Universidade de Évora - Instituto de Investigação e Formação Avançada

Programa de Doutoramento em Motricidade Humana

Tese de Doutoramento

Adaptation of the Professional Training of Physiotherapists in Function of the Technological Impact in their Clinical Practice: Formative Realities in the Iberian Peninsula

Tarciano Batista e Siqueira

Orientador(es) | José Alberto Parraça

João Paulo Brites de Sousa

Évora 2024

Universidade de Évora - Instituto de Investigação e Formação Avançada

Programa de Doutoramento em Motricidade Humana

Tese de Doutoramento

Adaptation of the Professional Training of Physiotherapists in Function of the Technological Impact in their Clinical Practice: Formative Realities in the Iberian Peninsula

Tarciano Batista e Siqueira

Orientador(es) | José Alberto Parraça

João Paulo Brites de Sousa

Évora 2024

A tese de doutoramento foi objeto de apreciação e discussão pública pelo seguinte júri nomeado pelo Diretor do Instituto de Investigação e Formação Avançada:

Presidente	Armando Manuel Raimundo (Universidade de Évora)
Vogais	José Alberto Parraça (Universidade de Évora) (Orientador) João Malta (Universidade de Évora) João Paulo Brites de Sousa (Universidade de Évora) João Paulo Brites de Sousa (Universidade de Évora) (Orientador) Maria António Ferreira de Castro (Instituto Politécnico de Leiria - Escola Superior de Saúde) Maria Dolores Apolo Arenas (Universidad de Extremadura) Raúl Alexandre Nunes da Silva Oliveira (Universidade de Lisboa - Faculdade de Motricidade Humana (FMH))

Évora 2024

Dedico esse trabalho ao meu pai Tarcizo Amancio de Siqueira (in memoriam), ele incentivou minha trajetória profissional e deu o seu melhor para que todos os meus sonhos se tornassem realidade.

AGRADECIMENTOS

Depois de alguns minutos de reflexão, iniciei a redação dos agradecimentos, ainda pensando em todas as pessoas e instituições que, de alguma forma, contribuíram ao longo do desenvolvimento deste trabalho. As imagens do caminho percorrido até aqui surgem nitidamente na memória: meu último Natal em família, o jantar de despedida feito pelos meus amigos e colegas de trabalho na cidade de Coari, AM, Brasil; o dia em que peguei o ferry para percorrer os rios da Amazônia até chegar a Manaus, AM e poder abraçar o meu irmão Mynicio Kewvy antes de pegar o voo a São Paulo, SP e, posteriormente, de São Paulo a Lisboa. Foram milhares de quilômetros dentro do Brasil e mais de 8 mil quilômetros cruzando o oceano Atlântico para estar aqui.

Dificuldades? Claro que as tive! As diferenças entre o Português Brasileiro e o Português de Portugal; o frio do primeiro inverno, a solidão causada pelo isolamento decorrente da pandemia, que ocorreu justamente no meu primeiro semestre de estudos; o falecimento do meu pai poucos meses antes de finalizar este trabalho. Coisas boas? Com certeza! Foi de um valor incalculável dedicar quatro anos da minha vida a aprender, aperfeiçoar e construir novos conhecimentos. Conheci novas culturas, aprendi novos idiomas, apreciei a arte, a comida e as belezas naturais que vi durante as viagens por vários países da Europa; expandi meu network de trabalho e construí novas e valiosas amizades que levarei por toda a vida. Acredito que, por tudo isso e muito mais, é chegada a hora de agradecer.

Ao Espírito Santo. Sim, esse mesmo, aquele que habita dentro de nós e que também dá nome ao Colégio do Espírito Santo, o edifício mais antigo da Universidade de Évora. Agradeço por me acolher e proteger durante essa caminhada, e por emanar na minha vida os seus sete dons: sabedoria, entendimento, conselho, fortaleza, ciência, piedade e temor a Deus.

Aos meus orientadores, o professor Dr. João Paulo Brites de Sousa e o Dr. José Alberto Frade Martins Parraça. Meus orientadores compartilharam comigo suas experiências científicas com proximidade, humildade e empatia. Permitiram-me desbravar o caminho com a certeza de ter um porto seguro para amparar as aflições derivadas do processo exaustivo e, ao mesmo tempo, prazeroso da pesquisa. Ao me tornar pesquisador, levarei sempre um pouco de cada um deles. Obrigado!

À minha tutora de estágio doutoral, a Dra. Ires Machado de Oliveira, pela calorosa recepção na Faculdade de Fisioterapia da Universidade de Vigo. Ao meu tutor de estágio doutoral, o Dr. Julio Gómez Soriano, pela acolhida na Universidade de Castilla – La Mancha. Foi um período de grande aprendizado, tanto do idioma castelhano como da rotina de ensino em fisioterapia. Obrigado pela acolhida.

Ao ISB – Instituto de Saúde e Biotecnologia e à Universidade Federal do Amazonas, agradeço pelo apoio concedido. Todo o conhecimento adquirido estará a serviço do bem comum. Quero expressar meu agradecimento especial aos amigos que estiveram mais próximos durante esse processo de construção e conclusão da tese:

À Ercília de Sousa Andrade, que esteve tão presente ao longo desses anos, mesmo estando no Amazonas, enquanto eu estava em Évora. Em breve, estarei entrando em nossa sala de trabalho e poderei dizer: "Amiga, eu consegui."

Ao meu querido amigo João Paulo Oliveira, por partilhar suas experiências como doutorando e brasileiro residente em Évora, e por ter sido a minha porta de entrada para o nosso maravilhoso grupo de amigos, a quem carinhosamente chamamos de "30B". A gratidão que tenho a você se estende a todo o nosso grupo. Ao meu caro amigo e colega de curso, Carlos Borralheira, sua amizade, proximidade e apoio foram muito importantes. Esse amigo fez de sua casa minha casa. Ele foi o primeiro coração português que pude conhecer através de um laço tão lindo que é o laço de amizade.

Aos companheiros de casa, André Vitor de Albuquerque Santos e Frederico Felizardo. Hoje, estamos todos seguindo o mesmo caminho da educação e da ciência. Mas, sem dúvida, o que fortalece esse agradecimento não é o simples fato de sermos doutorandos, mas sim de sermos amigos, convivendo nos tempos de calma, amparando nos tempos de lágrimas e aplaudindo nos tempos de glória. À minha família: minha mãe, Maria de Fátima; meu pai, Tarcizo Amancio (in memoriam); meus irmãos, Corino Honório e Mynicio Kewvi; e agora a minha pequena sobrinha, Isis Marie, que nasceu durante esse período em que estive desenvolvendo este trabalho de pesquisa. Enquanto buscava fazer o meu melhor como profissional, também tentei ser um bom amigo, filho, irmão e tio, mesmo à distância, estarei mais próximo em breve. Amo vocês.

ACKNOWLEDGMENTS

After a few minutes of reflection, I started writing my thanks, still thinking of all the people and institutions who, in some way, contributed throughout the development of this work. The pictures of the journey so far clearly emerge in my memory: my last Christmas in family, the farewell dinner made by my friends and colleagues at work in the city of Coari, AM, Brazil; the day when I took the ferry to cross the Amazon rivers until arriving at Manaus, AM, and was able to embrace my brother Mynicio Kewvy before taking the long flight from São Paulo to Lisbon. They've traveled thousands of miles inside Brazil and over 8,000 miles across the Atlantic Ocean to be here.

Difficulties? Of course, I had them! The differences between the Brazilian Portuguese and the Portuguese of Portugal; the cold of the first winter; the loneliness caused by isolation due to the pandemic, which occurred precisely in my first semester of studies; the death of my father a few months before finishing this work Good things? Sure! It was of immeasurable value to devote four years of my life to learning, refining, and building new knowledge. I met new cultures, learned new languages, and appreciated the art, food, and natural beauties that I saw while traveling through various countries in Europe. I expanded my work network and built new and valuable friendships that I will keep for the rest of my life. I believe that for all this and much more, it is time to thank you.

To the Holy Spirit: Yes, the same, the one that lives within us, and that also gives name to the College of the Holy Spirit, the oldest building of the University of Évora. I thank you for welcoming and protecting me during this journey and for emanating into my life his seven gifts: wisdom, understanding, counsel, strength, science, piety, and fear of God.

To my counselors, Professor Dr. João Paulo Brites de Sousa and Dr. José Alberto Frade Martins Parraça: My mentors shared their scientific experiences with me with proximity, humility, and empathy. They allowed me to pave the way with the certainty of having a safe haven to embrace the afflictions arising from the exhaustive and, at the same time, pleasant process of the research. When I become a researcher, I'll always take a little bit of each of them.

Thank you!

To my doctoral tutor, Dr. Ires Machado de Oliveira, for the warm reception at the Faculty of Physiotherapy of the University of Vigo. To my doctoral tutor, Dr. Julio Gómez Soriano, for his admission to the University of Castile, La Mancha. It was a period of great learning, both of the Castilian language and of the routine teaching in physiotherapy. Thank you for the welcome.

I thank the ISB (Institute of Health and Biotechnology) and the Federal University of Amazonas for their support. All the knowledge acquired will be at the service of the common good. I would like to express my special thanks to the friends who were closest during this process of building and completing the thesis:

To Ercília de Sousa Andrade, who has been so present throughout these years, even being in the Amazonas while I was in Évora. Soon, I'll be entering our working room, and I can say, "Friend, I got it."

To my dear friend João Paulo Oliveira, for sharing his experiences as a doctoral student and Brazilian resident in Évora, and for having been my gateway to our wonderful group of friends, whom we affectionately call "30B." The gratitude I have for you extends to our whole group.

To my dear friend and classmate, Carlos Borralheira, his friendship, proximity, and support were very important. That friend made his house my home. He was the first Portuguese heart I could know through a bond so beautiful that it is the bond of friendship.

To my flatmates, André Vitor de Albuquerque Santos and Frederico Felizardo: Today, we are all following the same path of education and science. But undoubtedly, what strengthens this gratitude is not the simple fact that we are doctoral students, but rather our being friends, living together in times of quietness, supporting each other in times of tears, and applauding in days of glory. To my family: my mother, Mary of Fatima; my father, Tarcizo Amancio (in memoriam); my brothers, Corino Honorio and Mynicio Kewvi; and now my little niece, Isis Marie, who was born during this period in which I was developing this research work. While trying to do my best as a professional, I also tried to be a good friend, son, brother, and uncle. Even at a distance, I will be closer soon. I love you.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AI	Artificial Intelligence
ABC	Activities-Specific Balance Confidence Scale
ANCOVA	Analysis of Covariance
BDI – II	Beck Depression Inventory-II
BRPE	Borg Rating of Perceived Exertion
BBS	Berg Balance Scale
BFH	Bern University of Applied Sciences
Bont-A	Botulinum Toxin Type
BSN	Bachelor of Nursing
BWST	Bodyweight-Supported Treadmill Training
CAU	Care a Usual
CANTAB	Cambridge Neuropsychological Test Automated Battery
CG/CTRL	Control Group
CLT	Conventional Locomotor
COPD	Chronic Obstructive Pulmonary Disease
CPS	Cyber-Physical Systems
CR	Cognitive Reserve
CRI	Cognitive Reserve Index
CVG	Conventional Group
DSP	Digital Signal Processor

EMS	Exercise Motivation Scale
ETC	Exergame Treatment Group
E-RAGT	End-Effector Robot-Assisted Gait Training
EU	Upper Extremity
EWB	Exercising Wearing the Bracelet
EXG	Exercise Group
EG	Experimental Group
FAC	Functional Ambulation Category
FMA	Fugl-Meyer Assessment
FVG	Fruit and Vegetable Group
FVE	Fruit, Vegetable, And Exercise Group
GSS	Guided Self-Study
HBR	Home-Based Rehabilitation
HBPM	Home Blood Pressure Monitor
HR	Heart Rate
HRS	Robotic Home Care Systems
HRKOL	Health-Related Quality of Life
ICT	Information and Communication Technologies
IG	Intervention Group
IHE	Institutions Higher Education
LMC	Leap Motion Controller

MAS	Modified Ashworth Scale
MC	Multiple Choice
aMCI	amnestic Mild Cognitive Impairment
MI	Motricity Index
ML	Machine Learning
MS	Multiple Sclerosis
MSP	Mentored Student Project
NFT	Neurofeedback Training
NOS	Newcastle Ottawa Scale
OSCE	Objective Structured Clinical Examination
PBL	Problem-Based Learning
PCA	Principal Component Analysis
PEDro	Physiotherapy Evidence Database
PD	Parkinson's Disease
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RAGT	Robot-Assisted Gait Training
RG	Robotic Group
Rob2	Risk of Bias Tool for Randomized Trials
ROM	Range of Motion
RCT	Randomized-Controlled Trial
SASMP	Smartphone App-Based Self-Management Program

SDL	Self-Directed Learning
Sdtl	Self-Determined Learning
SG	Searched Groups
SPT	Physiotherapy Undergraduate Students in the Third Semester
SMS	Sawai Man Singh
SWM	Spatial Working Memory
TL	Teaching and Learning
TG	Technological Group
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty
TYR	Tyromotion
UL	Upper Limb
VR	Virtual Reality
WLT	Walkbot-Assisted Locomotor Training
WMFT	Wolf Motor Function Test
WCPT	World Confederation for Physical Therapy
WHO	World Health Organization

ABSTRACT

Objective: The goal of this thesis was to find out how the professional training of physiotherapists is being interpreted and changed in response to the impact of technology on clinical practice. This was done by analyzing the realities of physiotherapy training in the Iberian Peninsula to find out how physiotherapy curriculum needs to change in response to technological advances in the field. Methods: This work consists of four main studies. The PRISMA declaration, or Preferred Reporting Items for Systematic Reviews and Meta-Analyses, served as a guide for the two initial studies that make up the theoretical foundation. The following is an observational study of a multi-methodological nature that analyzes the structure of the training of physiotherapists in Institutions of Higher Education (IHE) in the Iberian Peninsula. Finally, a study that integrates physiotherapy finalists in a Delphi approach **Results:** The first systematic review study indicated evidence of technologies that are effective in the rehabilitation practice exercised by physiotherapists. The second review addresses innovative teaching methods capable of intermediating the learning of new skills in the training of contemporary physiotherapists. A total of 4 IHE hosted the in-situ research for direct observation of their formative structures. In the Delphi approaches, we obtained the participation of 62 student finalists and 31 professors and researchers of physiotherapy, representing the training experts in the IHE involved. **Conclusion:** The set of studies brings to light new perspectives on the innovation of the curriculum of physiotherapy in the IHE with this training, pointing out aspects that can contribute to quality educational education and the development of clinical skills that facilitate the integration of the professional in training in environments that use technology to promote quality health in the physical rehabilitation of patients who need this attention.

Keywords: Physiotherapy, Technologies, rehabilitation, clinical skills, Curriculum Development, Higher education.

RESUMO

Adaptação da Formação Profissional de Fisioterapeutas em Função do Impacto Tecnológico na Prática Clínica: Realidades Formativas na Península Ibérica.

Objectivo: O objetivo desta tese foi compreender de que modo está a ser interpretada e adaptada a formação profissional do fisioterapeuta em função do impacto tecnológico na prática clínica, identificando quais serão as necessidades de adaptação curricular da fisioterapia relativas ao avanço tecnológico na prática desse profissional a partir da análise de realidades formativas na Península Ibérica. **Métodos:** Esse trabalho é constituido por quatro estudos princiapais. Os dois estudos iniciais compõem a fundamentação teórica e foram orientados pela declaração Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISMA. Na sequência um estudo observacional de caráter multimetódológico, que analisa a estrutura de formação de fisioterapeutas em Instituições de Ensino Superior (IES) na Península Ibérica. Por fim um estudo que integra alunos finalistas de fisioterapia em uma abordagem Delphi. **Resultados:** O primeiro estudo de revisão sistemáticas indicou evidencias das tecnologias que se apresentam eficientes na prática de reabilitação exercida pelos fisioterapeutas. A segunda revisão aborda métodos inovadores de ensino capazes de intermediar o aprendizado de novas habilidades na formação de fisioterapeutas contemporâneos. Um total de 4 IES acolheram a pesquisa in loco para observação direta de suas estruturas formativa. Nas abordagens Delphi obtivemos a participação de 62 alunos finalistas e 31professores e pesquisadores de fisioterapia representando os expertos da formação, nas IES envolvidas. **Conclusão:** O conjunto de estudos traz a luz novas perspectivas de inovação do currículo de fisioterapia nas IES com essa formação, pontuando aspectos que podem contribuir para educação formativa de qualidade e desenvolvimento de competências clínicas que facilitem à integração do profissional em formação em ambientes que usam a tecnologia para promover saúde de qualidade na reabilitação física de pacientes que necessitam dessa atenção.

Palavras-chave: Fisioterapia, Tecnologias, Reabilitação, Habilidades Clínicas, Desenvolvimento de Curricular, Ensino superior.

CHAPTER 1
GENERAL INTRODUCTION

1.1 BACKGROUND AND GENERAL MOTIVATION

A successful future is being actively worked on by scientists and researchers around the world through the development of plans, rules, and regulations. Physiotherapy and other rehabilitation-related fields are particularly interested in these projects (Walton 2018). The "Wireless Body Area Network" (WBAN), a sensor system that performs continuous outpatient monitoring of health through a network of body areas connected to an individual, is one of the many examples of how technological advancements are presented in the field of rehabilitation (Jovanov et al. 2005).

Another such may be seen in the Lokomat® robotic orthoses, which were created to automate and facilitate simulations of walking, primarily in those with neurological impairments that prevent them from doing so (Jezernik et al. 2003). The findings of studies on technology advancements are supposed to prompt introspective reflection and meaningful action to get the physiotherapy profession ready for the future (Walton 2018). Science is constantly working to create prototypes that lead to creative, effective, and preferably accessible devices, such as apps that operate on smartphones and can automatically encourage the reduction of cardiovascular health risks, promote therapeutic exercise, and improve quality of life (Murphy et al. 2021).

A study conducted at the University of Oxford in 2013 analyses the probability of computerization in about 702 professions, and this technological impact may promote, even, the extinction of some of these professional activities (Frey and Osborne 2017). Physiotherapy is part of the professional careers that are suffering from technological impact in clinical practice activities that were traditionally done manually and many evidence points to changes in the traditional clinical practice of the physiotherapist to more technological practices (Frey and Osborne 2017).

Robotic home care systems (HRS) based on cyber-physical systems (CPS) are spreading more and more. These systems are referred to as enabling technologies since they use

artificial intelligence to map movements and collect them, as well as save a variety of health data quickly in the cloud (Yang et al. 2020). In clinical decision support, patient monitoring and training, patient care, and system administration, many artificial intelligence (AI) advancements in healthcare have produced impressive results (Rowe 2019).

Physical therapy, which is constantly evolving, only achieved professional affirmation in the twentieth century. This was due to certain events, such as the polio epidemic during the First World War, which left soldiers with disabilities and made physical therapy famous for its role in the rehabilitation of locomotor system pathologies and its functional implications (Moral-Munoz et al. 2018). As a result, it is important and pertinent to comprehend how technological advancement in biomedicine will continue in the twenty-first century. This is because the technological evolution is having noticeable effects on many health sectors (Walton 2018).

Practiced healthcare personnel must develop new skills to understand the new tools and systems as the impact of AI on clinical operations grows (Frey and Osborne 2017). Even though it has been proven scientifically that AI can produce outcomes in more accurate health approaches than traditional methods, there have been few research that have concentrated on the formative preparation of health practitioners inside higher education institutions. As a result, efforts should now be undertaken to encourage the integration of technology in training that focuses on both professionals and apprentices (Cheng et al. 2020).

Information and communication technologies (ICTs) have helped train students to be responsible and aware of educational technologies in the context of knowledge management in higher education and assist IHE in creating new educational policies to reflect academic and scientific progress (González-Zamar et al. 2020). In order for AI to speed up student learning during training, there must be active collaboration and promising futures for this type of educational research (Cheng et al. 2020). Online educational technologies have a lot to offer for physiotherapy teaching and learning, and they have been recommended as powerful instruments to enhance learning and your perceptions of physical therapy teaching and learning (Mącznik, Ribeiro, and Baxter 2015).

Studies show that websites can help students perform their practical skills more effectively when they engage in discussion forums that foster knowledge acquisition as well as the growth of critical and reflective thinking in physiotherapy students (Mącznik, Ribeiro, and Baxter 2015). Investigating the components of excellence and innovation in the academic and clinical training of physiotherapists and developing recommendations of transformative actions for this profession's training can meet the new needs of society by achieving higher levels of mastery (Jensen, Nordstrom, et al. 2017).

Studies have looked into the curricular frameworks, teaching methods, and environmental factors that support professional development and have resulted in fundamental educational reforms for the training of new physiotherapists in an effort to understand the evolution of this profession (Jensen, Hack, et al. 2017). Instead of displaying pessimism or despair, it is important to consider opportunities for professional growth (Frey and Osborne 2017). We are confident that we can make a difference to ensure that physiotherapy remains a profession with prominence in the treatment of locomotive disorders, the prevention of such diseases, and the rehabilitation process.

Physiotherapists continue to seek out advanced educational opportunities in programs that consistently offer high-quality education with a common focus on providing health care in the creative context of social needs even though they are immersed in a complex and changing environment to meet patients' needs (Furze et al. 2016) This study aims to direct the modernization of the technical-scientific skills of physiotherapy professionals from the moment we know: the teaching profile in this area in different formative realities in the Iberian Peninsula; the suitability of teaching to the emerging technological reality of professional performance; and the potential resistance of instructors inining a traditional model of curriculum and training.

According to McDaniel, Roth, and Miller (2005); a full description of each discipline's goals as they are handled in the theoretical and practical elements makes up the majority of the curriculum structure. It is well known that there aren't many research that consider modernizing and updating the curriculum framework of physiotherapy courses (Rapport, Stelzner, and Rodriguez 2007).

As a broad goal, we want to comprehend how the physiotherapist's professional training is interpreted and modified in response to the impact of technology in clinical practice.

To do this, we'll analyze educational realities in the Iberian Peninsula to determine what physiotherapy's curricular adaptation requirements will be considering technological advancements in this profession.

1.2 STRUCTURE OF THE THESIS

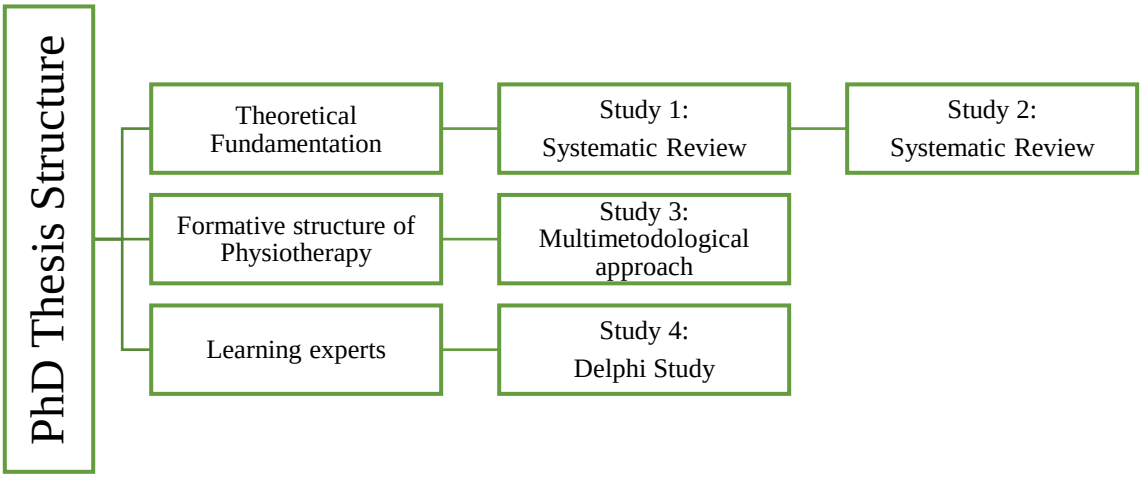

Figure 1-1. Structure of the Thesis

This thesis work collects three major elements that, when linked together, as shown in Figure 1-1, combine a series of separate research related to each other by subjects relating physiotherapy education and clinical practice. The first section (Chapters 2, 3) is the thesis's theoretical foundation. We conducted a comprehensive literature search to assure the best evidence and to back up our effort, and from that search, two systematic review studies were born; these investigations followed the principles outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al. 2021).

The second and third chapters, "Rehabilitation in a Context of Technology-Based Clinical Practice" and "The Innovation of the IHE in the Model of Teaching and Training New Professionals," respectively, present an overarching view of the field. The theoretical foundation allowed for the development of the primary data collection instruments used in the empirical research methods employed in the investigations given in the subsequent chapters. The organizational framework of Iberian Peninsula IHE for physiotherapy education is the subject of Chapter 4. Chapter 5 presents a method using trainees and the Delphi technique (Brady 2015).

The goals of this thesis are investigated throughout five separate experiments (Chapters 2, 3, 4, and 5). In Chapter 6, we provide a synthesis of the findings, drawing out the common threads throughout the various studies while also highlighting their individual shortcomings and promising future directions. The assessment phase of this effort, which followed a cutting-edge organizational framework, aimed to spark discussions among IHE on the novel approaches to physiotherapy education and practice on the Iberian Peninsula.

1.3 DISSEMINATION OF THESIS WORK

Peer-reviewed Articles

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Available rehabilitation technology with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review (*accepted*)

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Heutagogy in Physiotherapy Training: A Systematic Review of Innovations in Higher Education in Health (*submitted*)

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Rehabilitation Technologies In Clinical Practice And Training Of Physiotherapy Students In The Iberian Peninsula: A Delphi Study On The View Of Trainees (*submitted*).

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Innovation Perspectives in The Formative Structure of Physiotherapists: a study of clinical practice with Rehabilitation Technologies *(submitted).*

Chapter of eBook

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Practical Implications of Heutagogy for Clinical Education in Physiotherapy Undergraduate (*waiting for ebook chapter publication*)

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023) Rehabilitation Technologies in the Training of Physiotherapists of the Iberian Peninsula: An Observational Study of Innovations in Higher Education (*waiting for ebook chapter publication*)

Book of Abstracts

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Tecnologias de Reabilitação na Prática Clínica e Formação dos Jovens Alunos de Fisioterapia na Península Ibérica: Um estudo Delphi sobre a visão dos Formandos. Conference: VI Seminario Ibérico De Investigación En Juventud At: Cáceres España (*waiting for book of abstract publication*).

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Rehabilitation technologies with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review. Conference: 4th CHRC Annual Summit At Palácio D. Manuel, Évora – Portugal (*waiting for book of abstract publication*).

Oral Communications at Scientific Conferences

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Tecnologias de Reabilitação na Prática Clínica e Formação dos Jovens Alunos de Fisioterapia na Península Ibérica: Um estudo Delphi sobre a visão dos Formandos. Conference: VI Seminario Ibérico De Investigación En Juventud At: Cáceres España.

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Rehabilitation technologies with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review. Conference: 4th CHRC Annual Summit At Palácio D. Manuel, Évora – Portugal.

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Heutagogia Na Transformação Do Conteúdo Formativo De Fisioterapia: Uma Revisão Sistemática Sob Perspetiva De Inovações No Ensino Superior Em Saúde. Conference: V Congresso Nacional de Educação para a Saúde At Colégio Pedro da Fonseca – Universidade de Évora – Portugal.

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Inclusão De Novas Tecnologias De Reabilitação Na Formação De Fisioterapeutas Da Península Ibérica: Um Estudo Observacional. Conference: V Congresso Nacional de Educação para a Saúde At Colégio Pedro da Fonseca – Universidade de Évora – Portugal

Poster Presentation at Scientific Conference

Siqueira, Tarciano; Parraca, J A; Sousa, João Paulo (2023). Adaptation of the Professional Training of Physiotherapists in Function of the Technological Impact in their Clinical Practice: Formative Realities in the Iberian Peninsula. Conference: 4th CHRC Annual Summit at Palácio D. Manuel, Évora – Portugal.

REFERENCES

A McDaniel, E., Roth, B., & Miller, M. (2005). Concept Mapping as a Tool for Curriculum Quality. Issues in Informing Science and Information Technology, 2, 505–513. https://doi.org/10.28945/847

Brady, S. R. (2015). Utilizing and Adapting the Delphi Method for Use in Qualitative Research. International Journal of Qualitative Methods, 14(5), 160940691562138. https://doi.org/10.1177/1609406915621381

Cheng, C.-T., Chen, C.-C., Fu, C.-Y., Chaou, C.-H., Wu, Y.-T., Hsu, C.-P., Chang, C.-C., Chung, I.-F., Hsieh, C.-H., Hsieh, M.-J., & Liao, C.-H. (2020). Artificial intelligence-based education assists medical students' interpretation of hip fracture. Insights into Imaging, 11(1), 119. https://doi.org/10.1186/s13244-020-00932-0

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Furze, J. A., Tichenor, C. J., Fisher, B. E., Jensen, G. M., & Rapport, M. J. (2016). Physical therapy residency and fellowship education: Reflections on the past, present, and future. Physical Therapy, 96(7), 949–960. https://doi.org/10.2522/ptj.20150473

González-Zamar, M.-D., Abad-Segura, E., López-Meneses, E., & Gómez-Galán, J. (2020). Managing ICT for Sustainable Education: Research Analysis in the Context of Higher Education. Sustainability, 12(19), 8254. https://doi.org/10.3390/su12198254

Jensen, G. M., Hack, L. M., Nordstrom, T., Gwyer, J., & Mostrom, E. (2017). National Study of Excellence and Innovation in Physical Therapist Education: Part 2—A Call to Reform. Physical Therapy, 97(9), 875–888. https://doi.org/10.1093/ptj/pzx062

Jensen, G. M., Nordstrom, T., Mostrom, E., Hack, L. M., & Gwyer, J. (2017). National Study of Excellence and Innovation in Physical Therapist Education: Part 1—Design, Method, and Results. Physical Therapy, 97(9), 857–874. https://doi.org/10.1093/ptj/pzx061

Jezernik, S., Colombo, G., Keller, T., Frueh, H., & Morari, M. (2003). Robotic Orthosis Lokomat: A Rehabilitation and Research Tool. Neuromodulation: Technology at the Neural Interface, 6(2), 108–115. https://doi.org/10.1046/j.1525-1403.2003.03017.x

Jovanov, E., Milenkovic, A., Otto, C., & de Groen, P. C. (2005). A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation.

Journal of NeuroEngineering and Rehabilitation, 2(1), 6. https://doi.org/10.1186/1743-0003-2-6

Mącznik, A. K., Ribeiro, D. C., & Baxter, G. D. (2015). Online technology use in physiotherapy teaching and learning: a systematic review of effectiveness and users' perceptions. BMC Medical Education, 15(1), 160. https://doi.org/10.1186/s12909-015-0429-8

Moral-Munoz, J. A., Arroyo-Morales, M., Herrera-Viedma, E., & Cobo, M. J. (2018). An Overview of Thematic Evolution of Physical Therapy Research Area From 1951 to 2013. Frontiers in Research Metrics and Analytics, 3(March), 1–11. https://doi.org/10.3389/frma.2018.00013

Murphy, A. C., Farouque, O., Yeo, B., Dick, R., Koshy, A. N., Roccisano, L., Reid, C., Raman, J., Kearney, L., & Yudi, M. B. (2021). SMARTphone Based Cardiovascular Risk Reduction in BREAST Cancer Patients (SMART-BREAST): A Randomised Controlled Trial Protocol. Heart, Lung and Circulation, 30(9), 1314–1319. https://doi.org/10.1016/j.hlc.2021.03.271

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. The BMJ, 372. https://doi.org/10.1136/bmj.n160

Rapport, M. J., Stelzner, D., & Rodriguez, J. (2007). The Doctor of Physical Therapy Degree: A New Curriculum for a New Degree. Physical Disabilities: Education and Related Services, 26(1), 63–76. www.apta.org

Rowe, M. (2019). An Introduction to Machine Learning for Clinicians. Academic Medicine, 94(10), 1433–1436. https://doi.org/10.1097/ACM.0000000000002792

Walton, D. M. (2018). Standing at a Critical Nexus in the Evolution of Physiotherapy. Physiotherapy Canada, 70(3), 199–201. https://doi.org/10.3138/ptc.70.3.gee

Yang, G., Pang, Z., Jamal Deen, M., Dong, M., Zhang, Y.-T., Lovell, N., & Rahmani, A. M. (2020). Homecare Robotic Systems for Healthcare 4.0: Visions and Enabling Technologies. IEEE Journal of Biomedical and Health Informatics, 24(9), 2535–2549. https://doi.org/10.1109/JBHI.2020.2990529

CHAPTER 2

REHABILITATION TECHNOLOGIES IN PHYSIOTHERAPY PRACTICE

Available rehabilitation technology with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review.

ABSTRACT

Background: The development of prototypes capable of intervening in rehabilitation in physical therapist clinical practice activities that were previously carried out in a traditional way, that is, manually, demonstrates how technology is having an impact on professional careers such as physiotherapy. **Objective:** The purpose of this study is to present a comprehensive examination of various technologies employed in the facilitation of patient rehabilitation, with a focus on their potential integration within the clinical practice of physical therapists. **Methods:** We conducted a systematic search in four electronic databases (CINAHL, Embase, PEDro, and PubMed) for research on rehabilitation technologies. The eligible studies should demonstrate a clear utilization of technology in various aspects of the clinical approach to the rehabilitation process and have been published between 2000 and 2021 in either Portuguese or English. **Results:** A total of 18 articles that satisfied the selection criteria were included in the study. The studies were classified into four distinct categories of rehabilitation technologies, which were determined by the specific characteristics of the technology employed and its integration with the therapeutic approach to rehabilitation. These categories include digital technologies, artificial intelligence and/or robotics, virtual technologies, and hybrid technologies. **Conclusion:** Rehabilitation technologies possess the capacity to effectively facilitate clinical activities performed by physical therapy professionals, including injury prevention, movement monitoring, and coordination of rehabilitation programs, with minimal or negligible intervention from the physical therapist. Further research is required to ascertain the precise capabilities of various technologies in collaborating with physiotherapists to deliver comprehensive care for patients' physical well-being, encompassing both therapeutic and preventive approaches.

Trial Registration: PROSPERO registration number CRD42020222288

Keywords: Physiotherapy, Rehabilitation, Health technologies, Artificial Intelligence, Technological rehabilitation.

2.1 INTRODUCTION

The integration of technologies into the everyday work routines of professionals has resulted in the development of tailored and flexible services that cater to the specific requirements of users across different age groups (Tortorella et al., 2020). Consequently, healthcare professionals have integrated various software, sensors that establish connections between patients and mobile devices, and robots into their everyday routines. (Raso, Hervás, and Bravo 2010).

Researchers have employed virtual reality (VR) technology to address post-traumatic stress disorder (PTSD) and aid in the rehabilitation of individuals afflicted with chronic pain or other incapacitating medical conditions. (Wiederhold, Miller, and Wiederhold 2018). The efficacy of employing interactive computer-generated simulations, which offer users the opportunity to actively engage in surroundings that closely emulate real-world scenarios, can be attributed to the method's achievements. (Clark, Sivan, and O'Connor 2019).

Digital health technologies provide the capacity to offer fresh ways for healthcare practitioners to approach and administer healthcare, grounded in a concept of suitability that challenges established conventional healthcare practices. (Olu et al. 2019). The utilization of proactive equipment can facilitate a range of clinical activities, including consultations, examinations, follow-ups, diagnoses, and preventative interventions. (Ritschel et al. 2019). Rehabilitation technologies that fall under the category of specific interventions are primarily designed to enhance an individual's functionality and independence, promote active involvement, and enhance overall well-being. (Clark, Sivan, and O'Connor 2019).

In response to the limited availability of healthcare resources, there is a growing inclination to employ Artificial Intelligence (AI) methodologies in the development of healthcare facilities and eldercare services. Within such settings, the utilization of robots

and other advanced technologies can serve as an auxiliary group of proficient caregivers, doing tasks such as disease prognosis, aided diagnosis, therapy facilitation, and rehabilitation assistance. (Yang et al. 2020).

One of the most appealing aspects of implementing this technology in healthcare is its capacity to replicate independent practice at higher dosages than what can be achieved through conventional therapy. (Kumar, Gadag, and Nayak 2021). Hence, these technologies share various similar properties, including increased repetition and intensity of training, as well as reduced duration of expert monitoring. (Clark, Sivan, and O'Connor 2019).

It is anticipated that in the coming years, families will experience a rise in the presence of social robots designed to provide healthcare support (Ritschel et al. 2019). It is our contention that there exists a dearth of research that categorizes rehabilitation technologies as having the capacity to intervene in the therapeutic duties of a physical rehabilitation program with minimal or negligible participation from a rehabilitation professional.

Therefore, the purpose of this study was to present a comprehensive survey of the many technologies employed in aiding patient rehabilitation and their potential integration into the clinical practice of physiotherapists.

2.2 METHODS

2.2.1 Research Design

This review was influenced by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 declaration (Page et al. 2021). After consulting the International Prospective Register of Systematic Reviews (PROSPERO) of the Center for Reviews and Dissemination of York University (United Kingdom), we were able to confirm that the work presented here was original. We then registered the protocol for this review (ID: CRD42020222288) in PROSPERO's database.

2.2.2 Information Sources

A thorough search of four electronic databases (CINAHL, Embase, PEDro, and PubMed) as well as an analysis of the bibliographies of papers that were included and interviews with rehabilitation technology experts (BT and AL) helped find pertinent articles.

2.2.3 Search Strategy

In the Embase database, the search terms were specified. "Physiotherapy" OR “rehabilitation" AND "'artificial intelligence" OR "technological rehabilitation" were utilized as the search approach. The search keywords were modified as needed to investigate more databases.

The database was searched in December 2020 and again in April 2021. The study's design didn't initially have any search criteria. This process made sure that every article was available for summary reading. After the search algorithms were used, the studies that were located were exported to a Mendeley® file and subsequently compiled in a Prisma flowchart (Figure 2-1). By reading the whole papers and the keywords displayed in the electronic databases, the study design might be identified. Artificial intelligence, rehabilitation, physiotherapy, and technology rehabilitation were used as keywords.

2.2.4 Eligibility Criteria

Included were complete publications from randomized clinical trials that were conducted between 2000 and 2021, were written in Portuguese or English, and related to rehabilitation technology used in physiotherapists' daily practices. Selections from observational, cross-sectional, and longitudinal research were made early on in this systematic review. When there was no proof of efficacy despite the application of rehabilitation technologies, pilot studies were disregarded. We chose to take an inclusive strategy that was targeted at a hugely diverse audience with variances in demographics, age, and gender to get a more complete picture of how technologies are used.

Studies with clinical outcomes relating to the functionality of rehabilitation technologies that demonstrated a positive outcome regarding safety in the use of technology for the patient and the professional; maintaining patient engagement with the proposed

intervention, efficiency of technology in prevention, evaluation, monitoring, and improvement of physical and functional capabilities after intervention were prioritized.

2.2.5 Study Selection

Two reviewers (TS and JS) with backgrounds in physiotherapy and rehabilitation technologies were involved in the search strategy and identification of pertinent records to determine eligibility. Consensus was reached to settle disagreements when they arose.

2.2.6 Data Collection Process

One reviewer (JS) tested a data extraction form on three randomly chosen publications to summarize the evidence. Data extraction was checked by a second reviewer (TS), and any discrepancies were worked out through conversation. This tactic enhanced the accuracy of data extraction and the detection of additional items that needed to be gathered. Despite being integrated with other papers, the entire published characteristics of each study were considered in data extraction to prevent discrepancies and restrictions.

2.2.7 Data times

No assumptions were made when an article lacked the necessary information. The review team did not get in touch with the authors to get a confirmation or more details. Reporting data that was readily accessible to end users was our main concern. Data extraction was coded for applicable publications. The information gathered is summarized in Table 2.3, Table 2.4, and Table 2.5, which include information like the author and year of publication, methodological details, technological instrument(s) used that may be incorporated into the physiotherapist's routine clinical practices (evaluate, treat, or monitor the rehabilitation routine), and the key findings of each study.

2.2.8 Risk of Bias

The studies included in this review were assessed using the Cochrane RoB - 2 method, which is designed for analyzing the risk of bias Table 2.1, of reviews that contain studies from randomized clinical trials. The 5 domains of the RoB - 2 tool, namely: bias arising from the randomization process; bias due to deviations from intended interventions; bias due to missing outcome data; bias in outcome measurement; and bias in selection of

reported outcome, were individually analyzed for each of the 18 included studies. (Higgins, J. P., Li, T., & Deeks 2023). Regarding the methodological designs of seven of the 18 included studies, we found minor red flags during the evaluation, which are shown in Table 2.1 of the Risk of Bias assessment. The classification of research as having a low risk of bias was not jeopardized by anything we found, though.

Table 2.1. Assessing Risk of Bias in Randomized Trials with the Cochrane Collaboration Tool.

Evaluated studies (author, year)	Domains and General Risk Assessment					
	D - 1	D - 2	D - 3	D - 4	D - 5	Overall
Aprile, I et al (2020)	−	−	−	−	−	−
Bickmore, T. W., Schulman, D., & Sidner, C. (2013)	−	−	−	−	−	−
Cecchi, F et al (2020)	−	−	✓	−	−	−
Chae, S. H et al (2020)	−	−	−	−	−	−
Fernández-González et al (2019)	−	−	−	−	−	−
Jirayucharoensak, S et al (2019)	−	−	✓	−	−	−
Kim, H et al (2020)	−	−	−	−	−	−
Lao, C et al (2021)	−	−	−	−	−	−
Padua, L et al (2020)	−	−	−	−	−	−
Park, C et al (2020)	✓	✓	−	✓	✓	✓
Park, S et al (2020)	−	−	−	−	−	−
Persell, S et al (2020)	−	−	−	−	−	−
Picelli, A et al (2016)	−	−	−	−	−	✓
Salarian et al (2007)	−	−	−	−	−	−
Tousignant, M et al (2011)	−	−	−	−	−	✓
Tramontano, M et al (2020)	−	−	✓	−	−	−
Yeh, S et al (2014)	−	−	−	−	−	−
Zhang, L et al. (2002)	−	−	−	✓	−	−

D – 1: Bias arising from the randomization process
D – 2: Bias due to deviations from intended interventions
D – 3: Bias due to missing outcome data
D – 4: Bias in measurement of the outcome
D – 5: Bias in selection of the reported result

Overall risk-of-bias judgement:

Low risk of bias = − Some concerns = ✓ High risk of bias = ®

2.3 RESULTS

2.3.1 Study Selection

The initial search turned up 121 studies, 12 of which were duplicates and were eliminated prior to screening. A total of 109 studies were found and screened; the results are displayed in Figure 2-1.

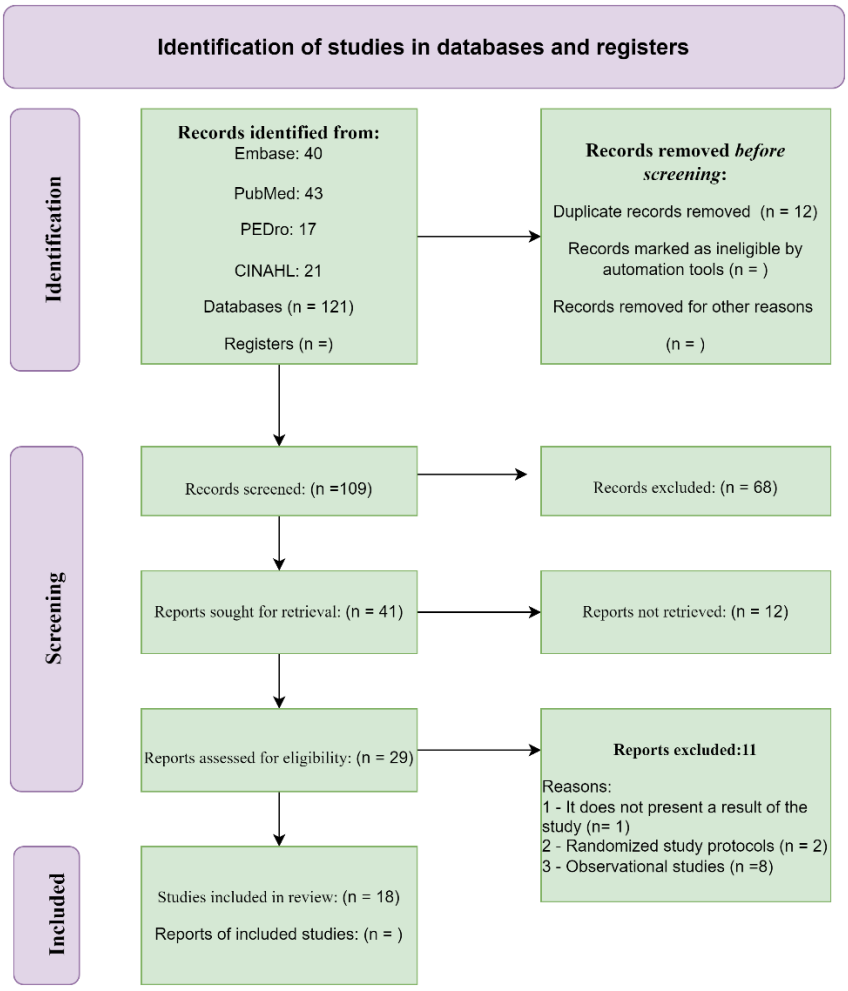

Figure 2-1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

In the initial round of screening, we found that 33 studies lacked a title and/or abstract that was appropriate for the review's goal, and another 35 studies lacked a proposal that was appropriate for the rehabilitation techniques used by the physiotherapist. We eliminated 12 more studies during a second round of screening, including 3 studies without full texts and 9 review studies.

After the two screening phases, we examined the 29 studies' eligibility. A complete analysis was conducted before a decision to exclude was reached. We found 1 study with ambiguous findings, 2 studies with unfulfilled randomized study protocols, and 8 studies that were observational. After doing the final screening analysis, we eliminated 11 more studies. The screening produced 103 exclusions and 18 additions of studies that were appropriate for review.

The most pertinent information of the analysis was presented in tables that show the particulars and summary of the study results to ensure a better understanding of the objective of this review and better comprehend how included studies fit into the framework of rehabilitation technologies.

2.3.2 Study Details

The data reported in Table 2.2 - Categorization of Rehabilitation Technologies - was the most pertinent data for this investigation. There were 18 randomized studies in total that were looked at. The technologies found in the reviewed research were first categorized, considering the type of technology and its applicability in physical rehabilitation with the potential to be included into the work routine of physiotherapists in areas of professional importance. Based on the attributes of the technologies, a classification is shown in Table 2.2 below.

Table 2.2. Categorization of rehabilitation technologies.

Technology Type	**Digital: telerehabilitation and mobile applications.**	**AI/R - Artificial Intelligence and/or Robotics: robots, software and intelligent devices.**	**Virtual: serious games and immersive and non-immersive virtual reality.**	**Hybrid: technology made up of more than one of the above components.**
Applicability of Technology in the Physiotherapist's Routine.	Prevention and monitoring: action that aims to avoid physical and systemic disabilities or reduce complications from pre-existing problems in the patient.	Assessment: clinical activity to identify physical and systemic disorders that support the treatment plan.	Intervention: approach focused on carrying out rehabilitation.	Hybrid: performs more than one activity in the rehabilitation process.

2.3.3 Synthesis of Results

Regarding the abilities and capabilities of the physiotherapy professional, four categories of rehabilitation technologies were recognized. Robotics, virtual reality, assistive technology, and smartphone applications are just a few of the many technologies that could be used in the rehabilitation process.

The key information about the papers examined in this review is presented in three tables. Table 2.3 shows the technology used, the goal of the research, and the applications of each study. Table 2.4 gives an overview of the countries that conducted research in technologically aided rehabilitation as well as a description of the types of patients who benefited from these interventions. Table 2.5, our last table, offers details regarding the interventions and the most important findings.

Table 2.3. Technologies and Applicability.

Author	Type of Technology	Objectives	Applicability
(Aprile et al. 2020)	Bipodalic platform (Prokin, Technobody, Italy).	Evaluate technological proprioceptive rehabilitation compared to conventional rehabilitation in patients after lasty total hip arthritis (THA).	Treatment: to improve proprioception in orthopedic patients after hip arthroplasty.
(Bickmore, Schulman, and Sidner 2013)	Software for simulated conversations with users on their home computers and pedometer steps.	An automated health counselor agent was designed to promote both physical activity and fruit and vegetable consumption through a series of simulated conversations with users on their home computers.	Automated health behavior change interventions.
(Cecchi et al. 2021)	A set of robotic sensor-based devices (Motore, Humanware; and Amadeo, Diego and Pablo, from Tyromotion).	The present study aimed to identify baseline patient characteristics that may predict response to robotic or physiotherapy-based treatment in our RCT, and to verify whether, in our sample, specific subgroups of patients may be more responsive to either intervention.	Upper extremity (UE) recovery after stroke.
(Chae et al. 2020)	Smartwatch (watch style W270, LG,) that can be connected to a personal smartphone after installing a custom-programmed app.	This study aimed to (1) develop a home-based rehabilitation (HBR) system that can recognize and record the type and frequency of rehabilitation exercises conducted by the user using a smartwatch and smartphone app equipped with a ML algorithm and (2) evaluate the efficacy of the home-based rehabilitation system through a prospective comparative study with chronic stroke survivors.	Home Rehabilitation System (HBR) Determine the most accurate way to detect the type of exercise at home as a cost-effective tool for home care for stroke survivors.
(Fernández-González et al. 2019)	LMC Non-immersive video games system used with serious games.	The primary aim of the present study was to evaluate the effectiveness of the LMC system using serious games designed for improving UL grip muscle strength, coordination, speed of movements and fine and gross dexterity. Furthermore, we sought to assess satisfaction and compliance levels among those in mild-to-moderate stages of the disease.	Technological rehabilitation for individuals with PD

THA: Total hip arthroplasty; EU: Upper extremity; RCT: randomized-controlled trial; ML: machine learning; HBR: home-based rehabilitation; LMC: Leap Motion Controller; PD: Parkinson's disease; UL: upper limb; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment; E-RAGT: end-effector robot-assisted gait training; BWST: bodyweight-supported treadmill training; CR: cognitive reserve; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; SASMP: smartphone app-based, self-management program;COPD: chronic obstructive pulmonary disease; HRKOL: health-related quality of life; VR: Virtual reality; HBPM: home blood pressure monitor; BoNT-A: Botulinum toxin type; MAS: modified Ashworth scale; MS: Multiple Sclerosis; TKA: total knee arthroplasty.

Table 2.3 *(continued)*

Author	Type of Technology	Objectives	Applicability
(Jirayucharoensak et al. 2019)	A game-based neurofeedback training system.	The main aim of this study was to examine whether a newly developed game-based neurofeedback training (NFT) system may enhance neurocognitive performance in healthy elderly subjects and patients with amnestic mild cognitive impairment aMCI.	Improve cognitive performance in patients with mild amnestic cognitive impairment (aMCI) and healthy elderly.
(Kim et al. 2020)	E-RAGT and BWST	The purpose of this study was to compare, in individuals with hemiparetic stroke, the effects of E-RAGT vs. BWST on cortical activation and clinical outcomes, including lower limb motor function and gait speed.	Locomotor neurorehabilitation after hemiparetic stroke
(Lao et al. 2021)	Sports Smart Bracelet	The purpose of this study is to study the effectiveness of the combined use of sports smart bracelets and multi-sports training programs on the motivation for the elderly in the Macau community.	Increase the motivation and participation of the elderly in exercises.
(Padua et al. 2020)	A robotic device	The aim was to assess if CR can influence the outcome of motor rehabilitation in stroke patients and if CR could provide information to direct the patient to robotic or conventional rehabilitation.	Upper limb rehabilitation after stroke.
(C. Park et al. 2020)	Walkbot-assisted locomotor training (WLT).	The present study aimed to compare the effects of WLT with CLT on balance and gait, cardiopulmonary and psychological functions and fall confidence in acute hemiparetic stroke.	locomotor training on balance and gait, cardiopulmonary and psychological functions and confidence in the fall in acute hemiparetic stroke.
(S. K. Park, Bang, and Lee 2020)	(S. K. Park, Bang, and Lee 2020)	The purpose of this study was to examine the effect of a 6-month SASMP on self-care behavior in people with COPD. Secondary outcomes included exercise capacity, exercise, physical activity, symptoms, HRQOL, and health care use.	Self-management for people with COPD based on smartphone app.
(Persell et al. 2020)	Smartphone coaching app plus an HBPM	To investigate the effect of an artificial intelligence smartphone coaching app to promote home monitoring and hypertension-related behaviors on systolic blood pressure level compared with a blood pressure tracking app.	Home monitoring of blood pressure.
(Picelli et al. 2016)	Robot-assisted gait	The main aim of this pilot study was to evaluate the combined effects of RAGT and BoNT-A on spastic equinus foot in patients with chronic stroke as measured by changes in the grade of resistance to rapid passive muscle stretch on the MAS.	Gait training in patients with chronic stroke.
(Salarian et al. 2007)	The proposed measurement system is based on three inertial Sensors attached to body parts.	The main goal of this study was to design a new method for the ambulatory monitoring of physical activity in PD patients during their daily activities by classifying basic posture allocations including sitting, standing,	Monitoring of physical activities in patients with PD.
(Tousignant et al. 2011)	Telerehabilitation	The purpose of this study was to investigate the satisfaction of patients and health professionals with in-home teletreatment as an alternative to face-to-face therapy for individuals at home following discharge from an acute care hospital after TKA	Home telerehabilitation as an alternative to conventional rehabilitation after discharge from total knee arthroplasty surgery.
(Tramontano et al. 2020)	Robotic-trained motor rehabilitation performed with PABLO®-Tyromotion.	The aim was to investigate the effects of a robotic-trained motor rehabilitation performed with PABLO®-Tyromotion on upper limbs'functions in MS patients.	Neuromotor rehabilitation of people with Multiple Sclerosis (MS), and upper limb function limitations.
(Yeh et al. 2014)	Virtual reality (VR) rehabilitative games adopted from Cawthorne–Cooksey exercises	The objectives of this study are to validate a VR system that can be used for imbalance patients rehabilitation.	Therapeutic effect
(Zhang et al. 2002)	Intelligent stretching device	The objectives of this paper were: 1) to develop a stretching device with intelligent control to stretch ankle joints with spasticity and/or contracture safely and efficiently throughout the ankle ROM to reduce spasticity and/or contracture; 2) to assess the feasibility of the stretching device based on a small sample of stroke patients.	Ankle joint stretching with contracture/spasticity in neurologically impaired patients

THA: Total hip arthroplasty; EU: Upper extremity; RCT: randomized-controlled trial; ML: machine learning; HBR: home-based rehabilitation; LMC: Leap Motion Controller; PD: Parkinson's disease; UL: upper limb; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment; E-RAGT: end-effector robot-assisted gait training; BWST: bodyweight-supported treadmill training; CR: cognitive reserve; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; SASMP: smartphone app-based, self-management program; COPD:

chronic obstructive pulmonary disease; HRKOL: health-related quality of life; VR: Virtual reality; HBPM: home blood pressure monitor; BoNT-A: Botulinum toxin type; MAS: modified Ashworth scale; MS: Multiple Sclerosis; TKA: total knee arthroplasty.

Table 2.4. Population and Sample

Author	Country	General Sample (n)	Sample per group	Gender	Ages and/or Middle Ages
(Aprile et al. 2020)	Italy	n = 64	CVG: 28 TG:36	CVG: 10 males and 18 females; TG: 10 males and 26 females	CVG: (age: 63.9 ± 15.2) TG: (age: 68.4 ± 10.5).
(Bickmore, Schulman, and Sidner 2013)	USA	n = 122	CG:31; EXG:31; FVG: 30; FVE: 30)	Male / Famale 39% males / 61% female	Age: 21 - 69 years old. (mean 33.0 ±12.6)
(Cecchi et al. 2021)	Italy	n = 224	CVG: 113; RG: 111	CVG: Man 64 (56.6%) Woman 49 (43.4%) RG: Man 63 (56.8%) Woman 48 (43.2%)	age between 40 and 85 yearsage CVG: 68,5 and RG: 69,5
(Chae et al. 2020)	South Korea	n = 23	CG: 6 EG – "HBR" 17	_____	age: 40 to 70 mean age: ----------
(Fernández-González et al. 2019)	Spain	n = 23	CG :11 EG:12	Male / Famale 11 /12	age: 45 to 79 years (mean age 66.65 ± 10.14 years)
(Jirayucharoensak et al. 2019)	Thailand	n=119	NFT - IG: 58 ETG:36 CAU: 25	119 women	Mean age: NFT 71.7 (6.5); Exagame 73.9 (6.2) and CAU 70.9 (5.1).
(Kim et al. 2020)	South Korea	n =28	E-RAGT:14 BWST: 14	E-RAGT: 11 male; 3 female / BWST: 12 male; 2 female.	mean age ± standard deviation, 54 ± 11 years)
(Lao et al. 2021)	China	n = 60	EWB: 20 EXG: 20 CG: 20	1 man and 19 women per group.	Age (years): 80.00 ± 5.38; 78.40 ± 6.75; 76.75 10.64 Age range(y/o) 67–90; 68–97; 68–92.
(Padua et al. 2020)	Italy	n = 75	CVG: 39 RG: 36	CVG: Male 25 (64.1%) and Female 14 (35.9%) RG: male 24 (66.7%) and female 12 (33.3%).	Age (years): CVG 65±12 / RG 66 ±10
(C. Park et al. 2020)	South Korea	n =14	CLT: 7 WLT:7	CLT: 4 men and 3 women WLT 5 men and 2 women	Age (years): CLT 69.86; WCLT 76.29 mean age = 72.8±9.9
(S. K. Park, Bang, and Lee 2020)	South Korea	n = 42	EG: 22 CG: 20	EG: men 19 (86.4%) women 3 /CG: men 14 (70.0%) women 6.	Mean age: 67.88 ± 10.49 (45–87) / EG: 70.45 ± 9.40 / CG 65.06 ± 11.12
(Persell et al. 2020)	USA	n = 297	EG:144 CG:153	(61.3%) were women EG: Female 91 (63.2) CG: 91 (59.5)	Age, mean EG 59.6 (12.4) / CG 58.3 (13.2)
(Picelli et al. 2016)	Italy	n = 22	EG: 11 CG: 11	Male /Famale EG: 7/4 CG: 9/2	Mean age EG 62.4 (9.5) / CG 65.1 (3.4).
(Salarian et al. 2007)	Switzerland	n = 20	PD: 10 CG: 10	Male /Famale DP: 5/5 CG: 5/5	PD: ages 61.5 7.8 years; CG: ages 63.6 10.5 years.
(Tousignant et al. 2011)	Canada	n =42	EG: 22 CG: 20	_____	mean age: EG 66.4 – 10.1 / CG 66.4 – 13.3
(Tramontano et al. 2020)	Italy	n = 30	EG:14 CG: 16	Male /Famale EG: 6/8 CG: 6/10	mean age: EG 46.7±10.4 / CG 52.3±5.4
(Yeh et al. 2014)	Taiwan	n = 84	EG:48 CG:36	Male /Famale EG: 25/23 CG: 20/16	mean age: EG 64±16/ CG 22±4
(Zhang et al. 2002)	USA	n = 9	EG: 4 CG: 5	9 men	EG: (53.2±7.9 years old) CG: (36,8 ± 12,8 years old)

CVG: Conventional group; TG: Technological group; CG: Control Group; EXG: Exercise Group; FVG: Fruit and vegetable group FVE: Fruit, vegetable, and exercise group; RG: Robotic group; EG: experimental group; HBR: home-based rehabilitation; NFT: neurofeedback training; CAU: care as usual; IG: intervention group; ETC: Exergame treatment group; E-RAGT, end-effector robot-assiste gait training; BWST:

bodyweight-supported treadmill training; EWB: Exercising Wearing the Bracelet; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; PD: Parkinson's disease.

Table 2.5. Intervention and Results.

Author	Intervention	Result
(Aprile et al. 2020)	**5 times week/ 4weeks** Both groups of patients performed post-operative conventional rehabilitation treatment, consisting of 20 daily 45-minute sessions for 4 weeks (5 times/week). Patients included in the CVG underwent group treatment sessions (3 or 4 patients) lasting 45 minutes, 5 times per week. The treatment included techniques to improve joint range of motion, muscle force, ability to adopt different postures and proprioceptive exercises.	All scales improved significantly in both groups after treatment ($p < 0.05$). Static balance improved in both groups, but there were greater improvements in the TG than in the CVG. All dynamic balance indexes showed significant improvements only in the TG after treatment.
(Bickmore, Schulman, and Sidner 2013)	**Once a day/ for two months** Subjects in the intervention groups accessed the system remotely over the Internet from their home computers daily during the two-month intervention period.	Participants in the physical activity intervention increased their walking on average compared to the control group, while those in the fruit and vegetable intervention and combined intervention decreased walking. Participants in the fruit and vegetable intervention group consumed significantly more servings per day compared to those in the control group, and those in the combined intervention reported consuming more compared to those in the control group.
(Cecchi et al. 2021)	**5 times/ week; 30 sessions or 6 weeks** In both groups, treatment was performed daily for 45 min, 5 days/week, for 30 sessions. All patients also underwent individual conventional physical therapy (6 times/week), lasting 45 minutes, focusing on the lower limbs, sitting, and standing training, balance and walking.	A sample of 190 patients was evaluated after the treatment; 121 were responders. Age, baseline impairment, and neglect were significantly associated with worse response to the treatment. Age was the only independently associated variable (OR 0.967, p=0.023). Considering separately the two interventions, age remained negatively associated with recovery (OR 0.948, p=0.013) in the conventional group, while none of the variables previously identified were significantly associated with the response to treatment in the robotic group
(Chae et al. 2020)	**12 Weeks** We selected four exercise tasks based on bilateral movement therapy, which is called bilateral arm training rehabilitation: (1) bilateral shoulder flexion with both hands interlocked; (2) wall push exercise; (3) active scapular exercise; and (4) towel slide exercise. All patients in the control group received personal education about the four exercise tasks for 30 minutes at the beginning of study enrollment. **CG:** In the control group, the participants received a printed handout to remind them about how to perform the four exercise tasks. In contrast, participants **EG:** in the HBR group received the same education and were given a smartwatch, and the HBR apps were installed on their own smartphones on the first day of the meeting.	The ML model created with personal data involving accelerometer combined with gyroscope data (5590/5601, 99.80%) was the most accurate compared with accelerometer (5496/5601, 98.13%) or gyroscope data (5381/5601, 96.07%). In the comparative study, the drop-out rates in the control and HBR groups were 40% (4/10) and 22% (5/22) at 12 weeks and 100% (10/10) and 45% (10/22) at 18 weeks, respectively. The HBR group (n=17) showed a significant improvement in the mean WMFT score (P=.02) and ROM of flexion (P=.004) and internal rotation (P=.001). The control group (n=6) showed a significant change only in shoulder internal rotation (P=.03).

CVG: control group; TG: Technological group; CG/ CTRL: Control Group; HBR: home-based rehabilitation; ML: Machine Learning; WMFT: Wolf Motor Function Test; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment: CAU: care as usual; SWM: spatial working memory; CANTAB: Cambridge Neuropsychological Test Automated Battery; E-RAGT, end-effector robot-assiste gait training; BWST: bodyweight-supported treadmill training; FMA: Fugl-Meyer assessment, EMS: exercise motivation scale; CRI: Cognitive Reserve Index; MI: Motricity Index; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; ANCOVA: analysis of covariance; ABC: activities-specific balance confidence scale; FAC: functional ambulation category; HR: heart rate; BDI – II: Beck depression inventory-II; BRPE: Borg rating of perceived exertion; BBS: berg balance scale; SASMP: smartphone app-based, self-management program; HBPM: home blood pressure monitor; PD: Parkinson's disease; RAGT: Robot-assisted gait training; TYR: Tyromotion; ROM: range of motion; DSP: digital signal processor.

Table 2.5 *(continued)*

Author	Intervention	Result
(Fernández-González et al. 2019)	**Six Week** Both the experimental group and the control group received two 30 min sessions per week over a six-week period (a total of 12 sessions for each group).	Within the experimental group, significant improvements were observed in all post-treatment assessments, except for Box and Blocks test for the less affected side. Clinical improvements were observed for all assessments in the control group. Statistical intergroup analysis showed significant improvements in coordination, speed of movements and fine motor dexterity scores on the more affected side of patients in the experimental group.
(Jirayucharoensak et al. 2019)	20 intervention sessions 30 min/ time and 2-3 times / week The baseline (pretreatment) neurocognitive functioning was measured using the CANTAB tests. Subsequently, subjects in both active intervention groups (CAU + NFT and CAU + Exergame) underwent 20 intervention sessions, 2–3 sessions a week, and then underwent a second cognitive evaluation using the CANTAB. Subjects in the control group had a second neurocognitive test after the same period of time (3 months).	NFT significantly improved rapid visual processing and spatial working memory (SWM), including strategy, when compared with exergame training and no active treatment. aMCI was characterized by impairments in SWM (including strategy), pattern recognition memory, and delayed matching to samples
(Kim et al. 2020)	**30 min/day, 5 times/week** The E-RAGT group received end-effector-based RAGT and the BWST group received treadmill gait training with partial bodyweight support 30 min/day, 5 times a week, for 4 weeks, for a total of 20 sessions25,26. E-RAGT was performed using the G-EO System Evolution (Reha Technology, Olten, Switzerland). The harness secured to the participants on two-foot plates, whose trajectories could be programmed to approximate a normal gait. During training, the participants received real-time visual feedback from the pressure plates regarding the weight distribution on their feet. They were also provided with verbal cues to help them ensure that their nucleus and trunk were centered, and their movements were symmetrical.	Clinical outcomes, including the Fugl-Meyer assessment (FMA), timed up and go test, and 10-m walk test scores, improved after training in both groups, with significantly better FMA scores in the E-RAGT group than in the BWST group. These findings suggest that E-RAGT effectively improves neuroplastic outcomes in hemiparetic stroke, although its superiority over conventional training remains unclear. This may have clinical implications and provides insight for clinicians interested in locomotor neurorehabilitation after hemiparetic stroke.
(Lao et al. 2021)	**12 weeks** The progress e intervention phase involved wearing sports smart bracelets during the 12 weeks of prescription exercise, which involved exercising three times a week for one hour at a time (including warm-up and strain relaxation). The exercise only group (25 people) were involved in 12 weeks of elderly prescription exercise, which was the same as for the group exercising while wearing the bracelet. The control group (25 people) involved in the progress e for 12 weeks did not do any exercise, nor were they equipped with any sort of sports smart bracelets and products.	After 12 weeks of multi-sport exercise training, the evaluation scores on the EMS increased significantly in the group wearing exercise bracelets and those taking part in the multi-component exercise program, and the degree of 22 progress eached a statistically significant level, but the control group did not show any statistically significant difference. The influence of the combination of sports smart bracelets and multi-sport training programs on elders' motivation is clearer.

CVG: control group; TG: Technological group; CG/ CTRL: Control Group; HBR: home-based rehabilitation; ML: Machine Learning; WMFT: Wolf Motor Function Test; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment: CAU: care as usual; SWM: spatial working memory; CANTAB: Cambridge Neuropsychological Test Automated Battery; E-RAGT, end-effector robot-assiste gait training; BWST: bodyweight-supported treadmill training; FMA: Fugl-Meyer assessment, EMS: exercise motivation scale; CRI: Cognitive Reserve Index; MI: Motricity Index; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; ANCOVA: analysis of covariance; ABC: activities-specific balance confidence scale; FAC: functional ambulation category; HR: heart rate; BDI – II: Beck depression inventory-II; BRPE: Borg rating of perceived exertion; BBS: berg balance scale; SASMP: smartphone app-based, self-management program; HBPM: home blood pressure monitor; PD: Parkinson's disease; RAGT: Robot-assisted gait training; TYR: Tyromotion; ROM: range of motion; DSP: digital signal processor

Table 2.5 *(continued)*

Author	Intervention	Result
(Padua et al. 2020)	6 Weeks; 45min/ time, 5 times/ week, All patients underwent a global conventional rehabilitative protocol f six sessions per week, each lasting 45 min, focused on postural changes, re-education and recovery of gait and balance. The CG performed exercises for hand, arm and shoulder oriented to sensor-motor re-programming, inhibition of the hypertonus, functional improvement and task-oriented exercises. In the RG, patients' upper limbs were treated by using the following devices : (a) a robotic device that allowed passive, active and active-assistive planar movements of the shoulder and elbow joints; (b) a robotic device that allowed passive, active and active-assistive finger flexion and extension movements; (c) a sensor-based device that allowed three-dimensional movements of shoulder, elbow and wrist joint, both unimanual and bimanual, without mechanical support; and (d) na electromechanical system that allowed three-dimensional, unimanual and bimanual, movements of the shoulder joint.	Considering all patients, a weak correlation was found between the CRI related to leisure time and MI evolution ($r = 0.276$; $P = 0.02$). Amongst the patients who performed a robotic rehabilitation, a moderate correlation emerged between the CRI related to working activities and MI evolution ($r = 0.422$; $P = 0.02$.
(C. Park et al. 2020)	Both groups received 30 additional minutes of therapy every day, 7 days/week for 2 weeks. The CLT group received the usual inpatient care, including at least one 60min physical therapy session per day, and an additional 30min standard physical therapy session focused on pre-gait and/or gait training activities. The WLT group received the usual inpatient therapy, including at least one 60min physical therapy session and an additional 30min WLT session	ANCOVA showed that WLT showed superior effects, compared to CLT, on FAC, HR, BRPE, BDI-II, and ABC scale ($P < 0.05$), but not on BBS ($P=0.0061$).
(S. K. Park, Bang, and Lee 2020)	The experimental group received the SASMP; the control group did not. At the first education session, participants in the experimental group received instruction on how to use each feature of the smartphone app. Four group exercise sessions were also offered during the first month of the 6-month intervention period for both groups. Each session, taught by an exercise expert who majored in exercise physiology, lasted about an hour and included stretching, main exercise, and stretching, in that order. The exercise expert helped the participants of both groups set an individualized goal for weekly exercise and physical activity, based on their personal exercise or physical activity status. For the experimental group, a video clip of each posture and motion, which was taught in the group exercise session, was included in the smartphone app's directory under exercise.	After randomization, the experimental group numbered 22, the control group numbered 20, and 2 participants dropped out. Significant differences between groups were found in change score for self-care behavior, total activity count per wear time, and percent time spent in moderate-to-vigorous physical activity over 6 months.

CVG: control group; TG: Technological group; CG/ CTRL: Control Group; HBR: home-based rehabilitation; ML: Machine Learning; WMFT: Wolf Motor Function Test; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment: CAU: care as usual; SWM: spatial working memory; CANTAB: Cambridge Neuropsychological Test Automated Battery; E-RAGT, end-effector robot-assiste gait training; BWST: bodyweight-supported treadmill training; FMA: Fugl-Meyer assessment, EMS: exercise motivation scale; CRI: Cognitive Reserve Index; MI: Motricity Index; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; ANCOVA: analysis of covariance; ABC: activities-specific balance confidence scale; FAC: functional ambulation category; HR: heart rate; BDI – II: Beck depression inventory-II; BRPE: Borg rating of perceived exertion; BBS: berg balance scale; SASMP: smartphone app-based, self-management program; HBPM: home blood pressure monitor; PD: Parkinson's disease; RAGT: Robot-assisted gait training; TYR: Tyromotion; ROM: range of motion; DSP: digital signal processor

Table 2.5 *(continued)*

Author	Intervention	Result
(Persell et al. 2020)	Control participants received an HBPM (7 Series Wireless Upper Arm Blood Pressure Monitor Model BP761N, Omron; or global Model HEM-7320T, Omron Healthcare Co Ltd), were instructed how to perform self-monitoring, and were asked to demonstrate use of the device. Intervention group participants received all interventions provided to the control group except the Omron smartphone app. Instead, they installed the HPCP coaching app.	At 6 months, self-confidence in controlling blood pressure was greater in the intervention group (0.36 point on a 5-point scale; 95% CI, 0.18 point to 0.54 point; P < .001). There were no significant differences between the 2 groups in other secondary outcomes. The adjusted difference in self-reported physical activity was 26.7 minutes per week (95% CI, −5.4 minutes per week to 58.8 minutes per week; P = .10). Subgroup analysis raised the possibility that intervention effects differed by age.
(Picelli et al. 2016)	All participants were injected with Abobotulinumtoxin A (Ipsen Pharma, Boulogne-Billancourt, France) into the spastic triceps surae muscle of the affected lower limb. all patients included in this study received a 60-minute session of electrical stimulation of the injected muscles (rectangular current pulses, 4 Hz, 0.2 ms, intensity adjusted to elicit visible muscle contraction).25 No other physical therapy, casting, taping or stretching procedures were done during the study period. In addition, patients allocated to the Group 1 underwent RAGT for 30 minutes a day for five consecutive days, beginning the day after BoNT-A injection. Robotic gait training was carried out on the G-EO System Evolution (Reha Technology, Olten, Switzerland)	No difference was found between groups as to the modified Ashworth scale and the Tardieu scale measured at the affected ankle one month after botulinum toxin injection. A significant difference in the 6-minute walking test was noted between groups at the post-treatment evaluation (P=0.045).
(Salarian et al. 2007)	A 45-min protocol was used that included typical daily tasks: quiet sitting and standing, eating, writing, talking while seated, walking inside the room, brushing the teeth, combing hair, walking in a 20-m pathway, climbing up and down the stairs, and lying on a bed. Participants carried the measurement system during the protocol and the measurement period was recorded on vídeo.	For the detection of posture transitions, compared to video recordings used as a reference system, the proposed algorithm demonstrated a sensitivity [true-positives divided by true-positives plus false-negatives) of 94.4% and a positive predictive value (PPV): true-positives divided by true-positives plus false-positives] of 96.9% for the controls (n = 232), and a sensitivity of 83.8% and a PPV of 87.0% for the PD patients (n = 272). In the classification of basic activities, i.e., walking, standing, sitting, and lying, the algorithm had a sensitivity of 99.1%, 96.1%, 99.5%, and 100%, respectively, for the control group and 98.5%, 83.6%, 86.3%, and 91.8%, respectively, for the PD patients. The specificity (true-negatives divided by true-negatives plus false-positives) of the algorithm for these basic activities for the control group was 99.8%, 97.9%, 99.8%, and 100%, respectively, and 97.8%, 96.5%, 98.0%, and 99.8%, respectively, for PD patients.
(Tousignant et al. 2011)	Both interventions (teletreatment and home care/outpatient clinic) focused on functional rehabilitation. The mean duration of each therapy session was about 1 h of treatment (including treatment assessment and recommendations between treatments). The teletreatments were delivered to the participants at a rate of two sessions per week for 8 weeks (total of 16 sessions). The home visit/outpatient clinic treatments were delivered as usual over a period of 2 months on average, and the number of sessions was not controlled by research procedures but took place as usual in-home care/outpatient clinic services. No change was made in frequency, duration, or exercises.	Both groups of patients (Tele and Comparison) were satisfied with the services received and no significant difference was observed between them. Moreover, the physiotherapists' satisfaction with regard to goal achievement, patient–therapist relationship, overall session satisfaction, and quality and performance of the technological platform was high.

CVG: control group; TG: Technological group; CG/ CTRL: Control Group; HBR: home-based rehabilitation; ML: Machine Learning; WMFT: Wolf Motor Function Test; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment: CAU: care as usual; SWM: spatial working memory; CANTAB: Cambridge Neuropsychological Test Automated Battery; E-RAGT, end-effector robot-assiste gait training; BWST: bodyweight-supported treadmill training; FMA: Fugl-Meyer assessment, EMS: exercise motivation scale; CRI: Cognitive Reserve Index; MI: Motricity Index; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; ANCOVA: analysis of covariance; ABC: activities-specific balance confidence scale; FAC: functional ambulation category; HR: heart rate; BDI – II: Beck depression inventory-II; BRPE: Borg rating of perceived exertion; BBS: berg balance scale; SASMP: smartphone app-based, self-management program; HBPM: home blood pressure monitor; PD: Parkinson's disease; RAGT: Robot-assisted gait training; TYR: Tyromotion; ROM: range of motion; DSP: digital signal processor

Table 2.5 *(continued)*

Author	Intervention	Result
(Tramontano et al. 2020)	Both groups performed the training three times a week for 4 weeks. Each session lasted 40 minutes and was performed in addition to the conventional neurorehabilitation. Both rehabilitation programs were carried out by a physiotherapist with experience in neurorehabilitation. Experimental group's intervention TYRg performed twelve sessions of upper limb training with PABLO®-Tyromotion. For each session, the training consisted in interactive games based on virtual reality which allowed a taskoriented approach and neurocognitive feedback. Control group's intervention CTRLg performed twelve sessions of upper limb sensory-motor training, without robotic support. Subjects performed specific exercises aimed to recover global upper limb functions, to control hand grasp and to improve hand's fine movements.	The within-subject analysis showed a statistically significant improvement in both groups, in the Modified Barthel Index and in the Rivermead Mobility Index scores and a significant improvement in Multiple Sclerosis Quality of Life-54 in the experimental. The analysis of effectiveness revealed that, compared with baseline (T0), the improvement percentage in all clinical scale scores was greater in the experimental group than the control group.
(Yeh et al. 2014)	The patients were given a standard 6-training session protocol. The training tasks and the balance test were conducted by currently practicing licensed physical or occupational therapists. The patients in the experimental group were divided into 3 groups: before treatment, undergoing treatment, and after treatment. Therapists were requested to conduct a Wii Fit balance test before and after each training session. Upon completion, all subjects were invited to join our survey, which focused on analyzing the sufficiency of gaming instructions, game appearance, system usefulness/playfulness, motivation promotion, and the ease-of-use of all game types. In addition, the subjects' personal information and their type of dizziness were recorded.	Analyzing the balance indices, in the patients who completed the training process, it was evidenced that they progressed and the difference between normal and patients is perceptible.
(Zhang et al. 2002)	The beginning of the experiment, the subject was examined for spasticity and contracture using the Ashworth scale (0 to 4), tendon reflex scale (0 to 4) and joint range of motionBefore the subject's ankle was exercised passively or actively, tendon reflexes were evaluated quantitatively by tapping the Achilles tendon with an instrumented reflex hammer and measuring the reflex responses. Before stretching, the joint stretching device was rotated manually by the operator to the extreme dorsiflexion and plantar flexion to set the extreme position limits (θp and θn). After the operator chose the Mp, Mn and θd values and entered them into the computer (default values and proper ranges were prespecified), the stretching device flexed the ankle throughout its ROM, with the DSP controller controlling the stretching velocity based on the resistance torque. The patient was asked to relax and not to react to the stretch (if they reacted to the stretch, it would simply make the stretching device reverse its rotation before reaching to the extreme positions). The typical stretching velocity and peak resistance torque were chosen based on practice of experienced physical therapists.	The relationship between the ankle dorsiflexion and external dorsiflexion torque (plantar flexor muscle resistance torque) during the strenuous stretching was quite different between healthy subjects and patients with spastic/contracted ankles. The passive ROM of the ankle joint increased considerably after the stretching treatment of spastic ankle, evaluated at comparable levels of stretching torque. For a representative case, dorsiflexion range increased from 11.9 to 16.5 at the same level of terminal torque (10 N·m) after a stretching session of 30 min. Similarly, plantar flexion range increased from 32.1 to 35.5 at a 10 N·m torque. Over multiple patients, the increase in ankle ROM was consistently observed in both dorsiflexion and plantar flexion, making the passive ROM closer to that of the healthy subjects.

CVG: control group; TG: Technological group; CG/ CTRL: Control Group; HBR: home-based rehabilitation; ML: Machine Learning; WMFT: Wolf Motor Function Test; NFT: neurofeedback training; aMCI: amnestic mild cognitive impairment: CAU: care as usual; SWM: spatial working memory; CANTAB: Cambridge Neuropsychological Test Automated Battery; E-RAGT, end-effector robot-assiste gait training; BWST: bodyweight-supported treadmill training; FMA: Fugl-Meyer assessment, EMS: exercise motivation scale; CRI: Cognitive Reserve Index; MI: Motricity Index; WLT: Walkbot-assisted locomotor training; CLT: conventional locomotor training; ANCOVA: analysis of covariance; ABC: activities-specific balance confidence scale; FAC: functional ambulation category; HR: heart rate; BDI – II: Beck depression inventory-II; BRPE: Borg rating of perceived exertion; BBS: berg balance scale; SASMP: smartphone app-based, self-management program; HBPM: home blood pressure monitor; PD: Parkinson's disease; RAGT: Robot-assisted gait training; TYR: Tyromotion; ROM: range of motion; DSP: digital signal processor.

2.4 DISCUSSION

This review looked for scientific proof of technology that could assist in the rehabilitation process in a complementary or alternative fashion to traditional methods. We made the decision to construct a study that focuses on several technologies because most of the studies we identified give support for rehabilitation technology tools. There is a dearth of literature connecting the peculiarities of technological intervention with the clinical skills that physiotherapists need to approach the process of physical rehabilitation.

Robotic equipment makes up the biggest percentage of technological gadgets that could be used in a rehabilitation program, as shown in Table 2.3 (Cecchi et al. 2021; Kim et al. 2020; Padua et al. 2020; C. Park et al. 2020; Picelli et al. 2016). Soon after that, assistive technologies that are compatible with mobile gadgets like tablets, cell phone applications, or smart watches started to appear (Bickmore, Schulman, and Sidner 2013; Chae et al. 2020; Lao et al. 2021; S. K. Park, Bang, and Lee 2020; Persell et al. 2020; Tousignant et al. 2011). Finally, we saw both immersive and non-immersive virtual reality gaming devices in clinical settings (Fernández-González et al. 2019; Jirayucharoensak et al. 2019; Yeh et al. 2014).

Another aspect that stands out is the fact that the majority of the included research look for scientific proof of the technologies under investigation in order to assist in the rehabilitation of patients who have motor deficits brought on by neurological disorders like stroke, Parkinson's disease, and Multiple Sclerosis. (Chae et al. 2020; Fernández-González et al. 2019; Kim et al. 2020; Padua et al. 2020; C. Park et al. 2020; Picelli et al. 2016; Salarian et al. 2007; Tramontano et al. 2020; Zhang et al. 2002).

However, other fields that embrace the rehabilitation of motor abnormalities brought on by fractures, following orthopedic surgeries, or after systemic diseases like cardiac and respiratory disorders are also aided by rehabilitation technologies. (C. Park et al. 2020; Persell et al. 2020).

The technologies under study have broad applicability and meet the primary goals and skills of clinical practice for a rehabilitation professional, especially preventive skills as a motivator for a balanced diet and regular exercise (Bickmore, Schulman, and Sidner 2013; Lao et al. 2021). Technology can also support assessment abilities with attention to

memory and care for systemic problems like high blood pressure (Jirayucharoensak et al. 2019; Lao et al. 2021). In addition to technology that can treat physical dysfunctions such orthopedic and respiratory conditions, as well as balance and gait issues, (Aprile et al. 2020; S. K. Park, Bang, and Lee 2020; Yeh et al. 2014).

Regarding country representation, it is clear from the demographic and sample statistics presented in Table 2.4 that Italy and South Korea stand out, each having five of the eighteen studies that are included and evaluate technology in the context of rehabilitation. If we look at the continents, Asia has had the most research done with eight, one more than Europe and four more than the united United States and Canada.

Only five studies were found in which the average age stated in the data was clearly below 60 years. Most studies were focused on the elderly population. In eight studies, there were more men than women; in two studies, the sex of the participants in the randomized groups was not stated; and in one study, the number of men and women who participated in the study was equal.

Regarding the clinical intervention findings shown in Table 2.5, all studies showed a substantial outcome of their individual technology-supported intervention suggestions. These findings bolster the body of scientific data showing physiotherapists and other rehabilitation specialists can use these technologies.

In general, all the technologies discovered in the studies examined in this review have the potential to bring about advantages like improved access to health services, quick access to low-cost professional activities, and high efficacy in the rehabilitation process, ensuring universal coverage of this service (Aprile et al. 2020). The use of technology-assisted rehabilitation has an impact on the frequency of appointments with rehabilitation specialists and helps ease the pressure on health systems that house reference facilities for the treatment of physical-motor diseases. (Bickmore, Schulman, and Sidner 2013).

Additionally, adopting web-based tools like mobile phone applications to track activities in rehabilitation facilities might help with patient monitoring. By using this strategy, specialists can lessen the difficulty of performing rehabilitation without being physically present as professionals.

There is still a need for assessment methods and research to verify the effectiveness of technological treatments. It is important to consider the possibility of instability in electrical energy supply systems and internet connectivity as these are crucial and required for the operation of most current technologies that have the potential for technological interventions in rehabilitation.

2.5 CONCLUSIONS

With little to no involvement from the physiotherapist, rehabilitation technologies have the potential to effectively intervene in physical rehabilitation in a variety of clinical activities carried out by professionals like physiotherapists. These clinical activities include injury prevention, movement monitoring, and coordination of rehabilitation programs. Given the quick modernization that ensures increasingly higher autonomy for existing equipment, new research that examine the effects of rehabilitation performed or monitored by digital technologies, artificial intelligence, and robotics continue to be essential.

REFERENCES

Aprile, I., Iacovelli, C., Cruciani, A., Simbolotti, C., Loreti, S., Galli, G., Vulpiani, M. C., & Padua, L. (2020). Technological rehabilitation versus conventional rehabilitation following hip replacement: A prospective controlled study. Journal of Back and Musculoskeletal Rehabilitation, 33(4), 561–568. https://doi.org/10.3233/BMR-181211

Bickmore, T. W., Schulman, D., & Sidner, C. (2013). Automated interventions for multiple health behaviors using conversational agents. Patient Education and Counseling, 92(2), 142–148. https://doi.org/10.1016/j.pec.2013.05.011

Cecchi, F., Germanotta, M., Macchi, C., Montesano, A., Galeri, S., Diverio, M., Falsini, C., Martini, M., Mosca, R., Langone, E., Papadopoulou, D., Carrozza, M. C., & Aprile, I. (2021). Age is negatively associated with upper limb recovery after conventional but not robotic rehabilitation in patients with stroke: a secondary analysis of a randomized-controlled trial. Journal of Neurology, 268(2), 474–483. https://doi.org/10.1007/s00415-020-10143-8

Chae, S. H., Kim, Y., Lee, K.-S., & Park, H.-S. (2020). Development and Clinical Evaluation of a Web-Based Upper Limb Home Rehabilitation System Using a Smartwatch and Machine Learning Model for Chronic Stroke Survivors: Prospective Comparative Study. JMIR MHealth and UHealth, 8(7), e17216. https://doi.org/10.2196/17216

Clark, W. E., Sivan, M., & O'Connor, R. J. (2019). Evaluating the use of robotic and virtual reality rehabilitation technologies to improve function in stroke survivors: A narrative review. Journal of Rehabilitation and Assistive Technologies Engineering, 6, 205566831986355. https://doi.org/10.1177/2055668319863557

Fernández-González, P., Carratalá-Tejada, M., Monge-Pereira, E., Collado-Vázquez, S., Sánchez-Herrera Baeza, P., Cuesta-Gómez, A., Oña-Simbaña, E. D., Jardón-Huete, A., Molina-Rueda, F., Balaguer-Bernaldo de Quirós, C., Miangolarra-Page, J. C., & Cano-de la Cuerda, R. (2019). Leap motion controlled video game-based therapy for upper limb rehabilitation in patients with Parkinson's disease: a feasibility study. Journal of NeuroEngineering and Rehabilitation, 16(1), 133. https://doi.org/10.1186/s12984-019-0593-x

Higgins, J. P., Li, T., & Deeks, J. J. (2023). Assessing risk of bias in a randomized trial. In W. V. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ (Ed.), Cochrane Handbook for Systematic Reviews of Interventions (Vers. 6.4). Cochrane. www.training.cochrane.org/handbook

Jirayucharoensak, S., Israsena, P., Pan-ngum, S., Hemrungrojn, S., & Maes, M. (2019). A game-based neurofeedback training system to enhance cognitive performance in healthy elderly subjects and in patients with amnestic mild cognitive impairment. Clinical Interventions in Aging, Volume 14, 347–360. https://doi.org/10.2147/CIA.S189047

Kim, H., Park, G., Shin, J.-H., & You, J. H. (2020). Neuroplastic effects of end-effector robotic gait training for hemiparetic stroke: a randomised controlled trial. Scientific Reports, 10(1), 12461. https://doi.org/10.1038/s41598-020-69367-3

Kumar, A., Gadag, S., & Nayak, U. Y. (2021). The beginning of a new era: Artificial intelligence in healthcare. Advanced Pharmaceutical Bulletin, 11(3), 414–425. https://doi.org/10.34172/apb.2021.049

Lao, C. K., Wang, B. L., Wang, R. S., & Chang, H. Y. (2021). The Combined Effects of Sports Smart Bracelet and Multi-Component Exercise Program on Exercise Motivation among the Elderly in Macau. Medicina, 57(1), 34. https://doi.org/10.3390/medicina57010034

Olu, O., Muneene, D., Bataringaya, J. E., Nahimana, M.-R., Ba, H., Turgeon, Y., Karamagi, H. C., & Dovlo, D. (2019). How Can Digital Health Technologies Contribute to Sustainable Attainment of Universal Health Coverage in Africa? A Perspective. Frontiers in Public Health, 7(November), 1–7. https://doi.org/10.3389/fpubh.2019.00341

Padua, L., Imbimbo, I., Aprile, I., Loreti, C., Germanotta, M., Coraci, D., Piccinini, G., Pazzaglia, C., Santilli, C., Cruciani, A., Carrozza, M. C., Pecchioli, C., Loreti, S., Lattanzi, S., Cortellini, L., Papadopoulou, D., Liberti, G., Panzera, F., Mitrione, P., … Lategana, M. (2020). Cognitive reserve as a useful variable to address robotic or conventional upper limb rehabilitation treatment after stroke: a multicentre study of the Fondazione Don Carlo Gnocchi. European Journal of Neurology, 27(2), 392–398. https://doi.org/10.1111/ene.14090

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J.,

Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. The BMJ, 372. https://doi.org/10.1136/bmj.n160

Park, C., Oh-Park, M., Dohle, C., Bialek, A., Friel, K., Edwards, D., Krebs, H. I., & You, J. (Sung) H. (2020). Effects of innovative hip-knee-ankle interlimb coordinated robot training on ambulation, cardiopulmonary function, depression, and fall confidence in acute hemiplegia. NeuroRehabilitation, 46(4), 577–587. https://doi.org/10.3233/NRE-203086

Park, S. K., Bang, C. H., & Lee, S. H. (2020). Evaluating the effect of a smartphone app-based self-management program for people with COPD: A randomized controlled trial. Applied Nursing Research, 52(September 2019), 151231. https://doi.org/10.1016/j.apnr.2020.151231

Persell, S. D., Peprah, Y. A., Lipiszko, D., Lee, J. Y., Li, J. J., Ciolino, J. D., Karmali, K. N., & Sato, H. (2020). Effect of Home Blood Pressure Monitoring via a Smartphone Hypertension Coaching Application or Tracking Application on Adults With Uncontrolled Hypertension: A Randomized Clinical Trial. JAMA Network Open, 3(3), e200255. https://doi.org/10.1001/jamanetworkopen.2020.0255

Picelli, A., Bacciga, M., Melotti, C., LA Marchina, E., Verzini, E., Ferrari, F., Pontillo, A., Corradi, J., Tamburin, S., Saltuari, L., Corradini, C., Waldner, A., & Smania, N. (2016). Combined effects of robot-assisted gait training and botulinum toxin type a on spastic equinus foot in patients with chronic stroke: a pilot, single blind, randomized controlled trial alessandro. European Journal of Physical and Rehabilitation Medicine, 759–766.

Raso, I., Hervás, R., & Bravo, J. (2010). M-Physio: Personalized accelerometer-based physical rehabilitation platform. UBICOMM 2010 - 4th International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies, c, 416–421.

Ritschel, H., Seiderer, A., Janowski, K., Wagner, S., & André, E. (2019). Adaptive linguistic style for an assistive robotic health companion based on explicit human feedback. ACM International Conference Proceeding Series, 247–255. https://doi.org/10.1145/3316782.3316791

Salarian, A., Russmann, H., Vingerhoets, F. J. G., Burkhard, P. R., & Aminian, K. (2007). Ambulatory monitoring of physical activities in patients with Parkinson's disease. IEEE Transactions on Biomedical Engineering, 54(12), 2296–2299. https://doi.org/10.1109/TBME.2007.896591

Tortorella, G. L., Fogliatto, F. S., Espôsto, K. F., Vergara, A. M. C., Vassolo, R., Mendoza, D. T., & Narayanamurthy, G. (2020). Effects of contingencies on healthcare 4.0 technologies adoption and barriers in emerging economies. Technological Forecasting and Social Change, 156(December 2019), 120048. https://doi.org/10.1016/j.techfore.2020.120048

Tousignant, M., Boissy, P., Moffet, H., Corriveau, H., Cabana, F., Marquis, F., & Simard, J. (2011). Patients' Satisfaction of Healthcare Services and Perception with In-Home

Telerehabilitation and Physiotherapists' Satisfaction Toward Technology for Post-Knee Arthroplasty: An Embedded Study in a Randomized Trial. Telemedicine and E-Health, 17(5), 376–382. https://doi.org/10.1089/tmj.2010.0198

Tramontano, M., Morone, G., De Angelis, S., Casagrande Conti, L., Galeoto, G., & Grasso, M. G. (2020). Sensor-based technology for upper limb rehabilitation in patients with multiple sclerosis: A randomized controlled trial. Restorative Neurology and Neuroscience, 38(4), 333–341. https://doi.org/10.3233/RNN-201033

Wiederhold, B. K., Miller, I. T., & Wiederhold, M. D. (2018). Using virtual reality to mobilize health care. IEEE Consumer Electronics Magazine, 7(january), 106–109.

Yang, G., Pang, Z., Jamal Deen, M., Dong, M., Zhang, Y. T., Lovell, N., & Rahmani, A. M. (2020). Homecare Robotic Systems for Healthcare 4.0: Visions and Enabling Technologies. IEEE Journal of Biomedical and Health Informatics, 24(9), 2535–2549. https://doi.org/10.1109/JBHI.2020.2990529

Yeh, S. C., Huang, M. C., Wang, P. C., Fang, T. Y., Su, M. C., Tsai, P. Y., & Rizzo, A. (2014). Machine learning-based assessment tool for imbalance and vestibular dysfunction with virtual reality rehabilitation system. Computer Methods and Programs in Biomedicine, 116(3), 311–318. https://doi.org/10.1016/j.cmpb.2014.04.014

Zhang, L. Q., Chung, S. G., Bai, Z., Xu, D., Van Rey, E. M. T., Rogers, M. W., Johnson, M. E., & Roth, E. J. (2002). Intelligent stretching of ankle joints with contracture/spasticity. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 10(3), 149–157. https://doi.org/10.1109/TNSRE.2002.802857

CHAPTER 3

REHABILITATION TECHNOLOGIES IN PHYSIOTHERAPY EDUCATION

Heutagogy in the Transformation of Physiotherapy Training Content: A Systematic Review from the perspective of Innovations in Higher Education in Health

ABSTRACT

Background: Learner autonomy and self-direction are key components of the student-centered teaching method known as heutagogy. Technology can help the heutagogy approach in higher health education by giving students access to a variety of learning resources and enabling them to customize their own learning. **Objective:** The goal of this review is to find and combine the strongest evidence from studies that examine the use of heutagogy in higher education in the health field, with results that might be applicable to physiotherapy programs, to determine whether this approach can serve as a model for adequate teaching for the technological evolution of rehabilitation teaching and learning that ensures the adaptation of theoretical and practical knowledge. **Methods:** A PRISMA assessment of randomized and observational studies in the Embase, PubMed, Physiotherapy Evidence Database (PEDro), and SciELO databases was contemplated in the protocol for this project, which was published on the PROSPERO platform and assigned a registration number. Studies written in English or Portuguese and published between 2000 and 2020 that clearly incorporated heutagogy in higher education training in the health field and had a direct connection to or the potential to be implemented in the curriculum of a physiotherapy degree were taken into consideration. **Results:** 537 of the 544 papers that were found did not fit the study's objectives. The PRISMA 2020 systematic review reporting flowchart served as the framework for organizing the screening of studies. Six observational studies have a medium risk of bias, according to the Newcastle-Ottawa Scale (NOS) risk of bias analysis. We employed the Cochrane RoB - 2 method for the one randomized study that was included, which led to a minimal risk of bias. Seven studies in total, two in medicine, two in nursing, two in physiotherapy, and one generic. **Conclusion:** The similarity between health courses encourages

interdisciplinary collaboration between the identified heutagogical approaches, which can enhance physiotherapy instruction by leveraging experiences from other disciplines' use of those approaches. Few studies were discovered, highlighting the need for fresh investigation that can assist educators and learners in developing critical, efficient, and independent clinical thinking while adding heutagogy into their training.

Trial Registration: PROSPERO registration number CRD42021253326

Keywords: heutagogy, learning, technological learning, higher education, health professions, physiotherapy.

3.1 INTRODUCTION

Since the development of the methods that support this process, the literary documentation of the methods, and the establishment of the conduct of those involved in disseminating it, the teaching and learning process has undergone constant changes, most notably in the figure of the teacher as holder of knowledge and of the student as the learner. (Solijonovna 2020).

Whether they are more classic, like pedagogy and andragogy, or more modern, like heutagogy, which is currently being investigated to assure the fullness of its potential, multiple methods are regarded vital in the teaching-learning process (Glassner and Back 2020).

Finding the learning approach that is best suited to the dynamics of the educational world in which they operate is one of the main obstacles for instructors when faced with changes in learning methodology (Dirk Vissers et al. 2018).

As an illustration, a teaching approach based on pedagogical principles has a tendency to minimize the student's role in the teaching-learning process and to place the teacher at the center of the most important choices, such as the selection of the themes that will be covered in the curriculum and the type of instruction that will be used along the way (Gülden 2014).

Alexander Kapp (1800–1869), a German professor, was the first to discuss andragogy as a method for teaching and learning adults in the European environment. He did so by

presenting it as a new teaching strategy(Loeng 2017). Malcolm Knowles, an American, expanded on Alexander's research and developed an innovative adult education teaching strategy in 1970, solidifying the term "andragogy"(Loeng 2018).

Like pedagogy, andragogy places the teacher in charge of instruction. The key distinction is that in andragogy, students are frequently older and have more control over how they learn the subject matter chosen by their teacher (Gülden,(Gülden 2014).

Heutagogy, developed by Stewart Hase and Chris Kenyon from the University of Southern Cross in Australia in the early 2000s, is another approach that has been gaining ground in instructional methods at all levels (Hase 2016). Heutagogy appears to be gradually catching up to the demands of the 21st century for a method of instruction that integrates technology (Narayan, Herrington, and Cochrane 2019).

When considering heutagogy, one must consider the balance between the teacher and the student as the learning's primary drivers; the teacher ceases to be the protagonist and instead acts as a mediator, teaching the student how to learn (Blaschke 2012). The student, in turn, assumes responsibility for looking for fundamental information to learn professional skills, operating independently and asking the teacher for assistance as needed (Moore 2020).

One of the key features of this teaching approach is the connection it makes with technology. As a result, digital tools like mobile apps and learning platforms designed to facilitate teaching through videos, photos, and sounds have emerged as crucial resources in the heutagogical learning process (Narayan, Herrington, and Cochrane 2019).

Information and communication technologies, or ICTs, are a frequent word for teaching-learning intermediary technologies (González-Zamar et al. 2020).

The pedagogical effectiveness and role of ICTs in the teaching-learning setting that fosters care skills in the fields of health training in higher education have also received a great deal of discussion (Vázquez-Cano et al. 2020).

This review aims to investigate the application of heutagogy in university health courses, with the purpose of evaluating the effectiveness of this model in improving learning. Furthermore, we seek to evaluate the potential success of implementing heutagogy in the training of physiotherapists. The focus of the analysis is on the adaptation of theoretical

and practical curricular contents that prepare physiotherapy students to perform their roles in rehabilitation, with the continuous promotion of the development of critical thinking and clinical reasoning.

3.2 METHODS

3.2.1 Research Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement served as the basis for this systematic review (Page et al. 2021). The ID for this study's publication in PROSPERO is CRD42021253326. It was prospectively registered.

3.2.2 Information Sources

A thorough search was conducted in the following electronic databases: Embase, PubMed, Physiotherapy Evidence Database (PEDro), and SciELO to find pertinent research. The bibliographical references of the publications were carefully examined, and the specifics of the techniques were extensively examined.

3.2.3 Search Strategy

The search terms "heutagogy" AND "learning" OR "technological learning" was combined to create the search equation. Full text, English, and portuguese are filtered from 2000 to 2020. For effective research retrieval in each database listed in the review's procedure, search phrases and Boolean operators AND and OR were modified. On July 30, 2021, and again on August 3, 2021, the databases were searched. The obtained studies were exported to a Mendeley® file after the search tactics were carried out, and the outcomes were compiled in a flowchart (Figure 3-1). The electronic scientific database's keywords and reading the whole articles helped determine the study design in the end. Keywords: higher education, health professions, physiotherapy, heutagogy, learning, technological learning.

3.2.4 Eligibility Criteria

We looked for papers that described research studies with demonstrable outcomes on educational approaches using heutagogy as a teaching-learning method at the university level. Cross-sectional, longitudinal, and observational studies were chosen for the beginning stages of this systematic review. We considered including observational, cross-sectional, or longitudinal studies conducted between 2010 and 2020 that were published in Portuguese or English and in some way address heutagogical methodologies that favor the incorporation of technologies into university teaching for physiotherapy graduation.

Studies involving teaching in other health-related vocations that contain curriculum units linked to physiotherapy and that use heutagogical methods throughout professional training were also emphasized for inclusion to extend the perspective on heutagogical methodology. Studies that did not have complete access to the material and pilot studies that attempted to reach higher education students in the field of health but produced no tangible outcomes were omitted.

3.2.5 Study Selection

Two reviewers (TS and JS), university professors with physiotherapy expertise, were involved in the search strategy and identification of pertinent records to determine eligibility. Consensus was reached to settle disagreements when they arose.

3.2.6 Data Collection Process

One reviewer (JS) evaluated a data extraction form that condensed the supporting details from three randomly selected papers. A second reviewer (TS) verified the data extraction, and any questions were answered through conversation. By using this method, it was possible to identify more things that needed to be collected and extract data with higher quality. Although they were integrated with other papers to prevent discrepancies and limits, the data extraction process considered all the information from each study.

3.2.7 Data items

No assumptions were made in cases when an article lacked all the necessary details. To confirm or get more information, the review committee did not speak with the authors.

Data direct access to end users was our main objective. Articles that could be used to extract data were coded. Table 3.3 and Table 3.4 list the data points that were gathered and provide details on the author and year of publication, methodological details, higher education in health that was evaluated, the type of heutagogical intervention utilized in training, and the key findings of each study.

3.2.8 Quality analysis of studies

We utilize two tools to evaluate the likelihood of bias and the caliber of the articles because this review contains both observational and randomized trials. The Newcastle Ottawa Scale (NOS) is used in observational studies, and the evaluation results are shown in Table 3.1. The NOS scale recommended by the Cochrane Collaboration consists of eight criteria categorized in three dimensions: selection, comparability, and outcome or exposure (Cook and Reed 2015).

Two reviewers (TS and JS) independently and blindly examined each study, establishing a value of "0" (if the item We utilize two tools to evaluate the likelihood of bias and the caliber of the articles because this review contains both observational and randomized trials. The Newcastle Ottawa Scale (NOS) is used in observational studies, and the evaluation results are shown in Table 3.1. The NOS scale recommended by the Cochrane Collaboration consists of eight criteria categorized in three dimensions: selection, comparability, and outcome or exposure. was not included) or "1" (if the item was included) for each item; specifically, to measure "comparability", a score of up to 2 could be awarded to that item. A third researcher could be consulted for a final conclusion if there were any differences in the scores given to each study. The sum of the values assigned to each domain cannot result in a score greater than 9, emphasizing that the closer the score is to 9, the higher the study's quality and the lesser the risk of bias.

Table 3.1. Newcastle – Ottawa Scale (NOS)

Study	**Selection 4/4**	**Comparability 2/2**	**Assessment of outcomes 3/3**	**Total Score (9/9)**
(Abraham and Komattil 2017)	2	0	3	5/9
(Bansal et al. 2020)	3	0	2	5/9
(Green and Schlairet 2017)	3	1	2	6/9
(Haraldseid, Friberg, and Aase 2016)	2	0	3	5/9
(Maloney et al. 2013)	3	1	3	7/9
(Rahmi 2020)	3	0	3	6/9

Overall risk-of-bias judgement on the final score: a score of seven to nine was deemed "Low risk of bias," a score of four to six was deemed "Medium risk of bias," and a score of three or less was deemed "High risk of bias." (Oremus et al. 2012).

The following factors were considered in the "Selection" domain evaluation: "representativity of the exposed cohort, choice of the external control group, identification of exposure, and absence of the outcome at the beginning of the study. Comparability of cohorts based on the project or analysis is one of the criteria evaluated under the "Comparability" domain. Evaluation of the outcome; monitoring for long enough for results to occur; and sufficiency of cohort monitoring are the criteria considered in the outcome/Exposure domain. (Oremus et al. 2012).

Following the risk of bias assessment, we used the Cochrane RoB - 2 tool to analyze the risk of bias of reviews that include randomized clinical trial studies and evaluates them by taking into account 5 domains, namely: bias arising from the randomization process; bias due to deviations from intended interventions; bias due to missing outcome data; bias in outcome measurement; and bias in selection of reported outcome. (Higgins, J. P., Li, T., & Deeks 2023).

Table 3.2. Assessing Risk of Bias with the Cochrane Collaboration Tool for Assessing Risk of Bias in Randomized Trials.

Evaluated studies	**Domains and General Risk Assessment**					
Author and Year	**D1**	**D2**	**D3**	**D4**	**D5**	**Overal**
Rogan, S; et al (2020)	−	−	−	−	−	−

D1: Bias arising from the randomization process; D2: Bias due to deviations from intended interventions; D3: Bias due to missing outcome data; D4: Bias in measurement of the outcome; D5: Bias in selection of the reported result. **Overall risk-of-bias judgement:** Low risk of bias = − Some concerns = − High risk of bias = −

In a unanimous judgment, the reviewers determined that 5 observational studies had a "Medium risk of bias" and 1 had a "Low risk of bias" among the studies assessed using the Newcastle-Ottawa Scale (NOS). The Cochrane Collaboration Tool (RoB-2) considered the only randomizing study included and evaluated using it to have a low risk of bias since it delivers high-quality data across all the tool's predetermined domains of analysis.

3.3 RESULTS

3.3.1 Study Selection

The databases were initially searched, yielding 544 articles, 14 of which were duplicates and were suppressed before screening. After duplicates were removed, 530 studies were subjected to the screening procedure, and the specifics of this procedure are shown in Figure 3-1.

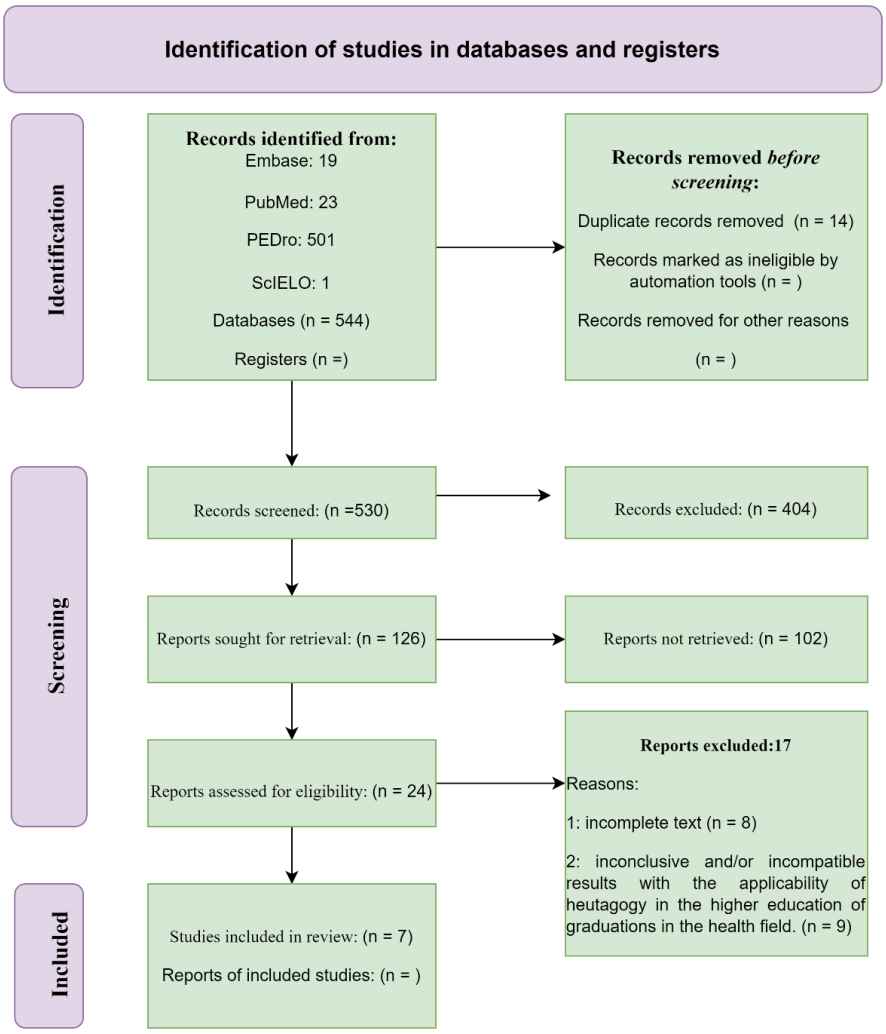

Figure 3-1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

We eliminated 404 papers from the first round of screening because their title and abstract did not match the research topic. After noticing that 102 research in a subsequent screening stage were inconsistent review articles for inclusion, we eliminated them. We

evaluated the eligibility of 24 research following the two screening phases. We thoroughly analyzed the texts, and a new exclusion of 17 studies was made; of these, 8 lacked a full text, and 9 studies were dropped because they were only partially related to teaching-learning activities for a higher-level course in the field of health. The most pertinent data from texts with possibility for inclusion were shown in two tables that were later provided in this study. A total of 537 papers were removed.

3.3.2 Study Details

The topic of introducing heutagogy into health occupations in university education was covered in seven papers, including randomized and observational research. According to Table 3.3: Characteristics of the Studies, the data were evaluated considering the study's location, objective, and demographic and sample characteristics.

Table 3.3. Implementation of the Heutagogic Method in Higher Education Careers in Health: Characteristics of the included studies.

Author and Year of Study	Country	Objectives	Higher health course.	Sample (n=) / SG	Age
(Abraham and Komattil 2017)	India	Consider the application of educational practices based on heutagogy in the context of PBL problem-based learning.	Medicine	(n=?) SG: second year students	_____
(Bansal et al. 2020)	India	The objective was to evaluate the students' perception in relation to three different TL methods (pedagogy, andragogy and heutagogy) in medical education.	Medicine	(n=?) SG: second year students	_____
(Green and Schlairet 2017)	USA	Understand how students perceived their experiences in the inverted classroom and how students' learning dispositions were affected by the inverted classroom experience.	Nursing	(n = 14) SG: Students in the first semester of the BSN.	Mean 26.4 (± SD 7.93); 21 to 48-years-old.
(Haraldseid, Friberg, and Aase 2016)	Norway	The aim of this study was to explore and describe the actual process of student involvement in the development of technological learning material for clinical skills training in a nursing faculty.	Nursing	(n=19) SG: All nursing students who want to participate in the study.	_____
(Maloney et al. 2013)	Australia	The aim of this study was to examine the use and user experiences of an online learning repository (Physeek) in a population of students.	Physiotherapy	(n=231) SG: fourth-year physiotherapy students (with previous clinical experience)	>18 years

PBL: problem-based learning; SG: Searched groups; TL: Teaching and Learning; SPT: physiotherapy undergraduate students in the third semester GSS: Guided Self-Study; BSN: Bachelor of Nursing; CG: Control group.

Table 3.3 *(continued)*

Author and Year of Study	Country	Objectives	Higher health course.	Sample (n=) / SG	Age
(Rahmi 2020)	Indonasia	Discover the relationship between teacher performance and student behavior related to: How did schools manage online classes in the early days of the pandemic? What will a quiz and student questions reveal about the relationship between teacher performance and student behavior?	General: multidisciplinary approach.	(n =75) SG: multidisciplinary approach.	_____
(Rogan et al. 2020)	Switzerland	The main objective of the study was to assess the feasibility of a self-directed GSS intervention that will be planned in an educational graduate program in physical therapy.	Physiotherapy	(n=49) SPT: physiotherapy undergraduate students in the third semester SG: GSS (n = 23) CG (n = 26)	_____

PBL: problem-based learning; SG: Searched groups; TL: Teaching and Learning; SPT: physiotherapy undergraduate students in the third semester GSS: Guided Self-Study; BSN: Bachelor of Nursing; CG: Control group.

We observe similarity among the professions that benefit from heutagogical methods, with two studies each for nursing, medicine, and physiotherapy. Five studies failed to include the participants' ages in the context of the study, while two studies failed to include the number of students they had approached.

3.3.3 Synthesis of Results

The several types of educational approaches that incorporate heutagogical practices in the context of teaching and learning for health career training are stated in Table 3.4.

Table 3.4. Heutagogic Approaches (Interventions and Outcomes)

Studies	Type of study / period of intervention	Interventions	Outcomes
(Abraham and Komattil 2017)	Observational registration cross-sectional / Not determined	Analyzed collaborative learning using technology and PBL. Implemented the Mentored Student Project (MSP) program, incorporating heutagogical principles into medical education.	Social media use supports student autonomy and cognitive engagement. Teachers need to provide scaffolding in this context. Heutagogy enhances students' execution skills. Using social media and PBL expands students' knowledge and improves their learning approaches.
(Bansal et al. 2020)	observational, transverse and comparative / October 2019	Surveyed second-year medical students at SMS Medical College, Jaipur. Assessed their perceptions of instructional strategies: lecture-based pedagogy, self-directed problem-based andragogy, and keyboard technology-based heutagogy.	$p < 0.05$ indicates significant differences among the methods. PCA showed that andragogy and heutagogy were the most effective. Competency-based andragogy and capability-based heutagogy are more effective teaching and learning methods for undergraduate medical students compared to lecture-based didactic pedagogy.

PBL: Problem-based Learning; MSP: Mentored Student Project; SMS: Sawai Man Singh; BFH: Bern University of Applied Sciences (BFH); GSS: Guided Self-Study; SDL: Self-directed Learning; SDtL: Self-determined Learning; MC: Multiple Choice OSCE: Objective Structured Clinical Examination; PCA: Principal Component Analysis

Table 3.4 *(continued)*

Studies	Type of study / period of intervention	Interventions	Outcomes
(Green and Schlairet 2017)	Observational Transverse / Autumn 2012 to Spring 2013	Conducted semi-structured face-to-face interviews with students from flipped classroom cohorts. Purpose: Gather information about their experiences in the flipped classroom.	Identified barriers to implementing the flipped classroom model. Barriers based on student values and preferences. Proposed strategies to overcome these obstacles. Students described their experiences in terms of insight, difficulty, significance, and authority.
(Haraldseid, Friberg, and Aase 2016)	Observational Transverse / Autumn 2013 and Spring 2014	Initiation phase: Informed all clinical skills course students about the project. Invited students to create technological learning materials using tablets for clinical skills training. Purposefully sampled all participants for the Investigation phase and exploratory test during the project's initial phase. After completing the clinical skills course, recruited students. Used portable SimPad® tablets as technological tools for teaching material. Allowed students to familiarize themselves with and freely use the tablets.	Identified five critical learning needs for students. Needs include clarifying learning expectations, recognizing the big picture, stimulating interaction, creating structure, and receiving context-relevant content. Students play a crucial role in adapting learning materials to meet their needs. Students mediate the iterative process of developing new technological learning materials. An adapted co-design process with teachers optimally involves students in tool development.
(Maloney et al. 2013)	Observational Transverse / 2 corresponding academic semesters in 2009 and 2010.	In the third and fourth years of their studies, students utilized the Physeek Digital Repository for 39 weeks of clinical learning. The Physeek repository is an online resource designed for physiotherapy students, offering keyword-searchable learning materials. Enabled remote access to learning resources during workplace practice. Sent a mass email invitation to fourth-grade students. Questionnaire included six statements assessing the impact of Physeek on learning.	Used a 5-point Likert scale for responses to statements. Students favored Physeek as a support tool for reviewing practical skills in clinical placement. Students found Physeek more effective than other educational content sources. Peak usage of Physeek occurred during high-academic-need periods, such as exams. Students see online repositories as valuable for lifelong learning and healthcare delivery. Healthcare professional students value the convenience and accessibility of online learning resources.
(Rahmi 2020)	Observational Transverse / March 2020	Individual optimized teleconferencing platforms. Zoom used for inviting guest lecturers to class. WhatsApp used for written discussions. Professor responsible for four subject areas: Course A: 29 students from various disciplines. Course B: 17 students from the class of 2017. Course C and Course D: 29 students each from the class of 2019.	Peer evaluations conducted in Course C. 29 Course C students evaluated themselves and others in different ways. Course A had the highest average number, followed by C, B, and D. An average of six questionnaires was used across the four courses (Mean = 6.22). Course C started at 8:30 a.m., while Courses A, B, and D started at 1:00 p.m. Proactive approach in developing students' learning skills. Students played a primary role in their own learning.
(Rogan et al. 2020)	Cross-sectional randomized / Between early October and late November 2019	Feasibility study with undergraduate physiotherapy students (n = 51) in their first semester at BFH. Assessed the feasibility of GSS (Guided Self-Study) during the first and third semesters. Curriculum included classroom sessions (lectures, seminars) and self-study units. GSS program comprised three cycles, each with eight components, divided into five periods. Cycles included cases for promoting clinical reasoning in cardiopulmonary, geriatric, musculoskeletal, and other areas. Control Group: Students received no email cases or additional information, following the traditional physiotherapy curriculum.	9 third-year undergraduate physical therapy students participated, with 23 in the GSS group and 26 in the control group. Fidelity in executing the exhibition was maintained. All three GSS phases completed within the 90-minute time frame. Day 8 presentation content tailored to curriculum learning objectives. SDL evaluation not possible as all groups chose the SDtL method. Suggested future research focus on incorporating SDL into tutor meetings. Strong correlation between student receptivity to the GSS session and exam performance (MC exam score and OSCE exam score) found.

PBL: Problem-based Learning; MSP: Mentored Student Project; SMS: Sawai Man Singh; BFH: Bern University of Applied Sciences (BFH); GSS: Guided Self-Study; SDL: Self-directed Learning; SDtL: Self-determined Learning; MC: Multiple Choice OSCE: Objective Structured Clinical Examination; PCA: Principal Component Analysis

Table 3.4 also contains pertinent details on the use of this approach in both theoretical and practical training contexts. The usage of videos, email communication between students and teachers, virtual conferences, and online classes are just a few of the training materials that are included.

3.4 DISCUSSION

Finding and combining the finest information from research that look at the use of heutagogy in college-level health education and whose findings suggest potential techniques to be implemented into physiotherapy higher education was the goal of this review. Additionally, the goal was to ascertain whether the heutagogical method could serve as a teaching model that supports technological innovation in rehabilitation teaching and learning, ensuring that training content could be tailored to the requirements of modern students, and ensuring the development of clinical reasoning and critical thinking skills necessary for physiotherapy clinical practice.

A single randomized study would not be sufficient to ensure a cogent response to the research question, so we examined the specifics of a combination of studies of both an observational and experimental nature because the information that was discovered is valuable and complementary.

Due to the small number of research that could be included in the meta-analysis, and the consequent lack of statistical power, only a few papers that related heutagogy to healthcare education could be examined. We debated whether to undertake a narrative analysis rather than a meta-analysis to comprehend the patterns, gaps, or nuances of existing studies more thoroughly on the topic of heutagogy because a meta-analysis would not be practical or credible given the dearth of data.

Connecting the studies, we can see some considerations made by various authors that contribute to the success of a heutagogical approach inherent to a first point to be addressed in this discussion about the relevant care for the construction and good conduct of the approach.

In the study (Abraham and Komattil 2017), the teacher's heutagogical presentation is crucial. This strategy would allow the teacher to facilitate student autonomy and help

them overcome obstacles to reach their goals. According to (Abraham and Komattil 2017) the shift from a teacher who controls the learning process to one who guides pupils to achieve their potential can lead to insecurity and a loss of power, including The major problem for heutagogical interventions is that they require more student autonomy and require the teacher to adapt to change.

He asserts in a supporting opinion (Bansal et al. 2020) that the function of the teacher who applies the heutagological model to his work is that of a guide and facilitator, informing students about the subject to be covered and the resources available to delve deeper into it rather than engaging in a detailed discussion. Although this concern about the teacher's role exists (Haraldseid, Friberg, and Aase 2016), it highlights the fact that in heutagological teaching approaches, even when students have looked for all conceivable sources of knowledge, they appreciate the teacher's input in particular. Although it was frequently the least common option, students perceived teacher help as the safest and highest-level source of information to test their knowledge.

Students' reluctance to the unfamiliar method is another potential hurdle to the reverse classroom model, according to (Green and Schlairet 2017). Students were mainly used to a more traditional Classroom model and had little experience with the reversed Classroom Model. According to this viewpoint, (Bansal et al. 2020) underlines the significance of observing students' abilities to differentiate between various teaching approaches and their confidence in learning through heutagogy.

The discovery of the need to clarify the teaching method, according to Green and Schlairet (2017), contributes to a richer understanding of the potentially previously identified discrepancies in student satisfaction with the model by requiring teachers to pay attention to students' preferences, which are a crucial component of evidence-based education.

The author of the study (Haraldseid, Friberg, and Aase 2016) highlights the process in which students actively participate in the creation of a collective and interactive process that prioritizes the identification of the students' own needs and attempts to meet them before adjusting the students to the needs and solutions suggested by the heutagological method, emphasizing that without this repetitive process, the development of the specific learning need will not be appropriate.

Therefore, (Maloney et al. 2013) emphasizes the need of using high-quality instructional technology resources. In their study (Maloney et al. 2013) , students viewed the web-based repository as the most efficient and preferable learning resource, however it should be improved to improve access. This emphasis on efficiency is supported by comments that finding helpful information quickly reinforces the search for relevant material and supports active learning.

The excessive solitude of tasks with short deadlines, use of technological resources that do not motivate students, and economic restrictions that may prevent some students from using laptops m ay cause constraints (Rahmi 2020)**.** However, the study of (Rahmi 2020) recognizes the flexibility of teaching with Smartphones and other devices.

In their study of undergraduate physiotherapy students, (Rogan et al. 2020) recommend timing heutagological activities correctly in the curriculum calendar to avoid high hourly load. In the program he developed, students were overburdened with weekly hourly loads, and this evidence shows that higher hours of teaching result in a greater student workload, which lacks stimulation for deeper learning and increases the likelihood of superficial learning approaches.

The presentation of various implementation options for a heutagogy-based approach is the second purpose of this debate; According to (Green and Schlairet 2017), there are many ways to flip a classroom and multiple presenting styles, each of which is specific to the participants. It is challenging to standardize the intervention enough to replicate it outside of a single instructor's course, though.

The study of (Abraham and Komattil 2017)described a heutagological approach to collaborative learning in which students work in groups and share resources to apply heutagonic principles using social media. This approach can improve clinical reasoning.

The approach of (Abraham and Komattil 2017) requires students to create environments that identify collective learning needs. They can then negotiate the level to which they want to maximize their learning, decide on the appropriate technology to engage in learning, and evaluate, which is validated by the facilitator, the teacher standing in as a guide.

After confirming the subject, social media integration, and teacher validation, the PBL-Problem Based Learning systematizes the path that follows the heutagological principles. According to (Abraham and Komattil 2017), medical students' clinical reasoning improved when the heutagological approach was combined with PBL.

Reading and sharing texts and videos of patients' and students' experiences in a class set up on mobile phones is part of learning that keeps students aware of the fundamental reality of the problem, which is presented with available digital resources, as described by (Bansal et al. 2020)to his medical students. Just like hospitals and communities, the digital platforms will be future workplaces. Heutagogy is cited in the study of (Bansal et al. 2020) as an efficient technique for building medical training capability.

A remodeled classroom in nursing training accommodated four-person tables and Wi-Fi-enabled portable devices for digital teaching materials (Green and Schlairet 2017). Open class with narrated lectures and pre-readings students could watch at their convenience created a deliberate, self-directed, and autonomous learning environment. Heutagogy-based exercises equip students for reverse classroom lesson application.

Discussing pre-learning topics with classmates and exploring other materials was encouraged. Students applied knowledge in pairs, small groups, short class discussions, problem-solving scenarios, case studies, simulation, readiness questionnaires, and presentations. Professors analyzed students' ideas, critiqued their flaws, and encouraged their strengths.

Nurses require better training to work efficiently and collaboratively (Green and Schlairet 2017). By teaching nurses critical thinking skills like understanding, reasoning, and exploration and building lifelong learning through the sharing of knowledge rather than the accumulation of knowledge, the reversed classroom and heutagological model of teaching can promote the necessary changes (Green and Schlairet 2017).

By actively involving nursing students in the development of technological learning material, the students described how they could learn more constructively, and the teacher became the advocate of learning needs to adapt the material to learning needs (Haraldseid, Friberg, and Aase 2016). Students prepared for a final oral exam with multiple choice questions, video movies, scheduled readings, and email correspondence with teachers. The study of Haraldseid, Friberg, and Aase (2016) suggested online discussion forums

and personal meetings, emphasizing tools that simplified the learning process by incorporating content through the layout and design of a tablet that allowed students to give feedback.

Using Monash University's Physeek, a keyword-searchable online repository of learning resources, Maloney et al; (2013) conducted a successful heutagogic experiment. Since undergraduate physiotherapy students needed remote access to learning resources in their practices, the repository was created. Web-based learning repositories like Physeek allow academic personnel to develop, store, and manage instructional information electronically. Authorized users with Internet access can utilize it. Education professionals liked comparing their knowledge and opinions to student notions. Lesson notes, practical demonstration films, self-directed learning modules, and practical lesson pre-readings encourage clinical practice competence (Maloney et al. 2013).

In March 2020, Rahmi (2020) conducted an analysis and description of the acquisition of knowledge among students in the health field. The author, in the role of a speaker, employed a combination of teleconference platforms to facilitate seven meetings across four courses. Various platforms were utilized for the purposes of inviting students and engaging in discussions on class topics.

Based on practicing self-study that is integrated into a physiotherapy course, Rogan et al (2020) outline and specify three different types of self-studies: free self-study (FSS), individual self-study, and directed self-study (GSS). In order to advance knowledge and skills in undergraduate physiotherapy students with regard to clinical reasoning in respiratory patients, balance and strength assessment in elderly people, and examination of patients with elbow disorders, Rogan et al; (2020) evaluated the viability of GSS, a multifaceted program that followed a student-centered learning approach. Learning activities were concentrated on classroom sessions, seminars, self-study, and exam preparation.

In order to implement a heutagological teaching-learning approach, it is important to take into account the prior and ongoing contributions made by the various authors (Abraham and Komattil 2017). Students who are supported in exercising more autonomy grow up to be high achievers as opposed to students who are under pressure to meet others' expectations. According to Abraham and Komattil (2017), the active use of social media

increases student engagement because the current generation is digitally savvy. This enables the implementation of curriculum reforms based on heutagogy by bringing the benefits of social networks, such as connectivity, interaction, and abundance of information.

In the work of Bansal et al; (2020), students have discovered heutagogy to be coherent in a practice-oriented type of education, which has given them more self-assurance about their capacity to relate to various teaching philosophies. Andragogy prepares them to use their skills in training environments, but heutagogy is a teaching-learning strategy that enables them to work under any conditions while utilizing their creative, cognitive, communicative, collaborative, and digital skills and successfully graduate to prepare professionals who are knowledgeable, skilled, and capable.

Even when students may feel unfavorably about a new learning paradigm, (Green and Schlairet 2017) emphasizes the need to take into account more in-depth, diversified evidence connected to student advancement in lifetime learning aspects. Due to the values and preferences of the students, we specifically identified hurdles to the reverse classroom model implementation and suggested solutions to overcome them.

As noted by Haraldseid, Friberg, and Aase (2016), students' iterative participation in the creation of new technology learning materials promotes the recognition of the student's significant learning needs. Additionally, it appears that the most appropriate level of involvement for students and instructors is closer when the knowledge of both students and teachers is used in a customized and balanced manner.

The researchers Maloney et al (2013), it's feasible that web-based repositories will serve as both the main way for healthcare students to access resources and a resource for informing patients and gaining access to "practical" knowledge. The findings of this study suggest that because online learning materials are convenient and easy to use, students of today's healthcare professionals value their advantages. This is a change from traditional learning methods to technological learning support, and it might be a sign of a developing relationship between learning style and social immersion in Internet-based interactions.

3.5 FINAL CONSIDERATIONS

We assessed the strengths and weaknesses of these research on this specific topic to provide valuable information and ensure a more thorough method to synthesize and critically evaluate the data. This review examined scientific evidence that heutagogical approaches in higher education in health that mediate the teaching-learning process through technologies can stimulate physiotherapy students' clinical reasoning for patient rehabilitation. We also wanted outcomes that may guide the adaptation of standard teaching-learning approaches by creative and technical ways that could be integrated into training.

Two elements are necessary for this discussion: first, recognizing what measures must be taken to perform a heutagogical approach. Second, learn how to use this technique to physiotherapy instruction based on experiences from this program or other health-related university training.

3.6 CONCLUSION

Health education, including physiotherapy, benefits from heutagogy, according to revised studies. It empowers students to lead their training, cultivating critical thinking, clinical reasoning, and lifelong learning. Heutagogy can meet technological demands in higher education, and health courses' interdisciplinarity allows for the transfer of approaches from other subjects. Given the scarcity of studies, additional research is needed to guide the incorporation of heutagological approaches in physiotherapist training to develop skills and competences in this area.

REFERENCES

Abraham, R. R., & Komattil, R. (2017). Heutagogic approach to developing capable learners. Medical Teacher, 39(3), 295–299. https://doi.org/10.1080/0142159X.2017.1270433

Bansal, A., Jain, S., Sharma, L., Sharma, N., Jain, C., & Madaan, M. (2020). Students' perception regarding pedagogy, andragogy, and heutagogy as teaching–learning methods in undergraduate medical education. Journal of Education and Health Promotion, 9(1), 301. https://doi.org/10.4103/jehp.jehp_221_20

Blaschke, L. M. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. The International Review of Research in Open and Distributed Learning, 13(1), 56. https://doi.org/10.19173/irrodl.v13i1.1076

Cook, D. A., & Reed, D. A. (2015). Appraising the Quality of Medical Education Research Methods. Academic Medicine, 90(8), 1067–1076. https://doi.org/10.1097/ACM.0000000000000786

Glassner, A., & Back, S. (2020). Three "Gogies": Pedagogy, Andragogy, Heutagogy. In Exploring Heutagogy in Higher Education (pp. 59–74). Springer Singapore. https://doi.org/10.1007/978-981-15-4144-5_5

González-Zamar, M.-D., Abad-Segura, E., López-Meneses, E., & Gómez-Galán, J. (2020). Managing ICT for Sustainable Education: Research Analysis in the Context of Higher Education. Sustainability, 12(19), 8254. https://doi.org/10.3390/su12198254

Green, R. D., & Schlairet, M. C. (2017). Moving toward heutagogical learning: Illuminating undergraduate nursing students' experiences in a flipped classroom. Nurse Education Today, 49, 122–128. https://doi.org/10.1016/j.nedt.2016.11.016

Gülden, A. (2014). Andragoji Kavramı ve Andragoji ile Pedagoji Arasındaki Fark. Ankara Universitesi Egitim Bilimleri Fakultesi Dergisi, 47(1), 279–300. https://doi.org/10.1501/Egifak_0000001327

Haraldseid, C., Friberg, F., & Aase, K. (2016). How can students contribute? A qualitative study of active student involvement in development of technological learning material for clinical skills training. BMC Nursing, 15(1), 2. https://doi.org/10.1186/s12912-016-0125-y

Hase. (2016). Self-determined Learning (heutagogy): Where Have We Come Since 2000? In D. J. Hoffman (Ed.), SITJAR (Special Ed). https://hdl.handle.net/10652/5723

Higgins, J. P., Li, T., & Deeks, J. J. (2023). Assessing risk of bias in a randomized trial. In W. V. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ (Ed.), Cochrane Handbook for Systematic Reviews of Interventions (Vers. 6.4). Cochrane. www.training.cochrane.org/handbook

Loeng, S. (2017). Alexander Kapp – the first known user of the andragogy concept. International Journal of Lifelong Education, 36(6), 629–643. https://doi.org/10.1080/02601370.2017.1363826

Loeng, S. (2018). Various ways of understanding the concept of andragogy. Cogent Education, 5(1), 1496643. https://doi.org/10.1080/2331186X.2018.1496643

Maloney, S., Chamberlain, M., Morrison, S., Kotsanas, G., Keating, J. L., & Ilic, D. (2013). Health Professional Learner Attitudes and Use of Digital Learning Resources. Journal of Medical Internet Research, 15(1), e7. https://doi.org/10.2196/jmir.2094

Moore, R. L. (2020). Developing lifelong learning with heutagogy: contexts, critiques, and challenges. Distance Education, 41(3), 381–401. https://doi.org/10.1080/01587919.2020.1766949

Narayan, V., Herrington, J., & Cochrane, T. (2019). Design principles for heutagogical learning: Implementing student-determined learning with mobile and social media tools. Australasian Journal of Educational Technology, 35(3), 86–101. https://doi.org/10.14742/ajet.3941

Oremus, M., Oremus, C., Hall, G. B. C., & McKinnon, M. C. (2012). Inter-rater and test–retest reliability of quality assessments by novice student raters using the Jadad and Newcastle–Ottawa Scales. BMJ Open, 2(4), e001368. https://doi.org/10.1136/bmjopen-2012-001368

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. The BMJ, 372. https://doi.org/10.1136/bmj.n160

Rahmi, R. (2020). Understanding heutagogy during a pandemic: A case of <scp>U</scp> niversitas <scp>I</scp> ndonesia. Proceedings of the Association for Information Science and Technology, 57(1), 2–5. https://doi.org/10.1002/pra2.361

Rogan, S., Taeymans J, J., Zuber, S., & Zinzen, E. (2020). Planning and Implementation of Guided Self-study in an Undergraduate Physiotherapy Curriculum in Switzerland—A Feasibility Study. Journal of Medical Education and Curricular Development, 7, 238212052094492. https://doi.org/10.1177/2382120520944921

Solijonovna, Z. A. (2020). Modern Information Technologies - A Factor Of Increasing Youth Education, Potential And Spirituality. The American Journal of Social Science and Education Innovations, 2(09), 554–560. https://doi.org/10.37547/tajssei/Volume02Issue09-83

Vázquez-Cano, E., León Urrutia, M., Parra-González, M. E., & López Meneses, E. (2020). Analysis of Interpersonal Competences in the Use of ICT in the Spanish University Context. Sustainability, 12(2), 476. https://doi.org/10.3390/su12020476

Vissers, D., Rowe, M., Islam, M. S., & Taeymans, J. (2018). Ownership and Attitudes towards Technology Use in Physiotherapy Students from Seven Countries. Health Professions Education, 4(3), 198–206. https://doi.org/10.1016/j.hpe.2017.12.003

CHAPTER 4

REHABILITATION TECHNOLOGIES IN THE FORMATIVE STRUCTURE OF PHYSIOTHERAPISTS AT THE IBERIAN PENINSULA

Rehabilitation Technologies in the Formative Structure of Physiotherapists of the Iberian Peninsula: A Multimethodological Study under the Perspectives of Innovation

ABSTRACT

Background: The changes in the professional performance of the physiotherapist are emerging points of constant reflection in the evolution of the profession, since the rehabilitation technologies with artificial intelligence capable of automating a physical rehabilitation program, have acquired more and more space in the clinical practice of the physical therapist. **Objective:** Therefore, this research arises with the aim of knowing the technological contribution of methods and equipment incorporated in the formative structure of teaching clinical activities in a sample obtained from the panorama of physical therapy courses of IES in operation in the Iberian Peninsula. **Methods:** This is a multi-methodological study with direct observation and Delphi approach. A script to direct the focus of the observation was previously created to obtain data in place and in official documents. The script was composed of a question with 5 items “A, B, C, D, E” for the observation of technologies in the physical space of the teaching laboratories and clinical practice learning sites; and one question with 3 items "A, B, C" for the analysis of the theoretical incorporation of rehabilitation technologies into the curriculum of physiotherapy courses. In addition to the script a Delphi approach was structured through a questionnaire with 5 questions sessions directed to a panel of expert teachers and researchers in the field of physiotherapy. **Results:** There are 87 IHE (colleges and universities) on the Iberian Peninsula that offer physiotherapy programs, which means there will be 7,686 open enrollment slots for new students in that field in 2023. Our Delphi method included 31 physiotherapy educators and researchers, and we received in-person consent from 4 IHE offering physical therapy programs. Direct inspection reveals that

certain facilities have the infrastructure necessary to implement remote rehabilitation, VR-based rehabilitation (either fully immersive or partially so), and motion capture sensors. One of the courses observed had a dedicated curriculum unit on digital health practices, but the other courses made no reference to the use of technology in rehabilitation and had no such modules. **Conclusion:** There is an imminent need for changes in the current curricular structure and in the structure of clinical practices carried out during the training of physiotherapists. New technologies and forms of approach will always be emerging which requires constant studies that help to meet the needs regarding this topic and contribute to implement changes in the curriculum structure and the structure of practices carried out during the training.

Keywords: higher education, physiotherapy, Iberian Peninsula, artificial intelligence, technology, rehabilitation

4.1 INTRODUCTION

The Iberian Peninsula is notable for being made up of Portugal and Spain, the only nations with which it has traditionally shared boundaries and ongoing cooperative relationships in a variety of fields (Amalia Yunia Rahmawati 2002). One of the many fields in which these two nations collaborate is education. Since the Bolonha process was established in 1999, which unified EU educational standards and provided opportunities for international student mobility between EU universities at all levels of higher education while upholding the autonomy of each educational institution, relations between these two countries have become more intense (Štech 2011).

This Iberian Peninsula study examines physiotherapy as a university career. The Royal Decree - R.D. of 26 July 1957 created physical therapy in Spain as a specialty and merged the functions of the ATS - Sanitary Technical Assistant. Over time, the specialization developed its own skills and knowledge, which became the major tool for a higher-level profession (Raposo Vidal et al. 2001).

Physiotherapy was integrated into university education through R.D. 2965/1980, and with the 1983 university reform, physical therapy was about to be recognized as a higher level titulation of the first cycle. In 2001, the reform was consolidated, and R.D.55/2005 approved and recognized the Degree in Physiotherapy.(Raposo Vidal et al. 2001).

The path taken by physiotherapy in Portugal to become a higher course of study began in 1979 with the establishment of the Polytechnic Higher Education and the Schools of Health in the Higher Technical Institutes, which were realized in the 1990s (Decreto-Lei nº 513-T/79 1979). Technical and regulatory requirements have been satisfied for the incorporation of academic training in higher education. Physiotherapists are currently included in the career of Diagnostic and Therapeutic Technician (TDT), which was established in 1985 by Decree-Law No. 384-B/85 on September 30 (Ministério da Saúde 1985).

Courses in this credential require the 12th year. In 1986, Portugal joined the European Economic Community (EEC), which required changes to the training of physiotherapists and TDTs. The European Directives (General Directive No. 89/48 of 21 December 1988) resulted in the formation of physiotherapists in higher education. 7 years after Portugal joined the EEC. Portugal's Polytechnic System of Teaching trains physiotherapists as higher-level professionals.(Emanuel, V; Carla, B; Cristina, G; & Isabel 2006). Regulation by professional associations or orders was another milestone in health care vocations. The professional orders strive to improve working conditions, access, internal qualification, and norms of conduct in regulated professions. (Aldridge 2008).

In terms of organization, Spain is represented by the General Council of the Colleges of Physiotherapists of Spain, which was established by Law 21/1998 of July 1 and whose statutes were issued by the Order of the Ministry of Health on November 24, 1999. A total of 17 professional representations from colleges and independent physiotherapy councils make up the General Council of Physiotherapists, the highest body of national representation. According to the laws of the region that each college or autonomous council represents, they decide what is necessary to practice as a physiotherapist legally (BOE-A-15584 1998).

The Order of Physical Therapists, also known as the Order, was established in Portugal after years of professional representation through the APFISIO - Portuguese Association of Physiotherapists. The Order's Statute was approved and published in Law No. 122/2019 of September 30, 2019, in the Diário da República (Portugal 2019) . The law establishes the holders of the professional certificate of physical therapist, issued in accordance with Decree-Law No. 320/99, of August, and approves the statute and legal

provisions applicable to the legal exercise of the profession of physiotherapist in the Portuguese territory (Portugal 2019).

As rehabilitation technologies have taken up more and more space in the clinical practices of rehabilitation that compete with this profession, changes in the professional performance of the physiotherapist are emerging points of constant reflection in the evolution of the profession (Hassett et al. 2021). There are many technologies that can work in tandem with a physiotherapist or more autonomously, as is the case with AI - artificial intelligence embedded in clothing with sensors that capture body movement, or robots programmed to carry out a physical rehabilitation program (Yang et al. 2020)(Yang et al. 2020).

4.1.1 Physiotherapy Higher Education Training in the Iberian Peninsula.

Although there is a system of educational collaboration in place in the Iberian Peninsula, each career develops in accordance with its own internal higher education institution regulations and national body decisions (Štech 2011). One significant issue is how higher education programs are acknowledged, supported, and assessed by the separate organizations in charge of accrediting higher education in each of the Iberian Peninsula's nations(Report 2012). We shall therefore go over how accreditation works in the Peninsula's member states below.

4.1.2 Accreditation of higher education in Spain

The Organic Law of Universities (BOE-A-7786 2007), which governs higher education in Spain, sets forth standards for accreditation and evaluation. ANECA, the National Agency for Quality Assessment and Accreditation, was founded in July 2002 as a state foundation tasked with certifying the standard of the university system and making improvements while keeping an eye on the agencies of the autonomous communities' competence (BOE-A-1112 2015).

ANECA credits and assesses portions of the university faculty and shares expertise with the Accreditation Agencies of the Autonomous Communities. Both must be registered in the EQAR (European Quality Assurance Register for Higher Education), which was required as part of the Bologna Process adaption for Spanish universities (Report 2012).

The Organic Law has made program accreditation in public and private universities mandatory and frequent, involving self-assessment, external review by the Accreditation Agency, and accreditation, with the Ministry of Education and Science for undergraduate courses and the Autonomous Communities for graduate courses.

The ANECA was converted into an autonomous organization connected to the ministry of education, culture, and sports through a law passed on September 15 and 16, 2014. New competitions were assigned to ANECA because of this change, and its statute was revised by the Real Decreto No. 1.112 of November 11, 2015. The Commission for National Evaluation of Investigative Activities (CNEAI) was also absorbed by the Agency as part of the reform (BOE-A-1112 2015).

4.1.3 Accreditation of higher education in Portugal

The Legal Regime of Higher Education Institutions (Law nº 62/2007) governs higher education in Portugal and strives to provide high-level credentials, disseminate knowledge, and build a quality framework for cultural, artistic, technological, and scientific training (Santos 2020). Although the goals of university and polytechnic education are comparable and are outlined in Articles 6 and 7 of the RJIES, the primary distinction is the social mission, with polytechnic institutes placing a greater emphasis on regional development (Duarte 2017). Additionally, polytechnic education only gives bachelor's and master's degrees, but university education can grant the academic degrees of bachelor, master, and doctorate (Decreto-Lei nº 74 2006).

The funding of Portuguese higher education is determined by various factors, resulting in a noticeable difference in budget allocation between Polytechnic Institutes and universities. This distinction is evident in the Budget Execution Report for the 4th Quarter of 2020, which was recently presented by the Monitoring and Budget Control Group (DGES, 2020). According to the Budget Execution Report for the fourth quarter of 2020, which was presented by the Monitoring and Budgetary Control Group (DGES 2020), although the funding of Portuguese higher education is established by Law Decree nº 37, 2003, the budget of the Polytechnic Institutes is significantly smaller than that of the universities (Decreto-Lei nº 37 2003).

According to Law Decree nº 38 from 2007 evaluating higher education in Portugal includes self-assessment, external evaluation, and worldwide evaluation. The institution itself conducts the self-evaluation, while the Higher Education evaluation and Accreditation Agency (A3ES), an independent foundation in charge of quality assessment and accreditation, does the external assessment (Decreto-Lei nº 38 2007).

Therefore, this study is conducted with the objective of identifying integration of novel rehabilitation technologies in the training and education physiotherapists in the Iberian Peninsula. Additionally, it aims to promote collaboration between Portugal and Spain for the advancement of higher education in the field of physiotherapy.

4.2 METHODS

4.2.1 Research Design

It is a study of a multi-methodological nature, designed to be developed with multiple qualitative approaches, which group the characteristics of philosophical analysis of analytical research (Schoonenboom and Johnson 2017). This study involves intensive observation to obtain accurate and detailed record of what happens in the environment, for interpretation and analysis of data using descriptions and narratives (Coy 2019).

In the descriptive-analytical research, the aim is to ascertain the status and situation of the research object, allowing for the expression of opinions and the determination of future projections based on the responses obtained through the description and analysis of objective and direct observations (Omair 2015).

The data acquisition methods employed in this study involved the utilization of a pre-existing survey, which was administered in an unbiased manner. Additionally, a descriptive analysis was conducted on various documents and information obtained from official sources responsible for the dissemination of accreditation for higher education programs and relevant information pertaining to higher education in the Iberian Peninsula.

4.2.2 Delphi Process

The present investigation employed a modified version of the Delphi Method to gather data from a group of physiotherapy experts. In contrast to the conventional Delphi Method, which entails iterative rounds of questionnaires, our approach involved a single round employing a structured questionnaire to acquire precise data regarding the content of physiotherapist training practices and the potential significance of modifications within the current training framework. (Gordon and Pease 2006).

4.2.3 Ethical approval

The present investigation has obtained approval from the ethics committee of the University of Évora and adheres to all ethical principles outlined in the Helsinki Declaration. All experimental protocols involved the participants' completion of the free and informed consent form, along with the acknowledgment of responsibility by the principal investigator.

4.2.4 Participants

The individuals who were extended an invitation to partake in this study were those affiliated with IES - Institutions of Higher Level, possessing advanced education in the field of physiotherapy within the Iberian Peninsula. Specifically, this included higher education teachers and actively engaged researchers involved in the training of physiotherapists in this region of Europe.

Institutions lacking accreditation or currently undergoing the accreditation process by relevant educational authorities were excluded from consideration for participation in the study. Teachers who fulfilled the predetermined criteria for inclusion, but lacked formal education in physiotherapy and did not teach subjects pertaining to clinical rehabilitation practice, were excluded from the selection process for the Panel of Experts in the Delphi Approach.

The participants established a Panel of Experts consisting of teachers who possessed specialized knowledge in physiotherapy and fulfilled multiple roles within the course, including instructing on theoretical concepts, overseeing practical exercises, and

managing the overall course operations. We also had the opportunity to incorporate students from the final year of training into the panel.

4.2.5 Procedure

The procedural framework for this investigation was delineated during a 4-month residency at the University of Castilla – La Mancha in Spain. During the visit, it was feasible to directly observe the dynamics of theoretical instruction and clinical application in the physiotherapy undergraduate program at this university. The Institute has facilitated the delineation of research methodologies to be implemented in other Institutions Higher Education (IHE) located in the Iberian Peninsula, in accordance with the procedures depicted in Figure 4-1.

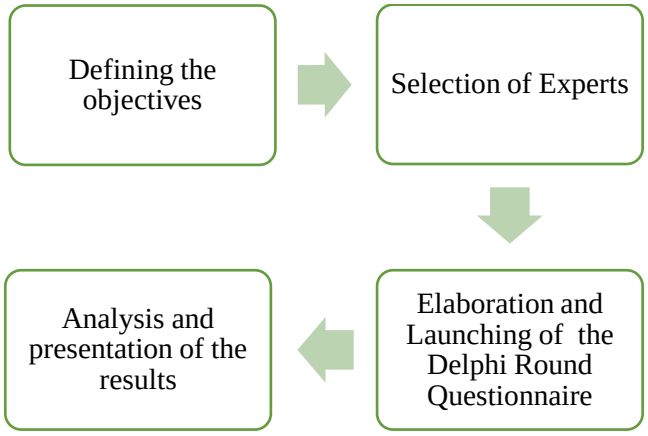

Figure 4-1. Steps to carry out the Delphi Method.

The data were collected from three primary sources: official information from DGES (General Directorate of Higher Education of Portugal) and the Ministry of Universities of Spain. These sources provided a comprehensive overview of physiotherapist training in the Iberian Peninsula. Through the utilization of a pre-existing script designed for the examination of the physical environment, as well as the extraction of pertinent information from the current course curriculum and curriculum units, and lastly, the collection of data from a group of experts using the Delphi Method, we conducted an in-depth analysis of clinical practice teaching laboratories.

4.2.6 Questionnaires

A systematic search was performed in reputable scientific databases (PubMed, Embase, and PEDro) to identify relevant studies pertaining to novel pedagogical approaches and technological advancements employed in the field of rehabilitation, including artificial intelligence, virtual reality, and robotics. Upon attaining specialized knowledge, it became feasible to formulate suitable inquiries for the Physical Space Assessment Guide, the course curriculum, and the Delphi approach. The inquiries were formulated in accordance with the empirical data presented in the study findings, pertaining to the aim of understanding the actuality of rehabilitation technologies and the prospective instructional approaches for physiotherapy training.

The initial iteration of the Delphi questionnaire was subsequently distributed to a cohort of esteemed academics and scholars specializing in the domain of physiotherapy at the University of Castilla – La Mancha in Spain during the month of December in the year 2020. This moment played a critical role in simulating the previous methodology employed in this study, as well as facilitating necessary modifications to the survey questions. These adjustments were made based on the expert opinions regarding the significance of each question. A total of 10 professors and researchers affiliated with the University of Castilla – La Mancha were surveyed, and subsequently, they were able to categorize the significance of the questions into three levels: high relevance, medium relevance, or low relevance, based on the study's objectives.

Following the conclusive categorization, educators and researchers may propose modifications to the interrogatives posed, with the aim of enhancing the questionnaire's pertinence by augmenting the participants' comprehension and facilitating a smoother approach. The implementation of the data collection instruments yielded an electronic form for the Delphi approach consisting of four primary sessions.

The initial session was designed with the purpose of extending an invitation to the prospective expert to engage in the research by means of the Informed Consent Form, which outlined the key aspects of the study. The subsequent session aimed to gather information regarding the participant's professional background, whether it pertained to clinical physiotherapy or teaching. The third session introduced various rehabilitation technologies, with the objective of assessing the participants' familiarity and affinity

towards these technologies. Lastly, the fourth session focused on the structure of the Curricular Units and General Curriculum of the Course.

Typically, the inquiries pertain to gaining insights into the scholarly background of the panel of specialists, encompassing their professional achievements, discerning analysis regarding rehabilitation methodologies involving technological advancements, and the necessity for contemporary enhancements in physiotherapy education.

4.2.7 Questions

Upon completion of the Informed Consent process, the participant was instructed to proceed to the subsequent section. In this section, the questions were presented in two distinct formats: objective questions with multiple alternatives, where only one answer could be selected; and questions that permitted multiple answers, allowing participants to select more than one option based on their experiences. Additionally, participants were provided with an additional space to provide an alternative answer if they desired to include any additional or supplementary information beyond the proposed alternatives.

4.2.8 Analysis

A quantitative examination of the acquired data was conducted by submitting the information for analysis, employing Microsoft Excel as the analytical tool (Quintela-del-Río and Francisco-Fernández 2017). The data pertaining to the formations in physiotherapy and the responses obtained through the Delphi approach with the panel of experts were presented in tables in the results section. These findings were further discussed in detail in the subsequent discussion section.

4.3 RESULTS

To enhance our comprehension of the data derived from this study, we have partitioned the obtained results into three distinct segments. Each subdivision encompasses a distinct objective; the initial section endeavors to elucidate the significance of physiotherapy based on pertinent data published on the official platforms of the governing bodies responsible for tertiary education in the Iberian Peninsula, particularly the DGES

(General Directorate of Higher Education) in Portugal and the Spanish Ministry of Higher Education.

The second component encompasses the outcomes derived from the examination of the formative framework of the IES - Institutions of Higher Education that were subject to on-site research. The objective of this phase of the investigation was to gain insight into the integration of technological and methodological advancements in the education of physiotherapists. In the third subsection of the results section, we present the data obtained through a Delphi approach conducted with a panel of experts consisting of teachers and researchers specializing in the field of physiotherapy.

4.3.1 Numbers of University Training in Physiotherapy in the Iberian Peninsula

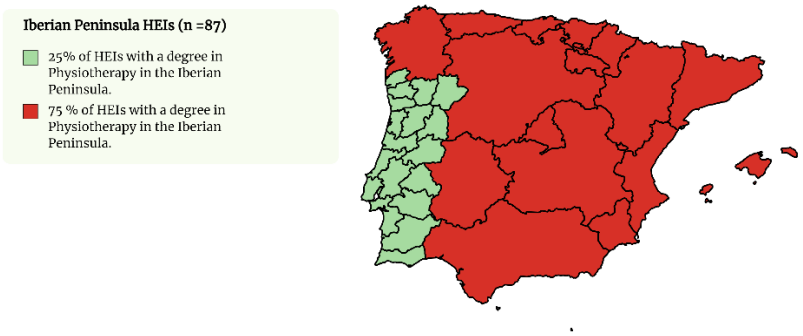

Figure 4-2. Physiotherapy in Numbers.

The information in Table 4.1 pertains to one (n = 87) IHE, or higher education institutions, in the Iberian Peninsula that offer a physiotherapy training program.

Table 4.1. IHE of Physiotherapy

Location	Total of IHE	IHE Public	Private IHE
Iberian Peninsula	(n= 87)	49 / 56%	38 / 44%
Portugal	22 / 25%	9 / 18%	13 / 34%
Spain	65 / 75%	40 / 82%	25 / 66 %

IHE: Institutions Higher Education

When classifying these Higher Education Institutions (IHE), it is observed that 56% of them are publicly funded, while the remaining 44% are privately funded. Out of the entire

set of Higher Education Institutions (IHE) that have been identified, 25% are situated in Portugal, whereas the remaining 74.71% are in Spain.

Spain exhibits a higher number of public Higher Education Institutions (IHE) specializing in physiotherapy. Specifically, 62% of all IHE in Spain are public, which accounts for 81% of the public IHE in the Iberian Peninsula and 46% of all institutions offering physiotherapy training in the Iberian Peninsula. In Portugal, the distribution of physical therapy institutions is such that 59% are privately owned, while the remaining 41% are publicly funded.

In Table 4.2, we have aggregated data from the DGES (General Directorate of Higher Education) in Portugal and the Spanish Ministry of Higher Education. This data pertains to the number of available positions for higher education in the field of physiotherapy. The analysis demonstrates that the quantity of vacancies exhibits variability across institutions, irrespective of their classification as private or public.

Table 4.2. Annual offer of vacancies in 2023.

Location	Total Vacancies	Vacancies in PUIHE	Vacancies in PRIHE
Iberian Peninsula	(n = 7.686)	3.600 / 47%	4086 / 53%
Portugal	1.058 /14%	354 / 10%	704 / 17%
Spain	6.628 / 86%	3.246 / 90%	3382 / 83%

PUIHE: Public Institutions Higher Education; **PRIHE:** Private Institutions Higher Education.

In the year 2023, a total of 7,686 new positions were created for advanced physiotherapy courses across the Iberian Peninsula. Among these vacancies, 47% were offered in public institutions, while the remaining 53% were provided by private institutions. A comprehensive analysis was conducted, revealing that 51% of the available vacancies in Spain and 66.54% in Portugal were designated for prospective physiotherapy students in private higher education institutions during the current academic year.

In addition to the quantitative data regarding the quantity of courses and available spots in higher education institutions, we are actively seeking information pertaining to the prospects and possibilities for pursuing postgraduate studies within the field of physiotherapy or its associated disciplines, such as Rehabilitation or Therapeutic Exercises. In Table 4.3 - Postgraduate degrees, we observe a total of 38 programs in the

Iberian Peninsula. Among these programs, 81.58% are classified as master's degrees, while the remaining 18.42% are categorized as PhD programs.

Table 4.3. Postgraduates

Location	Pg	Master (MSc)	MSc PUIHE	MSc PRIHE	Doctorate (PhD)	PhD PUIHE	PhD PRIHE
Iberian Peninsula	(n = 38)	(n = 31) 81,58%	(n = 16) 51,61%	(n = 15) 48,39%	(n = 7) 18,42%	(n = 4) 57,14%	(n = 3) 42,86
Portugal	(n = 18) 47,37%	(n =16) 51,61%	(n =11) 68,75%	(n = 5) 33,33%	(n = 2) 28,57%	(n = 2) 50%	__
Spain	(n = 20) 52,63%	(n= 15) 48,39%	(n = 5) 31,25%	(n = 10) 66,67%	(n = 5) 71,43%	(n = 2) 50%	(n = 3) 100%

Pg: Postgraduate; **MSc:** Master of Sciences; **PhD:** Philosophy Doctor; **PUIHE:** Public Institutions Higher Education; **PRIHE:** Private Institutions Higher Education.

Represents an examination of the feasibility of pursuing further education in master's and PhD programs within the same undergraduate institution. Out of the 87 research institutions that were surveyed, it was found that 73.56% of them do not offer postgraduate programs in the fields of physiotherapy, rehabilitation, or therapeutic exercises. On the other hand, 21.84% of the institutions do provide bachelor's and master's degree programs in these areas, while 4.60% offer both a bachelor's degree and a PhD program.

An intriguing observation pertains to the elevated density of Higher Education Institutions (IHE) in Portugal that possess both undergraduate and master's degree programs. Specifically, approximately 57.89% of the 19 IHE in Portugal, which represents the entirety of the Iberian Peninsula within this classification, exhibit this characteristic. Another set of data in the English language. Approximately 10.5% of Postgraduate programs in physiotherapy are offered by Higher Education Institutions (IHE) that do not possess a degree specifically in that field. It should be noted that not all the Postgraduate courses available are directly associated with the presence of a degree in physiotherapy within the same IHE represents an examination of the feasibility of pursuing further education in master's and PhD programs within the same undergraduate institution. Out of the 87 research institutions that were surveyed, it was found that 73.56% of them do not offer postgraduate programs in the fields of physiotherapy, rehabilitation, or therapeutic exercises. On the other hand, 21.84% of the institutions do

provide bachelor's and master's degree programs in these areas, while 4.60% offer both a bachelor's degree and a PhD program.

Table 4.4 represents an examination of the feasibility of pursuing further education in master's and PhD programs within the same undergraduate institution. Out of the 87 research institutions that were surveyed, it was found that 73.56% of them do not offer postgraduate programs in the fields of physiotherapy, rehabilitation, or therapeutic exercises. On the other hand, 21.84% of the institutions do provide bachelor's and master's degree programs in these areas, while 4.60% offer both a bachelor's degree and a PhD program.

Table 4.4. Graduate and Postgraduate Studies.

Location	Only BSc (n=87)	BSc + MSc (n=87)	BSc; MSc; PhD (n=87)	Only MSc (n = 38)	MSc + PhD (n =38)
Iberian Peninsula	(n = 64) 73,56%	(n = 19) 21,84%	(n = 4) 4,60%	(n = 3) 7,9%	(n = 1) 2,3%
Portugal	(n = 8) 15,5%	(n = 11) 57,89%	(n = 1) 25%	(n = 3) 100%	(n = 1) 100%
Spain	(n = 56) 87,5%	(n = 8) 42,11%	(n = 3) 75%	___	___

BSc: Bachelor of Sciences; **MSc:** Master of Sciences; **PhD:** Philosophy Doctor

An intriguing observation pertains to the elevated density of Higher Education Institutions (IHE) in Portugal that possess both undergraduate and master's degree programs. Specifically, approximately 57.89% of the 19 IHE in Portugal, which represents the entirety of the Iberian Peninsula within this classification, exhibit this characteristic. Another set of data in the English language. Approximately 10.5% of Postgraduate programs in physiotherapy are offered by Higher Education Institutions (IHE) that do not possess a degree specifically in that field. It should be noted that not all the Postgraduate courses available are directly associated with the presence of a degree in physiotherapy within the same IHE.

4.3.2 Analysis of the Formative Structure

An observational analysis was conducted in the physiotherapy teaching departments of four Institutions of Higher Education (IHE) located in the Iberian Peninsula. These IHE served as the research sites for this study. As delineated in Table 4.5, the initial iteration of the manuscript centered on the exploration of technological advancements that exhibit

promise for implementation in clinical settings pertaining to rehabilitation. It was feasible to ascertain within the physical premises of the IHE (Institute of Higher Education) the presence of technological aids specifically designed for the facilitation of clinical activities in the field of physiotherapy, intended for use by teachers.

Table 4.5. Clinical Practice Teaching Structure.

	Items Checked During In Loco Observation of IHE	**IHE Analysed**			
		1º	2º	3º	4º
A	Television monitors based on the teaching of evaluation and follow-up of patients with "telerehabilitation"	🟨	🟨	🟨	🟥
B	Digital technologies: Smart wacht, tablets or other that allow to simulate performances of clinical activities with these	🟥	🟥	🟥	🟥
C	Virtual reality equipment immersive or non-immersive.	🟩	🟩	🟩	🟥
D	Wearable motion capture sensors	🟥	🟩	🟩	🟥
E	Robotic equipment or artificial intelligence used for rehabilitation purposes	🟥	🟥	🟥	🟥

IHE: Institution Higher Education
🟩: Present in the teaching structure;
🟨: Partially present in the teaching structure;
🟥: Absence in the teaching structure;

After the presentation of the findings, we will present data pertaining to the analysis of the curricula's structure. In the analysis pertaining to the second inquiry of the script, we aim to examine the course curricula's description for indications of encouragement towards the integration of innovative methodologies and the inclusion of clinical approaches facilitated by rehabilitation technologies.

The findings presented in Table 4.6 indicate that the curricula of Higher Education Institutions (IHE) do not include specific program descriptions for curricular units focused on teaching rehabilitation approaches utilizing technology in IHE 1, 3, and 4. No evidence was discovered to suggest the utilization of methodologies that enhance learning and foster the cultivation of clinical reasoning in student apprentices through the implementation of technology-mediated methodological approaches. In IHE 2, we discovered a Curricular Unit that is not mandatory, specifically focused on Digital Health Practices and Health Innovation.

Table 4.6. Curriculum Structure.

	Items Presented During Analysis of the Structure of the Graduate Curriculum in Physiotherapy	IHE Analysed			
		1º	2º	3º	4º
A	Specific subjects for teaching rehabilitation approaches using technologies	■	■	■	■
B	There were one or more subjects related to the physiotherapist's areas of action that clearly mentioned rehabilitation approaches using technologies.	■	■	■	■
C	The curriculum alluded to the importance of incorporating innovative teaching methodologies and updating the educational content with the aim of bringing physiotherapy students closer to technological competence in their training.	■	■	■	■

IHE: Institution Higher Education
■: Present in the curriculum structure.
■: Partially present in the curriculum structure.
■: Absence in the curriculum structure.

4.3.3 Experts in the Training of Physiotherapists

This section is devoted to the dissemination of findings derived from the Panel of Experts in Physiotherapy, who participated in a series of inquiries utilizing the Delphi Method. The data will be organized into three sections, each containing graphical, tables and descriptive statistics. Each segment of the Delphi results corresponds to a distinct focal point within the methodology. The initial segment will encompass the aspects of training, clinical proficiency, managerial expertise, and pedagogy in the field of Physiotherapy. The subsequent section within this subdivision will examine the correlations between experts and certain modalities of rehabilitation technologies. In the subsequent section of the Delphi results, we will present findings pertaining to the perspectives of experts regarding modifications in the structure of the course curriculum.

The panel of physiotherapy experts consisted of 31 teachers and researchers from the participating IHE, who underwent the Delphi approach. These findings illuminate the wide range of perspectives and instructional backgrounds, the close association with rehabilitation technologies, and the varying viewpoints on how to effectively promote and integrate relevant innovations in the education of physiotherapists.

4.3.3.1 Training, clinical performance and teaching in Physiotherapy (n=31)

Following the implementation of the Delphi method, we proceeded with the examination and evaluation of the responses acquired from the expert panel. In the initial phase, our primary objective was to gather comprehensive information regarding the experts, including their duration of university education, clinical proficiency, teaching aptitude, and experience in course administration.

As depicted in Figure 4-3, it is evident that 55% of individuals have acquired a bachelor's degree in physiotherapy over 15 years ago.

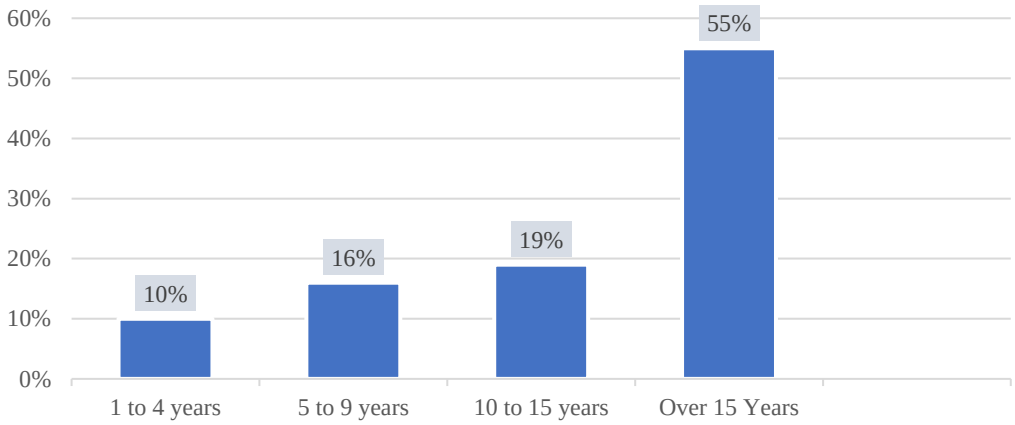

Figure 4-3. Years that completed the undergraduate course.

Primarily, as depicted in Figure 4-4, 87% of professionals are employed in the field of education, whereas 13% engage in both teaching and clinical practice within the domain of physiotherapy.

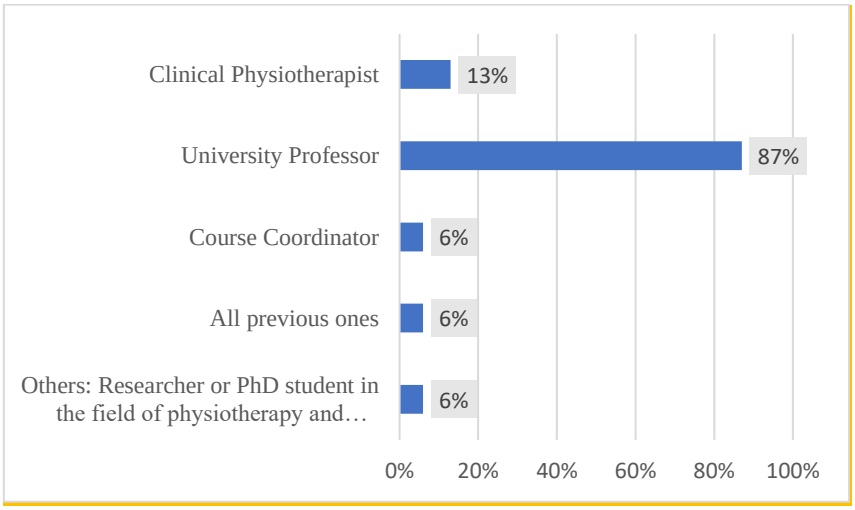

Figure 4-4. Exercise of Professional Activities.

Approximately 42% of the individuals comprising the Panel of Experts have served as educators for a duration exceeding 15 years, as illustrated in Figure 4-5. the segment with the second highest longevity comprised 16% of teachers who remained in the teaching profession for a duration of 10 to 15 years. Collectively, our group comprises a population of educators, of which 58% possess the attribute of being actively engaged in the profession for a duration exceeding a decade.

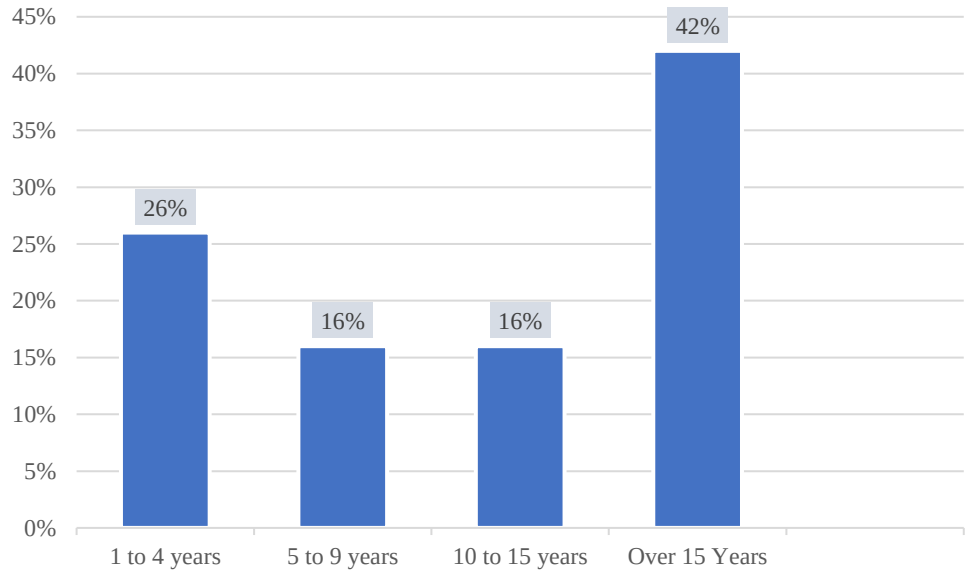

Figure 4-5. Working time as a professor.

Most professors and researchers assert that they engage in a full-time work schedule exclusively at a single academic institution. As depicted in Figure 4-6, a significant proportion of experts, approximately 71%, choose to discontinue their involvement in the practical application of physiotherapy and instead focus solely on educational pursuits.

Within the domains pertaining to the professional practice of physiotherapy, we have conducted inquiries with experts regarding the specific areas in which they have focused their work. It is observed that the domain exhibiting the greatest number of individuals who follow it is Physiotherapy in Orthopedics and Rheumatology, accounting for 39% of the total. This is followed by Neurological Physical Therapy, which has 32% of adherents, and Sports Physical Therapy, with a participation rate of 23%. Additionally, it is worth mentioning that the latter domain boasts the highest number of educators and researchers. Physiotherapy with manual therapies, despite covering only 3% of the total area,

exhibited the lowest level of engagement in terms of educational and research pursuits within this domain.

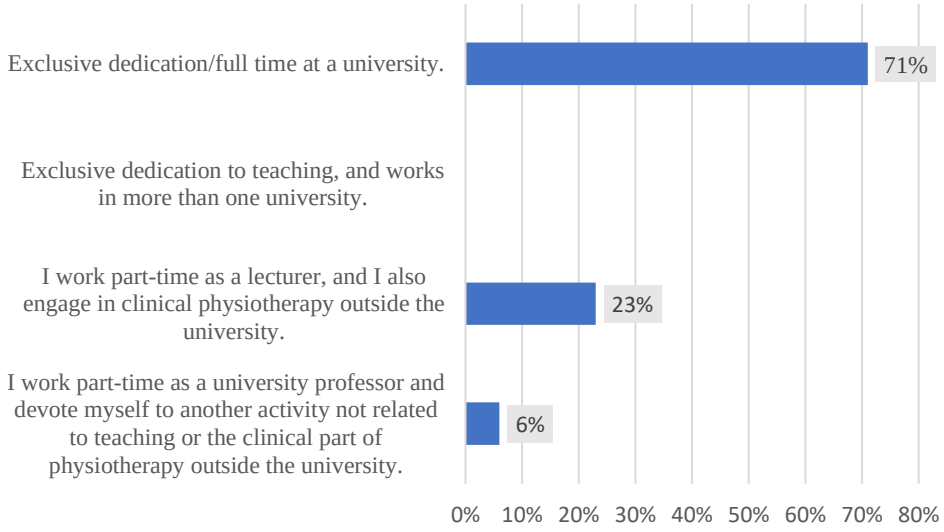

Figure 4-6. Working hours as a professor in higher education.

We conducted a study on the integration of technology in the professional activities of teaching and clinical practice. Out of the 31 experts surveyed, 58% reported using mobile phone applications in their professional work. Additionally, 51% of the experts utilized sensors, video analysis, and motion capture in their practice. However, none of the experts reported using robotic equipment. Considering the theoretical and practical impact that experts have made in the field of rehabilitation technologies, it is noteworthy that 42% of individuals had not engaged with any technological interventions at any stage of their training. The encounter with rehabilitation technologies was observed in 29% of doctoral studies participants, and an equal percentage of experts encountered them during improvement courses.

When queried regarding the perception of alterations in the proficiency of young professionals, encompassing the timeframe spanning from the graduation of the individuals under scrutiny to their present professional endeavors, all experts who responded to this inquiry (n = 30), as depicted in Figure 4-7, unanimously assert the existence of a novel modus operandi in contemporary physiotherapy.

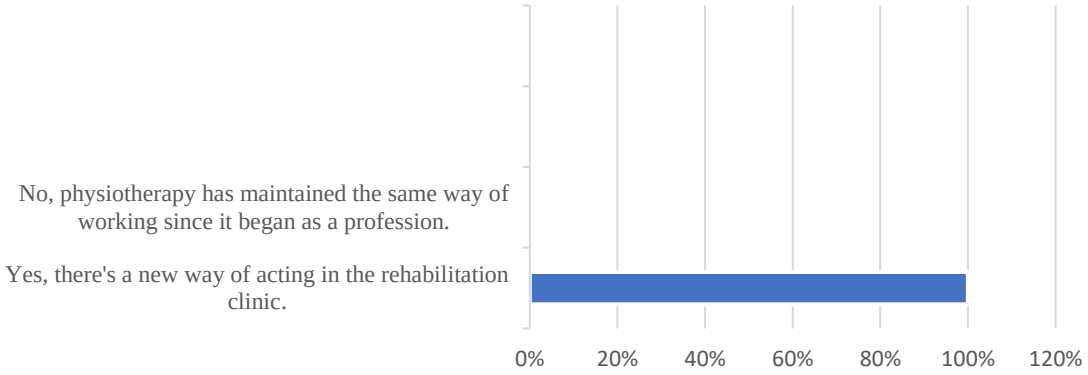

Figure 4-7. The existence of a new way of acting in clinical physiotherapy.

Acknowledging the ongoing evolution in clinical practices, 53% of surveyed physiotherapists perceive themselves as adaptable professionals. These professionals embrace change by recognizing the existence of multiple approaches to clinical practice with similar objectives. They critically evaluate the feasibility of adopting new practices and make informed decisions regarding their integration into their established work routines. Among the participants in our study, a mere 3% (n = 31) identify themselves as adherents of traditional professional practices. These individuals prioritize the instruction of physiotherapy techniques that are rooted in established methods. This approach is based on the recognition of physical therapy as a profession that operates at an advanced level. It emphasizes the practicality of manual therapies, therapeutic exercises, and conventional treatment modalities like hydrotherapy and electrotherapy. Given the potential to select from a set of three response alternatives and utilize a designated area for supplementary deliberations, none of the expert's expressed disbelief in the efficacy of rehabilitation technologies. According to the data, 45% of individuals hold the belief that technologies primarily serve as supplementary tools to clinical activities. Conversely, 42% of respondents assert that technological interventions are equally effective as traditional interventions.

Regarding the necessity for physiotherapists to utilize rehabilitation technologies According to the findings, a significant majority of the experts (87%) assert that technologies have already become an integral component of the physical therapist's professional regimen. Furthermore, they contend that the adept utilization of rehabilitation-enhancing technologies is a crucial professional competency that is here to stay. Intrinsic to the future of the profession, as well as the multitude of prior experts who

attest that technologies are integral to the professional regimen. According to a survey, 87% of respondents believe that the integration of technological advancements is a crucial aspect of career progression in the field of physiotherapy. Professionals in this domain are expected to effectively merge traditional in-person and hands-on approaches with innovative technologies that enable remote monitoring and/or more technologically driven assessments.

We inquired with the panel of experts regarding any observed alterations in the composition of the undergraduate curriculum over the past two decades. As depicted in Figure 4-8, approximately 80% of the experts comprising the panel reported observations of alterations. The image depicted in Figure 4-9 highlights a significant alteration in the composition of substances pertaining to the clinical application of rehabilitation. This alteration was identified by 92% of experts who have observed notable changes in recent times.

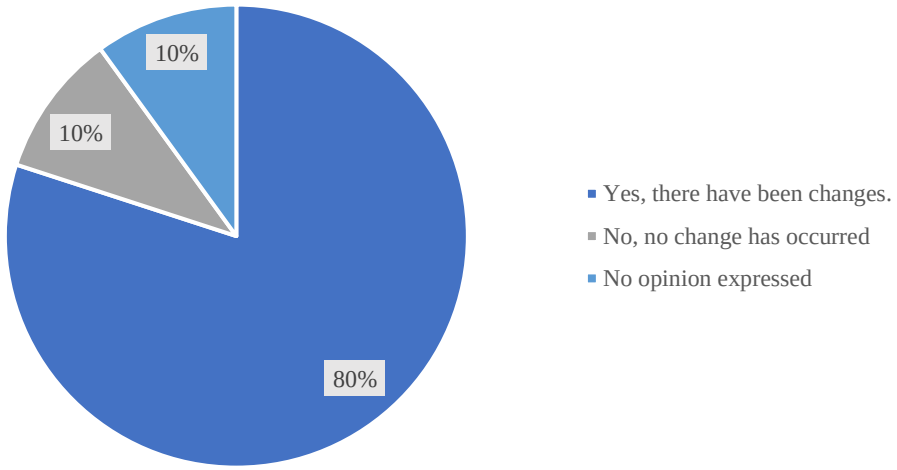

Figure 4-8. Changes occurred in the curricular structure of the undergraduate.

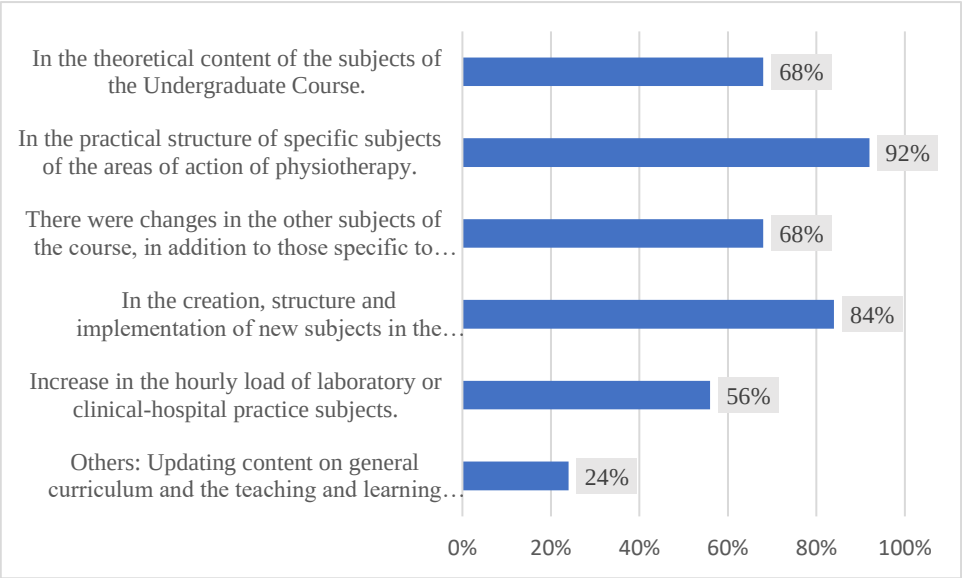

Figure 4-9. Changes that have occurred in the undergraduate curriculum.

Roughly 48% of the individuals comprising the Panel of Experts possessed the role of coordinators for undergraduate physiotherapy courses, which entailed involvement in research activities or demonstrated proficiency in management. Out of the entire population of experts who have fulfilled this role (n = 15), 53% of them, as depicted in Figure 4-10, have held the position for a duration exceeding 5 years.

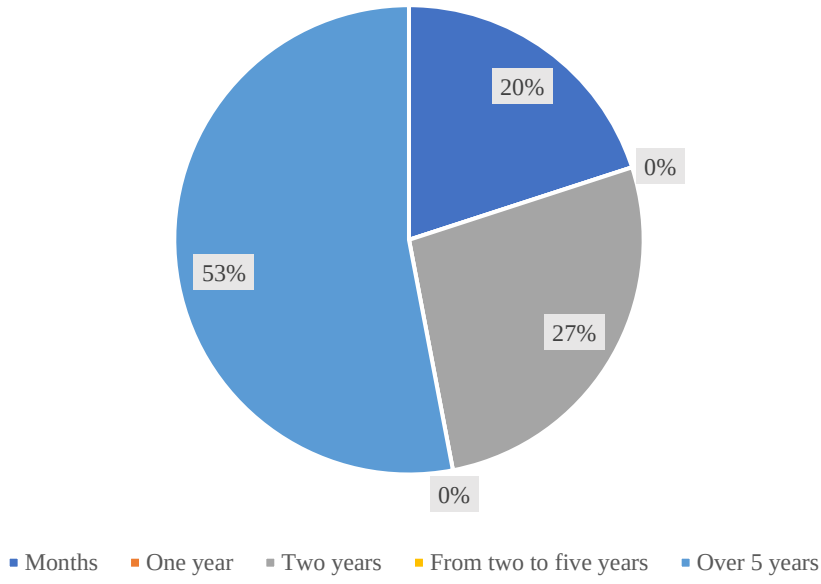

Figure 4-10. Time in the role of coordinator of the Physiotherapy undergraduate course.

Figure 4-11 illustrates that among the individuals with prior experience as coordinators of the physiotherapy degree program (n = 15), 60% reported minimal awareness of any modifications made to the curricular framework of the course.

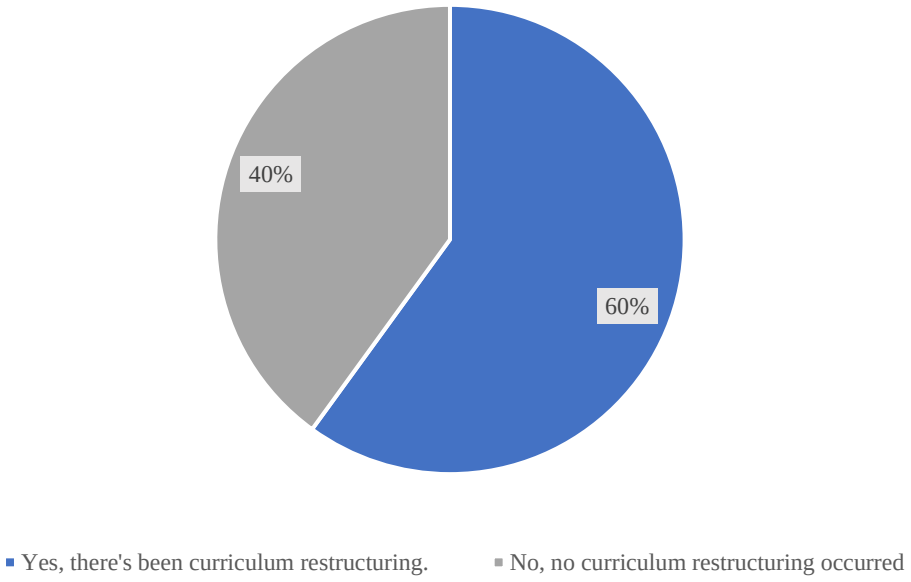

Figure 4-11. Reform of the graduation curriculum, in the period as managers.

According to the experienced experts who have served as graduate course coordinators, as depicted in Figure 4-12, the curricular modifications deemed most impactful were observed during their tenure as coordinators.

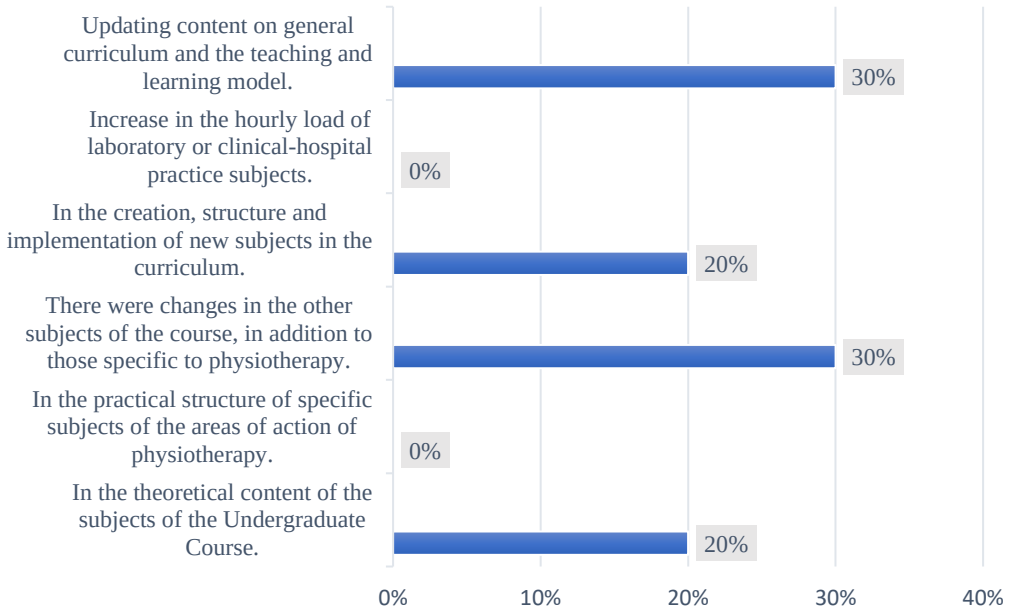

Figure 4-12. Curricular changes noted by undergraduate coordinators and ex-coordinators.

4.3.4 Technology Modes for Rehabilitation (n = 31)

4.3.4.1 Telehealth or remote rehabilitation

The second section of the Delphi questionnaire inquired about three specific modalities of Rehabilitation Technologies: Telehealth or Telerehabilitation, Digital rehabilitation technologies, and Robot-assisted rehabilitation. In the study, participants were surveyed regarding their participation in Telerehabilitation, specifically focusing on children, adults, and the elderly. The results showed that 61% of respondents have not been involved or are currently not engaged in telehealth or telerehabilitation practices within the educational setting. Similarly, 55% of respondents have not been involved or are currently not engaged in telehealth practices within the clinical setting.

Considering the widespread implementation of telehealth and remote rehabilitation techniques, encompassing therapeutic methodologies, client demographics, environmental suitability, intervention focus, and telehealth protocols and platforms, a

majority of 52% express concerns regarding inadequate dissemination and significant limitations. However, with regards to the fundamental requirements for the implementation of this technological modality, 45% of respondents indicate that remote rehabilitation has the capacity to enhance the quality of life for users. Additionally, 42% assert that there exists scientific evidence supporting the utilization of this practice, including interventions, adaptations, and innovations, which ensure satisfaction, quality of care, and widespread access to healthcare. Furthermore, 23% of participants believe that remote rehabilitation is a cost-effective modality. In relation to the placement of telehealth interventions in the field of rehabilitation compared to in-person interventions, 52% of respondents indicate that telehealth applied to rehabilitation has the potential to facilitate a favorable rehabilitation outcome, with effects that are either positive or superior to those observed in traditional interventions.

4.3.4.2 Digital Technologies for Rehabilitation

Intrinsic to Digital Rehabilitation encompassing (Games, Virtual Reality, Mobile Apps, and Software) When queried about the frequency of utilization of these technologies in their work regimen, 68% of respondents indicated that they employ them regularly in their instructional endeavors, while 52% reported employing them in the execution of clinical physiotherapy.

The participants were requested to assess the efficacy of rehabilitation methods utilizing digital technologies, categorizing them as highly effective, moderately effective, or having low effectiveness. Out of the respondents, 61% rated these approaches as effective, while none of the experts rated them as having low effectiveness. In comparison to traditional rehabilitation methods, 42% of individuals perceive that a conventional treatment lacking digital technologies is equally effective as one facilitated by digital technologies alone. Conversely, only 10% believe that the digital approach is less effective than the traditional method when a professional is involved. Additionally, another 10% assert that rehabilitation utilizing digital technologies surpasses the performance of a professional.

4.3.4.3 Robot-Assisted Rehabilitation

Concluding the presentation of findings pertaining to technological advancements, specifically in the field of robotics: 68% of experts reported no prior utilization of these

technologies in their instructional practices, while 61% acknowledged incorporating them in the context of clinical physiotherapy. Based on the analysis of efficiency, 71% of respondents indicate that the efficacy of this modality is comparable, complementary, or superior to rehabilitation solely facilitated by a physiotherapist.

Regarding the optimal mode of contribution of this modality in physiotherapy, 96% of respondents indicate that the most suitable approach is to implement it under the supervision of a physiotherapist, solely as a supplementary form. The prevailing consensus among individuals is that a particular domain of physiotherapy stands to gain the most from the utilization of this technological modality, with neurological physical therapy being widely regarded as the primary beneficiary.

4.3.5 Change in the structure of the course curriculum and content of the Rehabilitation Subjects of the Physiotherapist Training Areas (n=31)

The Delphi technique concluded with inquiries that facilitated professionals in providing their unpremeditated viewpoints on the curriculum of the Physiotherapy degree. At this juncture, professionals may propose modifications to the structure of the curriculum. In this phase, a total of 30 professionals were involved, out of which 53% hold the belief that the physiotherapy curriculum has failed to adjust to technological advancements in rehabilitation. They argue that the curriculum predominantly relies on traditional methods of theoretical instruction, lacking sufficient emphasis on the theoretical and practical aspects of incorporating technology into their professional practice.

A greater number of individuals were involved. According to a survey, 87% of individuals believe that curricular innovation involves the integration of rehabilitation technologies with conventional teaching approaches. These individuals also highlight specific obstacles that need to be addressed to ensure the successful implementation of modifications to graduation curricula. According to 83% of experts, the primary hindrance to curriculum innovation is the substantial financial investment required for acquiring new equipment.

The second major challenge, as identified by 47% of experts, pertains to the academic disparity between physiotherapy instructors who adopt a more adaptable teaching style

and those who adhere to a conventional, less technologically oriented approach. Furthermore, a significant proportion of individuals, approximately 40%, express concerns regarding the insufficiency of scientific evidence that substantiates the effectiveness of rehabilitation technology.

Upon analyzing the Delphi data, it has been determined that most experts, specifically 60%, hold the belief that the utilization of high-fidelity simulation through computerized whole-body mannequins, which replicate physiological responses and clinical examination findings such as pulse, blood pressure, oxygen saturation, and respiratory rate, has a positive impact on the enhancement of clinical reasoning skills in physical therapy students. Additionally, it is suggested that this approach also serves as a source of motivation for these students.

4.4 DISCUSSION

The objective of this study was to ascertain the integration of novel rehabilitation technologies in the training and instruction of clinical practice for physiotherapists in the Iberian Peninsula, with the intention of fostering cross-border cooperation for the advancement of higher education in the domain of physiotherapy in Portugal and Spain. To achieve this objective, we devised a methodological framework incorporating various observational techniques, specifically analytical ones. We conducted an active information retrieval process from official and descriptive databases, followed by an on-site observational and documentary analysis within the Higher Education Institutions (IHE). Additionally, we employed a Delphi approach as part of our methodology.

To present quantitative data regarding physiotherapy training, we have compiled information from authoritative sources such as the DGES (Dirección General de Educación Superior de Portugal) and the Ministry of Universities of Spain, which are official platforms of the educational departments in the Iberian Peninsula. The objective of this study was not to assess the caliber of the training provided by the Higher Education Institutions (IHE) involved in this survey, nor to establish any hierarchical ranking among the institutions. Taking into consideration the concept, we devised designations consisting of a generic acronym "IHE" and a numerical identifier "1,2,3,4" to ensure the anonymity of the data pertaining to the institutions involved.

By incorporating the "technological component" into their evidence-based clinical practice, physiotherapists attempt to adjust their tactics to promote health and well-being in response to the development of new health Technologies (Guo, Watts, and Wharrad 2016). This component presents a novel mode of intermediation within the daily practices of physiotherapists, who can be referred to as "e-health professionals" when incorporating technologies into their professional endeavors (Mesko and Győrffy 2019)

The methodology employed to investigate the formative framework primarily focused on the physical infrastructure of Institutions Higher Education (IHE). This involved utilizing technological equipment capable of facilitating simulations or supervised clinical practice conducted by professionals who have received training in real-life scenarios. The objective was to enable practical learning that promotes the prevention of injuries, clinical assessment, patient monitoring in diverse contexts, and physical rehabilitation (Stoikov et al. 2022).

In the realm of theoretical research, numerous studies have contributed to the establishment of the framework for the practical methodology(Green and Schlairet 2017). In the realm of theoretical research, numerous studies have contributed to the establishment of the framework for the practical methodology(Condon et al. 2016).

Our analysis was conducted to gain insight into the integration of technologies within the framework of physiotherapy. This includes examining how technologies facilitate various methods, contribute to the development of specific curricular units, and influence the evolution of the curriculum and the teaching of clinical practices. The aim is to enhance the training of professionals in physical rehabilitation, enabling them to effectively utilize technologies in their practice (Cassidy, Norris, and Williams 2020).

The second script question asked about the course curriculum and how technical competency concerns were addressed in training professionals (McMahon et al. 2016). In response to the items that sought curricular concern with apprentices' professional activities, clinical performance technologies for rehabilitation have been proven clinically advanced and effective, but their incorporation is shy and needs further development (Barradell 2017).

The findings derived from the implementation of the Delphi method involving experts in physiotherapy, namely teachers and researchers, have unequivocally demonstrated the

experts' possession of knowledge pertaining to a wide array of technological approaches that can be effectively employed in clinical rehabilitation procedures (Chesterton, Chesterton, and Alexanders 2023). With the acquisition of this knowledge comes the obligation to advocate for advancements in the curriculum. However, challenges related to the expenses associated with acquiring equipment and differences in attitudes among professional colleagues in the field remain a sensitive topic that warrants thorough and prompt discussion (Wells et al. 2021).

An "e-health professional" can be described as an individual who possesses expertise in the utilization of technological advancements within their clinical practice. They are knowledgeable about the most credible sources of health-related technologies. These individuals possess expertise in the utilization of health technologies, demonstrate proficiency in operating technological apparatus, and adhere to regulatory guidelines in their clinical endeavors. (Mesko and Győrffy 2019).

Understanding the potential expansion of care capabilities facilitated by emerging digital health technologies is of paramount importance. The World Health Organization (WHO) has released a taxonomy of digital health technologies with the aim of providing guidance on their utilization, to alleviate the administrative workload on healthcare professionals. The primary objective of this approach is to enhance the creative potential and individual capabilities of healthcare practitioners, thereby enhancing the safety and effectiveness of healthcare delivery. (WHO 2019).

In the realm of physiotherapy, the World Confederation for Physical Therapy has directed its focus towards the utilization of technology-mediated rehabilitation techniques. In the year 2017, the individual in question formed a task force in partnership with the International Network of Regulatory Authorities for Physiotherapy. The primary objective of this collaboration was to create a comprehensive document, known as a white paper, that would explore and provide insights into the practice and regulation of physiotherapy within the context of the digital era (Lee et al. 2020).

As indicated by Table 4.1 and Table 4.2 presented previously in chapter 4, a significant number of students annually consider pursuing a career in physiotherapy. These individuals anticipate that this career choice will be beneficial for their professional prospects. By comprehending the quantitative aspects of training in this field, they aim to

contribute to the development of guidelines and recommendations for physical therapy education (McMahon et al. 2016). Physiotherapy is recognized for its reliance on empirical evidence, and in recent times, there has been a burgeoning body of data pertaining to the efficacy of technological elements, particularly in domains such as prevention, physical assessment, implementation, and surveillance (Scurlock-Evans, Upton, and Upton 2014).

These procedures are in accordance with the competencies of physiotherapists, who are progressively investigating novel approaches to rehabilitation that eliminate the necessity for direct patient contact, thereby replacing previously manual procedures (Condon et al. 2016). Nevertheless, the integration of digital media as a foundational element and the subsequent progression towards robotic artificial intelligence methods pose a significant challenge for the pace of university education.

Societal contributions of this research

The objective of this study is to enhance cross-border relations between Spain and Portugal, with a focus on fostering collaboration for the implementation of innovative approaches in physiotherapist training within the Iberian Peninsula, in alignment with current demands in the field. Moreover, this study is in accordance with the Sustainable Development Goals (SDGs), specifically: "Ensuring Good Health and Well-being" (SDG 3), "Ensuring Quality Education" (SDG 4), and "Promoting Sustainable Industrialization and Innovation" (SDG 9) (Franco et al. 2019).

Practical Applications of this Research:

Annually, numerous higher education establishments facilitate the education of a substantial number of individuals seeking to pursue careers in a specific field, enabling them to apply the knowledge and abilities acquired throughout their four-year undergraduate programs. Nevertheless, the integration of emerging technologies such as artificial intelligence into physiotherapy curricula holds promise for facilitating rehabilitation. The findings of this study carry substantial practical implications for the training of physiotherapists, clinical practice, and the advancement of educational curricula. In the following section, we outline the primary practical ramifications:

The findings underscore the necessity of revising the curriculum for physiotherapist training, with a particular focus on incorporating dedicated modules that cover the proficient utilization of these technologies.

The successful implementation of technologies in physiotherapy necessitates the adoption of a multidisciplinary approach. Hence, it is imperative for curricula to facilitate the fostering of collaboration between physiotherapists and professionals in the field of technology, including biomedical engineers and computer scientists.

Continuous Updating: The expeditious progression of rehabilitation technologies necessitates that training programs facilitate the perpetual enhancement of physiotherapists' knowledge. It is imperative to promote and motivate students to stay abreast of advancements in their field and modify their methodologies in accordance with emerging technologies.

Higher education institutions tasked with the training of physiotherapists should make efforts to update their curricula, aiming to ensure that these professionals of the future can progress and avoid stagnation in their clinical abilities. It is of utmost importance for these professionals to possess adequate preparedness in order to confront the challenges encountered in their practice and to proficiently incorporate technological advancements within the realm of rehabilitation (Leal Filho et al. 2021).

Suggestions for Future Research:

Based on the findings of this empirical investigation and the lingering unresolved matters that have surfaced, several recommendations for prospective scientific inquiry encompass:

- Examine how continual training and education affect physiotherapists' capacity to keep up with technology. Maintaining professional knowledge and abilities is crucial.
- Examine the interdisciplinary collaboration among physiotherapists, biomedical engineers, computer scientists, and other technology professionals in the realm of research and development for pioneering rehabilitation solutions.
- Formulate a set of principles for the appropriate utilization of rehabilitation technologies in the context of clinical practice. This measure can aid in the

establishment of a uniform methodology and guarantee the well-being of the patient.

- Evaluate the competencies and proficiencies necessary for physiotherapists in utilizing rehabilitation technologies. This may involve the establishment of competency standards and the development of corresponding training programs.
- Examine the incorporation of rehabilitation technologies into the education of physiotherapists across various countries or regions, with a focus on identifying exemplary approaches and valuable insights gained.

The proposed recommendations for future investigations have the potential to enhance our comprehension of the utilization of rehabilitation technologies in the field of physiotherapy and advance the standards of professional practices. This, in turn, may result in improved patient outcomes and advancements in the realm of healthcare.

4.5 CONCLUSION

Based on the empirical evidence presented in this research, it is evident that there is a pressing necessity to acknowledge and tackle the existing challenges and enhance rehabilitation methodologies. This highlights the pressing necessity for a thorough restructuring of both curricula and training methodologies, integrating technologies in a manner that guarantees the physiotherapy apprentice of today can secure their professional niche in the future. It is of utmost importance to adequately equip professionals who possess not only the proficiency to employ contemporary methodologies, but also the ability to stay abreast of the continuous advancements in biomedical technologies. Ongoing research in this field is of utmost importance as novel technologies and methodologies continue to surface.

REFERENCES

Aldridge, S. (2008). The Regulation of Health Professionals: An Overview of the British Columbia Experience. Journal of Medical Imaging and Radiation Sciences, 39(1), 4–10. https://doi.org/10.1016/j.jmir.2008.01.001

Amalia Yunia Rahmawati. (2002). Geopolitical Traditions (D. Atkinson & K. Dodds (eds.); Issue July). Routledge. https://doi.org/10.4324/9780203449110

Barradell, S. (2017). Moving forth: Imagining physiotherapy education differently. Physiotherapy Theory and Practice, 33(6), 439–447. https://doi.org/10.1080/09593985.2017.1323361

BOE-A-1112. (2015). Real Decreto 1112/2015 aprobación Estatuto de ANECA. 119063–119081. https://www.boe.es/eli/es/rd/2015/12/11/1112

BOE-A-15584. (1998). Ley 21/1998, de 1 de julio, por la que se crea el Consejo General de Colegios de Fisioterapeutas. Boletín Oficial Del Estado, 157, 2 de julio, 38507. https://www.boe.es/buscar/pdf/1998/BOE-A-1998-15584-consolidado.pdf

BOE-A-7786. (2007). Ley Orgánica 4/2007, de 12 de abril, por la que se modifica la Ley Orgánica 6/2001, de 21 de diciembre, de Universidades. Boletín Oficial Del Estado, 16241–16260. https://www.boe.es/eli/es/lo/2007/04/12/4

Cassidy, E., Norris, M., & Williams, A. (2020). What does it take to graduate? A qualitative exploration of the perceptions of successful physiotherapy graduates from one university in the UK. Physiotherapy Theory and Practice, 36(2), 316–332. https://doi.org/10.1080/09593985.2018.1485799

Chesterton, P., Chesterton, J., & Alexanders, J. (2023). New graduate physiotherapists' perceived preparedness for clinical practice. A cross-sectional survey. European Journal of Physiotherapy, 25(1), 33–42. https://doi.org/10.1080/21679169.2021.1958007

Condon, C., McGrane, N., Mockler, D., & Stokes, E. (2016). Ability of physiotherapists to undertake evidence-based practice steps: a scoping review. Physiotherapy, 102(1), 10–19. https://doi.org/10.1016/j.physio.2015.06.003

Coy, M. J. (2019). Research Methodologies: Increasing Understanding of the World. International Journal of Scientific and Research Publications (IJSRP), 9(1), p8511. https://doi.org/10.29322/IJSRP.9.01.2019.p8511

Decreto-Lei no 37. (2003). Decreto-Lei n.o 37/2003 de 22 de Agosto Estabelece as bases do financiamento do ensino superior. Diário Da República n.o 193/2003, Série I-A de 2003-08-22. https://data.dre.pt/eli/lei/37/2003/p/cons/20190902/pt/html

Decreto-Lei no 38. (2007). Decreto-Lei n.o 38/2007 - Regime Jurídico da Avaliação do Ensino Superior. Diário Da Republica, 1a Série de 16 Abril de 2007, 157, 5310–5313. https://data.dre.pt/eli/lei/38/2007/08/16/p/dre/pt/html

Decreto-Lei no 513-T/79. (1979). Decreto-Lei no 513- T 79 de 26 de dezembro. Diário Da República n.o 296/1979, 3o Suplemento, Série I de 1979-12-26, páginas 60-64. https://diariodarepublica.pt/dr/detalhe/decreto-lei/513-t-1979-430025

Decreto-Lei no 74. (2006). Aprova o regime jurídico dos graus e diplomas do ensino superior. Diário Da República n.o 60/2006, Série I-A de 2006-03-24, 2242–2257. https://data.dre.pt/eli/dec-lei/74/2006/03/24/p/dre/pt/html

DGES. (2020). Relatório de Execução Orçamental de 2020 Relatório de Execução Orçamental de 2020. https://www.dges.gov.pt/pt/noticia/relatorio-de-execucao-orcamental-do-4o-trimestre-de-2020-das-instituicoes-de-ensino-superior

Duarte, J. G. (2017). O Impacte da Acreditação da A3ES na Gestão da Qualidade no Ensino Superior - Um estudo de caso no Instituto Politécnico de Tomar. http://hdl.handle.net/10400.26/21305

Emanuel, V; Carla, B; Cristina, G; & Isabel, M. (2006). O processo de profissionalização dos fisioterapeutas portugueses. A Revista Portuguesa de Fisioterapia-Arquivos de Fisioterapia., 1 no 2.

Franco, I., Saito, O., Vaughter, P., Whereat, J., Kanie, N., & Takemoto, K. (2019). Higher education for sustainable development: actioning the global goals in policy, curriculum and practice. Sustainability Science, 14(6), 1621–1642. https://doi.org/10.1007/s11625-018-0628-4

Gordon, T., & Pease, A. (2006). RT Delphi: An efficient, "round-less" almost real time Delphi method. Technological Forecasting and Social Change, 73(4), 321–333. https://doi.org/10.1016/j.techfore.2005.09.005

Green, R. D., & Schlairet, M. C. (2017). Moving toward heutagogical learning: Illuminating undergraduate nursing students' experiences in a flipped classroom. Nurse Education Today, 49, 122–128. https://doi.org/10.1016/j.nedt.2016.11.016

Guo, P., Watts, K., & Wharrad, H. (2016). An integrative review of the impact of mobile technologies used by healthcare professionals to support education and practice. Nursing Open, 3(2), 66–78. https://doi.org/10.1002/nop2.37

Hassett, L., van den Berg, M., Weber, H., Chagpar, S., Wong, S., Rabie, A., McCluskey, A., Lindley, R. I., Crotty, M., & Sherrington, C. (2021). Activity and MObility UsiNg Technology (AMOUNT) rehabilitation trial – description of device use and physiotherapy support in the post-hospital phase. Disability and Rehabilitation, 43(24), 3454–3460. https://doi.org/10.1080/09638288.2020.1790679

Leal Filho, W., Frankenberger, F., Salvia, A. L., Azeiteiro, U., Alves, F., Castro, P., Will, M., Platje, J., Lovren, V. O., Brandli, L., Price, E., Doni, F., Mifsud, M., & Ávila, L. V. (2021). A framework for the implementation of the Sustainable Development Goals in university programmes. Journal of Cleaner Production, 299. https://doi.org/10.1016/j.jclepro.2021.126915

Lee, A., Finnin, K., Holdsworth, L., Millette, D., & Peterson, C. (2020). Digital Physical Therapy Practice Task Force - Final Report. World Confederation for Physical Therapy, International Network of Physiotherapy Regulatory Authorities., March. https://www.wcpt.org/sites/wcpt.org/files/files/wcptnews/REPORT OF THE WCPTINPTRA DIGITAL PHYSICAL THERAPY PRACTICE TASK FORCE MARCH 2020.pdf.

McMahon, S., O'Donoghue, G., Doody, C., O'Neill, G., Barrett, T., & Cusack, T. (2016). Standing on the precipice: Evaluating final-year physiotherapy students' perspectives of their curriculum as preparation for primary health care practice. Physiotherapy Canada, 68(2), 188–196. https://doi.org/10.3138/ptc.2015-11E

Mesko, B., & Győrffy, Z. (2019). The Rise of the Empowered Physician in the Digital Health Era: Viewpoint. Journal of Medical Internet Research, 21(3), e12490. https://doi.org/10.2196/12490

Ministério da Saúde. (1985). Decreto-Lei n.o 384-B/85, de 30 de setembro. In Diário da República n.o 225/1985, 2o Suplemento, Série I de 1985-09-30 (pp. 5–9). https://diariodarepublica.pt/dr/detalhe/decreto-lei/384-b-1985-168598

Omair, A. (2015). Selecting the appropriate study design for your research: Descriptive study designs. Journal of Health Specialties, 3(3), 153. https://doi.org/10.4103/1658-600X.159892

Portugal. (2019). Diário da República, Lei no 122/2019. Diário Da República, 3–36. https://diariodarepublica.pt/dr/detalhe/lei/122-2019-125016439

Quintela-del-Río, A., & Francisco-Fernández, M. (2017). Excel Templates: A Helpful Tool for Teaching Statistics. The American Statistician, 71(4), 317–325. https://doi.org/10.1080/00031305.2016.1186115

Raposo Vidal, I., Fernández Cervantes, R., Martínez Rodríguez, A., Sáez Gómez, J. M., Chouza Insua, M., & Barcia Seoane, M. (2001). La Fisioterapia en España durante los siglos XIX y XX hasta la integración en escuelas universitarias de Fisioterapia. Fisioterapia, 23(4), 206–217. https://doi.org/10.1016/S0211-5638(01)72957-4

Report, A. (2012). ANNUAL REPORT 2012 European Quality Assurance Register for Higher Education (EQAR) aisbl / ivzw ANNUAL REPORT 2012 2 . Policy Developments in the EHEA. https://www.eqar.eu/register/agencies/eu

Santos, D. A. M. dos. (2020). Instituições de Ensino Superior Público Ensino Universitário e Ensino Politécnico. http://hdl.handle.net/10316/92720

Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. KZfSS Kölner Zeitschrift Für Soziologie Und Sozialpsychologie, 69(S2), 107–131. https://doi.org/10.1007/s11577-017-0454-1

Scurlock-Evans, L., Upton, P., & Upton, D. (2014). Evidence-Based Practice in physiotherapy: a systematic review of barriers, enablers and interventions. Physiotherapy, 100(3), 208–219. https://doi.org/10.1016/j.physio.2014.03.001

Štech, S. (2011). The Bologna Process as a New Public Management Tool in Higher Education. Journal of Pedagogy / Pedagogický Casopis, 2(2), 263–282. https://doi.org/10.2478/v10159-011-0013-1

Stoikov, S., Maxwell, L., Butler, J., Shardlow, K., Gooding, M., & Kuys, S. (2022). The transition from physiotherapy student to new graduate: are they prepared? Physiotherapy Theory and Practice, 38(1), 101–111. https://doi.org/10.1080/09593985.2020.1744206

Wells, C., Olson, R., Bialocerkowski, A., Carroll, S., Chipchase, L., Reubenson, A., Scarvell, J. M., & Kent, F. (2021). Work Readiness of New Graduate Physical Therapists for Private Practice in Australia: Academic Faculty, Employer, and Graduate Perspectives. Physical Therapy, 101(6), 1–12. https://doi.org/10.1093/ptj/pzab078

WHO. (2019). WHO guideline: recommendations on digital interventions for health system strengthening: web supplement 2: summary of findings and GRADE tables. No. WHO/RHR/19.7.

Yang, G., Pang, Z., Jamal Deen, M., Dong, M., Zhang, Y.-T., Lovell, N., & Rahmani, A. M. (2020). Homecare Robotic Systems for Healthcare 4.0: Visions and Enabling Technologies. IEEE Journal of Biomedical and Health Informatics, 24(9), 2535–2549. https://doi.org/10.1109/JBHI.2020.2990529

CHAPTER 5

INCLUSION OF REHABILITATION TECHNOLOGIES IN THE EDUCATION OF PHYSIOTHERAPY STUDENTS AT THE IBERIAN PENINSULA

Rehabilitation Technologies in Clinical Practice and Training of Physiotherapy in the Iberian Peninsula: A Delphi Study on the View of Trainees

ABSTRACT

Background: Background: Over the past few years, there has been a growing body of evidence on the effectiveness of incorporating technological components in-patient rehabilitation, as recommended by physiotherapists. **Objective:** Our objective is to know and understand the perspective of physiotherapy graduates regarding the increasing influence of technology on their future clinical practice. We also aim to assess any adjustments made to their training in response to this impact. **Method**: In this study, we used a qualitative method that involved a Delphi procedure. The survey involved two rounds of objective and multiple-choice questions administered via electronic questionnaires. **Results:** In the initial phase, a group of 62 physiotherapy degree finalists from three prestigious Institutions of Higher Education in the Iberian Peninsula were selected to form a Delphi panel of experts. Out of all the participants, 60% reported that they had not encounter rehabilitation technology. In the second round, a significant majority of participants expressed interest in incorporating curriculum content related to rehabilitation technologies into the physiotherapy course. They believe it would be relevant and beneficial for their clinical practice. **Conclusions:** This study determined the perspective of physiotherapy students on the value of rehabilitation technology and gives findings that suggest the necessity to give technological advancements in physical therapy training more attention.

Keywords: Physiotherapy, Technologies, Training, Iberian Peninsula, Young Professionals.

5.1 INTRODUCTION

Developing a teaching approach focused on clinical skills is essential in the field of physiotherapy. Physiotherapists are highly skilled professionals who specialize in understanding and improving movement and human function. They undergo extensive training to develop their expertise in this field (Kurunsaari, Tynjälä, and Piirainen 2018). The healthcare professional's journey of continuous development has witnessed rapid and consistent changes with the advent of numerous technologies that are proving to be increasingly effective in clinical approaches to prevention, evaluation, diagnosis, and treatment (Sapci and Sapci 2019).

In the traditional approach, a physiotherapist gathers information during the examination and evaluation of patients, which enables them to offer advice and guidance for a preventive approach. Methods of manual therapies and therapeutic exercises are utilized to assist patients in attaining optimal movement patterns (Kurunsaari, Tynjälä, and Piirainen 2021). With the advent of cutting-edge advancements in healthcare, physiotherapists are now delving into innovative approaches to enhance the promotion of health and well-being. Thus, they are becoming more at ease with embracing new equipment that allows them to incorporate their evidence-based clinical practice. This new component is referred to as the "technological component" (Guo, Watts, and Wharrad 2016).

The rapid progress of technology holds immense promise for transforming the everyday routines of physiotherapists. Health professionals who utilize technology in their work are often referred to as "e-health professionals" (Mesko and Győrffy 2019). A "e-health professional" is an individual who has specialized knowledge in incorporating technologies into their clinical practice or is well-versed in reliable and trustworthy health technology resources. The authors highlight the impressive skills in utilizing health technologies, seamless operation of technological equipment, and strict adherence to regulated clinical practice as notable strengths (Mesko and Győrffy 2019).

Understanding how new digital health technologies can support or enhance care capacities is of utmost importance. The World Health Organization has released a comprehensive classification of digital technologies for health, providing guidance on their utilization and highlighting the potential to alleviate the administrative workload of

healthcare professionals. By adopting this approach, it enhances the abilities and innovation of healthcare professionals, while also improving the safety and effectiveness of patient care (WHO 2019).

In relation to the performance of physiotherapy as a health profession, it is worth mentioning that the World Confederation for Physical Therapy has taken an interest in the rehabilitation practices facilitated by technologies. In 2017, they established a "task force" in collaboration with the International Network of Regulatory Authorities of Physiotherapy. The objective was to create a comprehensive "white paper" that examined the practice and regulation of physical therapy in the digital era (Lee et al. 2020). Physiotherapy relies on evidence-based practices, and in recent years, there has been a growing body of data on the effectiveness of incorporating technological components (Sundelin 2020).

In the various aspects of prevention, physical evaluation, implementation, and monitoring These procedures are closely tied to the skills of the physiotherapist, who is discovering innovative methods for rehabilitation that no longer require direct contact with the patient. In the past, these procedures were done manually(Moseley et al. 2020). Therefore, our aim is to understand the perspective of physiotherapy graduates regarding the growing influence of technology in their future clinical practice. We also intend to assess any adjustments made to your training in response to this impact.

5.2 METHODS

5.2.1 Delphi Process

We created a mixed observational approach study employing a two-round Delphi structured procedure, which included both qualitative and quantitative data (de Meyrick 2003). Participants who successfully completed the initial phase were then invited to take part in a follow-up phase to reach a consensus on the content of practices in physiotherapist training and the potential need for adjustments in the current training environment (Fletcher and Marchildon 2014).

5.2.2 Ethical approval

This study has been approved by the ethics committee of the University of Évora in Portugal and adheres to all the ethical standards set forth in the Helsinki Declaration. All participants were required to complete the free and informed consent form, along with acknowledging the responsibility of the investigator in charge.

5.2.3 Participants

Students studying physiotherapy from three different institutions of higher education located in the Iberian Peninsula were invited to take part in this survey. The undergraduate course in physiotherapy for potential participants should be operational and have received recognition from the national department of higher education regulation and quality assessment. Upon receiving the invitation to participate via Clear Consent, the finish students in the physiotherapy program had the opportunity to form a panel of experts.

5.2.4 Procedure

The stages for the execution of this study were carefully planned during a 4-month stay at the University of Castilla-La Mancha in Spain. This allowed for firsthand observation of the dynamics of clinical practice teaching during the graduation of physiotherapists. The Institute's capabilities have allowed for the development of research strategies to be implemented in other IES of the Iberian Peninsula, as illustrated in Figure 5-1.

5.2.5 Questionnaires

To create appropriate questions for the questionnaires, a survey was conducted on experimental studies in three databases commonly used in scientific research: PubMed, Embase, and PEDro. The objective of this investigation was to explore the various technologies employed in the rehabilitation process, including artificial intelligence, virtual reality, and robotics, and assess their effectiveness based on the evidence presented in the study findings. Through this research, we were able to delve into a series of inquiries and develop our methodology using two separate questionnaires, one for each round.

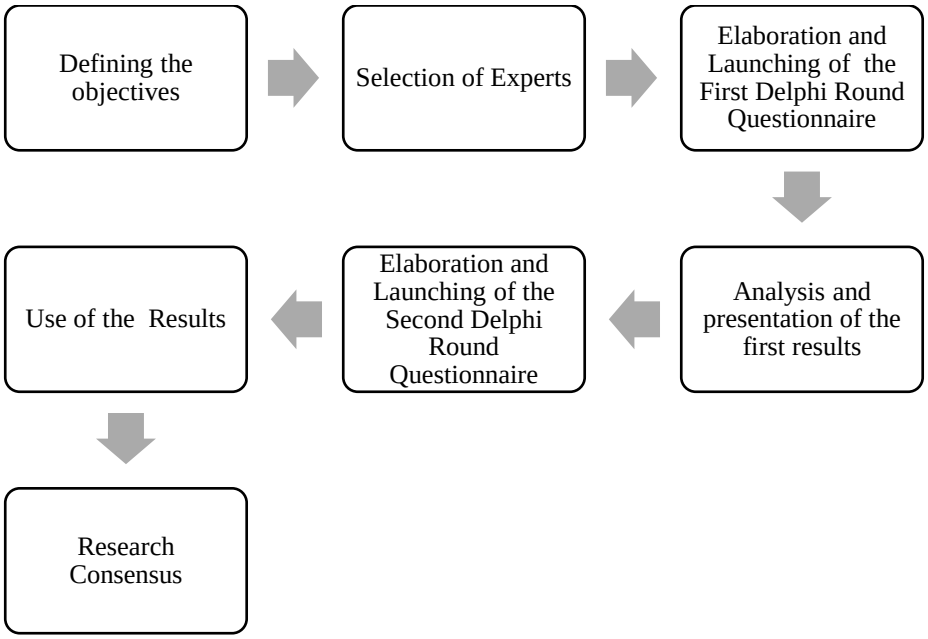

Figure 5-1. Steps to carry out the Delphi Method.

First round questionnaire

The initial questionnaire was created for electronic use and comprised of three sections. In the initial section following the title of the research, there was a provided link that allowed you to access the Terms of Consent. This link invited you to take part in the research and outlined the key aspects of the study. Upon completing the Terms of Consent, the participant proceeded to the next section, which included fields for providing basic information like name and email. In the third section, a series of questions were asked to gather information about the participants' experiences with technology during their training. The questions aimed to understand if the participants had any exposure to technology, the specific types of technology they had experience with, and whether this topic was covered in their training.

Question Formats

The questions were primarily presented in two different formats. Participants were given a neutral initial question with two options and were instructed to choose only one. The second question offered various options for the participant to choose from, allowing them to select multiple answers based on their personal experience. The second and third questions shared a common feature in terms of ease of marking multiple alternatives. Additionally, both questions provided a space for participants to provide an additional

answer that was distinct from the given alternatives. The participants were sent a link to the online questionnaire, along with all the necessary information about the study.

Second Round Questionnaire

The second survey, which was like the first-round questionnaire, had sessions that corresponded to the clarified consent terms and personal data. However, it differed from the first-round survey in its third session by presenting only two questions with different structures.

5.2.6 Question Formats

The first question was intended to be objective; it offered three possible responses, each of which gave the participant the opportunity to name only one answer that was appropriate to his perspective on the importance of the matter being discussed. And the second question was just an open space for extra placement if the participant had anything to offer to the research that they thought would be helpful.

5.2.7 Analysis

An analysis was conducted on the answers using mathematical techniques. The data was collected and processed using Microsoft Excel (Quintela-del-Río and Francisco-Fernández 2017)**.** The results session included the number of respondents and the percentages in descriptive statistics, which reflected the participants' engagement and interest in the topics presented in each round.

5.3 RESULTS

5.3.1 Round 1 questionnaire results

During the initial survey, it was found that among the 62 participants, a significant number (40%) had experience with various types of technology equipment used for rehabilitation purposes. These included digital, virtual, robotic, and artificial intelligence devices, which were incorporated into their training. In contrast, most participants, 60% to be exact, reported that they did not have this experience throughout their course. The initial findings shed light on the diverse range of experiences among physiotherapy graduates

when it comes to incorporating technologies into their training. The wide range of experiences can greatly impact how future professionals are prepared to handle the ever-changing technological requirements in the rehabilitation field.

Out of the 62 participants, a significant portion, 40%, had experience with rehabilitation technologies. In the study, a significant number of participants reported interacting with various advanced technologies. A notable 24% mentioned their experience with robotic technologies, while a majority of 68% had been in contact with digital technologies and mobile applications. Additionally, 60% of participants reported engaging with virtual reality games, while a smaller percentage of 8% had experience with artificial intelligence technologies. Therefore, it can be inferred that while a notable number of participants have interacted with rehabilitation technologies, a majority (60%) have not yet had the opportunity to do so.

Based on the overall context, these findings suggest that the integration of rehabilitation technologies into physiotherapist training is a continuous endeavor. While certain technologies like digital and virtual reality games have gained popularity, many individuals have yet to experience these cutting-edge tools. This observation emphasizes the importance of broadening and varying the utilization of rehabilitation technologies in physiotherapy training to ensure that all future professionals are equipped for a constantly changing field.

In the initial phase of the study, we investigated whether students possessed a theoretical understanding of the application of rehabilitation technologies in their respective fields, even without direct exposure to these technologies. The areas that stood out were neurological physiotherapy, which received 44% of the responses, and orthopedic physiology, which received 24%. It is evident that a considerable number of students were introduced to the theoretical aspects of utilizing rehabilitation technologies in neurological and orthopedic scenarios. In addition, 10% of the responses were related to ergonomic physical therapy, while cardiovascular physical therapy and respiratory physiotherapy were mentioned by 8% of the participants. The percentages in the other areas varied between 2% and 6%.

5.3.2 Round 2 questionnaire results

In the second phase of our research, we concentrated on evaluating how rehabilitation technologies impact the clinical performance of physiotherapists and their integration into the curriculum of the course. Out of the 35 students who participated in this survey, a significant majority of 86% found the integration of rehabilitation technologies to be highly relevant. This strong consensus among the participants highlights the broad agreement in research findings. In addition, 14% of students found it to be "partially relevant", while none of the participants deemed it "irrelevant".

Once a majority of the panel of experts has directed their response towards one of the alternatives presented, we can conclude that the Delphi consensus has been achieved. To accomplish the desired goal, which extends beyond gathering the perspectives of physiotherapy students, we conducted a thorough examination of the physical therapy curricula. We carefully selected experts in this field to participate in the study.

The purpose of the observation was to confirm the existence of curriculum "subject" that was focused on technologically assisted rehabilitation approaches and was designated in the curriculum as being necessary for successful completion of the higher course in physiotherapy. The curricula of the higher courses to which the experts were bound did not include any mandatory component that incorporated technologies in rehabilitation.

5.4 DISCUSSION

This study sought to gain insight into the perspective of physiotherapy graduates regarding the increasing influence of technology on their future clinical practice. Additionally, it aimed to assess any adjustments made in their training to accommodate these changes. Upon examining the data collected from the two rounds of the Delphi approach, it became evident that the initial research findings indicated a certain level of openness among certain areas of physiotherapy to discussing the potential role of rehabilitation technologies in their practice, even if only in theory.

However, they also suggest that there is potential to expand this conversation in all aspects of physiotherapy, equipping future professionals with a more comprehensive understanding of an ever-changing environment. The findings of the second round

indicate a strong desire from students for an enhanced and modernized approach in the physiotherapy curriculum that integrates rehabilitation technologies. They showcase robust student backing for the incorporation of these technologies into training and professional practice. It is worth mentioning that all the participants found this integration to be significant, indicating that students are well-informed about current trends and acknowledge the relevance of these tools in their future professions.

These findings provide valuable insights for higher education institutions and physiotherapy programs to enhance the integration of rehabilitation technologies into their curricula. This will help them better meet the expectations and needs of their students (Baldry Currens and Bithell 2000). As we continue our exploration, we will delve further into these findings and examine how they may impact physiotherapy training and future clinical practice.

Firstly, it is worth considering that the dynamics of the initial round of questions may have had a significant impact. Students had the chance to contemplate their experience (or lack thereof) with rehabilitation technologies and engage in a discussion with their classmates. These discussions might have heightened students' recognition of the significance of these technologies in their future professions (Jensen, Hack, et al. 2017).

In addition, the impact of educators and specialists can play a crucial role. The responses emphasized that teachers discussed the potential for incorporating technologies in the field of neurological physiotherapy. The particular emphasis on this subject may have underscored the importance of rehabilitation technologies in this situation (Chesterton, Chesterton, and Alexanders 2023).

Another crucial contextual factor is the increasing need for health services that integrate cutting-edge technologies. The demand for highly skilled physiotherapists may have shaped students' views on the importance of rehabilitation technologies in their training (Jovanov et al. 2005).

These factors indicate that the participants' responses were influenced by a mix of increasing awareness, expert opinions, and the necessity to cater to the healthcare market's requirements. The incorporation of rehabilitation technologies into the education of physiotherapists appears to align with the desires of students and current developments in the health field (Hassett et al. 2021).

The findings of this study hold significant importance for the field of physiotherapy and have broader implications for health and higher education. The study offers valuable insights into how physiotherapy students perceive the integration of rehabilitation technologies into their education and future clinical practices. It provides a comprehensive understanding of students' attitudes towards these technologies.

Most participants consider it important or somewhat important to incorporate these technologies into their future clinical practices. It appears that the upcoming generation of physiotherapists is receptive to incorporating technological methods into their professional practice. This mindset is essential as it demonstrates the field's capacity to adjust to ever-changing technological advancements.

The significance of these findings applies to the formulation of health policies. As rehabilitation technologies gain more acceptance and usage, it is crucial to ensure that health and education policies are in line with these evolving trends (Picelli et al. 2016) The findings of this study offer valuable insights for policymakers who are interested in fostering innovation in physiotherapy practice and the education of healthcare professionals.

In summary, the findings of this study have made a significant contribution to the field of physiotherapy. They provide valuable guidance for the training of future physiotherapists and highlight a positive outlook on rehabilitation technologies. They also have far-reaching implications for future research and can provide valuable guidance for the development of health policies focused on integrating advanced technologies into clinical practice.

The study examined a group of 62 physiotherapy finalists from three higher education institutions in Spain and Portugal. While the participants have been meticulously chosen to accurately represent the participating institutions, the sample size is still relatively small. It is important to exercise caution when generalizing results to a broader population. Participants were recruited based on their willingness to volunteer, which could have influenced the selection process. Students who had a particular interest in rehabilitation technologies may have had a higher likelihood of participating, which could have influenced the responses.

The study centered on students' perceptions of rehabilitation technologies, allowing for further investigation into additional factors that could impact the incorporation of these technologies into clinical practice. Additional investigation could explore more comprehensive aspects of this integration. While participants from institutions in Spain and Portugal have contributed, it is important to note that the collected data on curricula and educational approaches in a specific Iberian context may not be directly applicable to other geographical regions or education systems.

Although there are some limitations, the results of this study provide valuable insights into how physiotherapy students perceive rehabilitation technologies and their integration into higher education. It is important to consider these limitations when analyzing and implementing the findings of this study.

The findings of this study are in line with a prevailing pattern in current research that emphasizes the increasing significance of rehabilitation technologies in the field of physiotherapy (Yang et al. 2020). The results highlight the observations and increasing recognition of physiotherapy students regarding the significance of these technologies in the realm of healthcare.

Next, we will explore how our findings align with previous studies and relevant research:

- The significant majority (86%) of participants found the integration of rehabilitation technologies to be highly valuable in their clinical practice. This aligns with previous research that highlights the crucial role of technologies in physiotherapy (Rowe 2019).
- The findings support previous research that emphasizes the importance of adequately training future physiotherapists to effectively integrate rehabilitation technologies into their practice. This preparation is essential to meet the current demands of the healthcare market (Health Education England 2019).
- Exploring the Variances Amongst Different Areas of Physiotherapy: examining the areas of interest mentioned by students, such as neurological and orthopedic physiotherapy, aligns with scientific findings that indicate an increasing utilization of technology in specific forms of rehabilitation (McMahon et al. 2016). The increasing recognition of the importance of integrating rehabilitation technologies into the curriculum of physical therapy is evident from the lack of responses

suggesting that this integration is "irrelevant" (Chesterton, Chesterton, and Alexanders 2023).

- Unresolved Questions: the absence of any marked answers as "irrelevant" indicates that students are inclined to recognize the practicality of technologies in their respective fields. This suggests a potential enthusiasm towards utilizing these technologies (Wells et al. 2021)

In summary, the findings of this study support and build upon prior research, emphasizing the importance and necessity of integrating rehabilitation technologies into the education of physiotherapists.

5.4.1 Practical Implications for Real Life

The significant value that students attribute to rehabilitation technologies indicates the need for higher education institutions to integrate these technologies into their curricula. There are several practical implications that can be highlighted:

- Enhanced Training: It is crucial for educational curricula to incorporate specialized training, ensuring that upcoming physiotherapists are adequately equipped to utilize rehabilitation technologies (Stoikov et al. 2022). One can gain knowledge in various areas such as robotic equipment, mobile apps, virtual reality games, and artificial intelligence technologies.
- Clinical Practices: Aspiring physiotherapists of the future should receive comprehensive training that encompasses both theoretical knowledge and practical skills in utilizing rehabilitation technologies within clinical settings (Cassidy, Norris, and Williams 2020). This can be accomplished through a series of clinical stages that utilize advanced technologies or simulations.

The integration of rehabilitation technologies has a significant impact on the quality of patient care. It enables healthcare providers to offer more effective and personalized approaches, ultimately enhancing the overall care experience. Research has shown that this can lead to better outcomes for patients (Aprile et al. 2020) The findings can be a motivating factor for institutions to reassess their curriculum and explore opportunities to offer students both practical and theoretical exposure to these technologies (McMahon et al. 2016).

5.4.2 Future research

The findings of this study also highlight potential avenues for further investigation, including exploring the efficacy of rehabilitation technologies in various clinical scenarios and establishing evidence-based practice guidelines. This has significant implications for clinical practice, future research, and the development of educational policies in the field of physiotherapy (WCPT 2019).

Anticipating the future, these outcomes underscore the necessity for further investigation into the seamless integration of rehabilitation technologies within clinical practice and physiotherapy education. Subsequent research endeavors can yield valuable insights pertaining to clinical efficacy, student training methodologies, and the formulation of specific treatment protocols. In summary, the pragmatic implications of these results underscore the imperative to modernize and enhance physiotherapy curricula in alignment with the evolving demands of the healthcare sector. This, in turn, positively influences the preparation of physiotherapists and elevates the standard of patient care, thus fostering the continuous advancement of the profession.

5.4.3 Concluding thoughts

This study offered valuable insights into how future physiotherapists view the integration of rehabilitation technologies into their training and clinical practice. The participants emphasized the importance of rehabilitation technologies, specifically robotics, digital technologies, mobile apps, and virtual reality games.

The noticeable absence of hands-on experience with these technologies during training indicated a potential mismatch between the skills required by the job market and the content covered in the educational curriculum.

Neurological physiotherapy has become a focal point for teachers exploring the potential of technological methods, demonstrating an increasing recognition in this particular field (Lekkas et al. 2007). The importance placed on rehabilitation technologies in clinical practice was significant, indicating the acknowledgment of their potential influence on the quality of care.

5.5 CONCLUSION

Given the robust nature of the physiotherapy profession, which relies heavily on manual techniques and non-technological equipment, there has been a growing need for curriculum innovation. The practical implications of these findings are noteworthy, emphasizing the importance of revising physiotherapy curricula to align with evolving technological demands. This transformation is crucial in ensuring that upcoming physiotherapists are equipped for a contemporary, patient-focused clinical practice. In addition, these discoveries offer a foundation for further investigation that will enhance the influence of rehabilitation technologies on clinical practice, education policies, and the quality of patient care. This study adds to the ongoing conversation about the development of physiotherapy within a rapidly evolving technological landscape.

REFERENCES

Aprile, I., Iacovelli, C., Cruciani, A., Simbolotti, C., Loreti, S., Galli, G., Vulpiani, M. C., & Padua, L. (2020). Technological rehabilitation versus conventional rehabilitation following hip replacement: A prospective controlled study. Journal of Back and Musculoskeletal Rehabilitation, 33(4), 561–568. https://doi.org/10.3233/BMR-181211

Baldry Currens, J. A., & Bithell, C. P. (2000). Clinical education: Listening to different perspectives. Physiotherapy, 86(12), 645–653. https://doi.org/10.1016/s0031-9406(05)61302-8

Cassidy, E., Norris, M., & Williams, A. (2020). What does it take to graduate? A qualitative exploration of the perceptions of successful physiotherapy graduates from one university in the UK. Physiotherapy Theory and Practice, 36(2), 316–332. https://doi.org/10.1080/09593985.2018.1485799

Chesterton, P., Chesterton, J., & Alexanders, J. (2023). New graduate physiotherapists' perceived preparedness for clinical practice. A cross-sectional survey. European Journal of Physiotherapy, 25(1), 33–42. https://doi.org/10.1080/21679169.2021.1958007

de Meyrick, J. (2003). The Delphi method and health research. Health Education, 103(1), 7–16. https://doi.org/10.1108/09654280310459112

Fletcher, A. J., & Marchildon, G. P. (2014). Using the delphi method for qualitative, participatory action research in health leadership. International Journal of Qualitative Methods, 13(1), 1–18. https://doi.org/10.1177/160940691401300101

Guo, P., Watts, K., & Wharrad, H. (2016). An integrative review of the impact of mobile technologies used by healthcare professionals to support education and practice. Nursing Open, 3(2), 66–78. https://doi.org/10.1002/nop2.37

Hassett, L., van den Berg, M., Weber, H., Chagpar, S., Wong, S., Rabie, A., McCluskey, A., Lindley, R. I., Crotty, M., & Sherrington, C. (2021). Activity and MObility UsiNg Technology (AMOUNT) rehabilitation trial – description of device use and physiotherapy support in the post-hospital phase. Disability and Rehabilitation, 43(24), 3454–3460. https://doi.org/10.1080/09638288.2020.1790679

Health Education England. (2019). The Topol Review: Preparing the healthcare workforce to deliver the digital future. An independent report on behalf of the Secretary of State for Health and Social Care. National Health Service (NHS), February, 102. https://topol.hee.nhs.uk/wp-content/uploads/HEE-Topol-Review-2019.pdf

Jensen, G. M., Hack, L. M., Nordstrom, T., Gwyer, J., & Mostrom, E. (2017). National Study of Excellence and Innovation in Physical Therapist Education: Part 2—A Call to Reform. Physical Therapy, 97(9), 875–888. https://doi.org/10.1093/ptj/pzx062

Jovanov, E., Milenkovic, A., Otto, C., & de Groen, P. C. (2005). A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation. Journal of NeuroEngineering and Rehabilitation, 2(1), 6. https://doi.org/10.1186/1743-0003-2-6

Kurunsaari, M., Tynjälä, P., & Piirainen, A. (2018). Graduating Physiotherapy Students' Conceptions of their own Competence. Vocations and Learning, 11(1), 1–18. https://doi.org/10.1007/s12186-017-9177-8

Kurunsaari, M., Tynjälä, P., & Piirainen, A. (2021). Stories of professional development in physiotherapy education. Physiotherapy Theory and Practice, 00(00), 1–14. https://doi.org/10.1080/09593985.2021.1888341

Lee, A., Finnin, K., Holdsworth, L., Millette, D., & Peterson, C. (2020). Digital Physical Therapy Practice Task Force - Final Report. World Confederation for Physical Therapy, International Network of Physiotherapy Regulatory Authorities., March. https://www.wcpt.org/sites/wcpt.org/files/files/wcptnews/REPORT OF THE WCPTINPTRA DIGITAL PHYSICAL THERAPY PRACTICE TASK FORCE MARCH 2020.pdf.

Lekkas, P., Larsen, T., Kumar, S., Grimmer, K., Nyland, L., Chipchase, L., Jull, G., Buttrum, P., Carr, L., & Finch, J. (2007). No model of clinical education for physiotherapy students is superior to another: A systematic review. Australian Journal of Physiotherapy, 53(1), 19–28. https://doi.org/10.1016/S0004-9514(07)70058-2

McMahon, S., O'Donoghue, G., Doody, C., O'Neill, G., Barrett, T., & Cusack, T. (2016). Standing on the precipice: Evaluating final-year physiotherapy students' perspectives of their curriculum as preparation for primary health care practice. Physiotherapy Canada, 68(2), 188–196. https://doi.org/10.3138/ptc.2015-11E

Mesko, B., & Győrffy, Z. (2019). The Rise of the Empowered Physician in the Digital Health Era: Viewpoint. Journal of Medical Internet Research, 21(3), e12490. https://doi.org/10.2196/12490

Moseley, A. M., Elkins, M. R., Van der Wees, P. J., & Pinheiro, M. B. (2020). Using research to guide practice: The Physiotherapy Evidence Database (PEDro). Brazilian Journal of Physical Therapy, 24(5), 384–391. https://doi.org/10.1016/j.bjpt.2019.11.002

Picelli, A., Bacciga, M., Melotti, C., LA Marchina, E., Verzini, E., Ferrari, F., Pontillo, A., Corradi, J., Tamburin, S., Saltuari, L., Corradini, C., Waldner, A., & Smania, N. (2016). Combined effects of robot-assisted gait training and botulinum toxin type a on spastic equinus foot in patients with chronic stroke: a pilot, single blind, randomized controlled trial alessandro. European Journal of Physical and Rehabilitation Medicine, 759–766.

Quintela-del-Río, A., & Francisco-Fernández, M. (2017). Excel Templates: A Helpful Tool for Teaching Statistics. The American Statistician, 71(4), 317–325. https://doi.org/10.1080/00031305.2016.1186115

Rowe, M. (2019). An Introduction to Machine Learning for Clinicians. Academic Medicine, 94(10), 1433–1436. https://doi.org/10.1097/ACM.0000000000002792

Sapci, A. H., & Sapci, H. A. (2019). Digital continuous healthcare and disruptive medical technologies: m-Health and telemedicine skills training for data-driven healthcare. Journal of Telemedicine and Telecare, 25(10), 623–635. https://doi.org/10.1177/1357633X18793293

Stoikov, S., Maxwell, L., Butler, J., Shardlow, K., Gooding, M., & Kuys, S. (2022). The transition from physiotherapy student to new graduate: are they prepared? Physiotherapy Theory and Practice, 38(1), 101–111. https://doi.org/10.1080/09593985.2020.1744206

Sundelin, G. (2020). Evidence-based physiotherapy practice - editorial. European Journal of Physiotherapy, 22(4), 183. https://doi.org/10.1080/21679169.2020.1772548

WCPT. (2019). Evidence-based practice Policy statement. www.world.physio/resources/glossary

Wells, C., Olson, R., Bialocerkowski, A., Carroll, S., Chipchase, L., Reubenson, A., Scarvell, J. M., & Kent, F. (2021). Work Readiness of New Graduate Physical Therapists for Private Practice in Australia: Academic Faculty, Employer, and Graduate Perspectives. Physical Therapy, 101(6), 1–12. https://doi.org/10.1093/ptj/pzab078

WHO. (2019). WHO guideline: recommendations on digital interventions for health system strengthening: web supplement 2: summary of findings and GRADE tables. No. WHO/RHR/19.7.

Yang, G., Pang, Z., Jamal Deen, M., Dong, M., Zhang, Y.-T., Lovell, N., & Rahmani, A. M. (2020). Homecare Robotic Systems for Healthcare 4.0: Visions and Enabling Technologies. IEEE Journal of Biomedical and Health Informatics, 24(9), 2535–2549. https://doi.org/10.1109/JBHI.2020.2990529

CHAPTER 6
GENERAL DISCUSSION

6.1 INTRODUCTION

The current thesis work incorporates a blend of studies utilizing various methodologies that encompass the features of philosophical analysis in analytical research and the process of consensus formation in descriptive research, employing a qualitative approach (Schoonenboom and Johnson 2017). The goal of our research is to expand and reinforce a thesis by connecting the most pertinent findings from the studies that have been conducted, in addition to developing an ethically dynamic and multimethodological study.

The motivation to develop a suitable curriculum design for physiotherapy stemmed from research efforts aimed at enhancing the global discussion on physiotherapy education. For instance, a study conducted by Broberg et al in 2003 focused on developing a curriculum structure through international collaboration. This structure considered three key elements: the content or knowledge base of physical therapy, the student's learning process, and the sociocultural context in which physical therapies are experienced and practiced. The most intriguing aspect of (Broberg et al. 2003) work is the seamless integration of theory and practice, which enhances the fundamental principles of physiotherapy grounded in scientific knowledge.

The development of skills-based physiotherapy programs can help bridge the divide between theory and practice. These programs aim to not only meet the demands of employers, but also empower physiotherapists to become catalysts for innovation in their profession through their actions (D Vissers 2014). Understanding the unique aspects of higher education in physiotherapy and the teaching of advanced physical therapy from international curricula is the focus of research. The goal is to develop a curriculum that meets international standards, promotes the mobility of physiotherapy professionals, and provides clearer pathways for integration into clinical practices (Fennelly et al. 2020).

In our initial study, with PROSPERO registration number CRD42020222288, our goal was to offer a comprehensive review of the various technologies utilized to aid in patient rehabilitation and their potential integration into the clinical practice of physiotherapists. This study examines the integration of rehabilitation technologies into the everyday practice of clinical physiotherapists. It explores how physiotherapists are adapting to the use of various technologies, including digital tools, AI, robotics, and wearable motion sensors (Yang et al. 2020). AI has made significant advancements in various clinical fields, such as rehabilitation. This has led to a greater emphasis on understanding the healthcare context, the challenges that emerge, and the resulting impact on physiotherapists(Rowe 2019).

Physiotherapy, as a profession in global health, is increasingly being influenced by technology. The future of this career becomes more uncertain when we consider the findings of research that support a common point. For instance, there are studies that examine the impact of technological advances and the mechanization of work activities on professional careers in general (Frey and Osborne 2017).

We will conduct a second systematic review for the second study, which is registered under PROSPERO registration number CRD42021253326. Our objective is to discover and merge the most compelling evidence regarding the utilization of heutagogy in health-related university courses. The results will provide insights into the potential application of this method in higher education for physiotherapy, considering the evolving role of technology in shaping our learning experiences (Dailey-Hebert and Dennis 2015).

Over the years, there has been a growing focus on incorporating advanced technology into higher education. This has led to the implementation of SMART equipment, sensors, and chips on university campuses, offering sustainable and cost-effective solutions for creating smart classrooms (Cata 2015). A notable instance of educational modernization can be seen in the implementation of intelligent designs in educational systems across various countries and cities. Malaysia, Singapore, Australia, South Korea, the United Arab Emirates (UAE), Finland, and cities like New York have embraced smart learning programs, making it a prominent trend in the global educational field (Zhu, Yu, and Riezebos 2016).

Universities are increasingly recognizing the value of integrating technologies into teaching to promote sustainable practices. This includes utilizing wearable devices and intelligent objects for health monitoring, optimizing campus and classroom environments, and ultimately enhancing education and learning (Majeed and Ali 2018). It is widely recognized in higher education that the integration of information and communication technologies (ICTs) has greatly enhanced teaching methods, making them more dynamic and modern (Al-Rahmi et al. 2020). The evidence of the limitations of conventional teaching methods in adapting to technological advancements has prompted educational institutions to embrace innovative resources that facilitate the transition from digital to intelligent approaches (Dai et al. 2021).

Our latest study has brought attention to certain findings in the literature that may warrant further consideration. For example (Barradell 2017), study highlights the connection between physiotherapy and historical performance methods, and suggests that future physiotherapists, both current and from previous generations, will face significant challenges in the increasingly complex field of contemporary practice. The study also emphasizes the importance of developing the ability to navigate uncertain and diverse futures and calls for a reevaluation of the educational framework within the profession. Through our research, we aimed to combine the information gathered from previous studies and develop an observational approach for descriptive analysis. We used a modified version of the Delphi method (de Meyrick 2003) to understand the technological advancements made in the methods and equipment used in clinical activities within physical therapy courses offered by educational institutions in the Iberian Peninsula.

In the third study, it was noted that a significant number of training experts, teachers, and researchers expressed strong opinions regarding the challenges of integrating rehabilitation technologies into undergraduate courses in physiotherapy. When faced with any challenges in obtaining equipment, IES must ensure that they prioritize the dissemination of scientific updates in the field and the potential that the new equipment offers, even in theory(Elton 2003).

Advancements in technology are always happening, and it's amazing how quickly new equipment, programs, or approaches can make previous models outdated or obsolete (Shaban-Nejad et al. 2019). The price of new equipment can differ, with some options being more affordable and low-cost, like mobile apps, immersive and non-immersive

virtual reality games, remote rehabilitation platforms, moderately costly smart technologies, and wearable motion capture sensors. On the higher end of the cost spectrum, there are robots and high-tech artificial intelligence equipment (Wild and Langer 2013).

Recognizing advancements in the clinical practice of physiotherapy is crucial in reducing the learning curve for aspiring physiotherapists. It also highlights the broader range of possibilities available to physical therapists beyond traditional methods (Deusinger et al. 2014). Research is currently centered around the development of a technological learning environment that promotes sustainable practices and provides ample resources for an intelligent classroom. The goal is to create an environment that facilitates appropriate learning and student engagement (Dai et al. 2021).

Our fourth study aimed to understand the perspective of physiotherapy graduates regarding the increasing technological influence on their future clinical practice. We also aimed to assess any adjustments made in their training through a two-round Delphi study. Most of the panel of experts, consisting of finalist students, had limited exposure to rehabilitation technologies. An overwhelming 86% of them believe that the integration of rehabilitation technology into the curriculum is highly important for their professional development as physiotherapists.

Recognizing the crucial role of teachers in implementing curriculum changes, it is essential for them and their respective departments to be informed about the existence and effectiveness of new Therefore, as the scientific community continues to explore new methods of training, it becomes evident that health professionals are adapting their behavior in response to guidelines from reputable organizations like the World Health Organization. These guidelines aim to provide clarity on how digital technology can be effectively incorporated into clinical approaches (Pernencar et al. 2022).

A team from the WCPT—World Confederation for Physical Therapy—has developed a guide specifically for physiotherapists. This guide provides a set of guidelines for rehabilitation approaches that incorporate digital technologies. The guide was later published with WHO recommendations emphasizing the importance of involvement in this field and recognizing the unique requirements of the physiotherapy profession (Lee et al. 2020).

The main objective of this work was to address a gap in higher education by focusing on the integration of clinical approaches and technology in the training of physiotherapists. This area has been identified as a pressing need, as highlighted by The Topol Review in 2019 (Health Education England 2019).

6.2 PROSPECTS AND IMPLICATIONS

Identifying the gaps in the training of physiotherapists in the face of the increasing technological impact on clinical practice was one of the specific objectives of this study. By recognizing these gaps, our results are intended to provide guidance for future discussions on the need for innovation in the curricular adaptation of physiotherapy, considering the regional peculiarities that characterize the formative realities in the Iberian Peninsula. With the identification of 87 higher education institutions offering more than 7,000 vacancies per year to study physiotherapy, we are committed to working towards ensuring that future generations of physiotherapists have flexible training and adapt to the demands of their time.

Given the practical implications involved in the field of technologies, it is advisable for higher education institutions to carefully consider the most suitable teaching model. This should always be done in relation to the essential skills required for the clinical activities of a physiotherapist. The competences mentioned are well-documented in globally recognized sources, like the World Physiotherapy Convention, which serves as a platform for researchers in the field worldwide (WCPT 2019).

We suggest implementing a standing innovation support committee that convenes regular meetings to address the ongoing developments in equipment, system updates, and budget feasibility to manage the different expenses linked to each technology. This recommendation is in line with global goals, focusing on the UN Sustainable Development Goals, such as "Quality Health," "Quality Education," and "Industry, Innovation, and Infrastructure"(Franco et al. 2019).

Another suggestion is to provide clear guidelines on how the technologies will be integrated into the curriculum. This could be done by incorporating them throughout the degree program, focusing on subjects related to the clinical practice of physiotherapy, or by creating a dedicated section that covers topics related to patients' use of rehabilitation

technologies. It is important to consider indications, contraindications, proper handling, maintenance, and the specific areas of physiotherapy where these approaches are applicable. When discussing and deciding on course curriculum, it is important to prioritize educational matters and ensure that training innovations are not overly influenced by the interests of technology entrepreneurs and investors (Rowe 2019).

It is also suggested to consider the implementation of modern teaching approaches, such as heutagogy. Heutagogy, an approach that emphasizes student autonomy in the learning process, is highly relevant for integrating technologies with the essential competences of the physiotherapist's clinical activities (Canning 2010).

The heutagogy-based teaching method was developed in Australia in the early 2000s by Stwart Hase and Chris Kenyon of the University of Southern Cross. (Hase 2016). The primary goal of this study is to enhance students' proactivity and autonomy in the learning process, often facilitated by the use of technology (Narayan, Herrington, and Cochrane 2019). Integrating modern practices into the curriculum content can be effective in developing a more advanced curriculum. Heutagogy enables the extensive utilization of Information and Communication Technologies (ICT) as a means of support for teaching and learning (Dailey-Hebert and Dennis 2015)

Emphasizing the importance of safety in decision-making and fostering the development of critical thinking and clinical reasoning are essential components of training future professionals. This can be accomplished by developing educators who serve as facilitators, assisting students in transitioning from being recipients of knowledge to becoming independent learners (Blaschke 2012).

Our recommendations strive to encourage educational advancements and honor the independence of higher education institutions in terms of curriculum updates. We understand that every IES has a crucial role in regional development through the training of skilled professionals (Gül et al. 2010).

We hope that this study will encourage new discussions and reflections in the IES, directing the training of physiotherapists to a more dynamic and modern level, able to meet contemporary demands based on evidence. Be these demands of a traditional and manual nature or innovative and technological. Our research has benefited significantly from doctoral internships conducted in two regions of the Iberian Peninsula, at the

University of Castile-La Mancha in Toledo and at the Universidad de Vigo in Pontevedra, Spain, allowing direct contact with the formative realities of physiotherapy and the challenges related to technological advancement.

6.3 CONCLUSION

Our research on the formative realities of physiotherapy in the Iberian Peninsula in relation to technological advances in clinical practice reveals a scenario that requires attention and adaptation. Notably, we have identified a low adherence to significant changes in the curriculum structure and in the use of contemporary technologies for the clinical training of future physiotherapists.

However, it is important to highlight that both teachers and students have demonstrated a sharp awareness of the numerous evidence-based rehabilitation technologies available. They understand the importance of incorporating them into the curriculum, ensuring that future professionals are prepared for an increasingly technologically innovative world.

Cross-border collaboration presents itself as a promising path. By identifying similarities and differences in educational realities, we realize that these disparities should not be obstacles but rather opportunities to enrich and direct the common focus. The integration of technologies in the training of physiotherapists is a global challenge and requires joint efforts to promote high-quality, modern, and effective clinical practice.

We hope that our findings will serve as a catalyst for the review and adaptation of training approaches in physiotherapy in the Iberian Peninsula, thereby preparing future professionals to meet technological demands in a competent and innovative way. This is a journey in which everyone can play a key role.

REFERENCES

Al-Rahmi, W. M., Alzahrani, A. I., Yahaya, N., Alalwan, N., & Kamin, Y. Bin. (2020). Digital communication: Information and communication technology (ICT) usage for education sustainability. Sustainability (Switzerland), 12(12), 1–18. https://doi.org/10.3390/su12125052

Barradell, S. (2017). Moving forth: Imagining physiotherapy education differently. Physiotherapy Theory and Practice, 33(6), 439–447. https://doi.org/10.1080/09593985.2017.1323361

Blaschke, L. M. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. The International Review of Research in Open and Distributed Learning, 13(1), 56. https://doi.org/10.19173/irrodl.v13i1.1076

Broberg, C., Aars, M., Beckmann, K., Emaus, N., Lehto, P., Lähteenmäki, M. L., Licentiate, A., Thys, W., & Vandenberghe, R. (2003). A conceptual framework for curriculum design in physiotherapy education - An international perspective. Advances in Physiotherapy, 5(4), 161–168. https://doi.org/10.1080/14038190310017598

Canning, N. (2010). Playing with heutagogy: exploring strategies to empower mature learners in higher education. Journal of Further and Higher Education, 34(1), 59–71. https://doi.org/10.1080/03098770903477102

Cata, M. (2015). Smart university, a new concept in the Internet of Things. 2015 14th RoEduNet International Conference - Networking in Education and Research (RoEduNet NER), 195–197. https://doi.org/10.1109/RoEduNet.2015.7311993

Dai, Z., Sun, C., Zhao, L., & Li, Z. (2021). Assessment of Smart Learning Environments in Higher Educational Institutions: A Study Using AHP-FCE and GA-BP Methods. IEEE Access, 9, 35487–35500. https://doi.org/10.1109/ACCESS.2021.3062680

Dailey-Hebert, A., & Dennis, K. S. (2015). Transformative Perspectives and Processes in Higher Education. In A. Dailey-Hebert & K. S. Dennis (Eds.), Transformative Perspectives and Processes in Higher Education. Springer International Publishing. https://doi.org/10.1007/978-3-319-09247-8

de Meyrick, J. (2003). The Delphi method and health research. Health Education, 103(1), 7–16. https://doi.org/10.1108/09654280310459112

Deusinger, S. S., Crowner, B., Burlis, T. L., Stith, J. S., Deusinger, S. S., & Crowner, B. E. (2014). Meeting contemporary expectations for physical therapists : Imperatives , challenges , and proposed solutions for professional education Therapists : Imperatives , Challenges , and Proposed.

Elton, L. (2003). Dissemination of Innovations in Higher Education : Tertiary Education and Management, 9(3), 199–214.

Fennelly, O., Desmeules, F., O'Sullivan, C., Heneghan, N. R., & Cunningham, C. (2020). Advanced musculoskeletal physiotherapy practice: Informing education curricula. Musculoskeletal Science and Practice, 48(January), 102174. https://doi.org/10.1016/j.msksp.2020.102174

Franco, I., Saito, O., Vaughter, P., Whereat, J., Kanie, N., & Takemoto, K. (2019). Higher education for sustainable development: actioning the global goals in policy, curriculum and practice. Sustainability Science, 14(6), 1621–1642. https://doi.org/10.1007/s11625-018-0628-4

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Gül, H., Sallan Gül, S., Kaya, E., & Alican, A. (2010). Main trends in the world of higher education, internationalization and institutional autonomy. Procedia - Social and Behavioral Sciences, 9, 1878–1884. https://doi.org/10.1016/j.sbspro.2010.12.417

Hase. (2016). Self-determined Learning (heutagogy): Where Have We Come Since 2000? In D. J. Hoffman (Ed.), SITJAR (Special Ed). https://hdl.handle.net/10652/5723

Health Education England. (2019). The Topol Review: Preparing the healthcare workforce to deliver the digital future. An independent report on behalf of the Secretary of State for Health and Social Care. National Health Service (NHS), February, 102. https://topol.hee.nhs.uk/wp-content/uploads/HEE-Topol-Review-2019.pdf

Lee, A., Finnin, K., Holdsworth, L., Millette, D., & Peterson, C. (2020). Digital Physical Therapy Practice Task Force - Final Report. World Confederation for Physical Therapy, International Network of Physiotherapy Regulatory Authorities., March. https://www.wcpt.org/sites/wcpt.org/files/files/wcptnews/REPORT OF THE WCPTINPTRA DIGITAL PHYSICAL THERAPY PRACTICE TASK FORCE MARCH 2020.pdf.

Majeed, A., & Ali, M. (2018). How Internet-of-Things (IoT) making the university campuses smart? QA higher education (QAHE) perspective. 2018 IEEE 8th Annual Computing and Communication Workshop and Conference, CCWC 2018, 2018-Janua, 646–648. https://doi.org/10.1109/CCWC.2018.8301774

Narayan, V., Herrington, J., & Cochrane, T. (2019). Design principles for heutagogical learning: Implementing student-determined learning with mobile and social media tools. Australasian Journal of Educational Technology, 35(3), 86–101. https://doi.org/10.14742/ajet.3941

Pernencar, C., Aguilar, P., Saboia, I., Barreto, I., Theophilo, R., Oliveira, D., & Monteiro, L. O. (2022). Systematic mapping of digital health apps – A methodological proposal based on the World Health Organization classification of interventions. DIGITAL HEALTH, 8, 205520762211290. https://doi.org/10.1177/20552076221129071

Rowe, M. (2019). An Introduction to Machine Learning for Clinicians. Academic Medicine, 94(10), 1433–1436. https://doi.org/10.1097/ACM.0000000000002792

Sabus, C., & Macauley, K. (n.d.). Simulation in Physical Therapy Education and Practice : Opportunities and Evidence-Based Instruction to Achieve Meaningful Learning Outcomes. 3–13.

Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. KZfSS Kölner Zeitschrift Für Soziologie Und Sozialpsychologie, 69(S2), 107–131. https://doi.org/10.1007/s11577-017-0454-1

Shaban-Nejad, A., Kamaleswaran, R., Shin, E. K., & Akbilgic, O. (2019). Health intelligence. In Biomedical Information Technology. Elsevier Inc. https://doi.org/10.1016/B978-0-12-816034-3.00006-7

Vissers, D. (2014). Introducing Competency-Based Education Based on the Roles that Physiotherapists Fulfil. Journal of Novel Physiotherapy and Physical Rehabilitation, 1, 053–058. https://doi.org/10.17352/2455-5487.000010

WCPT. (2019). Evidence-based practice Policy statement. www.world.physio/resources/glossary

Wild, C., & Langer, T. (2013). Emerging health technologies : Informing and supporting health policy early. 87, 160–171. https://doi.org/10.1016/j.healthpol.2008.01.002

Yang, G., Pang, Z., Jamal Deen, M., Dong, M., Zhang, Y.-T., Lovell, N., & Rahmani, A. M. (2020). Homecare Robotic Systems for Healthcare 4.0: Visions and Enabling Technologies. IEEE Journal of Biomedical and Health Informatics, 24(9), 2535–2549. https://doi.org/10.1109/JBHI.2020.2990529

Zhu, Z. T., Yu, M. H., & Riezebos, P. (2016). A research framework of smart education. Smart Learning Environments, 3(1). https://doi.org/10.1186/s40561-016-0026-2

APPENDIX

APPENDIX 1: ETHICAL COMMITTEE DOCUMENTS 1

Documento	2	1	0	2	5

Comissão de Ética da Universidade de Évora

A Comissão de Ética da Universidade de Évora informa que, com base nas apreciações favoráveis dos seus membros, deliberou dar

Parecer Positivo

para a realização do Projeto: "*Adaptation of the Professional Training of Physiotherapists in Function of the Technological Impact in their Clinical Practice: Formative Realities in the Iberian Peninsula*", pelo doutorando **Tarciano Batista e Siqueira** sob a supervisão do Prof. Doutor João Paulo Brites de Sousa (responsável académico).

Universidade de Évora, 04 de maio de 2021

A Presidente da Comissão de Ética

(Prof.ª Doutora Margarida I. Almeida Amoedo)

APPENDIX 2: ETHICAL COMMITTEE DOCUMENTS 2

IPS Instituto Politécnico de Setúbal

Comissão de Ética

Identificação do documento: CE-IPS nº 28 / 2022

Título do projeto: *Adaptação da Formação Profissional do Fisioterapeuta em Função do Impacto Tecnológico na sua Prática Clínica: Realidades Formativas na Península Ibérica*

Investigador principal: Tarciano Barista e Siqueira, aluno do doutoramento de Motricidade Humana, na Universidade de Évora.

Equipa de investigação:

Professor Doutor João Paulo Brites de Sousa, https://www.cienciavitae.pt/portal/FF15-6069-1B42
Professor Doutor José Alberto Frade Martins Parraça, https://www.cienciavitae.pt/portal/331B-06C2-6DF3

Unidade Orgânica do IPS: Escola Superior de Saúde - IPS (Instituição de Ensino Superior participante)

Outras Unidades/Participantes: Universidade de Évora

ANÁLISE E JUSTIFICAÇÃO DO PARECER

Documentos recebidos

Foram recebidos os seguintes documentos:

- Requerimento e pedido de apreciação do projeto;
- CV do IP e Links Ciência Vitae dos restantes 2 membros da equipa;
- Protocolo do projeto (sinopse, métodos) e respetivo cronograma;
- Parecer positivo da Comissão de Ética da Universidade de Évora para a realização do projeto, datado de maio de 2021;
- Declaração de acolhimento da Unidade de Investigação *Comprehensive Health Research Centre*, datado de março de 2021;
- Declarações dos orientadores da tese, datadas de março de 2021;
- Instrumentos de recolha de dados e análise de dados, incluindo Guião de entrevista individual;
- Consentimento informado, esclarecido e livre.
- Declaração de Compromisso com as boas práticas assinada pelo investigador e orientadores.

Análise e justificação do Parecer

1. O projeto é proposto no âmbito do doutoramento em Motricidade Humana na Universidade de Évora.
2. O estudo tem como objetivo "compreender de que modo está a ser interpretada e adaptada a formação profissional do fisioterapeuta em função do impacto tecnológico na prática clínica, identificando quais serão as necessidades de adaptação curricular da fisioterapia relativas ao avanço tecnológico da prática profissional do fisioterapeuta, a partir da análise de realidades formativas na Península Ibérica." E de que "*a posteriori* seja possível desenvolver parte da pesquisa em uma abordagem no Curso de Fisioterapia do Instituto Politécnico de Setúbal."
3. Seleção e recrutamento de participantes: "Será criado um painel de peritos especialistas como sugere a aplicação do Delphi Method (Skulmoski, G. et al, 2007). Os peritos serão notadamente os elementos responsáveis pela formação profissional dos fisioterapeutas e elementos que têm participação ativa na prática clínica. Todos os elementos a incluir no painel de peritos serão convidados pessoalmente e/ou por carta formal a participar no nosso estudo. Em caso de concordância de participação terão de proceder ao preenchimento e devolução do consentimento livre e esclarecido, que tomará em conta todos os princípios éticos necessários à participação."
4. Está previsto que "será delineada uma revisão da literatura de abordagem descritiva e analítica, para conhecer o impacto tecnológico na formação profissional (curricular) do fisioterapeuta. Serão analisadas realidades formativas na Península Ibérica e traçado um perfil da formação profissional do fisioterapeuta. Esta revisão incluirá informação sobre: a estrutura curricular das formações analisadas; a titulação dos docentes; a estrutura dos laboratórios de ensino; e a implementação de auxiliares tecnológicos nos planos curriculares correntes. Além dos documentos oficiais (estrutura curricular e planos de estudos) de cada Instituição de Ensino Superior participante, serão pesquisados documentos emitidos pela Agência de Avaliação e Acreditação do Ensino Superior (A3ES) em Portugal e Agência Nacional de Avaliação da Qualidade e Acreditação (ANECA) que é o órgão espanhol de acreditação do ensino."
5. Está detalhado o processo de recolha de dados: "Será utilizado um guião de perguntas relacionadas à incorporação da tecnologia nas atividades clínicas aplicadas na formação dos estudantes de fisioterapia e na atuação dos profissionais em exercício. Esse guião será a principal técnica de recolha de dados. A aplicação do guião de perguntas será fundamentada no Método Delphi."
6. Está pouco detalhado o processo de armazenamento de dado: "Todos os dados recolhidos serão armazenados de forma a permitir a conformidade com a legislação portuguesa e da União Europeia relativa à proteção de dados e à privacidade e ao final da pesquisa serão

eliminados." **Solicita-se a clarificação deste ponto quanto ao local de armazenamento e à responsabilização do IP e seus orientadores.**

7. Quanto à documentação a facultar aos potenciais participantes, apresenta-se completa e conforme. Encontra-se, contudo em falta no processo submetido, a Declaração de ausência de conflito de interesses e incompatibilidades. **Solicita-se o envio deste documento.**

Parecer

Em conclusão, a CE-IPS considera que o estudo preenche os requisitos éticos da investigação e apresenta garantias de respeito pela dignidade e integridade dos participantes, bem como de privacidade e proteção de dados pessoais. Os elementos apresentados suportam o parecer favorável, sujeito ao esclarecimento pedido no ponto 6 e à submissão do documento solicitado no ponto 7 – em consequência, a Comissão emitirá parecer favorável para a realização da investigação nos termos do projeto, a partir da data deste parecer.

Relator/a: Maria João Pedroso Carmezim

Aprovação CE-IPS a 2 dezembro 2022

Presidente da CE-IPS

APPENDIX 3: RECORDS OF SYSTEMATIC REVIEWS: STUDY 1

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Technological components in the rehabilitation process: A systematic review of the available technologies incorporated into the physiotherapist's professional routine.

To enable PROSPERO to focus on COVID-19 submissions, this registration record has undergone basic automated checks for eligibility and is published exactly as submitted. PROSPERO has never provided peer review, and usual checking by the PROSPERO team does not endorse content. Therefore, automatically published records should be treated as any other PROSPERO registration. Further detail is provided here.

Citation

Tarciano Batista e Siqueira, João Paulo Brites de Sousa, José Alberto Frade Martins Parraça. Technological components in the rehabilitation process: A systematic review of the available technologies incorporated into the physiotherapist's professional routine.. PROSPERO 2020 CRD42020222288 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020222288

Review question

Review question/objective:

What technological aids are available to the physiotherapist during the rehabilitation process?

The purpose of this review is to identify and synthesize the best evidence available on the technologies used for the management of physical rehabilitation in patients being incorporated into the physiotherapist's clinical work routine.

Searches

A literature search will be conducted in the following electronic databases: Embase, PubMed, Physiotherapy Evidence Database (PEDro) and Ovid.

The search will be restricted in terms of publication date: from January 2000 to november 2020, and language: studies published in English or Portuguese will be selected, although studies in other languages will only be accepted if a published English or portuguese translation is available.

The search will exclude all those studies published in a language other than. English or Portuguese, which do not contain full access to the text and presentations at conferences, theses, books.

Types of study to be included

No study design restrictions will be imposed. The review will include all experimental and observational study designs that include original quantitative or qualitative data. Studies that assessed the effectiveness and / or safety of rehabilitation interventions using technology that reported any form of patient experience with these interventions will be included.

If potentially relevant conference abstracts are found, they will only be included if there is a full text available (where this is unclear, authors will be contacted for clarification of full text or data availability).

Condition or domain being studied

Technologies available for use by the physiotherapist in the clinical activities of his professional routine of evaluation

and monitoring of the physical rehabilitation process of patients with motor disabilities.

Participants/population

Eligibility criteria Inclusion:

Original studies in English or Portuguese published since 2000 that analyze the use of technologies for the management of physical rehabilitation of motor disabilities.

Exclusion criteria:

Studies that evaluate software, applications, robots or other technologies that are not used or have no potential for use in the professional activities of the physiotherapist as part of a preventive program or in support of a multidisciplinary rehabilitation team.

Studies that analyze the use of software, applications, robots, or other non-health technologies, such as instant messaging applications, video calls or any other application that is not created for health-related purposes.

Intervention(s), exposure(s)

Any technology-based rehabilitation intervention, synchronous or asynchronous, delivered via smartphone, tablet or Internet-based medium, including wearable sensors, motion monitoring using digital devices, interactive virtual system. Studies that describe and / or test software or mobile applications for rehabilitation management.The sofware or mobile applications include web based applications, mobile aplications or any sofware created with health purposes used in mobile or wireless devices.

Any intervention for the rehabilitation of patients that involves the use of electromechanical assistive equipment or devices with automation, sensors and automated and interactive dynamic control logic that uses only robotic devices that help patients regain their motor abilities. The types of robotic assistive devices for rehabilitation can be varied such as robotic exoskeletons and lokmat. Robotic interventions can be combined with other approaches that will be considered as rehabilitation technology (for example, semi-immersive and fully immersive game technologies or virtual reality).Technology-based rehabilitation can be performed alone or in conjunction with other interventions.

Comparator(s)/control

Not applicable

Main outcome(s)

The pre-specified main outcomes of the review include the quality of care, costs, access to care, quality of life, and ethical guidelines. To describe the state-of-the-art of technology-based assessment and rehabilitation in order to evaluate strenghths and limitations. Identify the types of technologies (software, mobile applications or robotics) used to manage the rehabilitation process.

Determine if there is any type of patient or patients with a specific disease that most benefits from the use of technologies in the rehabilitation process.

Measures of effect

Not applicable

Additional outcome(s)

Not applicable

Measures of effect

Not applicable

Data extraction (selection and coding)

Study selection:

Studies of moderate and high level of evidence published in English or in Portuguese from the year 2000 to the year 2020 that concern rehabilitation practices with the use of technologies by physiotherapists. Our review will include the use of technologies throughout the rehabilitation process from assessment to clinical follow-up with all types of disabilities within the scope of the physiotherapist's practice including motor language and cognitive disabilities in all settings.

The articles found will be added to the Mendeley bibliographic manager where the duplicate articles will be eliminated. We will be following PRISMA (Preferred Reporting terms of Systematic reviews and Meta-Analyses) guidelines to select; review; and report the included studies.

The screening will be carried out by two researchers who will filter the title and abstract of each article and categorize them as "included", "excluded" or "maybe" independently and not blinded as to the authors and journal. If necessary, a third person will be asked to assist in resolving the disagreement. Articles in the "included" and "maybe" categories will be read entirely by one person to verify if they meet our inclusion criteria. If they are excluded, we will note the reason for exclusion. The included studies will be compared between the two reviewers. In case of disagreement, consensus will be sought through discussion. If discrepancies remain to exist, a third researcher will make the final decision.

Data extraction:

The data of the included studies will be extracted using a pre-defined data collection form by two researchers independently and cross-checked by a third one. Data extracted about the study will include the article title, publication year, authors, study design, and quality of study.

Risk of bias (quality) assessment

Risk of bias assessment is not applicable. This review will not make any consideration nor metanalysis on the intervention effect. In other words, we will not summarize the effect of robot/virtual reality training on motivation and patients' satisfaction, conversely, we will analyze and summarize what tools were used in the reviewed studies to assess motivation and satisfaction.

Strategy for data synthesis

A narrative summary will synthesize the data obtained about the study, the field of therapy, clinical features, as well as the interventions. Due to the wide range of possible outcomes, patient populations, and clinical settings, no statistical analyses will be performed on this data. The synthesis of the data will be narrative because are not expect homogeneous results for a quantitative analysis. The data from the included studies will be analyzed qualitatively and by descriptive analysis. From the retained studies, data tables will also be created to present relevant information in a visual manner.

Analysis of subgroups or subsets

A subgroup analysis will be considered for the different technological devices.

Contact details for further information

Tarciano Batista e Siqueira

tarcianosiqueira@hotmail.com

Organisational affiliation of the review

Universidade de Évora
https://www.uevora.pt/

Review team members and their organisational affiliations

Tarciano Batista e Siqueira. Universidade de Évora
Dr João Paulo Brites de Sousa. Universidade de Évora
Dr José Alberto Frade Martins Parraça. Universidade de Évora

Type and method of review

Systematic review

Anticipated or actual start date [1 change]

27 December 2020

Anticipated completion date [1 change]

05 May 2021

Funding sources/sponsors

There are no funding sources.

Conflicts of interest

Language

English

Country

Portugal

Stage of review [2 changes]

Review Ongoing

Details of final report/publication(s) or preprints if available [1 change]

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

Humans; Physical Therapists

Date of registration in PROSPERO

23 December 2020

Date of first submission

23 November 2020

Stage of review at time of this submission [2 changes]

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 review was concluded and submitted for publication in a scientific journal.

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

23 December 2020
27 March 2021
13 January 2022
16 October 2023

APPENDIX 4: RECORDS OF SYSTEMATIC REVIEWS: STUDY 2

Heutagogy as a Facilitating Educational Model for the Implementation of Technological Teaching and Adaptation of Theoretical and Practical Contents that promote Critical Thinking and clinical reasoning in the decision making of undergraduate students in physiotherapy: A systematic review.

Citation

Tarciano Batista e Siqueira, João Paulo Brites de Sousa, José Alberto Frade Martins Parraça. Heutagogy as a Facilitating Educational Model for the Implementation of Technological Teaching and Adaptation of Theoretical and Practical Contents that promote Critical Thinking and clinical reasoning in the decision making of undergraduate students in physiotherapy: A systematic review.. PROSPERO 2021 CRD42021253326 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021253326

Review question

Can heutagogy be an adequate teaching model for the technological evolution of teaching and rehabilitation learning that guarantees adaptation of theoretical and practical content with the development of critical thinking and clinical reasoning in physiotherapy students?

Searches

A literature search will be conducted in the following electronic databases: Embase, PubMed, Physiotherapy Evidence Database (PEDro) and SciELO.

The search will be restricted in terms of publication date: from January 2000 to november 2020, and language: studies published in English or Portuguese will be selected, although studies in other languages will only be accepted if a published English or portuguese translation is available.

The search will exclude all those studies published in a language other than. English or Portuguese, which do not contain full access to the text and presentations at conferences, theses, books.

Types of study to be included

No restrictions on the study design will be imposed. The review will include all experimental study designs and observational studies that include original quantitative or qualitative data. Studies that evaluated the effectiveness of heutagogy in teaching and learning in health sciences that reported any form of experience with intervention of the heutagogical method will be included.

Condition or domain being studied

Teaching and learning method with the potential to incorporate technology and develop the clinical reasoning of undergraduate students in physiotherapy.

Participants/population

Teachers and Undergraduate Students in Physiotherapy and related areas.

Intervention(s), exposure(s)

Any intervention that incorporates heutagogical practices in the Physiotherapy Graduation and related areas of teaching in health sciences to stimulate the acquisition of professional skills and competences such as the development of critical thinking and clinical reasoning in health decision-making.

Comparator(s)/control

Not applicable

Main outcome(s)

Recommend strategies and methodologies for the development of critical health thinking and clinical reasoning.

Measures of effect

Not applicable

Additional outcome(s)

Not applicable

Measures of effect

Not applicable

Data extraction (selection and coding)

Studies of moderate and high level of evidence published in English or Portuguese from the year 2000 to the year 2020 that concern the practice of teaching undergraduate physiotherapy using the heutagogy method. Our review will include studies that demonstrate the heutagogy of technologies throughout the rehabilitation process from assessment to clinical follow-up with all types of disabilities within the scope of the physiotherapist's practice including motor language and cognitive disabilities in all environments.

The articles found will be added to the bibliographic manager of the Mendeley software where the duplicate articles will be eliminated.

Data extraction:

The data from the included studies will be extracted using a data collection form pre-defined by two researchers independently and crossed by a third one. The data extracted about the study will include the title of the article, year of publication, authors, study design and quality of the study.

Risk of bias (quality) assessment

To Reduce the Risk of Bias The screening will be carried out by two researchers who will filter the title and summary of each article and categorize them as "included", "excluded" or "maybe" independently and not blinded as to the authors and journal. The included studies will be compared between the two reviewers. In case of disagreement, consensus will be sought through discussion. If the discrepancies persist, a third researcher will make the final decision. We will be following the PRISMA guidelines (preferred reporting terms for systematic reviews and meta-analyzes) for selecting and reporting the included studies.

Strategy for data synthesis

The synthesis of the data will be narrative, since homogeneous results are not expected for a quantitative analysis. The data from the included studies will be analyzed qualitatively and by descriptive analysis. From the retained studies, data tables will also be created to present relevant information in a visual way.

Analysis of subgroups or subsets

None predicted.

Contact details for further information

Tarciano Batista e Siqueira

tarcianosiqueira@hotmail.com

Organisational affiliation of the review

Universidade de Évora

Review team members and their organisational affiliations

Professor Tarciano Batista e Siqueira. Universidade de Évora

Dr João Paulo Brites de Sousa. Universidade de Évora

Dr José Alberto Frade Martins Parraça. Universidade de Évora

Type and method of review

Systematic review

Anticipated or actual start date

31 May 2021

Anticipated completion date

30 November 2021

Funding sources/sponsors

There are no funding sources.

Conflicts of interest

Language

English

Country

Portugal

Stage of review

Review Ongoing

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

Clinical Reasoning; Decision Making; Humans; Models, Educational; Physical Therapy Modalities; Students, Nursing; Thinking

Date of registration in PROSPERO

05 June 2021

Date of first submission

05 May 2021

Stage of review at time of this submission [2 changes]

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 review was concluded and submitted for publication in a scientific journal.

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

05 June 2021

05 June 2021

13 January 2022

16 October 2023

APPENDIX 5: DOCTORAL INTERNSHIP CERTIFICATE 1

Oficina de Relaciones Internacionales. Campus de Toledo

Dª. ANA ISABEL FERNÁNDEZ PÉREZ, SUBDIRECTORA DE LA OFICINA DE RELACIONES INTERNACIONALES DEL CAMPUS DE TOLEDO,

HACE CONSTAR que,

D. **Tarciano Batista Siqueira**, con Nº Pasaporte FS206624, ha realizado una estancia de movilidad de doctorado en el Grupo de Investigación en Fisioterapia de la Facultad de Fisioterapia y Enfermería del campus de Toledo del 14 de septiembre de 2020 al 14 de enero de 2021.

Lo que firmo, a solicitud del interesado, en Toledo en la fecha abajo señalada.

Campus Fábrica de Armas. Avda/ Carlos III s/n - 45071 Toledo - España –
Tel. +34 925268800 (Ext. 5704 – 5998) e-mail: ori.to@uclm.es

ID. DOCUMENTO	PX5TIDEmwW	Página: 1 / 1
FIRMADO POR	FECHA FIRMA	ID. FIRMA
FERNANDEZ PEREZ ANA ISABEL	04-02-2021 11:37:18	1612435038779

PX5TIDEmwW

Termo de Reconhecimento Académico
Mobilidade Out

Ano Lectivo: 2020/2021
Nome: Tarciano Batista e Siqueira
Número: 44127
Grau: Programa de Doutoramento
Curso: Motricidade Humana (cód: 695)

Dados de Mobilidade

Instituição de Destino: Universidad de Castilha da Mancha
País: Espanha
Programa de Moblidade: ERASMUS+
Duração do Período de Mobilidade: 1º Semestre

Actividades extra-curriculares (para apresentação no Suplemento ao Diploma)

- (PT): Durante os 4 meses de mobilidade do aluno Tarciano Siqueira, desenvolveu diversas competências na área da fisioterapia nos laboratórios da Universidade de Castilla de la Mancha, mais especificamente:
  Atividades realizadas:
  1 - Visita a departamentos de ensino, áreas de ensino teórico-prático de fisioterapia e laboratórios de ensino e investigação.
  2 - Acompanhamento das práticas de pesquisa com o Dr. Diego Serrano Muñoz.
  3 - Visita aos serviços de reabilitação do Hospital Nacional de Paraplejicos de Toledo.
  4 - Acompanhamento das práticas clínicas de estimulação espinhal e manejo do Lokomat com a pesquisadora Natalia Comino Suarez.
  5 - Reunião com o Professor Javier Merino para discutir as práticas educativas e o uso de tecnologias no ensino da Fisioterapia Pediátrica.
  6 - Observação de dinâmicas educacionais para interpretação gráfica com Dr. Julio Gómez Soriano.
  7 - Participação em congresso científico: "aplicação de novas tecnologias na formação em ciências da saúde".
  8 - Tutoria com o Professor Julio Gómez Soriano para preparar um encontro virtual para abordar as novas tecnologias no ensino da fisioterapia.
  9 - Reunião e conversa com professores, fisioterapeutas e pesquisadores em fisioterapia da UCLM.
- (EN): During the 4 months of mobility of the student Tarciano Siqueira, he developed several skills in the field of physiotherapy in the laboratories of the University of Castilla de la Mancha, more specifically:
  Performed activities:
  1 - Visit to teaching departments, theoretical and practical areas of physiotherapy and teaching and research laboratories.
  2 - Monitoring of research practices with Dr. Diego Serrano Muñoz.
  3 - Visit to the rehabilitation services of the National Hospital of Paraplejicos de Toledo.
  4 - Monitoring of clinical practices for spinal stimulation and management of Lokomat with researcher Natalia Comino Suarez.
  5 - Meeting with Professor Javier Merino to discuss educational practices and the use of technologies in the teaching of Pediatric Physiotherapy.
  6 - Observation of educational dynamics for graphic interpretation with Dr. Julio Gómez Soriano.
  7 - Participation in scientific congress: "application of new technologies in the formation of health sciences".
  8 - Tutoring with Professor Julio Gómez Soriano to prepare a virtual meeting to address the new technologies in the teaching of physiotherapy.
  9 - Meeting and conversation with professors, physiotherapists and physiotherapy researchers at UCLM.

Total de ECTS obtidos em Mobilidade Out: **0**

Parecer da Comissão de Curso
Reconhecimento de Resultados proposto a 3 de maio de 2021, por Armando Manuel Mendonça Raimundo
Homologação do Presidente do Conselho Científico do Instituto de Investigação e Formação Avançada:
Homologado a 3 de maio de 2021, por Diogo Francisco Caeiro Figueiredo

APPENDIX 6: DOCTORAL INTERNSHIP CERTIFICATE 2

Universidade Vigo

Campus de Pontevedra Facultade de Fisioterapia

Campus A Xunqueira 36005 Pontevedra Tel. 986 801 752 Fax 986 801 780 www.fisioterapia.uvigo.es sdfisioterapia@uvigo.es
España

Universidad de Vigo – Facultad de Fisioterapia – Campus de Pontevedra
Certificado de Movilidad Doctoral

Mediante este certificado, yo, Profesora Dra. Iris Machado de Oliveira, Responsable de Relaciones Internacionales de la Facultad de Fisioterapia de la Universidad de Vigo en el Campus de Pontevedra, declaro que Tarciano Batista e Siqueira doctorando en Motricidad Humana en la Universidad de Évora – Portugal ha realizado su movilidad doctoral en la Facultad de Fisioterapia de la Universidad de Vigo en el Campus de Pontevedra.

Una vez considerado el objetivo de la estancia aclarado en el Acuerdo de prácticas "Learning Agreement for Traineeships" durante el periodo transcurrido del 15/09/2021 al 03/05/2022 el doctorando se integró en la Facultad de Fisioterapia participando en las siguientes actividades:

1 - Visitas a los departamentos de enseñanza y aprendizaje de la Facultad de Fisioterapia;
2 – Seguimiento de las prácticas de investigación por el Grupo de Investigación Health Fit;
3 – Participación en el curso complementario de la Universidad de Vigo "Evaluación y Abordaje Terapéutico de la Patología del Hombro"
4 - Encuentro con profesores de fisioterapia donde impartió la conferencia "Tecnologías de Rehabilitación y su Incorporación en la formación de fisioterapeutas"
5 – Reunión con alumnos de último curso de la carrera de fisioterapia donde impartió la conferencia: "Nuevas Tecnologías de Rehabilitación y su Aplicación en la Práctica Clínica de la Fisioterapia".
6 - Tutorías y Prácticas Supervisadas, donde fue posible: conocer la estructura física y curricular de la formación de fisioterapeutas, intermediar las actividades mencionadas anteriormente y garantizar la dinámica de las prácticas propuestas en el Contrato de Aprendizaje para Prácticas "Learning Agreement for Traineeships".

Y para que conste firmo a continuación,

MACHADO DE OLIVEIRA IRIS - 53861807Q

Firmado digitalmente por MACHADO DE OLIVEIRA IRIS - 53861807Q
Fecha: 2022.05.18 11:45:58 +02'00'

APPENDIX 7: CERTIFICATES OF ABSTRACT PRESENTED AT SCIENTIFIC EVENT 1.

JUNTA DE EXTREMADURA
Consejería de
Igualdad y Cooperación para el Desarrollo

CERTIFICADO VI SEMINARIO IBÉRICO DE INVESTIGACIÓN EN JUVENTUD

María Isabel Sánchez Jiménez, en calidad de Presidenta del Consejo de la Juventud de Extremadura, cargo para el que fue nombrada por Decreto 116/2022, de 6 de septiembre (DOE nº 176, de 13 de septiembre).

CERTIFICA:

Que, **D. Tarciano Batista e Siquiera,** con DNI **3Q2J24143,** ha participado como comunicador en el VI Seminario Ibérico de Investigación en Juventud, que se ha desarrollado los días 24 y 25 de marzo de 2023 en el Instituto de Lenguas Modernas (ILM) en Cáceres, con la siguiente ponencia:

"Tecnologías de Reabilitação na Prática Clínica e Formação dos Jovens Alunos de Fisioterapia na Península Ibérica: Um estudio Delphi sobre a visão dos Formandos".

Y para que conste a los efectos oportunos, firma el presente certificado Dña. María Isabel Sánchez Jiménez, Presidenta del Consejo de la Juventud de Extremadura.

PRESIDENTA DEL CJEx
Fdo. Dña. María Isabel Sánchez Jiménez
Firmado por ***5989** MARIA ISABEL SANCHEZ (R: ****5003*) el día 02/05/2023 con un certificado emitido por AC Representación

C/ Reyes Huertas, 1 - 1º Izq. 06800 MÉRIDA Tel.: 924 00 93 30 Fax: 924 00 93 37 www.cjex.org info@cjex.org

APPENDIX 8: CERTIFICATES OF ABSTRACTS PRESENTED AT SCIENTIFIC EVENT 2.

CHRC
COMPREHENSIVE HEALTH RESEARCH CENTRE

4th CHRC ANNUAL SUMMIT

May 25 & 26

CERTIFICATE

This is to certify that **Tarciano Batista e Siqueira** presented a Digital Poster entitled "**Adaptation of the Professional Training of Physiotherapists in Function of the Technological Impact in their Clinical Practice: Formative Realities in the Iberian Peninsula**" at the 4th Comprehensive Health Research Centre Annual Summit, held on May 25th & 26th 2023 at the University of Évora. The work presented is authored by Tarciano Batista e Siqueira, José Parraça & João Paulo Sousa.

Helena Canhão

Helena Canhão, MD, PhD
CHRC Coordinator

NOVA MEDICAL SCHOOL · UNIVERSIDADE DE ÉVORA · Escola Nacional de Saúde Pública · LISBON INSTITUTE for Global Mental Health · 20 FCT

Hosted by UNIVERSIDADE DE ÉVORA

CHRC
COMPREHENSIVE HEALTH RESEARCH CENTRE

4th CHRC ANNUAL SUMMIT

May 25 & 26

CERTIFICATE

This is to certify that **Tarciano Batista e Siqueira** presented an Oral Communication entitled "**Rehabilitation technologies with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review**" at the 4th Comprehensive Health Research Centre Annual Summit, held on May 25th & 26th 2023 at the University of Évora. The work presented is authored by Tarciano Batista e Siqueira, José Parraça & João Paulo Sousa.

Helena Canhão

Helena Canhão, MD, PhD
CHRC Coordinator

NOVA MEDICAL SCHOOL · UNIVERSIDADE DE ÉVORA · Escola Nacional de Saúde Pública · LISBON INSTITUTE for Global Mental Health · 20 anos FCT Fundação para a Ciência e a Tecnologia

Hosted by UNIVERSIDADE DE ÉVORA

APPENDIX 9: CERTIFICATES OF ABSTRACTS PRESENTED AT SCIENTIFIC EVENT 3.

CERTIFICADO

Certifica-se que **Tarciano Siqueira** apresentou uma Comunicação Oral intitulada «**INCLUSÃO DE NOVAS TECNOLOGIAS DE REABILITAÇÃO NA FORMAÇÃO DE FISIOTERAPEUTAS DA PENÍNSULA IBÉRICA: UM ESTUDO OBSERVACIONAL»**, de autoria de **Tarciano Siqueira, José Parraca e João Paulo Sousa** no V Congresso Nacional de Educação Para a Saúde, realizado no Colégio Pedro da Fonseca, da Universidade de Évora, nos dias 31 de maio, 01 e 02 de junho de 2023.

Jorge Bonito
(Presidente da Comissão Organizadora)
Évora, 05 de junho de 2023

CERTIFICADO

Certifica-se que **Tarciano Siqueira** apresentou uma Comunicação Oral intitulada «**HEUTAGOGIA NA TRANSFORMAÇÃO DO CONTEÚDO FORMATIVO DE FISIOTERAPIA: UMA REVISÃO SISTEMÁTICA SOB PERSPETIVA DE INOVAÇÕES NO ENSINO SUPERIOR EM SAÚDE»**, de autoria de **Tarciano Siqueira, José Parraca e João Paulo Sousa** no V Congresso Nacional de Educação Para a Saúde, realizado no Colégio Pedro da Fonseca, da Universidade de Évora, nos dias 31 de maio, 01 e 02 de junho de 2023.

Jorge Bonito
(Presidente da Comissão Organizadora)
Évora, 05 de junho de 2023

APPENDIX 10: COMPROVATIVES OF MANUSCRIPT SUBMISSION

UNIVERSIDADE DE ÉVORA

Tarciano Batista e Siqueira <tarciano.siqueira@uevora.pt>

Health Science Reports - Manuscript ID HSR-2023-09-1788

Vathsala Ramesh <onbehalfof@manuscriptcentral.com> 21 de setembro de 2023 às 10:25
Responder a: healthsciencereports@wiley.com
Para: tarciano.siqueira@uevora.pt, tarcianosiqueira@hotmail.com
Cc: tarciano.siqueira@uevora.pt, tarcianosiqueira@hotmail.com, jparraca@uevora.pt, jsousa@uevora.pt

21-Sep-2023

Dear Dr. Siqueira:

Your manuscript entitled "Available rehabilitation technology with the potential to be incorporated into the clinical practice of physiotherapists: a systematic review" by Siqueira, Tarciano; Parraca, Jose A ; Sousa, João Paulo, has been successfully submitted online and is presently being given full consideration for publication in Health Science Reports.

Co-authors: Please contact the Editorial Office as soon as possible if you disagree with being listed as a co-author for this manuscript.

Your manuscript ID is HSR-2023-09-1788.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to ScholarOne Manuscripts at https://mc.manuscriptcentral.com/hsr-wiley and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Center after logging in to https://mc.manuscriptcentral.com/hsr-wiley.

CASRAI CRediT Taxonomy: authors' contribution(s) to the submitted manuscript are attributed as below. Submitting Authors may provide Author Contributions at original submission but MUST provide the information at revised submission. At revision submission, all authors should check the contributions carefully as if your manuscript is accepted, this information will be included in the published article:
CRediT Taxonomy

Tarciano Siqueira
Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft

Jose A Parraca
Funding acquisition, Supervision, Validation

João Paulo Sousa
Funding acquisition, Supervision, Writing – review & editing

We would be most grateful if you could spare just a few moments to complete a short survey to help us look at our service to authors with the goal of understanding how authors come to learn about Health Science Reports and identifying things that we can do to improve the overall author service. Thank you for taking the time to give us your valuable feedback:
http://wiley.qualtrics.com/SE/?SID=SV_2bDQJTDFIztzix7

Thank you for submitting your manuscript to Health Science Reports.

Sincerely,
Health Science Reports Editorial Office

Health Science Reports - Decision on Manuscript ID HSR-2023-09-1788.R1 [email ref: DL-SW-1-a]

Vathsala Ramesh <onbehalfof@manuscriptcentral.com>

Dom, 04/02/2024 06:24

Para:tarciano.siqueira@uevora.pt <tarciano.siqueira@uevora.pt>;tarcianosiqueira@hotmail.com <tarcianosiqueira@hotmail.com>;jparraca@uevora.pt <jparraca@uevora.pt>;jsousa@uevora.pt <jsousa@uevora.pt>

04-Feb-2024

Dear Dr. Siqueira,

Thank you for submitting your revised manuscript to Health Science Reports. I very much enjoyed reading the revision.

I've reviewed your revised manuscript and your response to my comments and those of the reviewers, and I think all of the concerns raised have been satisfactorily addressed. I am thereby pleased to inform you that your manuscript has now been accepted for publication in Health Science Reports.

FIRST LOOK: Your manuscript is accepted. HOWEVER: Please note that your manuscript will undergo an integrity check, that includes the images. Publication will only proceed on the condition that all final files comply with the journal integrity checks. In the event that any file does not comply with our integrity checks, the journal reserves the right to rescind this decision, or, alternatively, you may be contacted to resolve any concerns raised by these checks.

While your submission has been accepted, the files will now be checked to ensure that we have everything in place for publication. The editorial office will return the manuscript to your Author's dashboard within 2 working days for you to make the final adjustments before proceeding with production. Once you have completed uploading the final files, we will proceed with production

The final version of your article cannot be published until the publisher has received the appropriate signed license agreement. Once your article has been received by Wiley for production the corresponding author will receive an email from Wiley's Author Services system which will ask them to log in and will present them with the appropriate license for completion.

Payment of your Open Access Article Publication Charge (APC):
All articles published in Health Science Reports are fully open access: immediately and freely available to read, download and share. Health Science Reports charges an article publication charge (APC).

Before we can publish your article, your payment must be completed. The corresponding author for this manuscript will have already received a quote email shortly after original submission with the estimated Article Publication Charge; please let us know if this has not been received. Once your accepted paper is in production, the corresponding author will receive an e-mail inviting them to register with or log in to Wiley Author Services (www.wileyauthors.com) where the publication fee can be paid by credit card, or an invoice or proforma can be requested. The option to pay via credit card and claim reimbursement from your institution may help to avoid delays with payment processing.

Once published, we encourage you to promote your article on social media and follow our Twitter account (@HSR_journal). If you would like us to tag any specific Twitter account or hashtag when we promote your article online, please let us know, and we'll explore this.

To further disseminate your research, you may consider creating a "Visual Abstract", an approach aimed at visually summarizing key points from an article, for use on social media. You can find more information, including a primer, examples, and videos, here: https://www.surgeryredesign.com/#resources-section.

Congratulations! I hope your experience with us was a positive one, and the reviews and editorial comments were useful and fair. I also hope you will consider us for future articles. Any final comments made by the referees are included below.

Thank you again for choosing Health Science Reports for publishing your work.

Best wishes,

Dr. Qian Chen
Managing Editor, Health Science Reports

Dr. Qian Chen
Editor-in-Chief, Health Science Reports

Senior Editor Comments to Author:

Reviewer Comments to Author:
Reviewer: 1

Comments to the Author
Thank you for the opportunity to review your manuscript again. I am satisfied with the changes made to the manuscript. The clarity and readability have significantly improved.

Best.

P.S. We believe your images might be appropriate for use on the cover of the journal. This is an optional, premium service that aims to increase exposure and showcase your research through a different medium. The cost of this service is $ for a front cover, which will be charged to you if your Cover Image is selected to be featured. If you would like to submit images from your paper, or an alternative original image related to the work, please email your suggestions to covers@wiley.com for consideration. Please see our Cover Image FAQ https://authorservices.wiley.com/author-resources/Journal-Authors/Promotion/journal-cover-image.html for details on Cover Image preparation and submission. Waivers and discounts are available, following the Wiley Open Access guidelines based on authors' location: https://authorservices.wiley.com/open-science/open-access/for-authors/waivers-and-discounts.html.

[motricidade] Submission Acknowledgement

Nuno Garrido <noreply@rcaap.pt>
Qui, 05/10/2023 20:45
Para:Tarciano Batista e Siqueira <tarcianosiqueira@hotmail.com>

Tarciano Batista e Siqueira:

Thank you for submitting the manuscript, "Heutagogy in Physiotherapy Training: A Systematic Review of Innovations in Higher Education in Health" to Motricidade. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: https://revistas.rcaap.pt/motricidade/authorDashboard/submission/33084
Username: tarciano

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Nuno Garrido

Available in http://revistas.rcaap.pt/motricidade/index

Indexed in ISI Web of Knowledge/Scielo Citation Index (Thomson Reuters), Elsevier (SCOPUS, EMCare), SCImago (SJR: Medicine, Health Professions), PsycINFO, IndexCopernicus, Scielo, CABI, Qualis, SPORTDiscus, EBSCO, CINAHL, Proquest, DOAJ, Latindex, Gale/Cengage Learning, SIIC Databases, BVS ePORTUGUESe, SHERPA/RoMEO, OCLC, Hinari/WHO and Swets Information Services.

[motricidade] Submission Acknowledgement

Nuno Garrido <noreply@rcaap.pt>

Dom, 15/10/2023 23:26

Para:Tarciano Batista e Siqueira <tarcianosiqueira@hotmail.com>

Tarciano Batista e Siqueira:

Thank you for submitting the manuscript, "Rehabilitation Technologies in Clinical Practice and Training of Physiotherapy Students in The Iberian Peninsula: A Delphi Study on The View of Trainees." to Motricidade. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: https://revistas.rcaap.pt/motricidade/authorDashboard/submission/33272
Username: tarciano

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Nuno Garrido

motricidade

Available in http://revistas.rcaap.pt/motricidade/index

Indexed in ISI Web of Knowledge/Scielo Citation Index (Thomson Reuters), Elsevier (SCOPUS, EMCare), SCImago (SJR: Medicine, Health Professions), PsycINFO, IndexCopernicus, Scielo, CABI, Qualis, SPORTDiscus, EBSCO, CINAHL, Proquest, DOAJ, Latindex, Gale/Cengage Learning, SIIC Databases, BVS ePORTUGUESe, SHERPA/RoMEO, OCLC, Hinari/WHO and Swets Information Services.

UNIVERSIDADE DE ÉVORA

Tarciano Batista e Siqueira <tarciano.siqueira@uevora.pt>

Manuscript submitted to Rehabilitation Research and Practice

Rehabilitation Research and Practice <rerp@hindawi.com> 30 de outubro de 2023 às 17:13
Responder a: Rehabilitation Research and Practice <isabella.flores@hindawi.com>
Para: Tarciano Batista e Siqueira <tarciano.siqueira@uevora.pt>

Hindawi

Dear Dr. Tarciano Batista e Siqueira,

Congratulations, the manuscript titled "Innovation Perspectives in The Formative Structure of Physiotherapists: a study of clinical practice with Rehabilitation Technologies" has been successfully submitted to Rehabilitation Research and Practice.

We will confirm this submission with all authors of the manuscript, but you will be the primary recipient of communications from the journal. As submitting author, you will be responsible for responding to editorial queries and making updates to the manuscript.

In order to view the status of the manuscript, please visit the manuscript details page.

Thank you for submitting your work to Rehabilitation Research and Practice.

MANUSCRIPT DETAILS

Kind regards,
Isabella Flores
Rehabilitation Research and Practice