www.jmir.org/2021/4/e22215

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Aged; Humans; Medical Informatics; Telemedicine

Date of registration in PROSPERO
18 March 2019

Date of first submission
24 January 2019

Stage of review at time of this submission [1 change]

Stage	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes
Formal screening of search results against eligibility criteria	Yes	Yes
Data extraction	Yes	Yes
Risk of bias (quality) assessment	Yes	Yes
Data analysis	Yes	Yes

Revision note
The systematic review was published.

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.
The record owner confirms that they will update the status of the review when it is completed and will add publication details in due course.

Versions

18 March 2019
22 May 2019
29 April 2021
29 April 2021
27 August 2022

4.9. DIGITAL BALANCE SERVICE

4.9.1. Medical profile

4.9.2. Patient profile