Research and studies

Barriers and levers for the use of telerehabilitation through experimentation in three countries

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This report exist in Brief format.

Summary

Summary

1. Context

The World Health Organisation (WHO) estimates that more than one billion people, or 15 per cent of the population, have a disability. Eighty per cent of people with disabilities live in low-income countries[1]. One of the difficulties faced by people with disabilities is access to care and rehabilitation. Rehabilitation is an essential element of universal health coverage, it can reduce the consequences of age-related pathologies, traumas or impairments, limiting people's disabling conditions and promoting their independence in daily life[2]. The development of Information and Communication Technologies (ICT), associated with the growing number of mobile phone and internet users, has enabled the emergence of digital health and telerehabilitation.

Telerehabilitation is defined as the use of ICT to provide rehabilitation services to people remotely in their environment. These services can be of different types, such as assessment, monitoring, intervention, supervision, education and counselling (Brennan et al., 2009). Humanity & Inclusion / Handicap International (HI) has integrated the use of ICT in several rehabilitation projects, such as the management and production of 3D orthoses, the PARI project[3] or, more recently, the creation and development of a rehabilitation application (OpenTeleRehab) in Vietnam.

The emergence of a global pandemic related to COVID-19 has encouraged the use of digital tools and the implementation of telerehabilitation in many HI projects to ensure the follow-up of beneficiaries. Telerehabilitation has been done differently in different projects, some have used rehabilitation applications, others only communication tools.

Whether planned or implemented after the pandemic, these experiments allowed professionals and beneficiaries to experiment fully or partially with telerehabilitation. These experiences have highlighted the barriers and levers for professionals and beneficiaries in the use of telerehabilitation.

2. General and specific objectives

The aim of this study is to describe and analyse the barriers and levers for the use of telerehabilitation and the use of rehabilitation applications in HI rehabilitation projects, at beneficiary and practitioner level.

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[1] WHO Draft Global Plan of Action on Disability 2014-2021
https://www.who.int/disabilities/actionplan/fr/

[2] Rehabilitation https://www.who.int/fr/news-room/fact-sheets/detail/rehabilitation

[3] IRAP: Access to rehabilitation services on islands

The objectives are:

1. Identify the difficulties and contributions of the use of rehabilitation applications for telerehabilitation in the care of beneficiaries, for professionals.
2. Identify the challenges and benefits of using telerehabilitation for beneficiaries.
3. Identify success factors and failure conditions in the application of these tools in projects.
4. Describe the characteristics of "age, gender, disability" of beneficiaries who have used telerehabilitation services based on available data.

3. Methodology

Three countries using rehabilitation applications were included in this study: Haiti, Madagascar and Colombia. As the level of deployment of telerehabilitation was different in these 3 projects, a mixed approach, with interviews and questionnaires, was applied to allow data collection from professionals and beneficiaries:

- Questionnaires were used to collect the opinions of beneficiaries and professionals who had experienced telerehabilitation.
- Individual and group interviews were conducted with:
    - Rehabilitation professionals trained in the use of the application, but who were not able to implement telerehabilitation with the beneficiaries.
    - The project leaders[4] in each country.

4. Results

Based on the data collected (from 27 professionals and 71 beneficiaries) in the three countries, this study identified barriers and levers for the use of telerehabilitation. The data collected were classified and analysed according to three factors: human factors, organisational factors and technological factors.

The use of a rehabilitation app is considered useful by most professionals. Apps can be a source of knowledge for professionals. They discover new exercises that they can transpose to their practices in rehabilitation centres.

However, applications have limitations:

- 50% of the professionals had difficulties in using it. The cross-checking of data indicates that difficulties of use are more frequent for professionals who do not use IT tools for the follow-up of beneficiaries.
- The application is not always compatible with beneficiaries' mobile phone operating systems, which limits its use.

[4] The project leaders and coordinators involved in the implementation of telerehabilitation are the project holders.

- The inclusion of young children may be limited because the exercises proposed in the application are not always adapted to their profiles/needs.
- Linguistic and ethnic limitations: the languages available are not always those mastered by the target population. The images and exercises do not consider the ethnic diversity of the contexts in which HI projects intervene, which does not favour the identification of beneficiaries.

Despite the technological limitations identified, practitioners used a wide range of tools to ensure communication and follow-up with beneficiaries (video calls, sending SMS, MMS, voice messages or printing the programmes on paper).

For the beneficiaries, the difficulties are at different levels. Firstly, in terms of technological factors, one third often encounter difficulties in accessing electricity, the Internet and mobile networks. Most of the beneficiaries have a smartphone, but the technical characteristics of the mobile phone do not always allow the application to be downloaded. 77% of professionals believe that these difficulties in accessing technological resources have a direct impact on the implementation of telerehabilitation.

Telerehabilitation places the beneficiary in his or her living environment, and professionals and beneficiaries feel that the equipment at home for rehabilitation exercises was missing. The visualisation of the environment is an important advantage for professionals, as it allows a patient-centred approach to adapt exercises and individualise rehabilitation goals in a more targeted way than during follow-ups in a rehabilitation centre.

In terms of human factors, socio-demographic factors were identified as limiting factors, such as high age, low level of education and the presence of difficulties in reading or understanding the exercises. These factors would favour the abandonment of rehabilitation follow-up during telerehabilitation.

Although difficulties have been detected, there are positive points in these experiments. Almost half of the beneficiaries indicate that telerehabilitation is identical or superior to traditional rehabilitation. In 40% of cases, telerehabilitation brings significant improvements in mobility, pain, functional abilities and social participation.

The majority of beneficiaries indicated that telerehabilitation has advantages, first of all the reduction of trips to the rehabilitation centre (57%), the reduction of health costs (43%), but also the possibility to perform more rehabilitation exercises (43%).

The main success factor of telerehabilitation was its experimentation in a real situation. This allowed a change of perspective among professionals, who identified the limits but also the potential of this device. Before the experimentation, some professionals thought that telerehabilitation was not adapted to their context of intervention. After the experimentation, all professionals and a large majority of beneficiaries wish to use telerehabilitation in the future.

However, telerehabilitation requires changes in professional practices. The establishment of interprofessional working sessions and training have been factors in encouraging professionals to adopt and motivating them to integrate these new practices.

On the other hand, the lack of training of local actors and the absence of regular support to practitioners on the ground have been identified as factors of failure.

From a more macro point of view, the absence of an economic model is a limit to some of the structures associated with HI for the deployment and sustainability of telerehabilitation. The economic dimension of the beneficiaries must be considered. Ownership of a smartphone, access to mobile data and electricity are factors that may exclude some beneficiaries from telerehabilitation.

5. Conclusion

Telerehabilitation is not intended to replace traditional rehabilitation, but it can be a complementary device that limits travel and promotes continuity of care for beneficiaries living far from the centres.

Telerehabilitation is seen as a solution to be developed for both professionals and beneficiaries. The deployment of these digital solutions requires support for professionals through training to make these devices their own. The creation of recommendations defining inclusion criteria and monitoring methods (adaptable to different contexts) could be tools enabling professionals to integrate these digital devices into their professional practices and limit situations of refusal or abandonment by beneficiaries.

The sustainability and development of telerehabilitation will also be linked to the national e-health policies developed and enacted by countries. The definition of an economic model that is sustainable for structures and accessible to the most vulnerable will be one of the challenges to be faced in thinking about telerehabilitation in the long term. The use of digital tools requires improved connectivity, coverage and access to the internet.

This research focuses on rehabilitation and has helped to identify barriers and levers for improving future projects. However, the factors limiting or favouring reflection are not limited to this area and may benefit other sectors that also rely on new technologies, such as mental health or education.

Introduction

1. Context

The World Health Organisation (WHO) considers disability to be a global public health problem, with 15% of the world's population, or one in seven people, living with a disability, or more than one billion people[5]. Eighty per cent of people with disabilities live in low-income countries. The increase in the proportion of people with disabilities is due to several factors, including the increase in population ageing, as well as the prevalence of chronic diseases such as diabetes, Stroke and mental disorders. People with disabilities face a number of barriers in accessing health care, including rehabilitation.

The WHO defines rehabilitation as "a set of interventions aimed at optimising functioning and reducing disability of people with health problems in interaction with their environment"[6]. WHO estimates that **2.4 billion people are currently living with a health problem that would require rehabilitation care**. **In some low- and middle-income countries, more than 50 per cent of people do not receive the rehabilitation services they need.** Changing global demographics and the prevalence of certain chronic conditions are expected to lead to an increase in rehabilitation needs[6]. Rehabilitation is an essential component of universal health coverage, alongside health promotion, prevention, treatment and palliative care. It can reduce the consequences of pathologies, trauma or age-related impairments, limiting people's disability and promoting their independence in daily life. There are many barriers for people with disabilities to access health care and services, such as high costs of health services and transport problems, lack of services in rural and remote areas, difficulties in physical accessibility to health care facilities[7].

WHO has launched the Rehabilitation 2030 initiative[8], which aims to scale up rehabilitation globally. The initiative has identified 10 priority actions to strengthen rehabilitation services in health systems. One of these is to establish comprehensive models of rehabilitation service delivery to progressively ensure equitable access to quality services, including technical aids, for all populations, including those living in rural and remote areas.

The development of various technologies, such as 3D printing or the use of Information and Communication Technologies (ICT) in healthcare and the development of e-health[9] have enabled the emergence of new health services (m-Health, telehealth, telerehabilitation, etc.).

[5] WHO Draft Global Plan of Action on Disability 2014-2021
[6] WHO Rehabilitation
[7] Disability and health WHO
[8] Rehabilitation 2030 WHO
[9] Definitions of digital health terms will be discussed in Part 3 of this document.

The hypotheses put forward in the scientific literature (Paglialonga et al., 2018 ; Seelman & Hartman, 2009) are that the use of digital health interventions (m-Health, telemedicine, telerehabilitation) should make it possible to meet needs related to difficulties in access to care, the shortage of specialised professionals, particularly rehabilitation professionals, reduce healthcare costs and promote continuity of care.

2. The use of new technologies in rehabilitation projects in HI

Already in 2014, HI became interested in the use of digital technologies to offer remote services, such as 3D orthopaedic fitting and online training or, more recently, telerehabilitation.

In 2016, HI carried out a pilot project with its own funds to test the added value of 3D printing technology for the manufacture of tibial prostheses in low-income countries (Togo and Madagascar) and in a war context (Syria)[10]. Following this experimentation, other 3D projects and studies were carried out, in particular the IMP&ACTE 3D project (Mali, Togo and Niger). The results have helped shape this digital transformation, with the ambition of improving access to rehabilitation services through an innovative service delivery model, combining traditional service delivery with the use of digital and 3D technologies[11].

HI's innovation was highlighted in 2020 by the European Union, which awarded two prizes[12] to HI for the TeReFa[13] and Odyssey 2025 / Drone projects.

HI has carried out other studies to find out how professionals and users represent the use of these technologies:

- Social impact study of telerehabilitation in the framework of the IMP&ACTE 3D project: Introduction of 3D printing technology for the manufacture of orthoses in West Africa.[14]
- "Evaluating the possibility of using telehealth for rehabilitation purposes in Oruro[15].

These two studies show a favourable perception of the use of new technologies in the context of rehabilitation by professionals and beneficiaries. In the 3D research, one of the conclusions is that the 3D printing/telerehabilitation binomial constitutes a solution to the shortage of professionals by opening up medical deserts, which mainly affect sub-Saharan Africa, by improving the productivity and skills of health professionals.

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[10] Jérome Canicave, Danielle Tan. Pilot of 3D Printing Technology for Transtibial Prostheses in Complex Contexts (Togo, Madagascar ans Syria). Research and studies n°5. Lyon: Handicap International, May 2017.

[11] Summary: Les StraTech 2020-2025 N°1 Technical Rehabilitation Strategy, December 2020, HI Document

[12] https://handicap-international.fr/fr/actualites/hi-deux-fois-primee-par-l-union-europeenne-pour-ses-projets-innovants-

[13] TereFa: TeleRehabilitation For all

[14] Social impact study of tele-rehabilitation in the IMP&ACTE 3D project: Introduction of 3D printing technology for manufacturing of orthoses in West Africa

[15] Assessing the possibility of using telehealth for rehabilitation purposes in Oruro, Bolivia.

Beyond 3D, other HI rehabilitation projects have integrated the use of ICTs, such as the PARI project "For access to quality rehabilitation services, connected and accessible to users on the islands of Madagascar and Haiti", or the project to develop a mobile rehabilitation application in Vietnam (OpenTeleRehab).

The **PARI project** aims to contribute to the effective and sustainable implementation of rehabilitation services for people with disabilities in Haiti and Madagascar. Through this project, HI promotes the use of ICTs to bring rehabilitation and health professionals closer to the most remote beneficiaries of these services. Access and delivery of rehabilitation services, especially for the economically and socially vulnerable, is being strengthened through a pilot scheme of a connected care pathway, connected vocational training, technical assistance to national health systems and innovative solutions for the financing of rehabilitation services.

The HI programme in Vietnam is developing a digital rehabilitation solution that will improve patient discharge and follow-up procedures, as well as the transition of care from the hospital to the community[16].

The use of ICT should enable users with limited access to rehabilitation services to benefit from quality remote monitoring and support. This support should help prevent complications and maximise the functional independence of the beneficiary, while respecting the principle of "do no harm".

Although programmes have integrated the use of ICTs in projects before 2020, the onset of a global pandemic related to the infectious disease COVID-19 was a catalyst for using ICTs to monitor beneficiaries. This global pandemic imposed periods of confinement, social distancing, limited physical contact, limited travel, making access to rehabilitation services more complex or impossible. According to WHO, approximately 60-70% of rehabilitation services have been disrupted by the COVID-19 pandemic.

To ensure the follow-up of beneficiaries, field teams have implemented new forms of remote support. To carry out rehabilitation interventions and follow-ups, some projects used mobile rehabilitation applications to transmit the exercises to the beneficiaries, others used videoconferencing to show the exercises to be carried out or to validate their implementation by the beneficiaries, others exchanged via MMS[17] (photos, videos) or SMS[18]. The monitoring methods can be synchronous [19]or asynchronous[20]. The implementation of telerehabilitation allowed professionals and beneficiaries to experiment with these digital solutions. These experiments have highlighted the difficulties and the levers to be identified in order to limit the difficulties and rely on the levers in the development of future telerehabilitation projects.

[16] Digital Rehabilitation : HI mobile App is coming

[17] Multimedia messaging service

[18] Short message service

[19] Synchronous: the beneficiary and the professional interact at the same time through the communication tool.

[20] Asynchronous: the beneficiary and the professional communicate in a time-delayed manner.

3. Aim of the study

The aim of this study is to describe and analyse the barriers and levers for the use of telerehabilitation through the use of rehabilitation applications in HI rehabilitation projects at beneficiary and practitioner level:

1. Identify the difficulties and contributions of the use of rehabilitation applications in the care of beneficiaries, from the point of view of professionals.
2. Identify the difficulties and benefits for beneficiaries in the use of telerehabilitation.
3. Identify success factors and failure conditions for the application of these tools in projects.
4. Describe the characteristics of "age, gender, disability" of beneficiaries who have used telerehabilitation services based on available data.
5. Propose recommendations for the cross-cutting seminar.

4. Goal of the study

The context of the global pandemic has been a catalyst for the use of ICTs and a necessity for remote monitoring of beneficiaries in rehabilitation. The number of projects using ICTs in rehabilitation increased from 4 before the pandemic to more than 15 during the pandemic. The implementation modalities and telerehabilitation actions carried out have been very different from one project to another depending on the context. The projects can be classified into three main categories:

- Projects based on software (mobile applications) for rehabilitation (Physitrack[21], Physiotec[22]).
- Projects that conducted monitoring mainly through mobile telephony, but did not use an existing exercise database.
- Projects that had access to resources but decided not to implement telerehabilitation.

Given the time frame of this study, it is not possible to include all projects that have implemented remote monitoring methods and to understand the advantages and difficulties encountered in each of them. In order to have a common frame of reference, it was decided to include countries that have used a mobile rehabilitation application in the context of telerehabilitation. Whatever the application used, professionals rely on an existing knowledge base (exercise database) and select exercises adapted to the needs of the beneficiaries and carry out remote monitoring. Three countries were included in this study, those of the PARI project (Haiti and Madagascar) and Colombia. In Haiti and Colombia, telerehabilitation has been effective with beneficiaries, unlike in Madagascar.

[21] https://www.physitrack.com/
[22] https://www.physitrack.com/

By questioning practitioners, beneficiaries and project managers, it is possible to identify the difficulties and levers for using telerehabilitation. Do the difficulties lie mainly in human, organisational or technological factors? What are the advantages of using telerehabilitation for practitioners and beneficiaries?

The identification of barriers and levers from the experiments should encourage the implementation of future telerehabilitation projects.

5. ICT definitions, e-health, tele-health, tele-rehabilitation

For the WHO digital technologies must be harnessed to achieve universal health coverage[23], the use of digital health and in particular the use of mobile communication in low- and middle-income countries opens up an opportunity to overcome the challenges of geographical accessibility of health care (World Health Organization 2019). Digital health, and in particular mHealth, has been shown to improve the quality and coverage of care, facilitate access to health information, services and knowledge, and promote healthy behavioural changes to prevent acute and chronic diseases[24].

In 2019 the WHO developed a guideline of recommendations on digital health interventions. A digital health intervention is defined as a discrete functionality of digital technology that is applied to achieve health objectives (World Health Organization 2019). Digital health is a dynamic field that is constantly evolving, terminology and associated definitions change over time.

Digital health is defined in the "Global strategy on digital health 2020-2025" (WHO 2020) as a field of knowledge and practice associated with the development and use of technology to improve health. Digital health extends the concept of e-health to include digital consumers, with a wider range of smart devices and connected equipment. It also encompasses digital health technologies such as the Internet of Things, artificial intelligence and robotics[25]. In the guide "Recommendations on digital interventions for health system strengthening", a more synthetic definition of digital health is given: "An umbrella term that includes e-health (which includes mobile health) and emerging areas, such as the use of computational sciences in artificial intelligence, big data and genomics" (World Health Organization 2019).

e-Health refers to all digital services used in health systems[26]. Due to the evolution of technologies, this term encompasses a wide variety of elements ranging from information systems (IS), to telemedicine for medical acts performed at a distance and, more globally, to telehealth (information portals for the general public, distance learning, etc.). The WHO defines telehealth as the use of information and communication technologies (ICT) for health and health-related issues, including health care services, health monitoring, health

[23] Press release. WHO issues first guidelines on digital health interventions.
[24] Use of approved digital technologies for public health. WHO 27 November 2017
[25] Global Digital Health Strategy 2020-2025, WHO.
[26] e-Health: "One of the most promising digital sectors".

documentation, education, knowledge and research. M-Health or mobile health (which refers to the use of mobile phones) is a component of e-health (World Health Organization 2019).

Information and Communication Technologies (ICT) are [27]: the set of technologies resulting from the convergence of computing and advanced multimedia and telecommunications techniques, which have enabled the emergence of more efficient means of communication by improving the processing, storage, dissemination and exchange of information. ICTs have increased data processing capacity, storage capacity, accessibility and speed of transmission.

The terms **telehealth and telemedicine** are sometimes used as synonyms or as different terms depending on the structures and authors. For the WHO these two terms are synonymous, but at European level a distinction is made, with telemedicine being a component of telehealth.

Telehealth: Telehealth refers broadly to electronic and telecommunication technologies and services used to provide care and services at a distance. The WHO defines telehealth as "the delivery of health services when patients and providers are separated by distance". Telehealth uses ICT for the exchange of information for the diagnosis and treatment of disease and injury, research and evaluation, and for the continuing education of health professionals. Telehealth can contribute to the achievement of universal health coverage by improving patients' access to quality health services wherever they are. It is particularly useful for people living in remote areas, vulnerable groups and ageing populations[28].

Telemedicine[29]**:** Provision of health services by all health professionals, where distance is a critical factor, through the use of ICT, including two-way interactive audio/video communications and telemetry systems, to deliver health services, mainly curative. Providing services to patients at a distance and facilitating the exchange of information between primary care physicians and specialists at a distance.

Telemedicine refers specifically to remote clinical services, while telehealth can refer to remote non-clinical services.

[27] Office québécois de la langue française.

[28] Data from the Global Health Observatory (WHO). https://www.who.int/gho/goe/telehealth/en/

[29] EY telemedicine services status report and recommendations for adoption https://ec.europa.eu/health/sites/health/files/ehealth/docs/ev_20171128_co09_en.pdf

Figure 1 illustrates the relationships and positioning between the different terms (eHealth, telehealth, telemedicine).

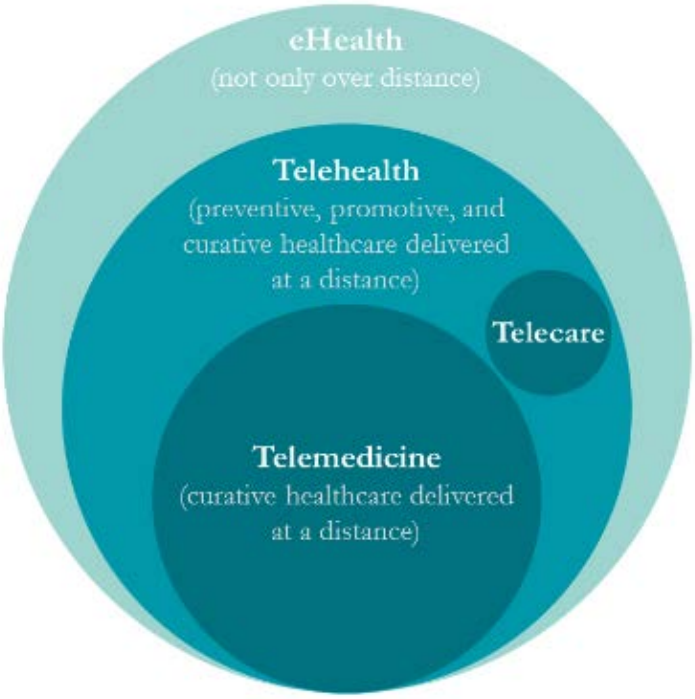

Figure 1 - Conceptual framework of the relationships between eHealth, telehealth, telecare and telemedicine (EU Telemedicine Status Report and Recommendations for Adoption)

Telerehabilitation (telerehabilitation, e-rehabilitation, digital rehabilitation): Telerehabilitation is a component of telemedicine. There is no consensus in the literature on the definition of telerehabilitation. Some authors define telerehabilitation as: "the use of telecommunication, via direct video or audio, to provide rehabilitation interventions. This excludes patient monitoring or general discussions between patients and health professionals, without interventions, and case studies, as well as simple access to exercise programmes. "(Appleby et al. 2019). However, other authors propose a different definition, as (Brennan, Mawson and Brownsell 2009) telerehabilitation "is defined as the use of ICT to provide rehabilitation services to people remotely in their environments. These services can be of different nature, such as assessment, monitoring, intervention, supervision, education and counselling". From a clinical perspective, the term "telerehabilitation" encompasses a range of rehabilitation and habilitation services including assessment, monitoring, prevention, intervention, supervision, education, consultation and training. ICTs used to deliver rehabilitation and habilitation services may include, but are not limited to, video and audio conferencing, instant messaging, wearable technologies, sensor technologies, patient portals or platforms, mobile health applications, virtual reality, robotics and therapeutic gaming technologies. Telerehabilitation services are provided to adults and children by a wide range of professionals (Richmond et al. 2017). For the purposes of this research, we have chosen to use Brennan's definition of telerehabilitation, which integrates assessment, monitoring, supervision and intervention.

m-Health has been defined as the use of devices - such as mobile phones, patient monitoring devices and wireless devices - for medical practice and public health. WORLDHEALTH ORGANIZATION, 2017).

6. Contribution and interest of m-health and telerehabilitation

Many studies have been conducted on the use of m-Health, in the case of chronic diseases and behaviour change (Cho et al. 2018), but also on the perception of professionals to use these technologies (Atinga et al. 2020; Odendaal et al. 2020). The perception of the use of m-Health by professionals is positive, it favours coordination between professionals, improves communication and relations with users and communities, favours monitoring and data recording. However, the technical limitations encountered may be an obstacle to the use of these technologies (Muzammil 2020).

Telerehabilitation is a practice that has been developing for many years (Winters 2002). The areas of use of telerehabilitation are numerous, they can respond to specific professional practices such as home assessment by occupational therapists (Ninnis et al. 2019), in physiotherapy in the treatment of various pathologies (Eichler et al., 2017; Pastora-Bernal et al., 2017), in speech therapy in the treatment of aphasia (Hill and Breslin 2018). Telerehabilitation can be used in the treatment and follow-up of many pathologies, in the follow-up of a stroke or brain injury (Appleby et al. 2019; Ricker et al. 2002) or in chronic pathologies (Spindler et al. 2019; Tousignant et al. 2012).

Recent meta-analyses show that telerehabilitation can be at least as effective as face-to-face therapy in the treatment of post-acute stroke (Laver et al. 2020). Many factors are involved in the implementation and deployment of telerehabilitation, and the acceptance and interest of telerehabilitation by professionals is an important factor for success (Almojaibel et al. 2020). In an article on the challenges for the emergence of telerehabilitation in a developing country (Philippines), the authors identified, based on a literature review, the main challenges for the development of telerehabilitation by breaking them down into 3 factors (Leochico et al. 2020): **human factors**, **organisational factors** and **technological factors:**

- **Human factors:** these include awareness of telerehabilitation, acceptance, knowledge and skills of the different actors (patients, relatives and carers, health professionals) and socio-demographic factors (age, educational level, resources).
- **Organisational factors** include administrative and financial aspects (such as the business model), working practices, data protection and confidentiality. The importance of formulating good practice guidelines and reorganising work to optimise the integration and use of telerehabilitation by the different actors is underlined.
- **Technical and technological factors take** into account the physical resources to carry out telerehabilitation, as well as technical skills.

The main limitations identified by the authors (Leochico et al. 2020), in terms of human factors, are the difficulty of acceptance of these devices by stakeholders, difficulties in terms of the knowledge and skills required to use telerehabilitation, and apprehensions about data confidentiality.

In terms of organisational factors, the most important aspect is the lack of a national e-Health policy or legislation.

In terms of technological factors, the most limiting element is the quality of the Internet and its coverage.

These three factors (Figure 2) are interdependent and their consideration in telerehabilitation projects is essential. Without communication devices (such as the absence of mobile phones by beneficiaries), or the absence of a mobile network, for example, telerehabilitation cannot be offered to beneficiaries.

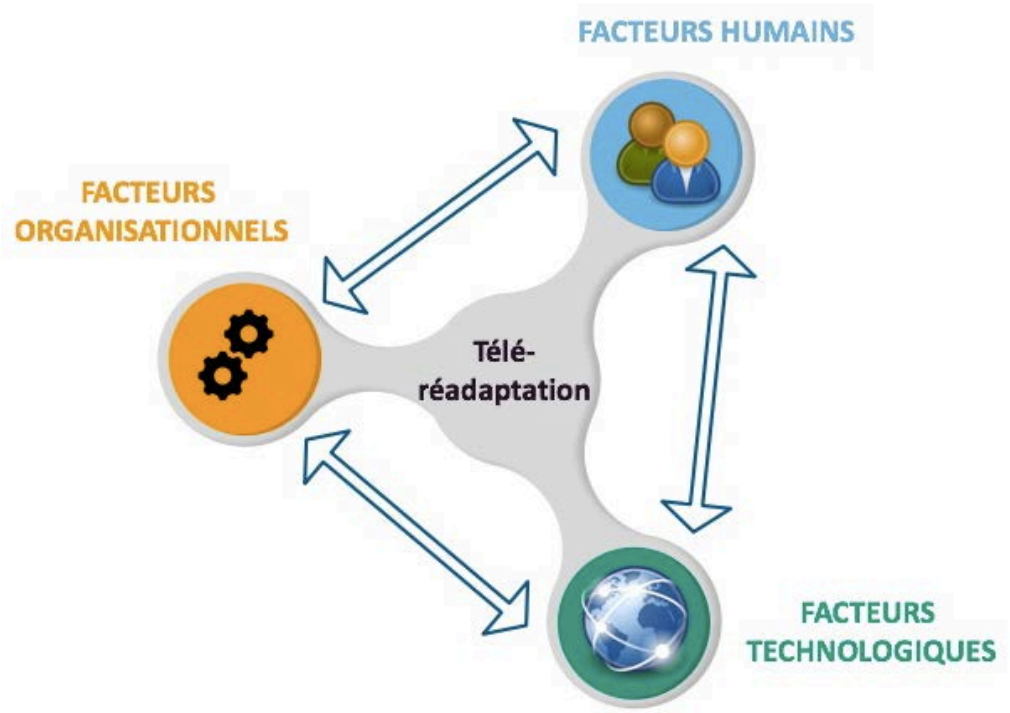

Figure 2 - The three factors (human, technological, organisational) involved in telerehabilitation deployment and use

7. Mobile phone and Internet use worldwide

The development of digital health interventions is directly related to the development and use of ICT (telephones, computers, Internet).

Mobile phone ownership and Internet use have increased considerably in recent years worldwide. According to data from the Digital Reports 2021[30], **5.22 billion people own a mobile phone** (+ 1.8% in 1 year), almost **4.66 billion people use the Internet** (+ 7.3% compared to January 2020), i.e. almost **59.5% of the world's population,** and more than 4.2 billion people use social networks (+ 9.2%).

These figures are steadily increasing, but there are many disparities in Internet access or phone ownership across countries. The map (Figure 3) from the Digital 2020 report illustrates the Internet penetration rate by region in relation to the world population. On the African continent, the Internet penetration rate is **23% in East African countries** and **36% in West African countries.** However, it is **60% in the Caribbean** and **72% in South America**.

The possession and use of these devices (mobile phones and the Internet), as well as the constant increase in access to these resources by the population, favours the implementation of digital health interventions. Numerous e-health initiatives are underway, and [the Observatory for eHealth in the South](#)(ODESS) brings together some of the initiatives carried out in the countries of the South. The WHO is also leading the project and has developed a digital application to improve care for the elderly[31].

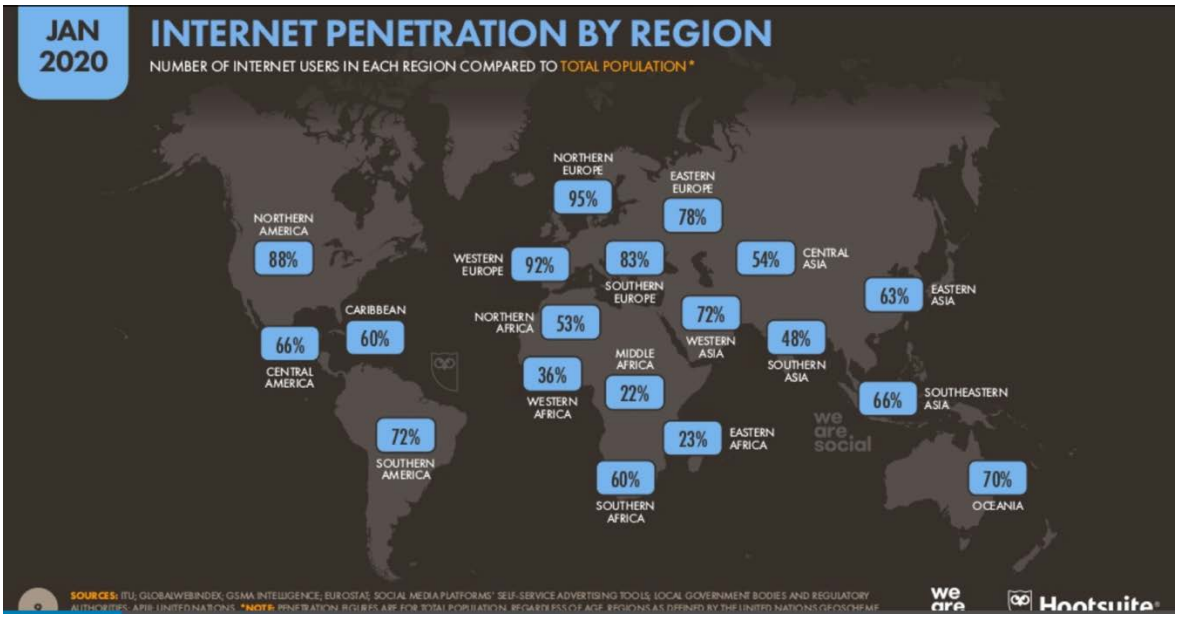

Figure 3 - Map of Internet penetration rates in the world

[30] Digital report 2021

[31] WHO launches digital app to improve care for older people.

8. Digital in Haiti, Madagascar and Colombia

Although the number of mobile phone and internet users worldwide is constantly evolving, there are disparities between countries. We have focused on the three countries in which the study is being conducted to understand the data on the number of users (phone and Internet) as well as the costs of mobile data. The hypothesis is that the cost of internet or mobile phone ownership can have an impact on access to technology for the most vulnerable people, who are the target of HI's actions. Table 1 presents the dataset.

Table 1 - Data on access to and cost of digital resources in the 3 research countries

	Haiti 	Madagascar 	Colombia 
Population	11.33 million	27.33 million	50.61 million
Urbanisation		37%	81%
Internet users	3.68 million	3.84 million	35.00 million
internet user population [32]	32%	9,8%	65%
Increase in internet users (2020 vs. 2019) [33]	+ 13%	+ 11%	+2,9%
Number of mobile phone subscriptions	6 399 040	10 654 700	66 283 200
Number of mobile telephone subscribers (per 100 inhabitants, 2019 data) [34]			131
Adult literacy rate (15 years and older) [35]	61% (2016)	74% (2018)	95% (2018)
Average price of mobile data (1 GB) in USD [36]	2,74	8,81	3,46
Average speed of mobile Internet connections (Mbps)	15,71	NC	18,71

[32] World Bank data
[33] Data from the Digital 2020 Report
[34] World Bank.
[35] World Bank.
[36] https://www.cable.co.uk/broadband/speed/worldwide-speed-league/

The data show the heterogeneity of ICT use and ownership among the populations of these three countries. While in **Colombia almost 65% of the population uses the internet, in Madagascar only 9.8% of the population does so.** Madagascar has the most expensive average price for mobile data: **$8.81,** compared to **$2.74 in Haiti**. While Colombia has the highest rate of internet users (65% of the population), Madagascar and Haiti have the highest growth rates in the number of internet users in a year (respectively +11% and +13%).

Methodology

1. Research design

The main objective of this research is to describe and analyse the barriers and levers for the use of telerehabilitation and the use of rehabilitation applications at the level of beneficiaries and practitioners in HI projects. **As the level of implementation of projects differs from country to country, we wanted to use tools that could be adapted to different contexts. For this purpose, a mixed methodology with individual interviews and questionnaires was used**.

Individual interviews and a focus group were conducted with rehabilitation professionals in Madagascar. They received training in the use of a rehabilitation application but did not deploy telerehabilitation to beneficiaries.

Two questionnaires were created, one for beneficiaries and one for practitioners. While these two tools make it possible to identify the difficulties at the level of human and technological factors, it seemed necessary to address the dimension of organisational factors with those in charge of the project (project coordinator and project manager) through interviews[37].

The literature review was conducted in October and December 2020, interviews were conducted in December 2020. Data collection through questionnaires was carried out in January and February 2021.

2. Location of the research

The countries included in the study are Haiti, Madagascar (PARI project country) and Colombia.

- In Madagascar, interviews were conducted with the rehabilitation teams of the SARs[38] of Diego Suarez and Tamatave.
- In Haiti, data were collected from professionals (HI staff and partners) and beneficiaries in Cap Haïtien and Ouanaminthe.
- In Colombia, data collection was carried out with professionals and beneficiaries in 5 locations: Bogotá, Maicao, Baranquilla, Medellín, Riohacha.

Due to the COVID-19 pandemic and restrictions related to the health crisis, field missions could not be carried out.

[37] In Appendix 2 a summary diagram presents the tools used and the target populations included in the study.

[38] Adaptation and rehabilitation service

3. Target population

Three groups form the target population of this research:

- Rehabilitation professionals involved in telerehabilitation projects.
- Beneficiaries (men, women, girls, boys) who have received full or partial telerehabilitation support in the countries covered.
- Project leaders involved in the implementation and deployment of telerehabilitation projects.

Table 2 shows the number of people included in this research, by country.

Table 2 - Target population of the study

	Rehabilitation professionals	Beneficiaries and their families	Project holders
Madagascar	2 doctors of the centre of rehabilitation 3 Physiotherapists 1 Orthopaedic Technician Individual interview / Focus group discussion		1 Project Manager Individual interview by videoconference
Haiti	2 Physiotherapists 5 Rehabilitation Technicians 3 Community health workers Online questionnaire	33 beneficiaries Application questionnaire with interviewers	2 Rehabilitation specialists 1 Project Manager Individual interview
Colombia	8 physiotherapists Online questionnaire	38 beneficiaries Online questionnaire	1 rehabilitation specialist Individual interview

4. Selection of participants

In Madagascar, rehabilitation professionals from the two centres participating in the telerehabilitation project were included. Individual interviews were conducted with **6 rehabilitation professionals** (2 head doctors, 3 physiotherapists and 1 Orthopaedic Technician) who had been trained in the use of the application. A **focus discussion** was held with all[39] rehabilitation professionals. In Madagascar, the deployment of the project did not allow for the inclusion of telerehabilitation beneficiaries, so there are no Malagasy beneficiaries in this study.

In Haiti, the target population was professionals and beneficiaries who had used telerehabilitation. A total of **11 professionals** (3 physiotherapists, 5 rehabilitation technicians and 3 community health workers) were included. During data collection, **10 of the 11 target professionals responded to the questionnaire (3 community health workers, 2 physiotherapists and 5 rehabilitation technicians)**. We wanted to be exhaustive and to include all beneficiaries (children or adults) who have been totally or partially followed up with telerehabilitation. **63 people** were included in the telerehabilitation project. During the data collection, **38 beneficiaries answered the questionnaire**. As for the 25 people who did not participate in the research: 1 person refused to answer, 2 people died at the time of the survey, 1 person moved, 21 people could not be contacted because of errors in their contact information in the follow-up files.

Of the 38 respondents, we excluded 5 beneficiaries, who were assessed by physiotherapists, but did not benefit from telerehabilitation. As the aim of the study was to identify barriers and levers for the use of telerehabilitation, we did not include their responses in the results.

In Colombia, telerehabilitation has been implemented in 5 locations. The 8 physiotherapists using telerehabilitation were contacted and all of them responded to the questionnaire. For the beneficiaries, a sample of 6 beneficiaries per locality was defined with the inclusion criteria that they had benefited from telerehabilitation and that they could answer an online questionnaire. **A total of 33 beneficiaries responded to the questionnaire**.

5. Data collection tools and procedures

The research protocol was discussed and validated by the members of the monitoring committee. Numerous exchanges with the field took place to validate the questionnaires, set up the individual interviews and organise the deployment of the questionnaires to beneficiaries and professionals.

[39] Professionals who have followed the training and those who have not.

The global context of the COVID-19 pandemic and travel restrictions made field missions impossible. To facilitate data collection, different ICTs were used, such as videoconferencing for interviews, and the Survey CTO tool, which allows for mobile data collection and sending responses to a server.

For each of these modalities, participants were provided with information about the objectives of the research and their consent was sought.

5.1 Collection of the questionnaires

Two questionnaires were created, one for practitioners and one for beneficiaries. The questionnaires were presented to the members of the monitoring committee as well as to the field workers in order to validate the topics addressed and the formulation of the questions in the different languages (French and Spanish). Both questionnaires were applied in the CTO survey. The answers to the questionnaires were entered anonymously.

- The beneficiary questionnaire was built on the basis of the initial work carried out in Haiti. The questionnaire was modified to adapt it to the contexts of other countries and enriched with items relating to: the difficulties and contributions of telerehabilitation, technological aspects, perception and level of satisfaction with the use of telerehabilitation.
- The professionals' questionnaire contains themes common to the beneficiaries' questionnaire. It deals with functional and technological levers and difficulties, but also with professional practices (frequency of follow-ups, abandonment), as well as professionals' satisfaction with the use of this device.

Data collection was carried out in different ways:

- **At the professional level**, each person received an email explaining the purpose of the research. A web link allowed direct access to the questionnaire and its completion online[40]. Two reminders were made (one by the person in charge of the research and one by the project managers).
- At the **beneficiary level,** collection was done differently in Haiti and Colombia. This difference can be explained by organisational and contextual reasons.
    - **In Colombia,** telerehabilitation interventions were still ongoing at the time of the study and were taking place in several locations across a wide geographical area. The recruitment and deployment of interviewers in each of these locations was not compatible with the research schedule. In Colombia, the language used is Spanish, the literacy level is 95% according to World Bank data, and the use of digital tools is common practice among beneficiaries. Taking these criteria into account, it was decided to send the questionnaires to the beneficiaries through an Internet link that would allow them to fill in the questionnaire online. Practitioners in each of the locations sent a text message via WhatsApp with the web link to the beneficiaries to invite them to fill in the

[40] The questionnaire could be completed on any tool (smartphone, computer, tablet).

questionnaire. The inclusion criteria were that beneficiaries had received telerehabilitation and used ICT to complete an online questionnaire.

- **In Haiti,** although French is used by many people, a large part of the beneficiaries only speak Creole. The literacy rate is 61%. To overcome any comprehension difficulties, interviewers were recruited to go and meet the beneficiaries. The interviewers used digital tablets on which the questionnaire was applied (CTO survey application). The interviewers were briefed and sensitised on the objective of the study, on the use of the tablet, on the interviewer's position before intervening with the beneficiaries. The project managers and the researcher supervised and accompanied the interviewers.

5.2 Collection of interviews with practitioners

A framework was developed for the individual interviews and the focus group. The aim of the interviews was to address the professionals' representation of telerehabilitation and to identify the difficulties and factors that have hindered the deployment of this system in their context of intervention. The interviews with the project managers aimed to discuss the results obtained and to specifically address organisational aspects. All interviews were conducted by videoconference and were recorded with the agreement of the participants, transcribed and summarised.

6. Data processing

Two types of data were collected, quantitative and qualitative. To process the qualitative data, a manual analysis by themes was carried out. Quantitative data from the questionnaires were processed with SAS JMP Pro 15.1.0[41].

7. Ethical considerations

This research followed the ethical guidelines proposed by HI[42] . Each person was informed that they had the right to stop at any time without consequence to themselves. The anonymity of the participants was respected, and each participant in the study verbalised their consent to participate in a free and informed manner.

[41] www.jmp.com

[42] Studies and research at Handicap International: for ethical data management. Aude Brus. Lyon, Handicap International, 2015.

Results and discussion

The research was carried out in three countries: Haiti, Madagascar and Colombia. The results presented are based on **11 individual interviews, one focus group and questionnaire responses from 71 beneficiaries and 18 practitioners.**

1. Profile of professionals and beneficiaries

1.1 Profile of professionals

Several categories of professionals were included in this research. Interviews and questionnaires **collected the views of 27 professionals**: 2 RAE chief physicians, 14 physiotherapists, including 3 project coordinators, 1 CAT, 5 rehabilitation technicians, 3 community health workers and 2 project managers.

Figure 4 shows the distribution of the professionals included. Physiotherapists represent 52%, i.e. the most represented profession, while the CAT profession represents only 4%. In the framework of these telerehabilitation follow-ups, it is the physiotherapists who carry out the assessments, create the rehabilitation programmes and ensure the follow-up of the beneficiaries, which explains why these professionals are the most represented.

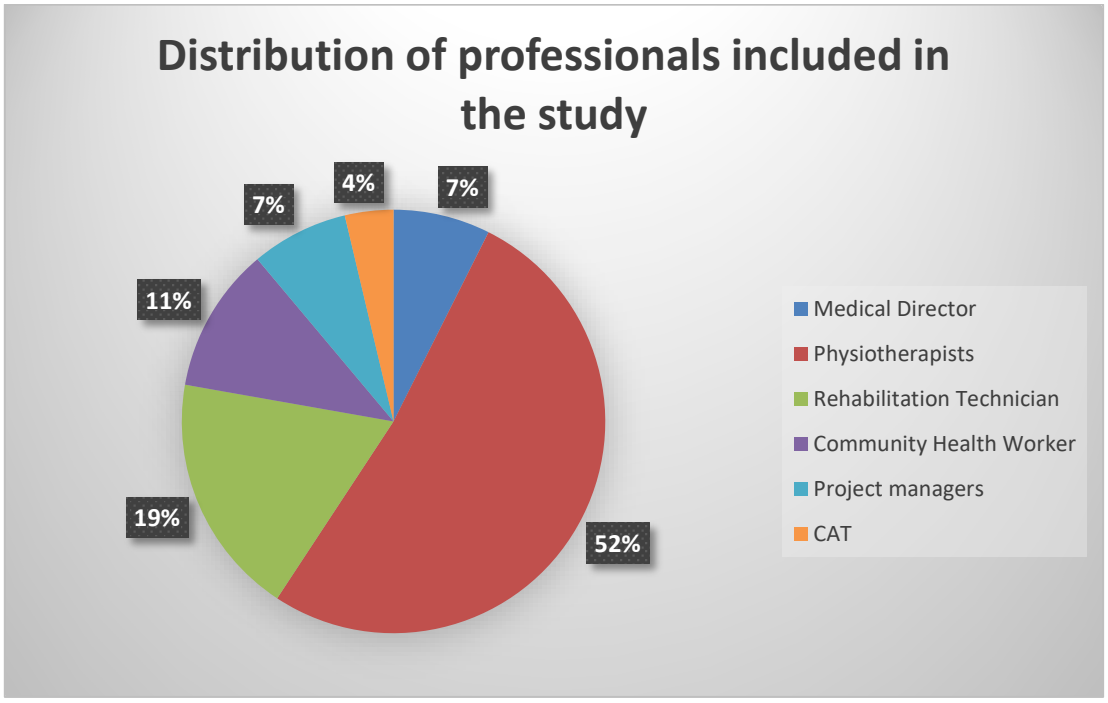

Figure 4 - Graphical representation of the distribution of rehabilitation professionals included in the study

The average age of the professionals who responded to the questionnaires was 40.5 years (minimum 30; maximum 58), with an average of 13 years of professional experience in rehabilitation (minimum 2; maximum 26). Of the professionals in the sample, excluding the project manager, **63% work in rehabilitation services, 19% in beneficiaries' homes and 4% in refugee camps.** Some professionals have mixed activities, working both in rehabilitation centres and in the beneficiaries' homes. **26% of the professionals live in Madagascar, 41% in Haiti and 33% in Colombia**.

1.2 Profile of beneficiaries

71 beneficiaries or family members responded to the questionnaire. Sixty-two percent of the respondents are beneficiaries themselves, 31% are family members and 7% are caregivers. 54% of beneficiaries live in Colombia and 46% in Haiti.

62% (n=44) of the beneficiaries were female. The average age of the beneficiaries is 38.6 years (minimum: 3; maximum: 79) and **that of the respondents is 34.7 years** (minimum: 23; maximum: 49). When we look at the average age of beneficiaries by country, we see a significant difference ($p<0.001$), in **Colombia the average age of beneficiaries is 31.10 years and that of Haitian beneficiaries is 47.3 years.** These results may be due to the criteria for inclusion of beneficiaries in the countries' telerehabilitation projects but may also be the result of a beneficiary selection bias in Colombia, where only the people most comfortable with ICTs responded to the questionnaire in this study.

The distribution of beneficiaries by age group indicates that people aged **18-59 years represent 54% of the people served, those aged 60 and over 24%, those aged 6-17 years 17% and those aged 0-5 years only 6% of the population**.

Figure 5 shows the distribution of beneficiaries by age group in the two countries. It can be seen that people aged 60 and over live mainly in Haiti. For children aged 0-5 years, only 4 children were included, all of whom live in Colombia. The application used in Colombia and in Haiti was different as were the exercises proposed for the children, this may explain why one of the applications is less responsive to the needs of the children.

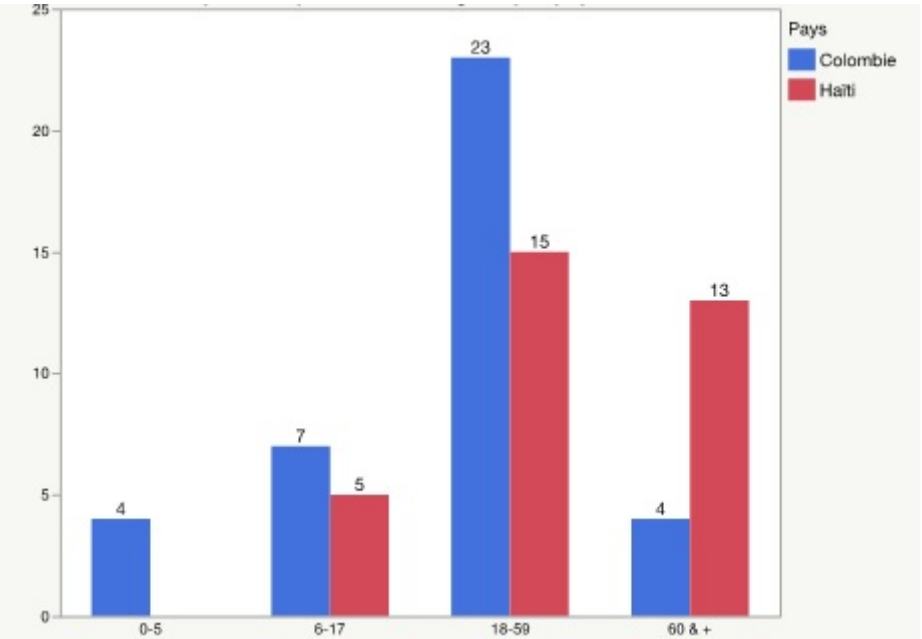

Figure 5 - Distribution of beneficiaries by age group and country

As for the level of education, **20% of the respondents had no education, 25% had primary education, 35% had secondary education and 15% had higher education**.

On average, beneficiaries live with 5 people in their households (minimum: 1; maximum: 14)**, 75% of beneficiaries have a family member helping them at home.**

On average, beneficiaries live **54.24 km from the rehabilitation centre** (minimum: 0; maximum: 1000), but these distances must be qualified, especially when the maximum distance of 1000 km is observed. For Haitians, the notion of kilometre is an abstract notion according to the project coordinators, which may have led to errors. There was a significant difference ($p<0.001$) in the average distances in the two countries (93.36 km in Colombia versus 9.18 km in Haiti). The people accompanied in Colombia are Colombians, but also Venezuelan migrants, the formulation of the question or the understanding of the question could have led to errors.

70% of beneficiaries need the help of a third party to reach the rehabilitation service. The data collected indicate **that the average cost of travel is USD 3,765**. The data collection tool (questionnaire) did not allow beneficiaries to specify whether the costs indicated were for one or two people and whether this represented a round trip or only one trip. Although these figures lack context, it is important to note that this amount of $3,765 is significant in relation to the countries' average monthly income. According to the World Bank[43], the poor population living on less than $1.90 a day represents 4.7% of the Colombian population (2015), 24.5% of the population in Haiti (2012).

43 https://donnees.banquemondiale.org/indicateur/SI.POV.DDAY?locations=1W&start=1981&end=2015&view=chart

We can assume that the direct and indirect costs of rehabilitation, including the beneficiary's and carer's travel, accommodation and sometimes the cost of sessions (which differ according to structures and countries) can be significant for beneficiaries. Limiting travel during telerehabilitation can be a lever for the continuation of follow-ups, if beneficiaries have access to technologies (internet, mobile phones, electricity).

In terms of disability status, 76% of beneficiaries report having only one physical disability and 24% have several disabilities (multiple disabilities, or physical disability associated with a sensory, cognitive or psychological disability).

The causes of disabilities are related to an illness in 41% of the cases, to an accident in 35% and to birth in 24%. The presence of disabilities is mostly chronic, 87% of the beneficiaries have had this disability for more than a year, 3% for less than a year and for 10% these impairments have been present for 2 to 6 months.

Of the 71 beneficiaries, 53 people indicated a diagnosis or described symptoms. In **49% of cases these were neurological pathologies** (stroke, paraplegia, hydrocephalus, hydrocephalus, tetraplegia, spina bifida, etc.), in 19% of cases they were related to traumatology (fracture of the lower limb, amputation in connection with an accident, etc.), in 15% of cases they were related to impairments (fracture of the lower limb, amputation in connection with an accident, etc.), in 19% of cases they were related to traumatology (fracture of the lower limb, amputation in connection with an accident, etc.), in 19% of cases they were related to traumatology (fracture of the lower limb, amputation in connection with an accident, etc.).), in **19% of cases they are related to traumatology** (fracture of the lower limb, amputation in connection with an accident), in **15% of cases the disabilities are related to cardiovascular pathologies** (arterial hypertension [AHT], heart disease), and in **11%** of cases **to other causes** (clubfoot, anaemia, tropical pathology, cancer, etc.).

The implementation or deployment of telerehabilitation can be analysed in terms of human factors, technological factors and organisational factors. In order to fulfil the main objective of this research, which is to describe and analyse the barriers and levers for the use of telerehabilitation, we analysed the results according to these three factors.

2. Human factors

Human factors include awareness and acceptance of telerehabilitation, as well as the knowledge and skills of the different actors (beneficiaries and health professionals) to use ICTs.

2.1 Awareness and acceptance of telerehabilitation

Before use:

- **45% of the professionals surveyed think that telerehabilitation will be a device to be implemented in the future,**

- **33% were not aware of telerehabilitation,**
- **22% felt that it was not appropriate for their context of intervention**.

The results show that, regardless of the starting profession (physiotherapist, rehabilitation technician or social worker), a part of the rehabilitation professionals did not know about telerehabilitation. The interviews indicate that the level of knowledge about telerehabilitation is different. Professionals who have been trained in the use of rehabilitation applications know and propose different definitions of telerehabilitation, however, team members who have not been trained, hear this term for the first time.

The lack of awareness of telerehabilitation may be due to the lack of knowledge of these devices on the part of the professionals, but it may also stem from the terminology used during the interviews. During the implementation of the projects, other terms were used, such as digital rehabilitation, remote monitoring or connected rehabilitation, which can be a source of confusion for professionals.

> **Definition of telerehabilitation by practitioners during interviews**
>
> "For me it is, patients who can't come to the ward at all times, so at home or in the suburbs where there is no fitting service we give gestures or techniques to help you during management."
>
> "Telerehabilitation is a way of delivering rehabilitation sessions through technology."
>
> "For me, telerehabilitation is when exercises are given through technology, either through videos or printouts."
>
> "It is a remote rehabilitation. It's consulting with someone remotely or by audio-visual means, but it's not on-site."

The adoption of a common terminology by HI professionals and partners can be a lever for sharing and pooling skills and knowledge related to telerehabilitation and project building. Terms and definitions related to digital health evolve over time. Thus, in 2016 the WHO defines digital health as "the use of digital, mobile and wireless technologies to support the achievement of health goals". Digital health describes the broad use of information and communication technologies (ICTs) for health and encompasses both e-health and mobile health."[44]. In 2019 the WHO definition of digital health will incorporate the areas of big data and artificial intelligence.

22% of the professionals who responded to the questionnaire considered that telerehabilitation was not adapted to their context of intervention prior to its deployment. These results were specifically addressed during the interviews with the project managers. For them, telerehabilitation was not adapted to their context of intervention for:

[44] Monitoring and Evaluating Digital Health interventions, 2016 (p 126)

- Technical reasons essentially linked to beneficiaries' difficulties of access to technologies (beneficiaries' ownership and type of mobile phone, level of Internet access and coverage, etc.),
- Beneficiaries' lack of skills and knowledge to use ICTs and the presence of cognitive disabilities,
- For some practitioners telerehabilitation consisted only of synchronous [45]and videoconferencing interactions with beneficiaries, which fits the definition proposed by (Appleby et al. 2019) but not the broader definition of the American Telemedicine Association[46].

While before the implementation of the telerehabilitation projects, **55% of the professionals were not aware of or considered that this device was not adapted to their context of intervention, after the experimentation, 100% of the professionals wish to integrate this device in their future professional practices**, as shown in Figure 6.

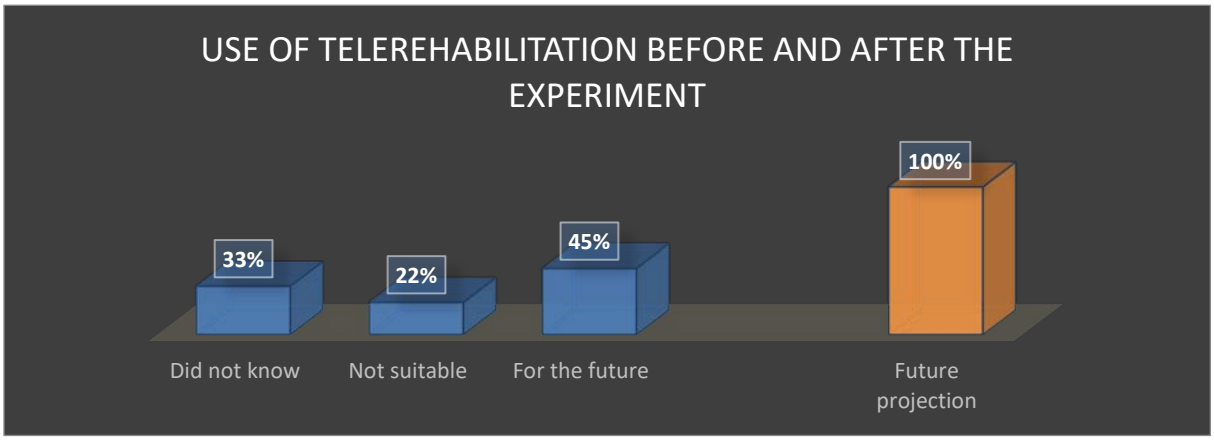

Figure 6 - Practitioners' perception of telerehabilitation in their contexts of intervention prior to the implementation of telerehabilitation and projection of its future use

87% of the beneficiaries indicated that they readily accepted telerehabilitation. While a majority of beneficiaries readily accepted telerehabilitation, it is not possible through this study to identify the factors favouring acceptance or rejection of telerehabilitation from the beneficiaries' point of view. However, when asked if they wanted to use telerehabilitation in the future, **97% of the beneficiaries responded favourably and only 3% did not want to use telerehabilitation in the future**.

[45] Telerehabilitation in synchronous mode is the simultaneous interaction of the practitioner and the beneficiary through the communication interface.

[46]The American Telemedicine Association states that the delivery of rehabilitation services may include, video and audio conferencing, instant messaging, wearable technologies, sensor technologies, patient portals or platforms, mobile health applications, virtual reality, robotics and therapeutic gaming technologies (Richmond et al. 2017).

In view of **the results, it is possible to hypothesise that the experimentation has led to a change in the positioning and perspective of professionals and beneficiaries on telerehabilitation.** During the interviews, the project leaders indicated that the experimentation allowed them to see that it was possible to adapt telerehabilitation to their context of intervention, by printing rehabilitation programmes, for example, by sending voice messages, mms or sms. Some professionals were initially sceptical about the functional "progress" that telerehabilitation could bring to beneficiaries, but they were positively surprised by the presence of functional results and the adherence of many beneficiaries to these new devices. During the interviews, most project coordinators and managers indicated that they would like to see telerehabilitation continue, as they saw positive aspects of support for some beneficiaries.

It is also possible to think that the desire to use telerehabilitation in the future is related to the level of satisfaction after experimentation. Thus, **84% of professionals and 89% of beneficiaries were satisfied or very satisfied with the use of telerehabilitation, as** shown in Figure 7.

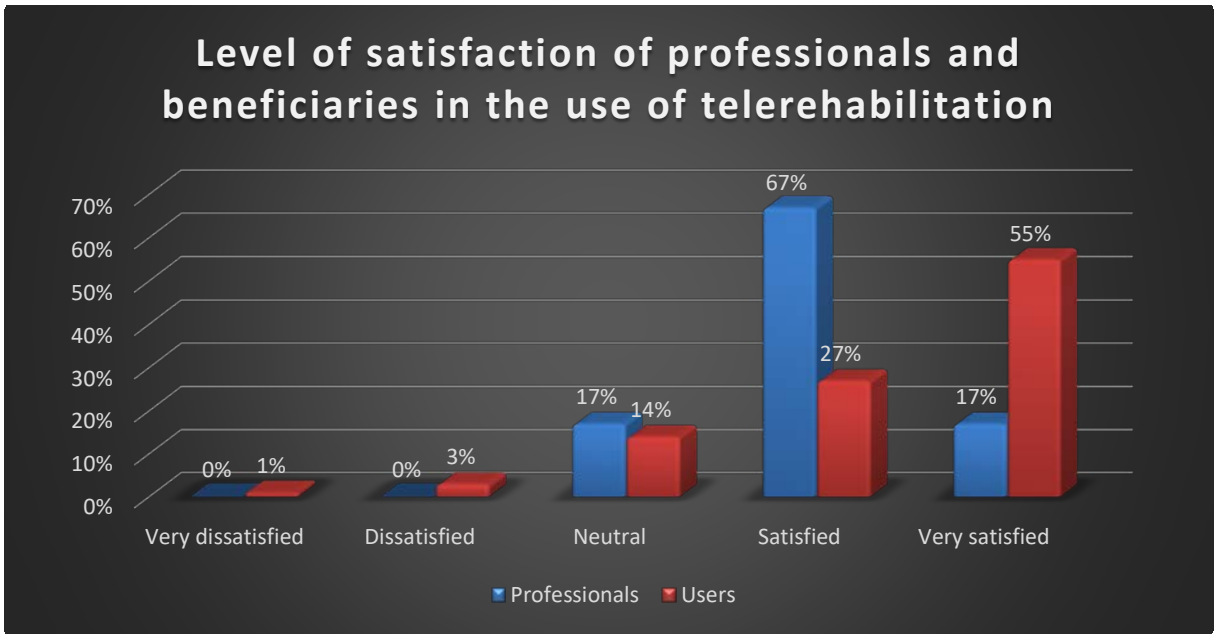

Figure 7 - Level of beneficiaries' and professionals' satisfaction with the use of telerehabilitation

2.2 Rejection of telerehabilitation

The professionals indicated that they had followed an average of **39.4 patients** (minimum: 3; maximum: 100). **61% of the professionals indicated that an average of 7.5 beneficiaries refused telerehabilitation care** (minimum: 1; maximum: 15).

Reasons for refusal of telerehabilitation reported by practitioners

"Lack of adequate materials"; "Lack of materials"

"Problems with the phone"; "They don't have a phone; they usually use someone else's phone."

"There are people who don't have telephones and in remote areas who don't have electricity."

"No mobile phone with the necessary functions for telerehabilitation. Informal work on the street all day long. "

"They say it's not the same, because of the contact".

"They want to be face-to-face because they pick up information more easily than remotely, or because they don't have a mobile device to connect to, or the camera is bad."

"They think this tool is not going to work, they don't have smartphones, they don't have internet, they don't have mobiles, they work all day, etc."

"The type of impediment."

The elements of rejection, from the practitioners' point of view, can be grouped into two categories:

- **Technological factors** such as lack of a smart phone, lack of phone functionality to enable video conferencing, but also difficulties in accessing the internet, electricity and lack of rehabilitation equipment.
- **Human factors** which refer to the reduction of human contact, the difficulties of beneficiaries to understand distance exercises, but also socio-economic aspects such as the need for beneficiaries to be professionally active.

It is possible to observe a significant difference ($p<0.001$) in the average number of refusals reported by professionals between the two countries, 10.2 **refusals on average in Haiti compared to 5.33 in Colombia.** Several hypotheses can be formulated to explain this difference:

- Firstly, the temporality and context of deployment of these projects. In Haiti, a pilot project was established in 2019, beneficiaries could accept or refuse to join this pilot project. In Colombia, telerehabilitation was launched after the COVID-19 pandemic. This pandemic context may have favoured the acceptance of telerehabilitation by Colombian beneficiaries, as it was the only device that had rehabilitation benefits.
- The average age of beneficiaries is different in the two countries, being higher in Haiti (47.3 years) than in Colombia (31.10 years). The scientific literature indicates that the advanced age of people is one of the barriers to the implementation of telerehabilitation (Kruse et al. 2020).

2.3 Dropout and motivation

56% of professionals believe that telerehabilitation monitoring does not encourage them to abandon rehabilitation more than traditional monitoring.

Practitioners estimate that an average of **8.6 beneficiaries** (minimum: 2; maximum: 20) **have dropped out of** telerehabilitation follow-up. According to the professionals, the reasons for dropping out are due to:

- 67% to loss or theft of the phone,
- 42% to the lack of motivation of the beneficiaries,
- 33% to the absence of a carer,
- 33% to the relocation of the beneficiary to another city,
- 25% because the home is not suitable for telerehabilitation.

Other causes of drop-out were indicated by professionals in free text:

> **Reasons for abandoning telerehabilitation monitoring for professionals**
>
> "Lack of follow-up of patients for the duration of the socio-economic crisis, borrowed phone, 65 years."
> "The disbelief in itself, in some patients, and the lack of electricity and smart phones".
> "Lack of electricity, unable to download the application".
> "Economic factor of the beneficiary or his family".
>
> "In some cases, users do not do the exercises due to lack of time or commitment to their rehabilitation."

According to professionals, an average of almost 9 beneficiaries have dropped out of telerehabilitation follow-up. As for the reasons for refusal, technological factors play an important role in the causes of drop-out from the professionals' point of view. But other environmental and human factors (unadapted home, absence of a carer, motivation) also play a role.

68% of beneficiaries responded that they had not resigned, 32% indicated that they had resigned during follow-up. The causes of drop-out indicated by the beneficiaries are related to:

- 39% to loss or theft of the phone,
- 13% for Internet connection reasons,
- 4% for the level of complexity of the proposed exercises,
- 4% to lack of motivation,
- 4% for lack of results
- 4% due to lack of time.

Other reasons for discontinuing telerehabilitation cited by beneficiaries

"Because of covid-19"

"Phone problem. Problem with the application"

"Lack of telephone and ability to use it".

Haitian beneficiaries indicate that one of the reasons for abandonment would be related to COVID-19. In Haiti, the pilot project started in 2019 and ended in January 2020, i.e. before the pandemic appeared. **One of the limitations of this research is recall bias.** This research was conducted at a distance from the end of the pilot project (D+10 months); this temporality may favour recall bias. It is important to note that, during the pilot phase, the country was going through a major socio-economic crisis, as indicated by one of the practitioners, which had an impact on the implementation of the project by limiting the travel of rehabilitation practitioners to carry out the assessments and also to ensure the follow-up of beneficiaries. This situation limited the follow-up of the beneficiaries, which may be an additional factor for abandonment.

Loss or theft of the mobile phone is the first cause of abandonment cited by 69% of professionals and 39% of beneficiaries. The possibility of lending a phone to beneficiaries to receive telerehabilitation services could be a factor of insecurity, depending on the context and the country.

The presence of drop-out by beneficiaries is an important point to take into account, in order to consider the sustainability of telerehabilitation in projects implemented by HI. The causes of abandonment cited by professionals and beneficiaries are mainly related to technological factors (loss or theft of the phone, lack of a smartphone, electricity problems, etc.). The literature has identified many barriers to the use of telemedicine, such as people's age, educational level, gender, motivation, etc. (Scott Kruse et al. 2018). Beyond the finding of the impact of technological factors on beneficiary dropout, we wanted to observe from a statistical point of view whether other variables could be related to beneficiary dropout from the literature data. We looked for correlations in the sample between the presence of dropout and socio-demographic elements such as age group, gender and duration of disability.

The results highlight several correlations. **Thus, drop-outs are linked to the age group of the beneficiary (p=0.0066), the older the beneficiary, the higher the number of drop-outs**. The **presence of difficulties in reading or understanding the exercises is also related to drop-out (p=0.0002).**

The results show a convergence of views between professionals and beneficiaries on the impact of technological factors on the causes of refusal and abandonment of telerehabilitation. However, there is a divergence in motivation. **Almost 42% of professionals consider lack of motivation as one of the causes of drop-out, but only 4% of beneficiaries indicated that they had dropped out due to lack of motivation.**

Motivation and choice of beneficiaries to use telerehabilitation are limiting factors frequently cited by professionals during the interviews. One of the beneficiaries indicated through the questionnaire his preference to follow rehabilitation in the traditional way "I would have liked to do the sessions in the rehabilitation centre".

For some practitioners, the lack of rapid results would translate into a lack of motivation and involvement of the beneficiary in their rehabilitation and, therefore, into treatment discontinuation. Patient motivation plays a role in treatment compliance, exercise frequency and may affect outcomes in terms of pain relief or improved functionality (Vong et al. 2011). Although lack of motivation does not appear to be a cause of dropout for beneficiaries in our study, beneficiary motivation is frequently identified in the literature as a lever but also as a barrier to the use of telerehabilitation (Schreiweis et al. 2019; Scott Kruse et al. 2018).

2.4 Knowledge and skills in the use of ICTs

This part deals with the skills and knowledge of professionals and beneficiaries in the use of ICT. For practitioners it is about identifying difficulties in using the rehabilitation application. All professionals were trained in the use of rehabilitation applications. The content and duration of the training was different in each country, some had a few hours of distance training and others had a theoretical and practical training during 2 days in person.

50% of the professionals say that they have encountered difficulties in using the application.

The difficulties encountered are diverse:

- 67% had difficulties accessing the application,
- 56% consider that the language used is not adapted to the beneficiaries,
- 33% indicate that the exercises offered do not meet the needs of the beneficiaries,
- 11% had difficulties in finding exercises
- 11% had difficulties in setting up a rehabilitation programme.

6 professionals indicated, in free text, other difficulties encountered when using the application:

- The lack of an Android phone or smartphone for recipients to download the application.
- Electricity and network problems.
- Impossible to create a programme for children.
- The literacy problem [47].

[47] The OECD defines literacy as: the ability to understand and use written information in everyday life, at home, at work and in the community to achieve personal goals and to extend one's knowledge and skills.

Practitioners can use different tools to track beneficiaries. **61% of practitioners use mixed means** (computer filing, use of an internal HI tracking application allowing data collection through SurveyCTO) and **39% only use paper files**.

We hypothesised that the presence of difficulties in the use of the application could be linked to the professionals' practice of using or not using digital tools for the follow-up of beneficiaries. **The results show that difficulties in the use of the application are more present for professionals who only use the paper file. We can hypothesise that the daily use of IT tools by professionals may facilitate and limit the difficulties in using the rehabilitation application.**

82% of beneficiaries indicated that they have a smartphone, 18% have a simple mobile phone and 3 beneficiaries indicated that they do not have a mobile phone. **Only 37% of beneficiaries were able to download the application on their mobile phones.** Although the percentage of people with smartphones is significant, it does not identify which versions of the phones' operating systems may not be compatible with the rehabilitation applications**.**

59% of beneficiaries indicate that they have no difficulty using the mobile phone, 28% indicate that they have some difficulty and only 7% indicate that they have a lot of difficulty.

We wanted to see if there was any correlation between the presence of difficulties in using the telephone and the socio-demographic criteria of the individuals (age, gender, level of education), but no correlation was found. However, our results cannot be generalised due to the size of the sample.

37% of the beneficiaries were able to download the application. The transmission of the rehabilitation programmes to the beneficiaries was mainly done through different means of communication. The most used means of communication were video calls (70%), sending messages (60%) and printing on paper (50%).

39% of professionals consider that one of the limitations of telerehabilitation is related to the beneficiaries' lack of comfort in the use of ICT, however, only 7% of beneficiaries indicate that they have a lot of difficulties in using mobile phones. Beneficiaries may not have difficulties in using mobile phones, in the functions of sending and receiving messages (audio messages, text messages, photos...) because it is a daily practice. However, they may have more difficulties in using the rehabilitation application, which requires the use of a username and password and navigation in different elements.

The use of different means of communication, messages, video calls, allows professionals to overcome the difficulties linked to the use of the application. Training and support for beneficiaries in the use of the applications must be foreseen in the implementation of a telerehabilitation pathway in order to limit the difficulties of use.

2.5 Educational level, reading comprehension and reading difficulties

The level of education or literacy of the beneficiaries was often cited by practitioners as a constraint for the use of ICTs. Twenty percent of the beneficiaries had no education, 25% had primary education and 50% had secondary or higher education.

Through the questionnaire, beneficiaries indicated the level of difficulty in reading or understanding the rehabilitation exercises, they had been given. **56%** of the **beneficiaries had no difficulty at all, almost a third, 28%, had some difficulty, and for 8% it was very or very difficult**, as shown in Figure 8.

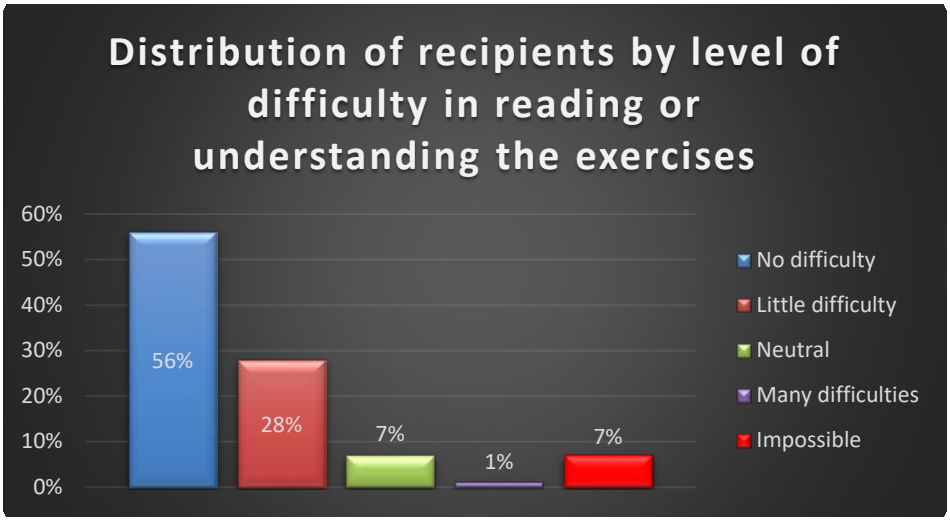

Figure 8 - Distribution of beneficiaries by level of difficulty in reading or understanding the exercises proposed by professionals during telerehabilitation

Our hypothesis is that the presence of difficulties in reading or understanding rehabilitation exercises could be correlated with certain socio-demographic elements.

The results show that the presence of difficulties in reading or understanding the exercises is correlated with the country of residence ($p<0.0011$) and the educational level of the beneficiary ($p=0.0030$). People with a lower level of education (primary and no education) have more difficulties than people with a secondary or higher level of education.

We note that difficulties in reading or understanding the exercises are more common for Haitian beneficiaries. We can think that these difficulties may be related to the difficulties reported by the professionals in terms of the quality of the translation of the exercises and the language available in the application (lack of Creole). The difficulties may also be related to the level of literacy of the populations of these two countries, as the OECD indicates that the literacy rate for people over 15 years of age is 74% in Haiti compared to 95% in Colombia, and that the majority of people aged 60 years and over live in Haiti.

2.6 Practitioners' fears about the use of telerehabilitation

The level of professionals' satisfaction with the use of telerehabilitation and their desire to use it in the future seem to indicate that professionals attribute benefits to telerehabilitation. However, these systems have limitations and fears expressed differently by practitioners during the interviews. In Madagascar, one of the fears expressed is the appropriation of knowledge by beneficiaries. Beneficiaries would use the "knowledge" present in the applications to position themselves as "carers" of other people.

> **Professionals ' fear of using telerehabilitation**
>
> "On the one hand it (telerehabilitation) helps us, it relieves us, but on the other hand it gives us a bit of a dilemma because..., if perhaps the person to whom the exercises are given, through technology, thinks that they can do this to other people".
>
> They say they can treat this disease with what they have been given. When we give them something, they think: I can treat this because they have given me what I have to do and I have done it, I am cured, so I can do it with others... but if people treat, if it cures much better, but what we are afraid of is that they are doing something that can harm the person even more. If our patients are aware, they will do it for them, and if someone asks them, they send the patient to us: go and ask the physio first, in that case it might be fine."

During interviews with project managers in other countries, we discussed this issue, for them telerehabilitation and the use of apps do not allow the appropriation of knowledge by the beneficiaries, because once the account is closed by the therapist the beneficiary no longer has access to the exercises.

The second fear expressed relates to the recognition of rehabilitation professions, especially in Haiti. According to the project coordinators, the use of telerehabilitation and its dissemination could be detrimental to the recognition of rehabilitation professionals by supervisory authorities and certain medical professionals. The "false" representation they may have of telerehabilitation is: "that it is enough to have an application and to give an exercise programme to the beneficiaries and that it is not necessary to have specific skills to create these programmes and ensure their follow-up". For Haitian professionals, the use of these digital tools could have a negative impact on the recognition of the competencies of rehabilitation professionals if there is no information work with supervisors and other professionals.

2.7 Benefits of telerehabilitation from a practitioner and client perspective

66% of beneficiaries indicate that telerehabilitation has benefits, Figure 9 presents the benefits identified by beneficiaries. For the beneficiaries the benefits are:

- Limit travel (57%),
- The possibility of exercising more (43%)
- Reduce health-related costs (43%).
- Greater freedom to do the exercises when they want to without time constraints (11%)
- Telerehabilitation seems to allow a form of ownership of rehabilitation by the beneficiaries.

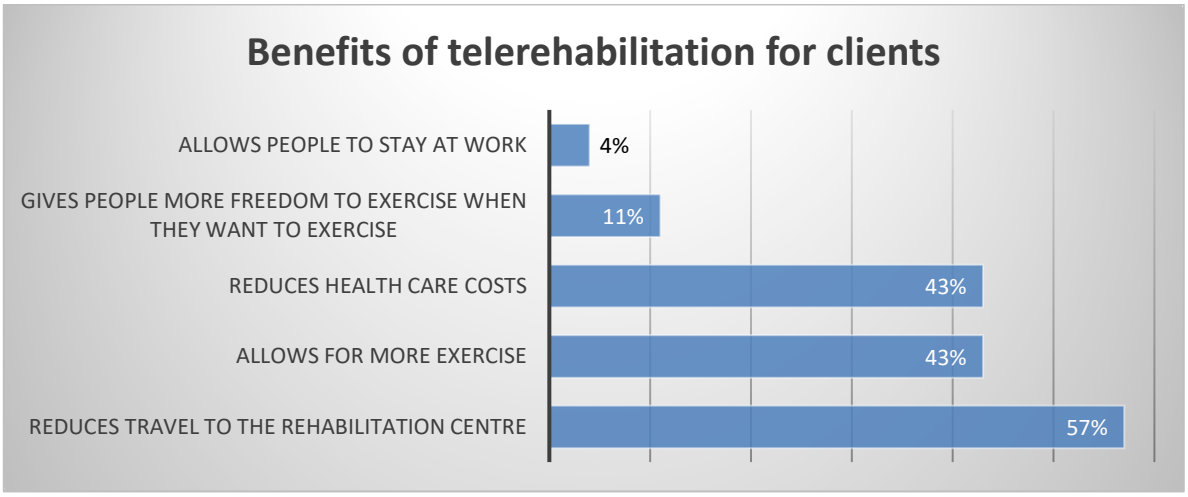

Figure 9 - Benefits of telerehabilitation from the recipients' perspective

Beneficiaries' comments on telerehabilitation

"He hopes that more people will benefit from this programme and that the survey will yield more satisfactory results."

"It reduces the need to bring family and friends."

"Waiting for the resumption of telerehabilitation activities".

"Excellent"; "Very good"; "Very good".

"This programme is very good because it helps us to grow with our disabilities".

"Due to the type of physical injury I have, telephone therapy is not as functional as it would need to be for a specialist to constantly assess my physical injuries."

"Thank God I had excellent therapies that were effective in their explanatory ways".

"Good human warmth" "It was a good explanation, so it was done satisfactorily".

"I liked the way my baby was treated."

For professionals, the main advantages of telerehabilitation are the reduction of healthcare costs for beneficiaries (89%) and continuity of care (83%). For 56% of professionals, telerehabilitation limits the number of patient journeys, and for 39% of professionals, it allows patients to do more rehabilitation exercises (39%).

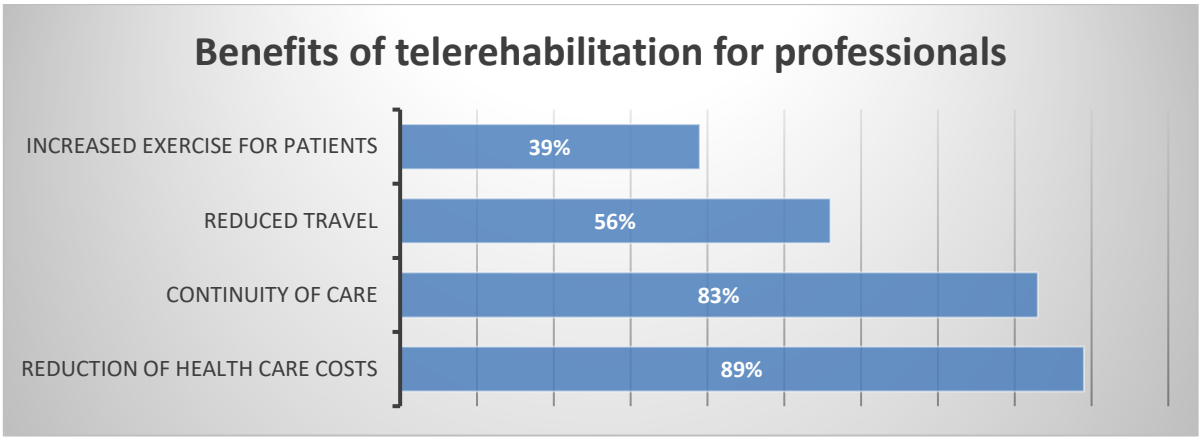

Figure 10 - Benefits of telerehabilitation for practitioners

Practitioners' comments on telerehabilitation

"Telerehabilitation is a very useful tool as a new intervention and inclusion strategy, enabling more people to access rehabilitation services."

"It is a very valuable tool for rehabilitation."

"I think it would be important to continue this project. That the project reaches more patients and has a longer duration."

"Through telerehabilitation, many people in a pandemic situation were accompanied, they did not feel alone, they always had an encouraging voice and a person looking out for them and therefore their mood improved, which helped the processes of confinement to become dynamic, participatory and become routine for many of those I attended to".

"It is a process of adaptation, when the patient has a caregiver, the treatment is easier".

"A lot of people I met would have liked to continue with the programme. And it's helping me to get a lot more practical experience. "

Although the use of telerehabilitation has advantages, practitioners have identified limitations:

- 67% (n=12) believe that telerehabilitation is not suitable for all target groups,
- 61% (n=11) consider that this device reduces human contact,
- 39% (n=7) consider that beneficiaries do not feel comfortable using ICTs.

67% of the professionals indicate that telerehabilitation is not suitable for all beneficiaries. During the interviews, the coordinators indicated several criteria to define people for whom telerehabilitation was not suitable:

- **Young children**, as the applications do not always allow for the creation of adapted programmes. Some professionals indicated that some parents prefer to have rehabilitation care done by professionals because they are afraid of doing it wrong with their children, especially when the children are young.
- Older people**,** the coordinators indicated that older people are the most frequent refusers of telerehabilitation. The rejection is related to a lack of confidence in the new technologies, the need for a caregiver and the lack of human contact in these devices. Many older people prefer to go to the centre and have rejected telerehabilitation outright.
- **The most vulnerable people,** because they have the most difficulties in accessing technology: lack of a smartphone, lack of electricity and lack of mobile network coverage.

3. Organisational factors

Organisational factors include administrative and financial aspects (such as the telerehabilitation business model), working practices, data protection and privacy.

3.1 Support and management of practitioners in the field

One of the barriers identified in the literature for the implementation and deployment of telehealth is the lack of knowledge of professionals and beneficiaries about telehealth, but also the motivation to use these devices (Schreiweis et al. 2019). The professional competences required were spontaneously addressed by different professionals during the interviews as one of the constraints encountered in the deployment of telerehabilitation.

Training and support to field practitioners in the use of telerehabilitation and digital tools (application) was done differently depending on the project. Some professionals received a few hours of training and others several days. In one of the countries, a community-based telerehabilitation system was planned to be set up through the involvement of local partners (bush doctors, social workers). However, the deployment of the project did not allow for the training of these community workers, and practitioners in the centres identified this as a major obstacle to the deployment of telerehabilitation in their intervention contexts.

For one of the project managers, the lack of a coordinator with specific skills in rehabilitation and in mastering the application was a major obstacle to supporting the professionals in the field in the deployment of this digital solution. For this project manager, the supervision by a "colleague" is a motivating and successful factor in supporting the professionals on the ground in the implementation of new professional practices. It can be noted that in the other projects the coordinators were all rehabilitation professionals. In one of the countries, the coordinators were in charge of the training of professionals by proposing theoretical and practical training and worked throughout the experimentation with all the actors and partners to adapt and find solutions (printing of the programmes on paper, for example). In one of the other projects, the

coordinator developed and implemented protocols/recommendations, which he passed on to the physiotherapists in the field. He also organised regular working sessions with the physiotherapists to share knowledge on the situations encountered.

Telerehabilitation requires changes in professional practices, both in the use of new technological tools and in the way beneficiaries are monitored. It is not possible to identify in this research whether a management/coaching model is more favourable to the appropriation of these tools by professionals. However, we note that regular support for professionals and time for meetings and training have favoured the deployment and use of telerehabilitation.

> **Training of professionals**
>
> "I want to learn more about telerehabilitation and follow up patients through seminars or training to get them interested in doing follow-ups."
>
> "There are fewer physiotherapists here, so you have to do things with the midwives or the nurse, while they have no experience in the field of rehabilitation".
>
> "Telerehabilitation is really very interesting, it's really very useful. We have to figure out how to make people, patients, understand it, but I don't know how to do it."

3.2 Financial aspects

Telerehabilitation requires the use of different resources, such as electricity to charge mobile devices, the possession of a smartphone, a tablet, a computer, but also access to telecommunications for internet or mobile networks. Each of these resources represents a financial cost for the beneficiaries and for the structures.

Among the 71 beneficiaries, **20% indicate that they have bought a new phone to benefit from telerehabilitation**. **According to the website cable.co[48] , the cost of 1GB would be USD 2.74 in Haiti, USD 8.81 in Madagascar and USD 3.46 in Colombia**, amounts that can be significant depending on the social situation of the beneficiaries. In iFAR's 2018 report on Madagascar, it states that almost 80% of the Malagasy population has less than USD 1 per day (the average Malagasy salary is USD 33)[49] . The assumption is that mobile data costs can be significant or impossible for the most vulnerable people.

To limit difficulties in accessing mobile internet data, some practitioners transferred mobile data to beneficiaries prior to the telerehabilitation session so that they could conduct the sessions by videoconference.

The question of the economic model was spontaneously raised by professionals during the interviews. Depending on the countries, programmes and structures, (traditional) rehabilitation is a paid service for the beneficiaries, but what happens when these services are provided remotely, without the presence of the beneficiary.

[48] https://www.cable.co.uk/mobiles/worldwide-data-pricing/

[49] iFAR 2018 Diagnosis Humanity & Inclusion

In the framework of these experiments, the beneficiaries did not have to finance the telerehabilitation services, however, this free model was identified as a long-term limit for certain professionals because it corresponds to a loss of financial resources for the structure.

> **Financial aspects of telerehabilitation**
>
> "For the performance, because there is a share that is a part of that act, the fee for service that goes to our staff and one is for the hospital, so there is a decrease in that performance bonus. There is a decrease in that overall revenue."

Beyond the accounting aspect, some of the professionals consider that there is an aspect of social representation to be taken into account. According to them, free telerehabilitation care could be perceived by the population as a system that does not offer quality compared to traditional rehabilitation, which would have to be paid for. For these professionals, the fact that the beneficiaries contribute financially to the care is important. Paying for sessions would allow for greater adherence and a better perception of the quality of care. The professionals proposed different methods of financing, such as:

- The possibility for beneficiaries to make payments for telerehabilitation sessions via mobile phones, in the same way as for other payments.
- Reflect on the prices of telerehabilitation sessions so that they are accessible to the beneficiaries and at the same time viable and sufficient for the partner structures.

One of the paradigms of telehealth is to enable people who have difficulties in accessing health services, especially because of geographical distance, to benefit from health services through ICTs. However, the possession of a mobile phone, the possibility to finance the costs related to the use of mobile data, access to resources such as electricity, raise the question of the equity of the most vulnerable to benefit from telerehabilitation. The "Gender Inequality in Mobile Telephony Report 2019" (Rowntree 2019) states that the cost of phones is the main barrier to mobile phone ownership. For some practitioners, the low ownership of smartphones by beneficiaries is one of the main barriers to the deployment of telerehabilitation: "The most vulnerable cannot afford a smartphone".

It will be interesting in future studies conducted by HI to quantify from an economic point of view the cost of telerehabilitation sessions for both the structure and the beneficiaries, and to compare it with the costs of traditional rehabilitation (session, travel, accommodation, etc.). Reflection on the construction of a sustainable economic model for telerehabilitation is an essential step in considering the continuation of this system in different contexts.

3.3 Communication and data protection

Telerehabilitation is based on the use of ICT to enable interaction and information exchange between professionals and beneficiaries. Although the rehabilitation applications used offer secure communication solutions (messaging, teleconsultation, e-mails), these tools have not been used by professionals for many reasons (impossibility to download the application on the beneficiary's phone, complexity of using these tools for beneficiaries, etc.).

Several channels of communication were used. **Thus, 61% of the professionals communicated by SMS, 89% made mobile phone calls, 44% used voice messages and 44% used video calls.**

94% of the professionals used the WhatsApp application to communicate with beneficiaries. This application was widely used, as many beneficiaries and professionals use it daily. The use of this application raises the issue of data protection.

Telerehabilitation is the provision of rehabilitation services at a distance, for people in a fragile situation (illness, disability, etc.), whose personal and sensitive data (e.g. medical data such as diagnoses) can pass through these different communication channels.

The establishment and implementation of telerehabilitation must integrate the data protection dimension. It is necessary to identify the types of data that are exchanged, whether data are sent from personal or professional phones, how long the data are retained and by whom.

Data protection is one of the important issues to be integrated into telerehabilitation projects, sometimes it can be a barrier for some patients to use telehealth devices (Kruse et al., 2020; Richmond et al., 2017).

3.4 Evaluations, frequency of sessions, follow-up and perception of quality and added value of telerehabilitation

Physiotherapists conducted an average of **12 telerehabilitation sessions** (min. 0; max.: 36) and beneficiaries indicated that they conducted an average of **9.15 sessions** (min.: 0; max.: 50).

Initial assessments were conducted 80% by teleconsultation and 20% face-to-face. Mid-term or final assessments were conducted 60% by teleconsultation and 40% in person. Assessments were mainly conducted by teleconsultation, although internal[50] or professional[51] recommendations recommend that initial assessments be conducted in the presence of the beneficiary. The presence of pandemic-related restrictions on physical contact and travel and the context of socio-economic crisis in Haiti may explain the use of teleconsultation to conduct assessments.

Follow-up by physiotherapists was 50% weekly, 40% fortnightly and 10% monthly.

The monitoring and supervision of follow-ups were carried out using different means of communication, with 80% of them using videoconferencing, 60% using telephone exchange and 50% using photographic exchange. There is heterogeneity in the frequency and communication tools used to follow up beneficiaries.

[50] Digital Rehabilitation Guide (internal HI document)

[51] Telerehabilitation. Guiding principles in physiotherapy (2018) Ordre professionnel de la physiothérapie du Québec.

51% of the beneficiaries used the help of a caregiver to perform the prescribed exercises, 23% used it partially and only 27% performed the exercises alone. Regarding the frequency of the exercises, 32% of the beneficiaries indicated that they performed the exercises daily, 31% performed the exercises several times a week and 23% performed the exercises weekly. **More than 50% of the beneficiaries need the presence of the caregiver to perform the exercises, the availability of the caregiver may be a factor in the frequency of performing the recommended exercises. The caregiver becomes an important actor to be integrated in the training and awareness of telerehabilitation.** In a future study, it would be interesting to observe and measure the level of adherence of the beneficiaries to the programme. It would then be possible to observe whether the frequency, duration of follow-up and number of contacts have an impact on the adherence of beneficiaries and whether this has consequences on functional outcomes.

Satisfaction with the quality of rehabilitation through telerehabilitation is important for both clients and practitioners. 72% of professionals and 79% of clients are satisfied or very satisfied with the quality of telerehabilitation (Figure 11).

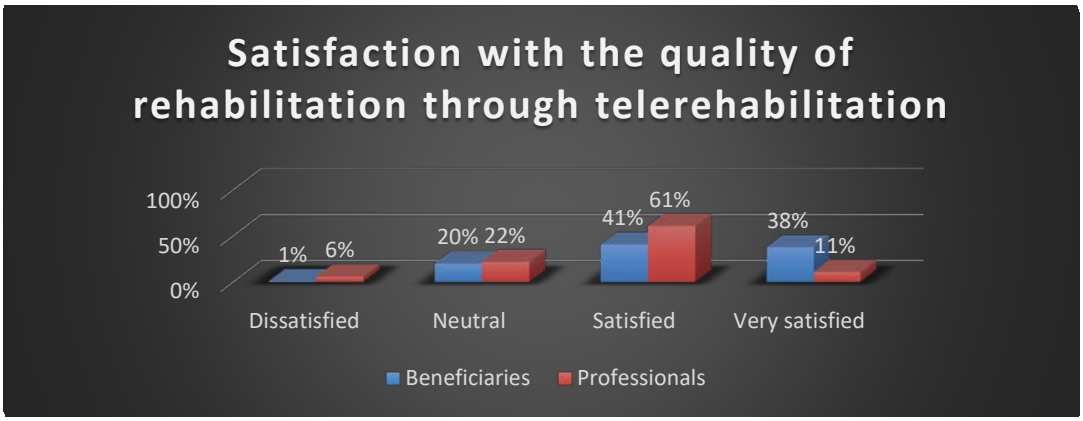

Figure 11 - Perception of quality of rehabilitation during telerehabilitation by practitioners and beneficiaries

The quality of telerehabilitation can be related to the perception of improvement in the areas of mobility, pain, improvement of functional abilities or social participation. Figure 12 shows the levels of improvement perceived by beneficiaries after telerehabilitation follow-up.

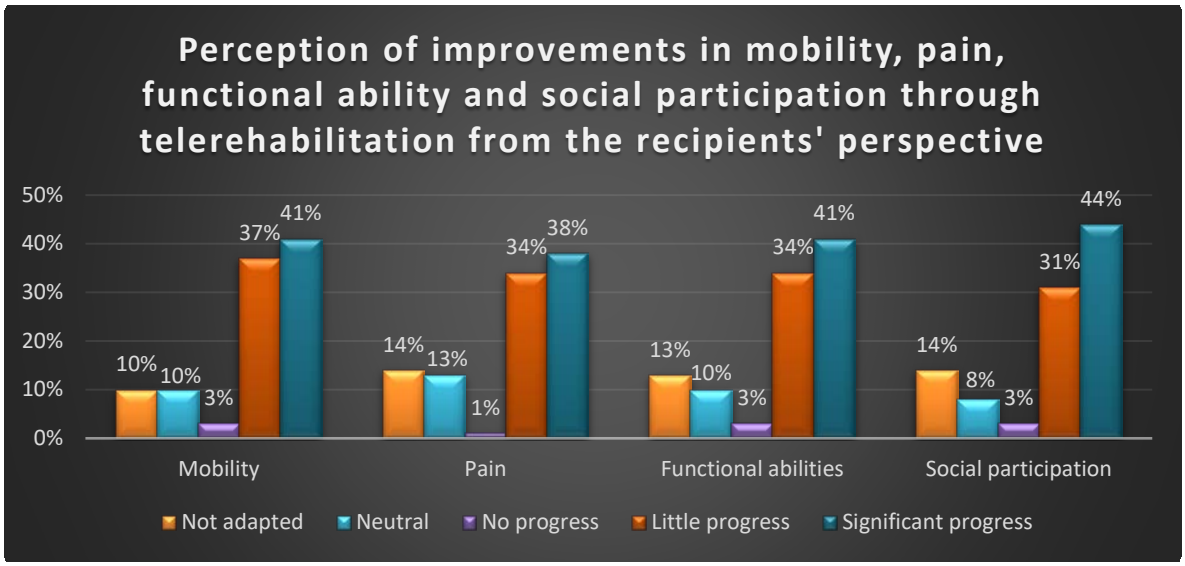

Figure 12 - Perceived level of improvement in mobility, pain, functional ability and social participation through telerehabilitation for users

Overall, 40% of the beneficiaries consider that telerehabilitation brings significant progress in the different dimensions and 30% of the beneficiaries consider that it brings little progress. Only 3% of beneficiaries consider that telerehabilitation does not bring any progress.

When beneficiaries compare telerehabilitation with traditional rehabilitation, 39% believe that telerehabilitation is inferior to traditional rehabilitation, 37% believe it is equal and 6% believe it is superior to traditional rehabilitation.

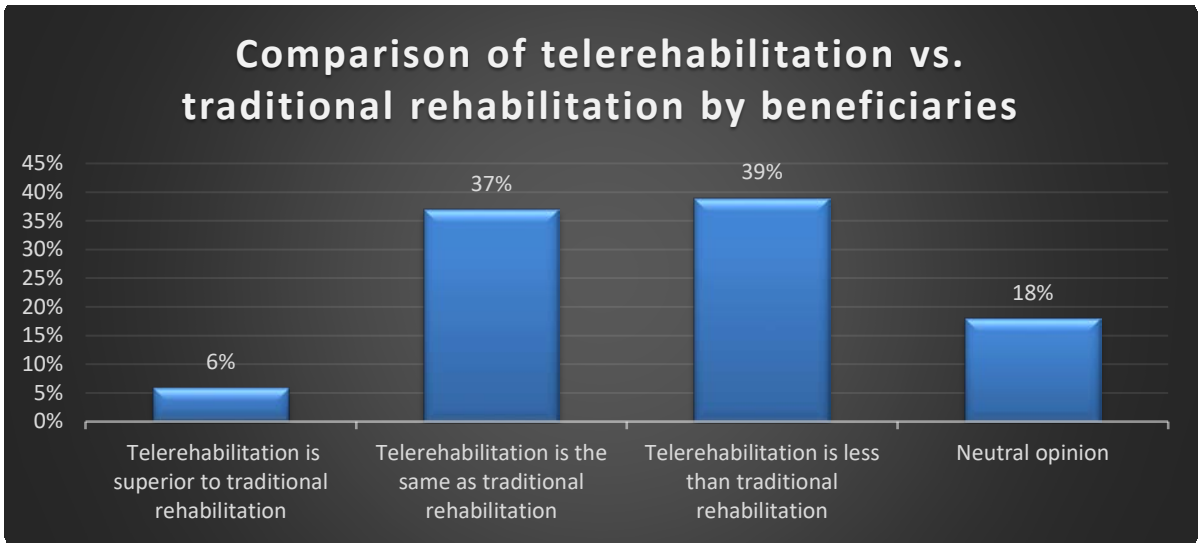

Figure 13 - Comparison of telerehabilitation vs. traditional rehabilitation by beneficiaries

The results obtained highlight a positive perception of telerehabilitation by professionals and beneficiaries. Evidence from the literature indicates that telerehabilitation can sometimes be as equivalent as face-to-face follow-up for certain pathologies (Cramer et al. 2019; Laver et al. 2020). To assess the impact of telerehabilitation from a functional perspective, it is necessary to use quantitative or qualitative scales and assessments. The use of

telerehabilitation may challenge the tools to be used, but also the procedures to be put in place to perform remote assessments and to allow the collection of follow-up data using digital tools.

Based on the experiences and lessons learned, but also on the recommendations of scientific societies, it would be interesting to create professional recommendations adapted to the different contexts of HI interventions, in order to propose a reference framework for the beneficiary's telerehabilitation pathway. These recommendations would provide a guide to the diagnostic tools and monitoring methods to be applied in the context of a telerehabilitation project. The presence of recommendations is a facilitator for professionals to use telerehabilitation (Hoel et al. 2021). The use of functional scales and measures and the collection of data at the different stages of care for the beneficiaries should make it possible to objectively assess the effects of telerehabilitation quantitatively and qualitatively during follow-up.

4. Technological factors

Technological factors have often been mentioned by practitioners as one of the constraints to the implementation of telerehabilitation. The impact of these technological factors is frequently cited in the literature (Hoel et al. 2021; Leochico et al. 2020). In this section, we will address the issues of internet access, electricity, mobile networks, but also the rehabilitation applications used and the rehabilitation equipment needed.

4.1 Implementation of rehabilitation

To carry out telerehabilitation, the professionals used two different software programmes, Physiotec and Physitrack, which allow access to large databases of exercises and the creation of rehabilitation programmes. For these programmes, mobile phone applications can be downloaded onto smartphones, allowing the beneficiary to access the rehabilitation programme on their phone. These applications allow professionals to follow the execution of the exercises, exchange information via secure messaging, transmit the programme and have information on the execution of the exercises (monitoring). The aim of this study is not to evaluate the tools used, but to describe how they can be a help or a constraint in the implementation of telerehabilitation.

44% of the professionals consider the use of an app to be very useful, 50% think it is useful and 6% think it is useless. Some professionals indicate that they have discovered new exercises thanks to the application and that they have been able to transpose these exercises to their daily practices in the rehabilitation department. For one of the project coordinators, the use of these tools makes it possible to pool and share knowledge among professionals, which can be a source of learning and continuous training.

Contributions of the application to professional practice

"It's very interesting, it's very useful. Because there are many exercises, many techniques, that we discovered in telerehabilitation."

"Yes, the application is a help. Because, here, the documentation of pathologies is scarce, so thanks to telerehabilitation we can discover various types of pathologies, techniques, exercises according to the pathologies. For example, the use of balloons. Because, here it did not exist before, but now here we can use balloon techniques."

While these programmes can be a help to professionals, they do have certain limitations:

Technological limitations:

a. The minimum system requirements of the application are not always compatible with the version of Android available on the beneficiary's phone and do not allow its installation.
b. The impossibility of including exercises from other applications, websites, or videos in the programme. All the physiotherapists have indicated that they have searched other internet media (Youtube, or physiopedia) for exercises to transmit to the beneficiaries.
c. These programmes require good Internet quality in order to create the programmes, transmit them and have them downloaded by the recipients.

Content limitations:

d. **Target population:** Practitioners indicated that it was sometimes difficult or impossible to create programmes beneficiaries (especially young children) in view of the available exercises.
e. **Language:** The applications offer exercises in several languages. However, some practitioners faced language problems in the description of certain exercises, or only English is available, which does not meet the needs of the beneficiaries (Creole). In addition, the quality of translation was one of the constraints identified by practitioners.
f. **Ethnic aspects:** For practitioners, it is important to consider ethnic aspects. The people doing the exercises in the apps do not correspond to the "ethnic criteria" of the intervention countries. In order for the beneficiaries to be able to identify with the people doing the exercises in the photos and videos of the apps, they consider it important to introduce more ethnic diversity.

Limitations of implementation in professional practice

"The exercises are for people who are fairly non-impaired. There are no exercises for children with cerebral palsy or for children with obstetric paralysis, but they are mainly for adults."

"Complete translation of all exercises into French, as only part of them are translated. In some programmes, there are exercises in English."

"Adapting exercises to a low-income country context, better translation of exercises".

"Those beneficiaries have the possibility to save the exercises for later use without the need for the internet."

The use of rehabilitation software is an aid for professionals, both in terms of supporting the construction of a rehabilitation programme and as a source of knowledge and learning. We can hypothesise that the usefulness and perceived ease of use of the applications may have a positive effect on practitioners' adherence to the use of telerehabilitation. **The two apps used have advantages, but also limitations. The ongoing development of a rehabilitation application by HI could make it possible to respond to certain needs and adaptations identified by professionals in terms of the type of content to be transmitted, which would be less voluminous, for example (requiring less data), but also integrating different languages, taking into account ethnic factors and adding new media**.

4.2 Internet access, electricity and mobile networks

Difficulties in accessing the internet, electricity and mobile networks are common to both beneficiaries and professionals. **27% of beneficiaries frequently (always and often) encounter difficulties in accessing electricity, 26% in accessing the internet and 21% in accessing mobile networks.**

The use of ICTs (computers, tablets, mobile phones) requires the use of electricity to recharge tools (tablets, phones) or to run computers. Electricity problems are prevalent in Haiti, with 27% frequently encountering difficulty in accessing this resource. Only 35% of the Haitian population has access to electricity through electricity grids and only 11% in [52]rural areas. During interviews with surveyors in Haiti, one surveyor mentioned that many Haitians try to charge their phones by creating systems with solar panels or other devices, but that this often results in damage or deterioration of the mobile phone in the medium term. There are alternative devices that use solar energy, and the company Bright has won an EU award[53] for such a tool that provides light and charges mobile phones using solar energy. Perhaps HI could establish a partnership with the structures proposing such devices to limit the difficulties associated with charging mobile phones.

In addition to electricity problems, there are difficulties in accessing mobile networks and the Internet via mobile networks. Communication and information exchange between different actors is based on the use of mobile networks and the internet, either through fixed/cable networks or with mobile networks. A study in Colombia indicates that it is possible to have internet through cable networks in municipalities, but when people live in rural areas internet access can only be done through mobile networks (Gómez Ortega et al. 2011).

Practitioners mentioned that beyond the costs of electricity or internet access for beneficiaries, mobile network coverage is unevenly distributed across territories.

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[52] Off-grid electricity supply in Haiti (2017)

[53] BRIGHT Move, from Norwegian SME Bright Products AS, provides refugees with light and energy thanks to an affordable, recyclable and rapidly deployable phone charging device combined with a solar lantern.

Difficulties in accessing technological resources

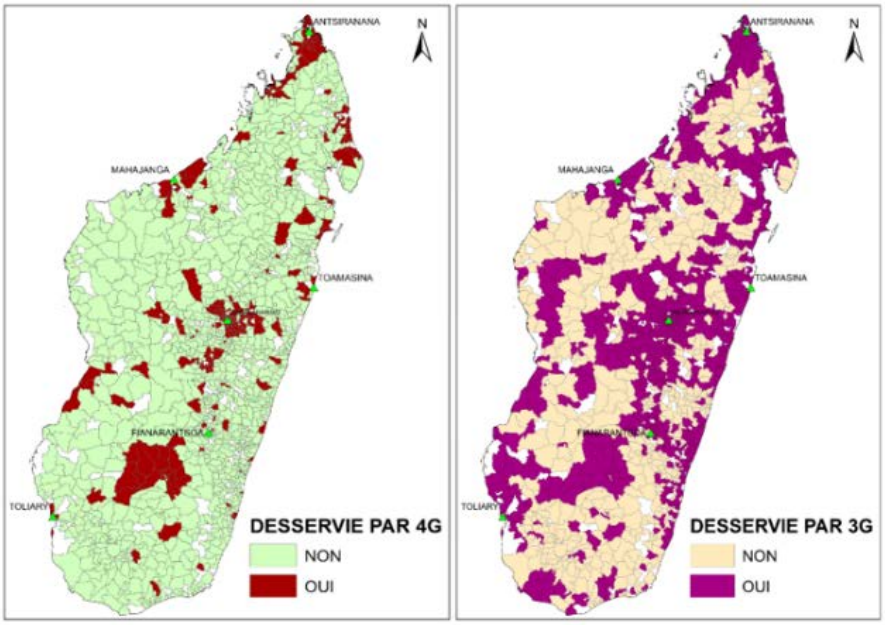
"The connection problems are outside the office because we don't have easy access to the internet here. Internet in Diego and Madagascar is too expensive."

"We communicate with them (the ASCs) by phone, the people in the bush don't have internet access, that's the problem, while the SAR has internet access, so we have to make phone calls. In fact, there is a concern about the network, it's more about network coverage, the concern in our area, most of the villages in the bush don't have network coverage and that's why there is the problem of connection. "

"For us, the limits are first and foremost those of the networks... Electricity and internet signal".

Lack of Internet, bad signal"; "Internet connection too slow"; "Internet connection too slow".

To illustrate these coverage difficulties, one can look at the situation in Madagascar. While the 3G mobile network covers 58.71%, the 4G-coverage rate is only 18.84%, according to the Internet Society[54]. The maps below show the [55]mobile broadband network coverage in Madagascar.



The use of applications requires a level and quality of network that allows data transfer (downloading of the application, consultation and viewing of exercises, downloading of videos, possibility of making video calls to exchange directly with the beneficiary). **77% of professionals believe that difficulties in accessing technological resources have an impact on the implementation of telerehabilitation.**

[54] https://isoc.mg/index.php/2020/06/05/231/ association which aims to promote the Internet on a national scale.

[55] https://isoc.mg/index.php/2020/06/05/231/ based on data from ARTEC Sources

4.3 Recipient environment for carrying out telerehabilitation

Telerehabilitation places the beneficiary in his or her environment. The home and carers become "actors" in their own right and must be integrated into telerehabilitation. Only **5% of the professionals believe that the beneficiaries' living environment allows them to perform the recommended exercises**. 25% of the professionals believe that beneficiaries have dropped out of telerehabilitation because the home was not suitable.

The use of ICT and visual tools such as videoconferencing allows professionals to observe the beneficiary's living environment. Thus, 100% of professionals believe that seeing the beneficiary's living environment has allowed them to adapt or modify rehabilitation objectives and 90% believe that it has allowed them to modify the recommended exercises. **Telerehabilitation seems to favour a holistic approach centred on the person and his or her environment. Several professionals indicated during the interviews that seeing the client's home and environment was one of the advantages of telerehabilitation.** Observing the beneficiary in his or her living environment allows professionals to better adapt and individualise rehabilitation goals according to the beneficiary's needs by taking into account his or her living environment.

When rehabilitation exercises are performed, the use of equipment may be necessary. **58% of beneficiaries believe that they did not have the necessary equipment to perform rehabilitation exercises.**

44% of professionals believe that beneficiaries do not have the necessary equipment to carry out telerehabilitation, 44% believe that some equipment is missing and only 11% believe that beneficiaries have the necessary equipment.

The project managers indicated that they paid particular attention to the exercises proposed to the beneficiaries, so as not to pass on exercises that require specific equipment or that cannot be substituted by everyday objects (e.g. using a broomstick as a walking stick). 30 clients and 8 professionals indicated that equipment was missing in the household. Table 3 presents the list of missing equipment.

Table 3 - List of missing equipment in beneficiaries' homes from the point of view of professionals and beneficiaries

Professionals	Beneficiaries
Balloons (n=8)	Balloons (n=7)
Elastic bands[56] (n=8)	Elastic bands (n=6)
Weighted weights (n=3)	Weighted weights (n=2)
Lack of housing space (n=3)	Exercise bikes (n=3)
Parallel bars (n=3)	Walker (n=2)
	Shoulder pulley (n=1)

[56] Elastic band of the thera-bands type

Beneficiaries and practitioners mentioned two types of equipment: specific rehabilitation equipment such as exercise bikes, pulleys or parallel bars, but also "small" rehabilitation equipment that is often used in rehabilitation services (balls, poles, weights, elastic bands of different resistances).

While it may be difficult to provide specific equipment, such as a bicycle or pulley, at the client's home, it may be possible to loan small pieces of equipment (such as elastic bands or weights)[57] between sessions, or to create or adapt them locally with available resources.

[57] Between telerehabilitation and face-to-face rehabilitation sessions

Limitations of the study

Many data was collected in this research, but there are limitations that should be kept in mind when reading the results.

1. Composition and representativeness

The results come from data collected in three countries, which cannot be representative of all HI projects that have used telerehabilitation. Although some of the barriers identified in this research coincide with data cited in the literature, other barriers could be identified in other projects depending on the context of intervention (emergency context, war, etc.).

2. Internet quality for interviews

Due to travel restrictions related to COVID-19, this research was conducted entirely remotely. Individual and group interviews were conducted online. The internet connection was not always of good quality, which had the effect of altering the quality of the interviews, requiring rephrasing by both parties several times, affecting the fluidity of the exchanges. The lack of visual information (due to low internet speed in some countries) reduced the interviews to "telephone exchanges" that did not allow access to the interlocutor's non-verbal language, which can serve as a guide to identify points of misunderstanding or the need to rephrase what was said. The poor quality of the connection and the presence of external noise (the professionals were at their workstations) had an impact on the quality and fluency of the exchanges.

3. Memory bias, selection bias

This research was conducted at a distance from the end of the telerehabilitation pilot project in two of the countries (Haiti and Madagascar), which may have induced a recall bias in the responses of professionals and beneficiaries. The other bias that may be present is that of the selection of beneficiaries in Colombia, where only people who do not have difficulties in using ICTs responded to the questionnaires.

4. Timing and conduct of experiments

The realised projects took place in different timeframes. In Haiti and Madagascar, the pilot project took place in 2019 and early 2020. In Colombia, the experimentation took place from March 2020. Although the IRAP pilot project was stopped, the use of telerehabilitation is still ongoing in Colombia. During the pilot phase, Haiti experienced a socio-economic crisis that had a direct impact on the progress of the project by limiting professionals' travel and follow-ups. These external factors may have influenced the beneficiaries' perception and level of satisfaction with telerehabilitation.

Recommendations

From the perspective of the development of telerehabilitation and the use of ICT in rehabilitation projects in HI, recommendations can be proposed based on the results of this study.

1. Establishing internal and external partnerships

Practitioners and beneficiaries frequently cite technological difficulties, such as access to electricity or the internet. Establishing partnerships with structures offering alternatives, such as recharging mobile phones using solar devices, could limit difficulties related to electricity and damage to beneficiaries' mobile phones.

The Internet is a necessary tool for telerehabilitation, but probably also for other projects carried out by HI. A mapping of HI intervention areas, whatever the field of intervention (health, education, rehabilitation, etc.), could be envisaged in order to identify common geographical areas of intervention. This could allow for joint advocacy actions with local actors to consider the pooling of technological factors such as the installation of a WI-FI terminal that could be used by a school, a health centre, a rehabilitation service and the community.

2. Training, professional practice and recommendations

The training and support of professionals is a lever for the implementation and sustainability of telerehabilitation. The use of telerehabilitation requires the acquisition of technical skills in the use of new technologies for professionals. The introduction and use of IT tools for monitoring beneficiaries can be a first step to be implemented in some countries, in order for professionals to acquire technical skills that can be transferred to the use of ICT in telerehabilitation.

The exchange of experiences between professionals, during multi-professional working sessions based on case studies, can favour interaction between professionals and the search for treatment plans adapted to telerehabilitation, to the contexts of intervention and to the situation of the beneficiaries (children, elderly). The creation of protocols, guidelines or recommendations resulting from the experiments can support the creation and development of future telerehabilitation projects.

3. Common terminology and data protection

The field of digital health interventions is an important one. In order to improve the visibility of HI actions and to encourage the exchange and sharing of knowledge or the creation of partnerships with local or national actors, it is necessary to define a common terminology to be used.

Telerehabilitation requires exchanges via different digital media between the professional and the beneficiary. Taking data protection into account is an essential element in ensuring the security of beneficiaries' data. Professionals need to reflect on and raise awareness of this issue in order to propose recommendations on the information that can be transmitted or the transmission methods to be favoured (possibility of using secure messaging or not).

4. Identifying a fair and sustainable business model

The experiments carried out on telerehabilitation in this study were based on a free model, but this model does not seem to be sustainable in the long term for HI partners. It seems necessary to create a sustainable and evolving economic model for this type of service that is viable for the structures and that takes into account the economic situation of the most vulnerable. Studies on the costs and benefits of telerehabilitation will be necessary to identify the economic benefit of this system for the beneficiaries and for the structures.

Conclusion

Based on the data obtained, this study has identified the barriers and levers for the use of telerehabilitation after the experiments.

1. Opinions of professionals

94% of professionals consider the use of a rehabilitation app in telerehabilitation practice to be useful. These apps can be a source of knowledge for some professionals who discover new exercises that they can then transfer to their practices in the rehabilitation centre. However, these mobile apps have limitations:

- A technological limitation: only 37% of beneficiaries were able to download the application on their phones.
- Next, a limitation in the target populations: the inclusion of young children may be limited because the proposed exercises are not adapted to their profiles/needs.
- Linguistic and ethnic limitations: the languages available are not always those mastered by the target population. The images and exercises do not take into account the ethnic diversity of the contexts in which HI projects intervene, which does not favour the identification of beneficiaries.

Numerous technological constraints were identified, notably the absence of a smartphone and difficulties in accessing the internet for beneficiaries. However, in order to adapt to the context of the interventions and limit technological constraints, practitioners used a wide range of tools to ensure communication and follow-up with beneficiaries (video calls, sending SMS, mms, voice messages or printing the programmes on paper).

Despite the difficulties, professionals consider that the use and development of telerehabilitation has many advantages, especially in terms of reducing health care costs and continuity of care, but also in terms of limiting travel.

2. Beneficiaries' views

Clients share their positive opinions about telerehabilitation. 43% indicate that telerehabilitation is as good as or better than traditional rehabilitation. 40% believe that telerehabilitation brings significant progress in improving mobility, pain, functional abilities and social participation. However, there are some limitations and barriers:

- In terms of human factors, socio-demographic factors were identified as limiting factors. Older age, lower educational level and the presence of difficulties in reading or understanding the exercises would favour abandonment of follow-up during telerehabilitation.

- In terms of technological factors, difficulties in accessing electricity and internet for 1/3 of the beneficiaries and the lack of a smartphone are common.
- The environment: The living environment is not always suitable, especially due to the lack of equipment for rehabilitation exercises. However, visualisation of the environment is an important advantage for practitioners, as it allows a patient-centred approach to tailor exercises and individualise rehabilitation goals more specifically.

Although the use of telerehabilitation presents some obstacles, it also has advantages for patients, such as reduced travel to the centre, lower health care costs and the possibility to perform more rehabilitation exercises.

Telerehabilitation is not intended to replace traditional rehabilitation, but it can be a complementary device that limits travel and promotes continuity of care for beneficiaries who live far from the centres. Telerehabilitation is seen as a solution to be developed for both professionals and patients. The implementation and deployment of these digital solutions requires the support of professionals through training in the use and integration of these devices. The creation of procedures and recommendations, the definition of inclusion criteria (motivation, age, possession of a telephone, level of coverage, level of understanding, the person's environment) and follow-up methods (assessment methods, frequency of follow-up) can be tools enabling professionals to integrate these digital devices into their professional practices and limit situations of refusal or abandonment by beneficiaries.

The sustainability and development of telerehabilitation will also be linked to the national e-health policies developed and enacted by countries. The definition of an economic model that is sustainable for structures and accessible to the most vulnerable will be one of the challenges to be faced in thinking about telerehabilitation in the long term. The use of digital tools requires improved connectivity, coverage and access to the internet.

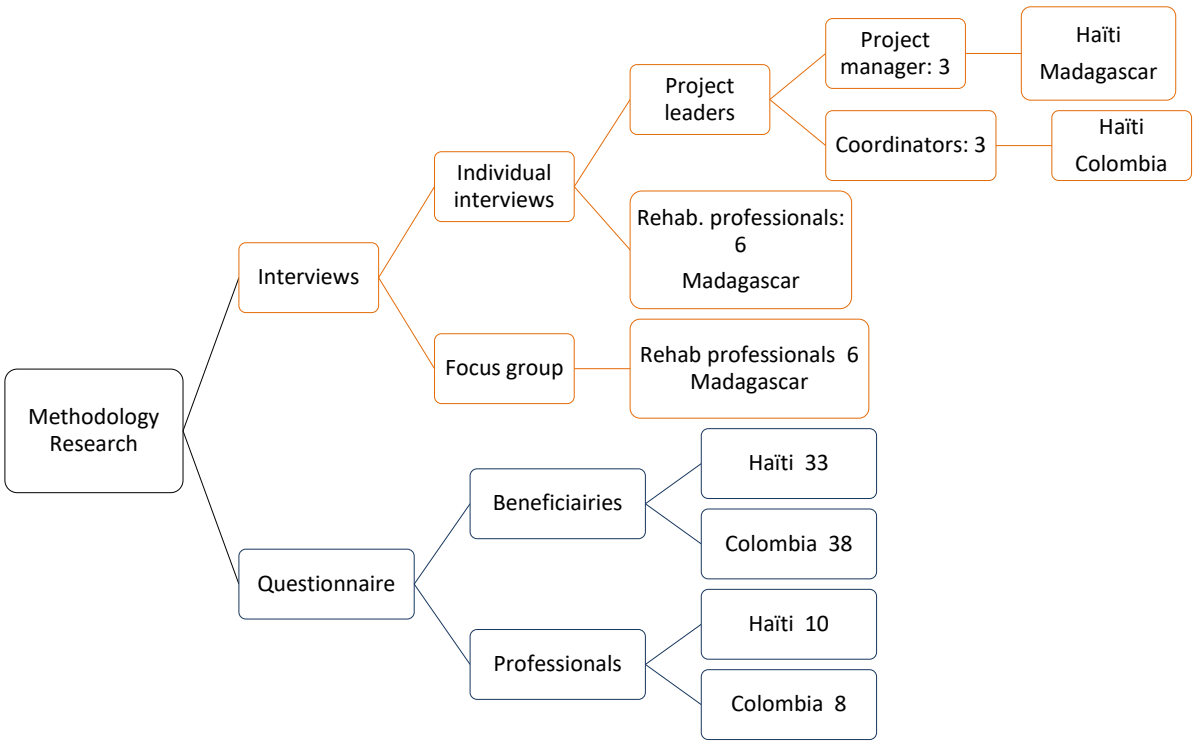
This research focuses on rehabilitation and has helped to identify barriers and levers for improving future projects. However, these elements of reflection are not limited to this area and can benefit other sectors that also rely on new technologies, such as mental health or education.

Annexes

1. Acronyms

ARTEC	Regulatory Authority for Communication Technologies
CSB	Base Health Centre
WHO	World Health Organisation
HI	Humanity & Inclusion
ICT	Information and communication technology

2. Research design: diagram of the tools used and the study's target population



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Barriers and levers for the use of telerehabilitation through experimentation in three countries

Information and communication technologies are increasingly used in Humanity & Inclusion's rehabilitation projects. Such as 3D printing technologies for the fabrication of orthoses, but also through telerehabilitation projects. Telerehabilitation is the provision of rehabilitation services when the practitioner and the beneficiary are geographically distant. The emergence of a global pandemic has encouraged the use of digital tools to support beneficiaries. The aim of this study was to identify, through quantitative and qualitative data, the barriers and levers for the use of telerehabilitation by professionals and beneficiaries, based on experiences in three countries (Haiti, Madagascar and Colombia). The barriers and levers were classified according to human factors, technological factors and organisational factors.

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