JYX
JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.

Author(s): Laine, Sanna; Leinonen, Heidi; Korpi, Hilkka; Sjögren, Tuulikki

Title: Telerehabilitation applications could solve the barriers of meaningful rehabilitee pathways in early stage of Multiple Sclerosis : a case study

Year: 2024

Version: Published version

Copyright: © 2024 Finnish Journal of eHealth and eWelfare

Rights: CC BY 4.0

Rights url: https://creativecommons.org/licenses/by/4.0/

Please cite the original version:

Laine, S., Leinonen, H., Korpi, H., & Sjögren, T. (2024). Telerehabilitation applications could solve the barriers of meaningful rehabilitee pathways in early stage of Multiple Sclerosis : a case study. Finnish Journal of eHealth and eWelfare, 16(4), 400-414. https://doi.org/10.23996/fjhw.146558

FinJeHeW Finnish Journal of eHealth and eWelfare

SCIENTIFIC PAPERS
VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

Telerehabilitation applications could solve the barriers of meaningful rehabilitee pathways in early stage of Multiple Sclerosis – A case study

Sanna Laine[1], Heidi Leinonen[1,2], Hilkka Korpi[1,3], Tuulikki Sjögren[1]

[1] Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä, Finland; [2] Laurea University of Applied Sciences, Espoo, Finland; [3] Oulu University of Applied Sciences, Oulu, Finland

Sanna Laine, Research Fellow, PT, Master's Student, Faculty of Sport and Health Sciences, University of Jyväskylä, Keskussairaalantie 4, FI-40014, Jyväskylä, FINLAND. Email: sanna-mari.k.laine@jyu.fi

Abstract

Multiple Sclerosis (MS) is a neurological disease affecting particularly the working age population. The prevalence of MS in Finland is one of the highest in the world. Finnish social, health care and rehabilitation services providers need to solve many complex challenges, for example, how to increase the cost-effectiveness of the services, simultaneously meeting the essential needs of rehabilitees. Physiotherapy is one of the most common rehabilitation modalities for rehabilitees with MS. Telerehabilitation as a novel mode of physiotherapy has been recognized in Finland, but its applicability for successful physiotherapy remains unclear.

This study is part of an interdisciplinary project conducted at the University of Jyväskylä, Finland. The goal of the project has been to develop a tentative prototype application of telerehabilitation for early stage MS rehabilitees. Information search was conducted to proof of concept of the telerehabilitation applications. Professional's consultations were conducted to understand the applicability and usability of our application. In addition, the application development principles for our development purposes were discussed.

In this study we report the idea of the developed telerehabilitation application as a product of a multiprofessional development process. Findings of this study highlights the importance of critical and open reflection at every stage of any application development work to support interdisciplinary product development, cocreation process, as well as research, development and innovation (RDI) activities at various organizations.

Keywords: digitalisation, telerehabilitation, physiotherapy, Multiple Sclerosis

Introduction

In general, telerehabilitation is a rapidly developing area. Researchers and software developers need to understand how digital technology can support health care services while also considering issues related to safety and ethics. In physiotherapy, there is a great need to include (remote) technology as

Published under a CC BY 4.0 license (https://creativecommons.org/licenses/by/4.0/).

part of the clinical practice settings, either to supplement the services or to replace some of them [1-3]. In the past, the focus of the development work has been on digital technologies itself. Less attention has been given to how telerehabilitation could be used with entirely new innovative approaches [3-4]. In the future, an open-minded approach involving new technologies is crucial in the Finnish public social and health care services to develop more personalized services and to ensure human resources [5]. There are ethical concerns related to telerehabilitation, including accessibility, privacy policy and autonomy of rehabilitees. Concerns arising from management of the patient information, decision-making of the authorities, work of the physiotherapists, and equal possibilities of the rehabilitee's participation should be taken into consideration when using telerehabilitation services [6]. The attitudes and opinions of rehabilitees should be considered already during the telerehabilitation development processes [3-4,7]. Several terms are used when talking about technology-assisted physiotherapy (i.e., blended treatment; remote, tele- or e-rehabilitation). In this article, we will use the term telerehabilitation, recommended by the American Physical Therapy Association [8]. Telerehabilitation is an umbrella term for digital(-assisted) physiotherapy [9].

Turning point of social and health care services in Finland

The goal of the social and health care reform introduced in Finland at the beginning of 2023 was to provide the best possible outcomes at the lowest possible costs. The aim was to "strengthen the financial basis of service delivery, to guarantee equal access to health and social services, and to reduce inequalities in health and well-being" [10]. These services still need to be reformed in a more cost-effective and efficient direction [11]. One often presented solution is to offer social and health services through digital platforms.

Use of digital services is common in Finnish outpatient care [12], and Finland is one of the first countries to use health data for knowledge-based management [5]. At an individual level, the use and competencies in technology skills are quite convincing, since approximately 79 % of Finns have basic digital skills. Nevertheless, approximately 40 % of the Finnish population have problems in using more demanding digital technologies [13].

Applications for digital health are strictly regulated in European Union, including Finland [14-20], because they might be categorized as medical devices (MDs) which are used for observing or alleviation of diseases. All MDs must be submitted to risk assessment, and outcome effectiveness and cost-effectiveness assessment [21]. Previous studies on digital health services have reported several challenges e.g., overlap and ambiguity of registry data, lack of the scientific knowledge, and limited national resources and incentives [22]. Telerehabilitation applications critical concerns include safety [23], user friendliness, personalization, availability [24], accessibility and integration [12], data privacy, security and accuracy of digital components [25].

Application prototype development and cocreation are collaborative and innovative processes operating within a service ecosystem which facilitates the development process by connecting and bringing people together [26] and emphasizing value creation [27]. The need for transdisciplinary competencies to develop and design human-centric, effective and evidence-based services has been detected [28,29]. Service, Technology, Organization and Finance (STOF) domain model [30] can be used to demonstrate business design domains and challenges of the development process. Various stakeholders and actors can be involved in the cocreation

process [31]. Cocreated platforms in health care, and business model-based data sharing in collaboration between private and public sector stakeholders [5] is one presented solution for health care development.

Working age rehabilitees with Multiple sclerosis (MS)

MS is a chronic neurological disease that is typically diagnosed between the ages of 20 and 50. The disease affects the human nervous system and is classified into subtypes based on disease symptoms and progression. Symptoms vary between individuals, but the main symptoms are fatigue, decline of cognitive ability, mood changes, visual impairment, sensory loss, and difficulties with coordination and walking [32]. The direct health care costs, direct nonmedical costs, and productivity costs per person per year for different subtypes of disease in Finland were 36 000–71 000 euros in 2015. Early retirement was one of the main reasons for MS-related costs [33]. The prevalence of MS in Finland is one of the highest in the world [34]. Based on current legislation, the responsibility for organizing physiotherapy services in Finland is shared between private sector stakeholders and the public sector [34,35].

The physical approaches in physiotherapy are based on evaluating the unique functioning of rehabilitees using the International Classification of Functioning, Disability and Health (ICF) model. MS-related impairment in body functions and structures lead to problems performing activities of daily living [36]. International guidelines of physiotherapy show how rehabilitees with MS should exercise during periods of stability, during and after relapse and with disease progression [32,37]. Rehabilitation should also include ongoing information and support for various symptoms [38]. Physiotherapists need to consider rehabilitee cognition, technology skills, risk of falling [39] and motivation to engage in regular exercise [40].

The use of telerehabilitation is low [41,42] and its effectiveness is limited [43-45], particularly among rehabilitees with stroke or MS [1,46,47].Telerehabilitation might be more flexible than traditional physiotherapy when considering exercise scheduling and lessened need to travel [4,39], thus creating more expectations for applying telerehabilitation to exercises on physical activity, mobility, balance and activities of daily living [48]. The attitudes and experiences of rehabilitees [4,49,50] and physiotherapy professionals [2,51] have not been a research focus area until very recently, i.e. in the early 2020s. In conclusion, the understanding of the significance of telerehabilitation is insufficient [4,50,52]. At the same time, the need for medical rehabilitation, including physiotherapy, is increasing internationally [53] and nationally [54]. In Finland, intensive medical rehabilitation has increased from 20 000 rehabilitees to almost 40 000 rehabilitees in less than 15 years [54]. Success in this challenging situation depends on achieving more in-depth knowledge and understanding of telerehabilitation [4,55].

Materials and methods

Aim

The aim of the study was to evaluate the applicability of the University of Jyväskylä (JyU), Finland, learning platform for creating a telerehabilitation application for rehabilitees with MS in Finland, and to identify the general components for such a telerehabilitation application. This study presents the idea of the telerehabilitation application creation as a cocreation process using this platform. Even though we are not focusing on the various functionalities of the JyU learning platform as such. The

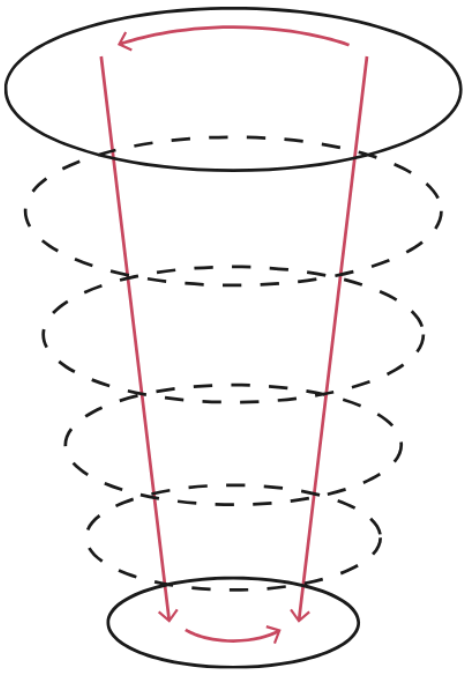
research question was: "Is the University's learning platform applicable for telerehabilitation in rehabilitees with early stage of Multiple Sclerosis"?

Design

This study is part of the interdisciplinary product development project at the JyU [55]. The project was undertaken by Faculty of Information Technology, JyU, and its duration was three months. Two physiotherapists and two engineers were in the project team. The project steering group consisted of project supervisor (PhD. Health Sci.), and ICT, RDI and rehabilitation professionals from JyU, at total five people. Stakeholders were from Hospital Nova (Central Finland) and Istekki Oy, Jyväskylä, Finland. STOF was used to guide the project team discussions and development of prototype. The first phase of the project was information search, and the second phase aimed at developing a telerehabilitation application prototype for the JyU learning platform including testing and introducing the idea (Figure 1).

Information search (Phase 1)

The project supervisor from the JyU has chosen rehabilitees with MS as the focus group, based on previous research focusing on physiotherapy experiences involving working age rehabilitees with MS in Finland [1,4,47,56]. Information search was conducted in September 2023 focusing on telerehabilitation applications for rehabilitees with MS. Applications were identified from Ebsco and Medline Ovid databases and from internet by the project team. In this phase, the main goal was to find out the amount and content of the telerehabilitation applications. Applications included had to meet the following inclusion criteria: 1) rehabilitees with mild to moderate stage of MS, 2) physical exercises were based on physiotherapy guidelines [37-38]. In total, we found two publications dealing with telerehabilitation platforms [57,58] and five publications with mobile applications [59-63] designed for rehabilitees with MS. One mobile application [60] was partially designed in Finland.



Proof of concept 9-10/2023

1. Idea and internet search
2. Discussions with steering group and stakeholders

Prototype planning 9-10/2023

3. Exercise selection (project team physiotherapists) Prototype building in e-learning platform (project team engineers)

Prototype testing 10-11/2023

4. User testing
5. Analyzing results
6. Finalizing prototype

Introducing the idea 11/2023

- Discussion with project steering group and stakeholders
- Closing project

Figure 1. Overview of telerehabilitation application cocreation process [55].

Development of telerehabilitation application (Phase 2)

After the information search, the cocreation session (No: 1, ideation) was conducted by the project team. The idea of the eKuntoutus application was to attract rehabilitation professionals and their rehabilitees as users of a single platform, which enables to offer different exercise ideas based on the unique functioning of the rehabilitee. The cocreation session (No: 2, discussions) were held with stakeholders to proof of concept in two 60 min. separate meetings. First meeting was with rehabilitation professional from Hospital Nova, the project supervisor and project team members. Second meeting was with project team members and two ICT specialists from Istekki Oy. In addition, the project team met with members of the steering group to test the idea.

Following discussions, the cocreation session (No: 3, prototype planning) was held to plan and build the prototype. The project team used STOF framework in discussions to support the application development phases. Exercises in the application were selected by team physiotherapists based on physiotherapy guidelines for rehabilitees with MS. The JyU learning platform was used to demonstrate the idea of the prototype and its core functionalities of the rehabilitee site of the application. The prototype was built by team engineers using components already available on the learning platform. The cocreation session (No: 4, user testing) was conducted with the project supervisor, a rehabilitation professional from the project steering group, and project team members. Following the testing session, a subsequent cocreation session (No: 5, analyzing results) were held during the project team meeting to evaluate the outcomes. Finally, the cocreation session (No: 6, finalizing prototype) took place to discuss the results of the prototype testing and gather input from project team discussions. In the final phase of the product development project, the project team, steering group members, and stakeholders from Istekki and Hospital Nova discussed the applicability and usability of the learning platform for telerehabilitation practices.

Results

The main findings are the platform complexity, scalability limitations when managing rehabilitees and creating new content, the lack of essential security requirements, and the impossibility to determine whether the application could be classified as a MD or not MD. Due to the complexity of the application management, the functionalities of the management site of the JyU learning platform are not appropriate for our specific purposes. Our study shows that it's important to develop digital solutions that are useful and efficient for Finnish rehabilitation practices. The prototype of eKuntoutus can be seen as the first Finnish national rehabilitation pathway, which brings together the rehabilitees and their professionals on a single platform. It has the potential to work as a base for future applications to enable a sense of meaningfulness and autonomy in one's rehabilitation pathway.

The core structures of eKuntoutus

The eKuntoutus is an application for three end user groups, and it includes the maintenance of technical support. There are different interfaces for the end user groups: the rehabilitee user site, and the site for content creators, professionals, and technical support administrators (Figure 2). From the rehabilitees point of view, the application offers a single platform to perform the exercises of the rehabilitation program and manage their own rehabilitation path.

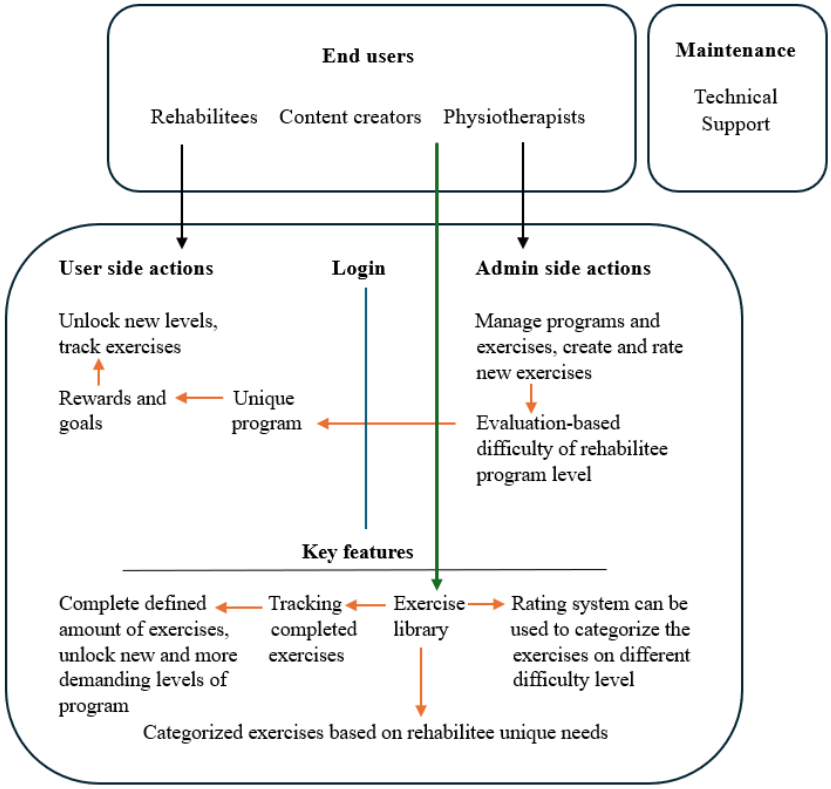


Figure 2. Overview of the eKuntoutus core structures [55].

The application has features for self-tracking progression, which helps the rehabilitees stay motivated and may thus improve rehabilitation outcomes. The physiotherapist can use the application to assign exercises to their rehabilitees from an exercise library created by health care professionals (content creator). Cocreation and versatility of the exercise library are the key factors when evaluating the usefulness of the application in a telerehabilitation setting. The prototype of eKuntoutus didn't include the exercise library, nor was it tested with actual rehabilitees.

From the perspective of rehabilitees, the end user can track their progress and unlock new, more demanding exercises by performing a set of exercises at their current level. The application gives the rehabilitees freedom to perform exercises that are appealing and increases their motivation to perform them. The autonomy to track and perform exercises could provide inspirational goals and a feeling of freedom and progress. The actual ability of the application to meet these expectations remains unclear, because the application has not been tested on rehabilitees with MS.

In professional context, physiotherapists can use the application as an admin to manage and track the rehabilitees' progression in their rehabilitation program (performed exercises and tasks). Sets of exercises can be assigned based on rehabilitee's needs and capabilities to perform the exercises. The exercise categorization into different difficulty levels reflects the rehabilitees' physical and cognitive ability to perform different exercises and tasks. This supports the physiotherapists' ability to consider the unique functioning ability of a rehabilitee in selecting the baseline difficulty level for the exercise program.

Feedback on eKuntoutus was obtained from a rehabilitation specialist at the JyU through demonstrations made by developers. From the perspective of constantly evolving legislation, changes in the organization of rehabilitation, as well as funding of social, health care and rehabilitation services, should serve as a foundation for these types of projects.

Service, technology, organization and finance domains of eKuntoutus

The greatest issues of development and use of the telerehabilitation applications in Finland arise from the cost structure, revenue streams, and legislation. Possible issues should be thoroughly addressed during the preliminary phase of the product development process before advancing to subsequent stages. STOF model demonstrates more detailed business design domains and possible challenges of eKuntoutus prototype (Table 1).

Table. 1. The prototype domains based of the Service, Technology, Organization and Finance (STOF) -model.

Critical Design Issues	Description	Balancing requirements
Service domain		
Targeting	How to define the target group of the rehabilitation service	KELA vs. wellbeing services county vs. private sector organization
Creating value	How to create value for end users	Technological possibilities vs. user needs and wishes
Branding	How to promote/brand the service	Pricing vs. technological modelling
Trust	How to enhance end users' trust in the service	Security vs. ease of use; Privacy vs. added value
Customer retention	How to stimulate recurrent usage of the service	Customer lock-in vs. customer annoyance
Technology domain		
Accessibility	Health service needs to be accessible to everyone	Accessibility vs. simplicity
Security and processing of personal data	Service contains sensitive personal information and therefore security needs to be top-notch	Security vs. Costs
System integration	Integration with existing systems (OmaKanta, KELA)	Seamless integration vs. costs
Organization domain		
Partner selection	What partnership could be beneficial for both parties (THL, STM, etc.)	Quality vs. quantity
Network openness	Who are allowed to offer the service	Private owned vs. public owned
Finance domain		
Division and valuation of costs and revenues between network actors	Assessment of valuation is based on access to resources, direct revenue and strategic benefits	Cost-benefit valuation on level of network versus cost benefits for individual partners
Investments	Capital investment and risk assessment	Operational financial interest vs. intangible benefits
Pricing	Price level for service providers	Pricing seems to be aligned with maximizing profits vs. creating market share vs. nonprofit business modelling

THL = The National Institute for Health and Welfare; Kela = the Social Insurance Institution of Finland; STM = Ministry of Social Affairs and Health

Suggestions for future development

From the end user's point of view, exercise variation, rehabilitee's functional ability and willingness to use a telerehabilitation application, user-friendliness and data protection are the key factors of a successful product. In addition, the coloring and typing of the design and text are important aspects of accessibility. All accessibility principles should be resolved early in the development process. From a technical perspective, the application should have at least the following aspects: user support, e.g., chatbots, feedback possibilities, improved user interfaces, more versatile rehabilitation tasks, the possibility of interaction between rehabilitees and health care professionals, and the use of a mobile application that complements the online version. Possible further needs will arise during the later phases of the product development process.

Discussion

The aim of this study was to increase knowledge and understanding of telerehabilitation, and to identify factors that can promote or prevent development and use of telerehabilitation applications in Finland. Our application prototype was developed for rehabilitees with MS, which is a common neurological disease in Finland. Previous studies have shown that the knowledge of telerehabilitation utility and effectiveness is rapidly increasing worldwide [23]. The main finding in this study is that the University's learning platform is not suitable for this type of telerehabilitation application mainly due to the security, availability and accessibility.

Our study supports the idea that the starting point for developing telerehabilitation is either the goal of changing operations or developing a completely new operating model, which is often presented as a process. This process includes modelling, evaluating and measuring operational processes and implementing selected improvement measures. These practices from an iterative process of quality improvement, aimed at evaluating and implementing changes in line with the objectives, treating them as controlled elements within a systematic and continuous process [64].

In this creating process is important to understand the maturity level of the used telerehabilitation technology. Previous literature [3] has identified the following application development stages: 1) application concepts and design formulations, 2) proof of concept with key technological functions, 3) demonstration of an integrated system with full functionality, 4) effectiveness testing with the general population or in a controlled environment, and 5) effectiveness testing or clinical trial target users in the intended use environment. Our prototype of the eKuntoutus is currently in stage 2, where now, for the first time, we have created a concept with key technological functions in rehabilitees with MS.

According to the previous literature, the market value of telerehabilitation is quickly increasing [65], which might attract a wide variety of operators to the market. From an ethical point of view, it's important that technology promotes justice, improves quality of life, minimizes the harm caused by technology [66] and considers how the unethical use of systems can be prevented [67]. Telerehabilitation should focus on supporting a sense of meaningful life and human dignity in the part of the physiotherapy process.

In general, the design of rehabilitation-oriented techniques begins with a rehabilitee-oriented approach, examining societal objectives and activities from an interdisciplinary perspective, from which new technologies are expected to emerge. Nevertheless, only a few studies have considered end user perceptions and experiences of rehabilitees

with MS [4]. It appears that once accessibility is improved, rehabilitees can participate and engage, requiring less assistance to follow the prescribed exercises [3].

Finally, the essential conditions for the meaningful use of telerehabilitation include identifying the rehabilitees' current functioning, needs and goals, supporting their motivation and commitment, choosing relevant and meaningful activities, creating safe and variable environments, and enabling social interaction and relationships. These are the key elements for promoting rehabilitees' individual self-rehabilitation pathways and functional ability [4]. Treating rehabilitees as part of the cocreation process might be the only ethical way to develop an effective and user-friendly telerehabilitation applications.

Limitations

The study was part of an interdisciplinary project of the JyU, and it has some limitations. Firstly, the project was conducted in three months while corresponding projects usually take at least six months. Secondly, the application was built on the University's learning platform, whence the research team had no previous experience, which made the product development process more difficult. Thirdly, we were unable to evaluate rehabilitees' perceptions of eKuntoutus to provide insights into its meaningfulness. Thus, essential factors for users may have been ignored in the design.

Conclusion

Our study shows how open and critical reflection of use of the telerehabilitation application and the learning platform, could support the future research, development and innovation work of the universities. The idea of the meaningfulness of physiotherapy as a part of telerehabilitation is promising, but more information about the perceptions of rehabilitees is needed. The next step is to complete the prototype and test it in rehabilitees with MS. Research and reporting on ongoing telerehabilitation product development at different stages of maturity is a crucial foundation for designing system functions and selecting appropriate technologies. Those results can also be used more widely to identify telerehabilitation challenges and possibilities, especially at level two, which is the stage of "proof of concept with key technological functions".

Conflict of interest

None.

Acknowledgements

We would like to express our special thanks to the eKuntoutus project members master's students Aatu Laitinen and Susanna Lähde, project manager Katja Tynkkynen and Professor of Practice Sakari Luukkainen from JyU and Associate Professor of Clinical Physiotherapy Riku Nikander at Hospital Nova and JyU, Finland.

References

[1] Rintala A, Hakala S, Sjögren T. Etäteknologian vaikuttavuus liikunnallisessa kuntoutuksessa: järjestelmällinen kirjallisuuskatsaus ja meta-analyysi [Effectiveness of technology-based distance physical rehabilitation. A systematic literature review and meta-analysis, in Finnish]. Sosiaali- ja terveysturvan tutkimuksia 2017: 145. Helsinki: Kela; 2017. 166 p. http://hdl.handle.net/10138/180932

[2] Sjögren T, Anttila MR, Kivistö H, Haapaniemi V. Paajanen T, Piirainen A. Innovatiiviset etäkuntoutuspalvelut. In: Salminen AL, Hiekkala S (eds). Kokemuksia etäkuntoutuksesta. Kelan etäkuntoutushankkeen tuloksia. Helsinki: Kelan tutkimus; 2019. p. 206–225. [In Finnish] http://urn.fi/URN:NBN:fife2019052416890

[3] Moral-Munoz JA, Zhang W, Cobo MJ, Herrera-Viedma E, Kaber DB. Smartphone-based systems for physical rehabilitation applications: A systematic review. Assist Technol. 2021 Jul 4;33(4):223-236. https://doi.org/10.1080/10400435.2019.1611676

[4] Sjögren T, Korpi H. Supporting Sense of Meaningful Life and Human Dignity in Digitally Assisted Physiotherapy Environment: Qualitative Secondary Research with Thematic Analyses and Inductive Synthesis. In: Särestöniemi M, et al. Digital Health and Wireless Solutions. NCDHWS 2024. Communications in Computer and Information Science, vol 2083. Springer, Cham; 2024. p. 371-386. https://doi.org/10.1007/978-3-031-59080-1_27

[5] Lehto P, Malkamäki S. The Finnish Health Sector Growth and Competitiveness Vision 2030. Sitra working paper. Helsinki: Sitra; 2023. 29 p. https://www.sitra.fi/en/publications/the-finnish-health-sector-growth-and-competitiveness-vision-2030/

[6] Guy M, Blary A, Ladner J, Gilliaux M. Ethical Issues Linked to the Development of Telerehabilitation: a Qualitative Study. Int J Telerehabil. 2021 Jun 22;13(1):e6367. https://doi.org/10.5195/ijt.2021.6367

[7] Landi D, Ponzano M, Nicoletti CG, Cola G, Cecchi G, Grimaldi A, Mataluni G, Mercuri NB, Sormani MP, Pacileo G, Marfia GA. Patient's point of view on the use of telemedicine in multiple sclerosis: a web-based survey. Neurol Sci. 2022 Feb;43(2):1197-1205. https://doi.org/10.1007/s10072-021-05398-6

[8] Lee AC, Deutsch JE, Holdsworth L, Kaplan SL, Kosakowski H, Latz R, McNeary LL, O'Neil J, Ronzio O, Sanders K, Sigmund-Gaines M, Wiley M, Russell T. Telerehabilitation in Physical Therapist Practice: A Clinical Practice Guideline from the American Physical Therapy Association. Phys Ther. 2024 May 1;104(5):pzae045. doi: 10.1093/ptj/pzae045. Erratum in: Phys Ther. 2024 Jun 4;104(6):pzae077. https://doi.org/10.1093/ptj/pzae077

[9] Alexander M. Chapter 1, Introduction. In: Alexander M, ed. Telerehabilitation Principles and Practice. Elsevier; 2022. p. 1–3. https://doi.org/10.1016/C2020-0-01483-0

[10] Kangas O, Kalliomaa-Puha L. Finland finalises its largest-ever social and healthcare reform. ESPN Flash Report 2022/39. European Social Policy Network (ESPN). Brussels: European Commission; 2022. 2 p. https://urn.fi/URN:NBN:fife2022091258782

[11] Aejmelaeus R, Pitkänen L, Matinheikki J. Tiedosta tekoihin – Hyvinvointialueiden tiedolla ohjaaminen ja vaikuttavuus: Valtiovarainministeriön Kustannusvaikuttavuuden osaamiskeskus -hankkeen loppuraportti [From knowledge to action – Knowledge guidance and effectiveness of wellbeing services counties. Final report of the Ministry of Finance's Centre of Excellence for Cost-Effectiveness

project, in Finnish]. Helsinki: Valtiovarainministeriö; 2023 Oct. 95 p. https://urn.fi/URN:ISBN:978-952-367-673-2

[12] Pennanen P, Jansson M, Torkki P, Harjumaa M, Pajari I, Laukka E, Lakoma S, Härkönen H, Verho A, Martikainen S, Kouvonen A, Leskelä RL. Digitaalisten palvelujen vaikutukset sosiaali- ja terveydenhuollossa [Impact of digital services in health and social care, in Finnish]. Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 2023: 52. Helsinki: Valtioneuvoston kanslia; 2023. 114 p. http://urn.fi/URN:ISBN:978-952-383-059-2

[13] Digi- ja väestötietovirasto. Digitaitoraportti 2022 [Digital skills report 2022, in Finnish]. [Internet]. Digi- ja väestötietovirasto (DVV); 2022 [cited 2024 April 3]. Available from: https://dvv.fi/digitaitoraportti

[14] EUR-Lex. Regulation (EU) 2017/745 Of the European Parliament and of the Council of 5 April 2017 on medical devices, amending Directive 2001(83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC. European Parliament, Council of the European Union; 2017. http://data.europa.eu/eli/reg/2017/745/oj

[15] Finlex. Yhdenvertaisuuslaki 1325/2014 [Non-discrimination Act 1325/2014, in Finnish]. Oikeusministeriö; Dec. 30, 2014. https://www.finlex.fi/fi/laki/alkup/2014/20141325

[16] Finlex. Laki digitaalisten palvelujen tarjoamisesta 306/2019 [Act on the Provision of Digital Services 306/2019, in Finnish]. Valtiovarainministeriö; March 15, 2019. https://www.finlex.fi/fi/laki/alkup/2019/20190306

[17] AVI. WCAG 2.1: legal requirements. [Internet]. Aluehallintovirasto (AVI) [Regional State Administrative Agency]. [cited 2024 April 1]. Available from: https://www.webaccessibility.fi/requirements-of-the-act-on-the-provision-of-digital-services/wcag-2-1-legal-requirements/

[18] Finlex. Laki Kansaneläkelaitoksen kuntoutusetuuksista ja kuntoutusrahaetuuksista annetun lain muuttamisesta 145/2015 [In Finnish]. Sosiaali- ja terveysministeriö; Feb. 20, 2015. https://www.finlex.fi/fi/laki/alkup/2015/20150145

[19] Sosiaali- ja terveysministeriö. Lainsäädäntö ohjaa asiakas- ja potilastietojen hallintaa [Legislation and recommendations for management of client and patient information, in Finnish]. [Internet]. Sosiaali- ja terveysministeriö [Ministry of Social Affairs and Health]; 2024. [cited 2024 April 1]. Available from: https://stm.fi/asiakas-potilastietojen-hallinta

[20] Rouvinen J, Alanko S. Teknologia Kelan järjestämässä etäkuntoutuksessa [Technology in telerehabilitation organized by Kela, in Finnish]. Kuntoutus nyt 2023: 3. Helsinki: Kela; 2023. 19 p. http://urn.fi/URN:NBN:fi-fe20231127149515

[21] Blomster J, Turpeinen M, Parkkila AK, Mattila K, Roine R. Lääkinnällisten laitteiden käyttöönotto edellyttää tietoa toimivuudesta, vaikuttavuudesta ja kustannusvaikuttavuudesta [in Finnish]. Sic! Lääketietoa Fimeasta 3/2018. Lääkealan turvallisuus- ja kehittämiskeskus Fimea; 2018 Sep 7. 2 p. https://urn.fi/URN:NBN:fi-fe2018091836022

[22] Haaga T, Herzig M, Kortelainen M, Nokso-Koivisto O, Saxell T, Sääksvuori L. Use, users, production and effectiveness of digital health services. Preliminary study. Helsinki: Ministry of Social Affairs and Health; 2024 March. 77 p. http://urn.fi/URN:ISBN:978-952-00-5665-0

[23] Zampolini M, Oral A, Barotsis N, Aguiar Branco C, Burger H, Capodaglio P, Dincer F, Giustini A, Hu X, Irgens I, Negrini S, Tederko P, Treger I, Kiekens C. Evidence-based position paper on Physical and Rehabilitation Medicine (PRM) professional practice on telerehabilitation. The European PRM position

(UEMS PRM Section). Eur J Phys Rehabil Med. 2024 Apr;60(2):165-181. https://doi.org/10.23736/S1973-9087.24.08396-5

[24] Velez M, Lugo-Agudelo LH, Patiño Lugo DF, Glenton C, Posada AM, Mesa Franco LF, Negrini S, Kiekens C, Spir Brunal MA, Roberg AB, Cruz Sarmiento KM. Factors that influence the provision of home-based rehabilitation services for people needing rehabilitation: a qualitative evidence synthesis. Cochrane Database Syst Rev. 2023 Feb 10;2(2):CD014823. https://doi.org/10.1002/14651858.CD014823

[25] Frontera WR, Degroote W, Ghaffar A; Health Policy and Systems Research for Rehabilitation Group. Importance of health policy and systems research for strengthening rehabilitation in health systems. A call to action to accelerate progress. Eur J Phys Rehabil Med. 2023 Dec;59(6):657-659. https://doi.org/10.23736/S1973-9087.23.08225-4

[26] Teixeira JG, Patrício L, Tuunanen T. Advancing service design research with design science research. J Serv Manag. 2019;30(5):577-592. https://doi.org/10.1108/JOSM-05-2019-0131

[27] Vargo S, Akaka M. Value Cocreation and Service Systems (Re)Formation: A Service Ecosystems View. Serv Sci. 2012;4(3):207-217. https://doi.org/10.1287/serv.1120.0019

[28] Carr VL, Sangiorgi D, Büscher M, Junginger S, Cooper R. Integrating evidence-based design and experience-based approaches in healthcare service design. HERD. 2011 Summer;4(4):12-33. https://doi.org/10.1177/193758671100400403

[29] Paavola S, Lipponen L, Hakkarainen K. Epistemological Foundations for CSCL: A Comparison of Three Models of Innovative Knowledge Communities. In: Stahl G, editor. Computer Support for Collaborative Learning: Foundations for a CSCL community. Proceedings of the Computer-supported Collaborative Learning 2002 Conference. Hillsdale, NJ: Erlbaum; 2002. p. 24–32. https://doi.org/10.3115/1658616.1658621

[30] Bouwman H, Faber E, Haaker T, Kijl B, De Reuver M. Conceptualizing the STOF Model. In: Bouwman H, De Vos H, Haaker T. (eds). Mobile Service Innovation and Business Models. Berlin, Heidelberg: Springer; 2008. https://doi.org/10.1007/978-3-540-79238-3_2

[31] Markovic S, Bagherzadeh M. How does breadth of external stakeholder co-creation influence innovation performance? Analyzing the mediating roles of knowledge sharing and product innovation. J Bus Res. 2018;88:173-186. https://doi.org/10.1016/j.jbusres.2018.03.028

[32] Rohrig M. A Resource for Healthcare Professionals. Physical Therapy in Multiple Sclerosis [Internet]. Canton, MA, USA: National MS-society: 2024. [cited 2024 April 10]. Available from: https://www.nationalmssociety.org/

[33] Purmonen T, Hakkarainen T, Tervomaa M, Ruutiainen J. Impact of multiple sclerosis phenotypes on burden of disease in Finland. J Med Econ. 2020 Feb;23(2):156-165. https://doi.org/10.1080/13696998.2019.1682004

[34] Tarnanen K, Kuusisto H, Laakso S, Nuotio K. MS-tauti. Käypä hoito –suosituksen MS-tauti potilasversio [in Finnish]. Helsinki: Suomalainen Lääkäriseura Duodecim; 2024 [cited 2024 April 17]. Available from: https://www.kaypahoito.fi/khp00090

[35] Sosiaali- ja terveysministeriö. Lääkinnällinen kuntoutus [Medical rehabilitation, in Finnish]. [Internet]. Sosiaali- ja terveysministeriö [Ministry of Social Affairs and Health]; 2024 [cited 2024 April 20]. Available from: https://stm.fi/laakinnallinen-kuntoutus

[36] Bickenbach J, Cieza A, Selb M, Stucki G (eds). ICF Core Sets. Manual for Clinical Practice. Electronic ICF-based Documentation Tool. [Internet]. Göttingen: Hogrefe; 2020 [cited 2024 May 8]. Available from: https://www.icf-core-sets.org/ https://doi.org/10.1027/00572-000

[37] Williams K, Hoang P. Strength and cardiorespiratory exercise for people with multiple sclerosis (MS). MS Practice / For Health Professionals. MS Australia; 2009. ISBN: 978-0-9806637-3-0. http://dx.doi.org/10.13140/RG.2.1.4205.1041

[38] NICE. Multiple Sclerosis in Adults: management. NICE Guideline [NG220]. [Internet]. NICE (National Institute for Health and Care Excellence); 22 June 2022 [cited 2024 April 17]. Available from: https://www.nice.org.uk/guidance/ng220

[39] Gopal A, Bonanno V, Block VJ, Bove RM. Accessibility to Telerehabilitation Services for People With Multiple Sclerosis: Analysis of Barriers and Limitations. Int J MS Care. 2022 Nov-Dec;24(6):260-265. https://doi.org/10.7224/1537-2073.2022-002

[40] Flachenecker P, Bures AK, Gawlik A, Weiland AC, Kuld S, Gusowski K, Streber R, Pfeifer K, Tallner A. Efficacy of an Internet-Based Program to Promote Physical Activity and Exercise after Inpatient Rehabilitation in Persons with Multiple Sclerosis: A Randomized, Single-Blind, Controlled Study. Int J Environ Res Public Health. 2020 Jun 24;17(12):4544. https://doi.org/10.3390/ijerph17124544

[41] Hellstén T, Arokoski J, Sjögren T, Jäppinen AM, Kettunen J. The Current State of Remote Physiotherapy in Finland: Cross-sectional Web-Based Questionnaire Study. JMIR Rehabil Assist Technol. 2022 Jun 7;9(2):e35569. https://doi.org/10.2196/35569

[42] Hellstén T, Arokoski, J, Sjögren T, Jäppinen A-M, Kettunen, J. Remote physiotherapy in Finland – suitability, usability, and factors affecting its use. Eur J Physioter. 2023 Jul 24;25(6):378-387. https://doi.org/10.1080/21679169.2023.2233560

[43] Hakala S, Rintala A, Immonen J, Karvanen J, Heinonen A, Sjögren T. Effectiveness of technology-based distance interventions promoting physical activity: Systematic review, meta-analysis and meta-regression. J Rehabil Med. 2017 Jan 31;49(2):97-105. https://doi.org/10.2340/16501977-2195

[44] Hakala S, Rintala A, Immonen J, Karvanen J, Heinonen A, Sjögren T. Effectiveness of physical activity promoting technology-based distance interventions compared to usual care. Systematic review, meta-analysis and meta-regression. Eur J Phys Rehabil Med. 2017 Dec;53(6):953-967. https://doi.org/10.23736/S1973-9087.17.04585-3

[45] Lahtio H, Rintala A, Immonen J, Sjögren T. The Effectiveness of Physical Activity-Promoting Web- and Mobile-Based Distance Weight Loss Interventions on Body Composition in Rehabilitation Settings: Systematic Review, Meta-analysis, and Meta-Regression Analysis. J Med Internet Res. 2022 Mar 24;24(3):e25906. https://doi.org/10.2196/25906

[46] Rintala A, Päivärinne V, Hakala S, Paltamaa J, Heinonen A, Karvanen J, Sjögren T. Effectiveness of Technology-Based Distance Physical Rehabilitation Interventions for Improving Physical Functioning in Stroke: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Arch Phys Med Rehabil. 2019 Jul;100(7):1339-1358. https://doi.org/10.1016/j.apmr.2018.11.007

[47] Rintala A, Hakala S, Paltamaa J, Heinonen A, Karvanen J, Sjögren T. Effectiveness of technology-based distance physical rehabilitation interventions on physical activity and walking in multiple sclerosis: a systematic review and meta-analysis of randomized controlled trials. Disabil Rehabil. 2018

Feb;40(4):373-387. https://doi.org/10.1080/09638288.2016.1260649

[48] Seron P, Oliveros MJ, Gutierrez-Arias R, Fuentes-Aspe R, Torres-Castro RC, Merino-Osorio C, Nahuelhual P, Inostroza J, Jalil Y, Solano R, Marzuca-Nassr GN, Aguilera-Eguía R, Lavados-Romo P, Soto-Rodríguez FJ, Sabelle C, Villarroel-Silva G, Gomolán P, Huaiquilaf S, Sanchez P. Effectiveness of Telerehabilitation in Physical Therapy: A Rapid Overview. Phys Ther. 2021 Jun 1;101(6):pzab053. https://doi.org/10.1093/ptj/pzab053

[49] Anttila MR, Kivistö H, Piirainen A, Kokko K, Malinen A, Pekkonen M, Sjögren T. Cardiac Rehabilitees' Technology Experiences Before Remote Rehabilitation: Qualitative Study Using a Grounded Theory Approach. J Med Internet Res. 2019 Feb 7;21(2):e10985. https://doi.org/10.2196/10985

[50] Honkanen S, Korpi H, Chichaeva J, Holopainen R, Sjögren T, Aartolahti E. Chapter 6: Robottien, virtuaalitodellisuuden ja lisätyn todellisuuden merkityksellisyys kuntoutuksessa [in Finnish]. In: Ilves O, Korpi H, Honkanen S, Aartolahti E (eds). Robottien, virtuaalitodellisuuden ja lisätyn todellisuuden vaikuttavuus ja merkityksellisyys lääkinnällisessä kuntoutuksessa: Järjestelmälliset kirjallisuuskatsaukset [Effectiveness and meanings of robots, virtual and augmented reality in rehabilitation. Systematic literature reviews]. Sosiaali- ja terveysturvan tutkimuksia 2022: 159. Helsinki: Kela; 2022. p. 130-186. http://urn.fi/URN:NBN:fi-fe2022052037517

[51] Grabtchak A, Heimo I, Häivölä S, Korpi H, Sjögren T. Miten kuntoutusalan ammattilaiset kokevat etäkuntoutuksen? [in Finnish] Fysioterapia 2021;68(7):42–47.

[52] Anttila MR, Soderlund A, Paajanen T, Kivistö H, Kokko K, Sjögren T. Biopsychosocial Profiles of Patients With Cardiac Disease in Remote Rehabilitation Processes: Mixed Methods Grounded Theory Approach. JMIR Rehabil Assist Technol. 2021 Nov 3;8(4):e16864. https://doi.org/10.2196/16864

[53] Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2021 Dec 19;396(10267):2006-2017. https://doi.org/10.1016/S0140-6736(20)32340-0

[54] Heino P, Seppänen-Järvelä, R. Vaativan lääkinnällisen kuntoutuksen asiakasprofiili muuttui. [in Finnish, Internet]. Kelan tutkimusblogi. Kela; 2023 March 2 [cited 2024 April 1]. Available from: https://tietotarjotin.fi/tutkimusblogi/722643/vaativan-laakinnallisen-kuntoutuksen-asiakasprofiili-muuttui

[55] Laine S, Laitinen A, Leinonen H, Lähde S. eKuntoutus -Platform for Social-, Healthcare and Rehabilitation Practices in Finland. Unique Rehabilitee Pathway is the Key to Meaningfulness. TEKS4005 Interdisciplinary project. University of Jyväskylä: Faculty of Information Technology; 2023. 35 p. [Unpublished, available from authors by request]

[56] Köngäs R, Paltamaa R, Rintala A, Korpi H, Sjögren T. Chapter 3.2: Terapeuttisen harjoittelun vaikuttavuus multippeliskleroosia sairastavien henkilöiden kävelyyn. In: Sjögren T, Rintala A, Paltamaa J, Korpi H (eds). Fysioterapian vaikuttavuus ja merkityksellisyys aivoverenkiertohäiriötä ja multippeliskleroosia sairastaville kuntoutujille: Järjestelmälliset kirjallisuuskatsaukset kävelyn ja tasapainon meta-analyyseista ja fysioterapian koetun merkityksellisyyden metasynteeseistä [Effectiveness and relevance of physiotherapy in rehabilitees with cerebrovascular disorder and multiple sclerosis. Systematic reviews on the meta-analyses of walking and balance and meta-synthesis of the perceived relevance of physiotherapy, in Finnish]. Sosiaali- ja

terveysturvan tutkimuksia 2022: 161. Helsinki: Kela: 2022. p. 178-198. http://urn.fi/URN:NBN:fife2022110163955

[57] Busse M, Latchem-Hastings J, Button K, Poile V, Davies F, O' Halloran R, Stensland B, Tallantyre E, Lowe R, Wood F, Dawes H, Edwards A, Jones F. Web-based physical activity intervention for people with progressive multiple sclerosis: application of consensus-based intervention development guidance. BMJ Open. 2021 Mar 16;11(3):e045378. https://doi.org/10.1136/bmjopen-2020-045378

[58] Giraffe Healthcare. Platform for physiotherapy, podiatry and palliative care. [Internet]. Giraffe Healthcare CIC [cited 2024 May 3]. Available from: https://www.giraffehealth.com/

[59] Geurts E, van Geel F, Feys P, Coninx K. WalkWithMe: Personalized Goal Setting and Coaching for Walking in People with Multiple Sclerosis. In: Proceedings of the 27th ACM Conference on User Modeling, Adaptation and Personalization (UMAP '19). New York, NY, USA: Association for Computing Machinery; 2019. p. 51-60. https://doi.org/10.1145/3320435.3320459

[60] Giunti G, Mylonopoulou V, Rivera Romero O. More Stamina, a Gamified mHealth Solution for Persons with Multiple Sclerosis: Research Through Design. JMIR Mhealth Uhealth. 2018 Mar 2;6(3):e51. https://doi.org/10.2196/mhealth.9437

[61] Jongen PJ, Sinnige LG, van Geel BM, Verheul F, Verhagen WI, van der Kruijk RA, Haverkamp R, Schrijver HM, Baart JC, Visser LH, Arnoldus EP, Gilhuis HJ, Pop P, Booy M, Lemmens W, Donders R, Kool A, van Noort E. The interactive web-based program MSmonitor for self-management and multidisciplinary care in multiple sclerosis: concept, content, and pilot results. Patient Prefer Adherence. 2015 Dec 11;9:1741-50. https://doi.org/10.2147/PPA.S93783

[62] Thomas S, Pulman A, Dogan H, Jiang N, Passmore D, Pretty K, Fairbanks B, Davies Smith A, Thomas PW. Creating a Digital Toolkit to Reduce Fatigue and Promote Quality of Life in Multiple Sclerosis: Participatory Design and Usability Study. JMIR Form Res. 2021 Dec 9;5(12):e19230. https://doi.org/10.2196/19230

[63] Tonheim AN, Babic A. Assessing Information Needs for a Personal Multiple Sclerosis Application. Stud Health Technol Inform. 2018;247:486-490.

[64] Keto H, Palomäki J. Informaatio systeemien prosessiontologinen mallinnus. In: Laakkonen M, ed. Informaatioteknologian filosofia, etiikka ja digitalisoitunut yhteiskunta. SoPhi 146. Jyväskylä: Jyväskylän yliopisto; 2021. p. 101-119. http://urn.fi/URN:ISBN:978-951-39-8804-3

[65] Precedence Research. Telerehabilitation Market (By Component: Hardware, Software; By Services; Clinical Assessment, Clinical Therapy; By Therapy; Physical Therapy, Occupational Therapy, Others) - Global Industry Analysis, Size, Share, Growth, Trends, Regional Outlook and Forecast 2023-2032 [Internet]. Canada: Precedence Research; 2024 [cited 2024 May 25]. Available from: https://www.precedenceresearch.com/table-of-content/3619

[66] Valtakunnallinen sosiaali- ja terveysalan eettinen neuvottelukunta ETENE [National Advisory Board on Social Welfare and Health Care Ethics ETENE]. Teknologia ja etiikka sosiaali- ja terveysalan hoidossa ja hoivassa [in FInnish]. ETENE-julkaisuja 30. Helsinki: Sosiaali- ja terveysministeriö; 2010. 36 p. http://urn.fi/URN:ISBN:978-952-00-3081-0

[67] Research Council of Finland. Etiikka ja älykkäiden teknologioiden suunnittelu 1.0. ETAIROS-hanke [in Finnish]. Research Council of Finland: Strategic Research; 2022 March. 83 p. https://doi.org/10.17011/etairos/1