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Adherence and Practical Challenges of Long-Term Telerehabilitation in COPD Patients: A Mixed-Method Study.

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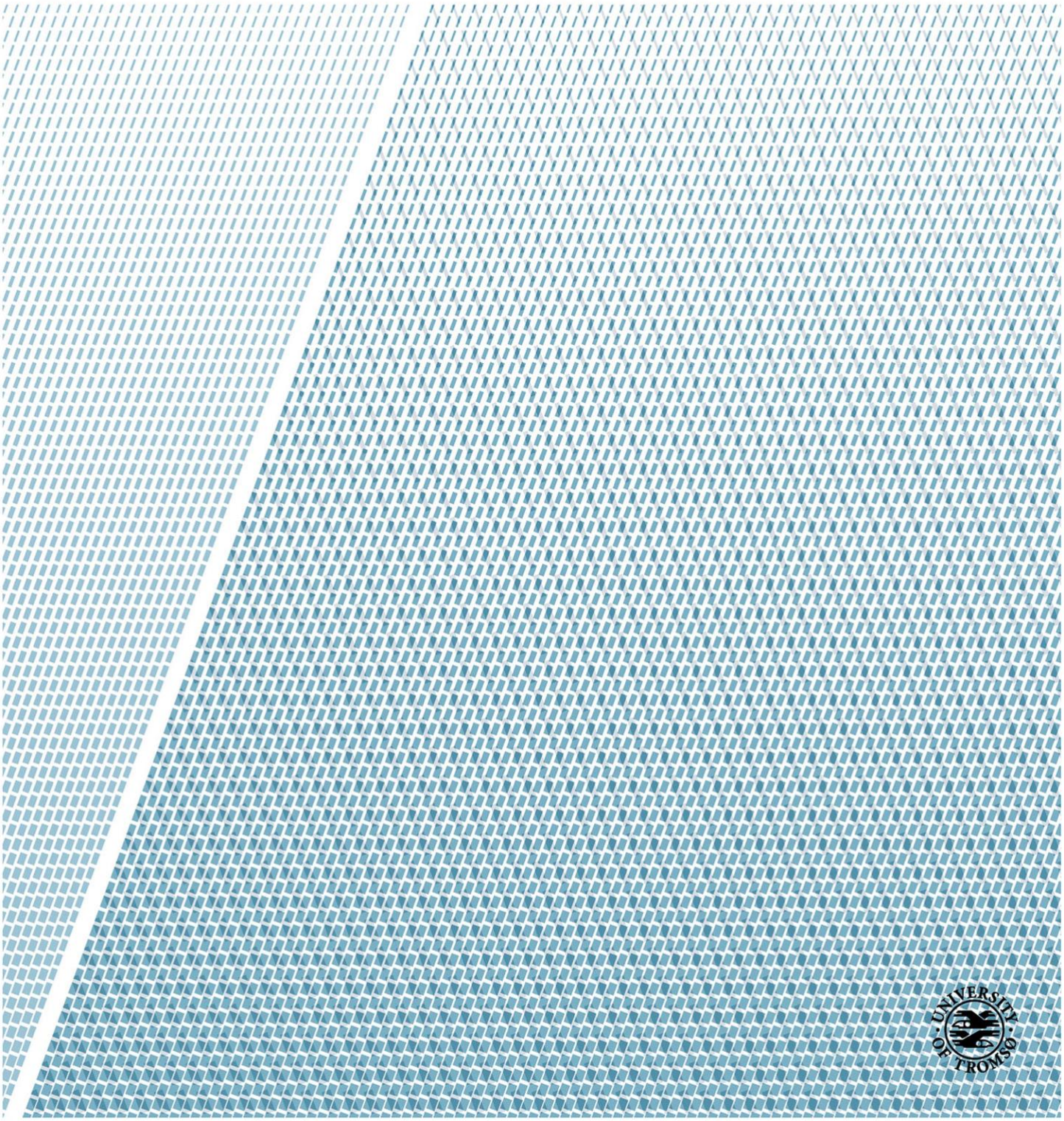

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Abbreviations

PR = Pulmonary Rehabilitation.

COPD = Chronic Obstructive Pulmonary Disease.

TR = Telerehabilitation.

EQ-5D = EuroQol 5 dimensions.

CAD = COPD assessment test.

6MWD) = six-minute walking distance.

PGIC = global impression of change.

HAD = hospital anxiety and depression scale.

ITT = intention to treat.

GSES = generalized self-efficacy scale.

Abstract

Background: Telerehabilitation (TR) increases accessibility towards pulmonary rehabilitation (PR) in chronic obstructive pulmonary disease (COPD) patients. It appears to be a cost-effective alternative to PR. We aimed to study adherence of COPD patients participating in long-term TR and practical challenges of TR from professional´s perspective.

Methods: 40 COPD patients participated in TR for 2 years. Participants performed training exercise and registered their training and daily observations in a webpage. We measured adherence by calculating frequency of registrations. Eight semi-structured interviews with professionals were conducted to explore practical challenges of TR. The Framework Method was used to analyze the qualitative data from these interviews.

Results: On average, adherence to training exercise was 1.8 sessions/week (recommended of 3 times/week) and adherence to daily observations was 2.9 registrations/week (recommendation 7 times/week). Six categories were identified by using the framework analysis: acceptance of telerehabilitation by participants and professionals, characteristics of participants, ethical and privacy-related issues, logistic issues, suggestions for improvement, and technical issues.

Conclusion: Participants managed to adhere to training exercises and daily registration of symptoms to a great extent, thus integrating TR into their everyday life. Professionals faced many practical challenges, including technical, logistic and Internet-related issues, along with ethical and privacy-related issues. Both participants and professionals accepted and appreciated TR.

Relevant key words

Telemedicine, Telerehabilitation, COPD, Pulmonary rehabilitation, Framework analysis, Semi-structured interviews.

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INTRODUCTION

Chronic respiratory diseases, such as interstitial lung diseases (ILD), chronic asthma, chronic obstructive pulmonary diseases (COPD), and bronchiectasis consist of 7 % of global burden of disease (Maio, Baldacci, Carrozzi, Pistelli, & Viegi, 2006). According to WHO, COPD is the third leading cause of mortality and 5th leading cause of disability by 2020 (Murray & Lopez, 1997). Its prevalence has been increased sharply specially among women (WHO, 2009).

Chronic Obstructive Pulmonary Disease (COPD)

Following Global Initiative for Obstructive Lung Disease (GOLD) guidelines, COPD is defined as "a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases" (Vestbo et al., 2013). In other words, COPD is a progressive limitation of airflow limitation. It has a considerable burden on patients, their families and healthcare budgets, especially when patients are at later stages of the disease and show up more at emergency department (ED) presentations and hospitalizations (Sullivan, Ramsey, & Lee, 2000). They often encounter acute exacerbations which, in worse cases, leads to hospitalization (Garcia-Aymerich et al., 2011).Furthermore, when a patient is discharged after treating acute exacerbation, it is highly expected that the patient can be hospitalized again (McGhan et al., 2007). Symptoms of COPD are breathlessness, tiredness, recurring chest infections and coughing (McCarthy et al., 2015). The most common symptom is dyspnoea in connection with depression and anxiety in acute events (Hill, Geist, Goldstein, & Lacasse, 2008). The most potential predictor of mortality with COPD patients is decreased physical activity (Waschki et al., 2011). A COPD patient feel deceased physical activity, compromised quality of life, and reduced exercise performance even when the patient is at mild stages of disease (Garrido et al., 2006).

Pulmonary Rehabilitation (PR)

Pulmonary rehabilitation (PR) is defined as "a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviors." (Garvey et al., 2018). It is well established in managing COPD and is evaluated as a standard care for symptomatic, chronic lung diseases (Garvey et al., 2018). Its most potential component is exercise training (Hoaas et al., 2016; McCarthy et al., 2015). There are some other optional components in PR which are education about self-management, dietary advice, assessment and psychological support (McCarthy et al., 2015). It is a multidisciplinary, comprehensive, evidence-based (Troosters, Gosselink, Janssens, & Decramer, 2010) and traditional way of delivering rehabilitation to COPD patients (McCarthy et al., 2015). Its beneficial effects for COPD patients are well documented (Alkalay, Kaplan, Sharma, & Kimbel, 1980) and there are sufficient studies which reports that PR enhance exercise tolerance and general well-being of a COPD patient (R. Goldstein, Gort, Avendano, Stubbing, & Guyatt, 1994) which in turn leads to reduced use of health resources. PR is a short-term rehabilitation program for patients with air flow limitation of moderate to high intensity. After attending a PR program, patients feel more active physically, less breathlessness and improved quality of life in terms of health. In traditional PR program, patient has to visit the specialized centre every day (R. Goldstein et al., 1994).

The target goals of PR are to enhance physical as well as psychological condition of patients in a way that encourage patients to adhere heath enhancing behaviours in a long run (Spruit et al., 2013). Unfortunately, if an effective and constructive maintenance plan is not followed after PR, its beneficial effects start to fades away over the following 12 months (Ries, Kaplan, Myers, Prewitt, & medicine, 2003; Spruit & Singh, 2013). Maintenance of long-term exercise adherence is difficult for COPD patients due to exacerbations, different day-to-day situations, hospital admissions transportation problems (Zanaboni et al., 2016), patient inconvenience, inappropriate insurance coverage, cost (Garvey et al., 2018) and absence of follow-up programs. Dropout rates among participants of PR varies between 20% to 40 % (Cockram, Cecins, & Jenkins, 2006; Garrod, Marshall, Barley, & Jones, 2006). Access to PR is limited, especially in remote areas. Exercise maintenance can be improved by goal setting, professional support, social

support, frequent review of exercise intensity, availability of supervised exercise programmes and optimistic personal attribute (Hellem, Bruusgaard, Bergland, & practice, 2012). Barriers (such as demanding traveling and transportation time and distance, disturbance in everyday routine, unsuitable timings of PR programs, fear of exacerbating medical condition or breathlessness, absence of social support, little self-confidence and inadequate perceived benefit) prevent 50% of patients in Norway to join a PR program. A study on attendance and adherence of COPD patients in PR found that non-adherence among participants was 29.1%. In general, the strong predictors of attendance and adherence of COPD in PR were smoking status, age, marker of disease severity (such as long-term oxygen therapy), travel distance and availability of social support (Hoaas et al., 2016). Damhus et al. studied enablers and barriers of COPD TR and they have concluded that for the implementation of TR, barriers and enablers are important for the health professionals. While working on TR, health professionals faces new kind of tasks while working on exercising with patients, such as changing their ways of communication. It also influence health care workers professional roles and their self-perceived capability (Damhus, Emme, & Hansen, 2018).

Technology such as TR system appears as a powerful tool to surpass the barriers which hinder COPD patients to remain adherent to PR program by improving availability. TR uses the same principles of PR program but is technology-supported (Garvey et al., 2018). Hence it becomes an effective home-base TR program and evidence are there to support these home-based training programs (Burkow et al., 2015; Fernández et al., 2009; Güell et al., 2008; Maltais et al., 2008).

Telerehabilitation

"Telerehabilitation is the use of information and communication technologies to provide clinical rehabilitation services from a distance"(Cox et al., 2018). Interestingly, TR seems to be more promising when it comes to adherence. It means that if we compare TR with standard centre-based PR, adherence of patients can be higher with a TR-based exercise program. In order to make TR effective, essential elements of traditional PR should be present in it, such as individual prescription of exercises, outcome measurements, self-management education and patient support (Garvey et al., 2018). TR increases accessibility towards PR (Hoaas et al., 2016).The adverse effects of TR are comparable or even less to those of centre-based care (Hwang et al., 2015). Szalewska et al. studied

home-based telemonitored cardiac rehabilitation which was home-based telemonitored in year 2015 and they have found that a home-based telemonitored program facilitates patients' adherence to CR (cardiac rehabilitation) and improved physical capacity. In heart failure patients, adherence to CR seems to be even better for home-based telemonitored CR than for standard CR (Szalewska et al., 2015). TR platform encouraged clinician-patient interaction beyond the hospital setting and offers the advantage of cost savings, convenience, at-home monitoring, and coordination of care, all of which are geared to improve adherence (Chughtai et al., 2018). TR is acceptable, feasible and having potential value for low vision TR (Bittner et al., 2018).

Adherence

It is defined by the World Health Organization (WHO) as "the extent to which a person's behaviour-taking medication, following a diet, and/or executing lifestyle changes—corresponds to the recommendations of a healthcare provider" (Conraads et al., 2012). Moseley et al. defined adherence as "the degree to which patients and research participants act in accordance with the advice of their clinician or researcher" (Moseley & Rheumatology, 2006). Whereas Piotrowicz et al. defined adherence as "the percentage of patients who carried out the prescribed exercise training" (Piotrowicz et al., 2010). Adherence must be carefully defined according to situations with delineated adherent parameters in an appropriate health behaviour under study. The methods used for this process should be sensitive to change, reliable and valid (Vitolins, Rand, Rapp, Ribisl, & Sevick, 2000). When one think about adherence, two things come in mind: exercise adherence and exercise persistence.

Exercise adherence

It can be defined as "the extent to which a patient acts in accordance with the advised interval, exercise dose, and exercise dosing regimen. The unit of measure for adherence is performed exercise doses per defined period of time reported as a proportion of prescribed exercise doses undergone at the prescribed time interval" (Conraads et al., 2012).

Exercise persistence

It can be defined as the total exercise time from the start of performing exercise to the end of the therapy measured in time units, such as number of weeks per month to discontinuation of therapy (Conraads et al., 2012).

Types of adherence

In general, there are three types of adherences on the basis of patient´s adherence to the prescribed exercise doses, which are following

Adherent Patients

Adherent patients are those patients who adhere to both number of prescribed training sessions as well as exercise duration by 80%, then he is called adherent patient.

Non adherent Patients

Non adherent patients are characterized by the patients who adhere to less than 20% of the number of prescribed exercises along with prescribed duration.

Partially Adherent Patients

Partially adherent patients try to perform prescribed exercises but often omit some sessions. They also do not perform exercise according to prescribed duration also (Piotrowicz et al., 2015).

Cox et al. worked on PR and considered a patient to be adherent, if he/she performed 70% of the exercise prescribed (Cox et al., 2018).

Assessment and reporting of exercise adherence

Mostly, adherence is measured by assessing the number of attendance in training sessions (Piotrowicz et al., 2010). There are some cases in which after performing exercises, patients use activity logs on which they self-report their attendance as well as duration of exercise. These logs are then later verified by some objective tools (Hwang et al., 2015).

When we talk about attendance in PR, then there is no clear criteria for attendance. There is neither obligatory number of attendance nor report of attendance is adviced by PR guidelines. Criteria for attendance of exercise session is very vague (Williams et al., 2014).

When we look at studies conducting exercise programmes for COPD patients, only 37% of studies reported attendance. Out of these 37% studies, only 12% had attendance as prior criteria. Reporting of attendance in exercise programmes is low but it is gradually increasing (Williams et al., 2014). This can be seen in the Figure 1.

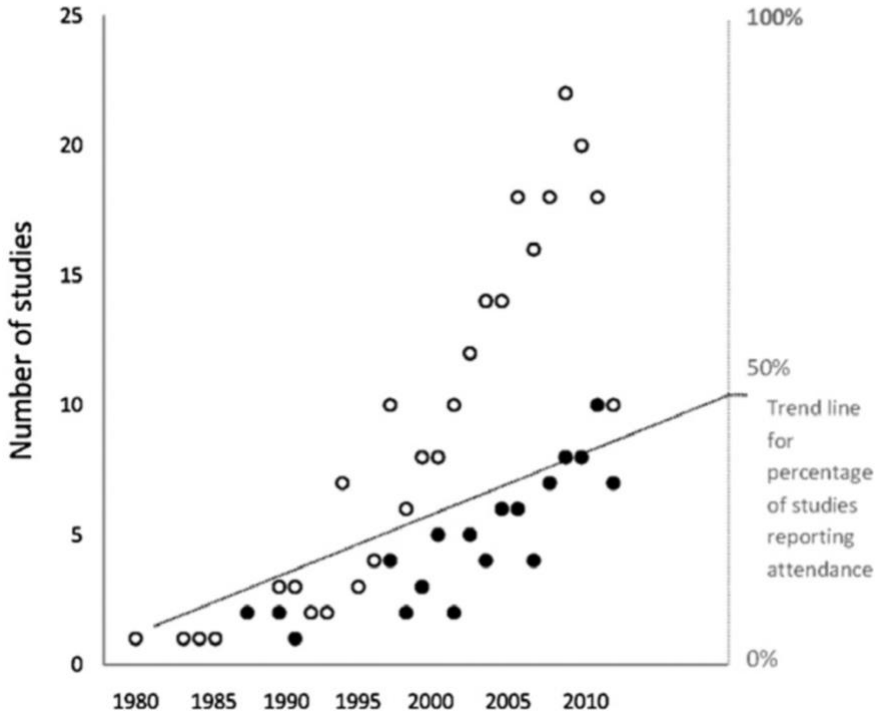

Figure 1:Scientific studies for exercise training for COPD patients, ○, Studies not reporting attendance exercise training for COPD patients,•, studies reporting attendance in exercise training for COPD patients (Williams et al., 2014).

Significance of measuring adherence

Sufficient adherence to a behavioral and medical intervention is very necessary in order to make it work productively and efficiently. It is very important for researchers and clinicians that patient keep on adhering to the recommended regime, in terms of duration as well as interval, so that the intervention remain effective (Vitolins et al., 2000). There is a linear relationship between improvement as exercise outcome and attendance (Williams et al., 2014). Attendance information is very useful for clinicians as well. If they previously had information about attendance of patients, then they can effectively manage resources (staff, equipment and space) and recruitment process (Williams et al., 2014).

According to Goldstein et al. details of adherence to telemedicine in COPD are lacking. However, in most chronic disease management programs, patient adherence has been shown to be over 77% in the medium-term but it markedly decreases over time (R. S. Goldstein & O'Hoski, 2014). This means that adherence slowly declined over time and higher adherence was observed for endurance compared with resistance exercise (Hwang et al., 2015). Non-attendance could impact upon training load (exercise dose) and consequent improvements in functional exercise outcomes (Williams et al., 2014).

Barriers to Adherence

Palazzo et al. (2016) worked on to find barriers associated with adherence of patients with recommended exercise regime at home with lower back pain. They also worked on the expectations of patients with new emerging technologies (TR). Recommended routine of participant can be affected by certain factors. These factors are seen as barriers for adherence of participants.

Barriers associated with the exercise program

Number of exercises

Patients who are not used to practice a regular physical activity usually consider that more than 4 exercises in a program is difficult. Patient acceptance of proposed training is very important when it comes to adherence (Piotrowicz et al., 2015).

The effectiveness of the program

Exercises that causes or increases pain are usually stopped by patients, where as those that immediately relieves pain are carried on by patient. So, to make a program more adherent by patient, it is recommended that exercises should be pain symptom revealing relatively.

The complexity of the program

Sometimes patients are not sure if they have the correct position or the correct motion while exercising, so they prefer to stop the exercise own their own. So, it is important that

the patient is very clear about his exercise specific goals and have no personal concern about recommended exercise.

The burden of exercising

Sometimes, exercises are considered repetitive and boring, which do not help with regular practice. This can be overcome by doing some other activities which are interesting for the patients. For example, while listening to music.

Barriers associated with the healthcare journey

A breakdown between supervised group and home-based sessions

Patients notice a gap (difference) between intensive supervised programs with support by care providers or other patients and a home-based exercise program performed alone without any support, which could lead to a feeling of abandonment.

A lack of follow-up

With time patients lose interest in doing exercise. They need to have close follow-up from a professional health care provider to maintain their motivation to exercise.

Difficulties in contacting care providers

Patients who stop their program either for health or personal reasons express the need to quickly contact a physical therapist or a physician to plan a "refreshing" of their exercise program. Patients usually doesn´t get emergency appointment with health care professional very early as wished by patients.

Barriers associated with patient representations

Illness perception

According to personal views of patients on causality of the disease (punishment, fatality, non-reversible damage to the body), they could be more or less adherent.

Exercise perception

Fear of movement and false beliefs regarding exercises were associated with limited adherence. Sometimes patients are frightened that doing the prescribed exercise may harm them.

Despondency

The chronicity of symptoms and the uncertainty regarding recovery could induce low spirit in patients concerning the disease and its treatments.

Depression

Patients report difficulties in practicing exercises when they feel depressed.

Lack of motivation

Most patients underline the need for strong motivation to perform exercises, which is considered as a personal coping strategy.

Barriers associated with environmental factors

Attitudes of others

The absence of listening and support has a negative impact on adherence to exercises. The burden of explaining the condition and treatments to others or to hide because of the fear of being stigmatized has been reported.

Difficulties to plan or organize exercise practice

The lack of time is often a cause of non-adherence by young and working patients.

Table 1: Barriers to Adherence (Palazzo et al., 2016).

Barriers associated with the exercise program
1. Number of exercises
2. The effectiveness of the program
3. The complexity of the program
4. The burden of exercising
Barriers associated with the healthcare journey
1. A breakdown between supervised group and home-based sessions
2. A lack of follow-up

3. Difficulties in contacting care providers
Barriers associated with patient representations
1. Illness perception
2. Exercise perception
3. Despondency
4. Lack of motivation
Barriers associated with environmental factors
1. Attitudes of others
2. Difficulties to plan or organize exercise practice

Palazzo et al. worked with home-based exercise programme in lower back pain. They used TR for 29 patients and had a very peer view on barriers to telerehabilitation technology. They say that there are some patient-related factors as well, which can impair adherence to exercise routine, such as fear of pain, poor self-efficacy and failing to make exercise fit into everyday life (Beinart, Goodchild, Weinman, Ayis, & Godfrey, 2013; Medina-Mirapeix et al., 2009; Palazzo et al., 2016; Slade, Patel, Underwood, & Keating, 2015). Other factors which serve as barriers are large number of exercises, "one size fits for all" design programmes, care provider´s way of handling patient (monitoring of patients and giving feedback) (Henry, Rosemond, & Eckert, 1999; Jordan, Holden, Mason, & Foster, 2010; Slade et al., 2015).

Some strategies to enhance adherence from patient's perspectives

There are some strategies which can make telerehabilitation more effective if they are used from patient´s side.

Increasing the attractiveness of exercise programs

Some patients think that entertaining ways of doing exercises can help them improving their adherence to recommended exercise routine. Such as a playlist of songs or watching a TV program while doing exercise.

Improving patient performance

Following a model

This includes all methods where the patient can practice exercises following a model. For example, they can watch a movie of exercises or virtual coach, while performing exercise.

Providing feedback

Patients expresses the need for feedback on their performance. The feedback may include correction, encouragement and congratulations on accomplishing the targeted goal.

Favoring the feeling of being supported by care providers

Care providers are expected to modify some skills and attitudes while long distance supervised sessions (TR). They need to explain more detailed explanations on the disease, objectives of exercises, and the choice of exercises included in the program. The need for individualized advice to integrate exercises into daily life is also mentioned by a patient.

By other patients

Patients expect connections and dialog with other patients to share information, experiences or advice and to support each other.

Frequency of exercise sessions

It has been seen that patients tend to be more adherent to exercise program when it is recommended more frequently (Williams et al., 2014).

Expectations regarding new technologies to enhance adherence

Reminder tools

Most patients are not very enthusiastic regarding the use of a simple anonymous reminder (short message service, email, watch). Reminders should reinforce a personalized challenge.

Exchange tools

Patients are mainly favorable to social networks. They were afraid of the lack of confidentiality and consequences it could have. Mean people are willing to share but anonymously (Palazzo et al., 2016).

Table 2: Some strategies to enhance adherence from patient's perspectives (Palazzo et al., 2016).

Increasing the attractiveness of exercise programs
Improving patient performance
a) Following a model
b) Providing feedback
Favoring the feeling of being supported by care providers
a) By other patients
Frequency of exercise sessions
Expectations regarding new technologies to enhance adherence
a) Reminder tools
b) Exchange tools

TR as an alternative to PR

Although PR is proven to be effective for COPD patients, it often demands for too many resources. Less than 5% of eligible COPD patients get the chance to avail the offer of PR. This was estimated on an annual basis. The potential barriers to attend these PR programmes are transportation system, traveling from patients homes to clinical setting, disability, referral practices and limited number of PR staff (Cox et al., 2018; Zanaboni et al., 2016). These barriers make patients to compromise on available PR programme, especially those living in rural and remote areas. It is a good idea to use TR as an alternative to PR to provide access to patients who are eligible for PR but cannot take part in it due to barriers. TR is act as a replacement to PR. This will not only help to approach equity in access but also equity among patient related outcomes (Cox et al., 2018). Travel and distance barrier of PR can be terminated if we use telerehabilitation. Then regardless of the distance between patient and rehabilitation centre, every patient can take part in rehabilitation programme. TR is very safe and adverse event has never been reported

(Barberan-Garcia et al., 2014; Dinesen et al., 2012; Holland et al., 2013; Stickland et al., 2011; Tabak, Vollenbroek-Hutten, van der Valk, van der Palen, & Hermens, 2014; Tousignant et al., 2012; Zanaboni, Lien, Hjalmarsen, Wootton, & Telecare, 2013). TR seems to promote more efficient integration of exercise routine into daily life over long-term. However, there are some technical difficulties and challenges of TR as well. Such as availability of good internet connection. There are few studies about TR in COPD. For this reason, we also looked at home-based rehabilitation in other health fields such cardiac and chronic lower back pain TR.

Objectives/ Aims

The current study aims at analysing the use of long-term TR in COPD by patients participating in an international multicentre clinical trial (iTrain) and exploring the main practical challenges encountered by patients and health professionals in delivering the interventions. This study aims at addressing the following research questions.

Use of long-term TR by patients with COPD

- What is the level of use and adherence of the TR by participants?
- How do use and adherence vary across time and place?
- How do use and adherence differ among participants?

Practical challenges of long-term TR by patients with COPD

- Which practical challenges have been encountered by participants?
- How do practical challenges affect use and adherence to the intervention?
- Which are the main factors affecting scalability and future implementation?

Potential types of challenges

- practical issues (e.g. usability, confidence with exercise, social support, time)
- logistic issues (e.g. delivery of the equipment, space available at home)
- technical issues (e.g. videoconferencing, Internet, technical problems with equipment)
- organizational issues (e.g. scheduling of videoconferences, availability of study personnel, turnover)

- other issues (e.g. health related problems, exacerbations, periods of absence, holidays)

METHODS

Design of iTrain

iTrain is an international and multicentre project. It was conducted at the same time in three countries (Australia, Denmark and Norway). It was ethically approved in all three countries. Total 120 COPD patients took part in this project for a duration of two years. These patients were then divided into 3 arms (control, telerehabilitation and treadmill) with a ratio 1:1:1 randomly using randomized control trial (RCT).

Eligibility criteria for iTrain

To participate in iTrain, inclusion criteria were the following.

1. Diagnosis of COPD.
2. Should have airflow limitations, forces expiratory volume in 1s percentage (FEV_1) <80%.
3. At least 1 COPD related hospitalizations or emergency presentations in last 12 months.
4. 40 to 80 year age.
5. Can provide written consent to take part in iTrain.

There were some exclusion criteria as well.

1. Participation in any PR programme in last 6 months.
2. Participation in any other clinical study which may have an impact on iTrain outcomes.
3. Susceptibility of patient to be unfit for iTrain by healthcare team.
4. Presence of comorbidities which, in the opinion of healthcare´s team can hinder patient to take part in the project safely. Such as cognitive and neurological impairments.
5. Home environment not supporting installation and use of monitoring and telerehabilitation equipment.

Three arms of iTrain

Participants were divided into three arms: control arm, treadmill arm and telerehabilitation arm.

Control arm

Standard care was offered to participants in control arm. This means that they can attend regular PR programmes anytime during the two-year study duration if there are clinical indications for it. It was made sure that they would not be denied accessing PR.

Treadmill arm

Treadmill was the only equipment which was provided to participants in the treadmill arm. They were given prescribed exercise without any supervision. They were asked to write about their training sessions on a paper diary. So, they were doing unsupervised training exercise. This arm would bed later used to compare telerehabilitation with supervision and telerehabilitation without supervision.

Telerehabilitation arm

An integrated intervention was offered to participants of telerehabilitation arm. These interventions were training of exercise, self-management and telemonitoring. A treadmill, a customized tablet computer, a pulse oximeter and a holder for holding of tablet computer on the treadmill were provided to the patient to perform telerehabilitation. This can be seen in the Figure 2.

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Figure 2: Patient using telerehabilitation (Zanaboni et al., 2016).

Figure 3: Videoconferencing between participant and physiotherapist (Zanaboni et al., 2017).

A videoconferencing software “Acano” was used to make videoconferencing between patients and physiotherapist. A physiotherapist using Acano, can be seen in Figure 3.
Participants were given individualized exercise prescription. These exercises were interval or continuous training exercises on treadmill and strength exercises according to the guidelines. Strength exercise included squat, calf rise, shoulder press, calf rise and biceps curl.
The treadmill exercise programme should last for 30 minutes. The frequency for continuous training was 3-5 times/week, for interval training was 3 times /week and for strength training was 2-3 sessions per week.
Participants were clinically assessed at baseline, 6 months, 1 year and at 2 year. These assessments included spirometry, answering of EuroQol 5 dimensions
(EQ-5D) questionnaires, 6-min walking test (6MWD), COPD assessment test (CAT), level of physical activity, MMRC dyspnoea scale, patient global impression of change (PGIC), pharmacological treatment, hospital anxiety and depression scale (HAD), health care utilization and generalized self-efficacy scale (GSES).

Dropout

Participants could dropout the programme willingly when-ever they wanted. A participant would be considered dropped out only when he requested to take his/her consent of participation back. Otherwise, he/she is considered participating with an intention-to-treat (ITT) approach.

Webpage

A customized webpage was made for this iTrain project. The purpose of this webpage was to access individual training programmes, training diary and daily diary, exchange of electronic messages between participants and physiotherapist, review historical data, assessment to individual´s goal settings and scheduling of videoconferencing. This can be seen in the tabs of Figure 4.

Webpage from patient´s view

Every participant was given an identity code, for example Au001. An id and password were also provided to them so that they can get access to iTrain webpage. When they

open webpage, they can see the recommended exercise training by physiotherapist. This view can be seen in Figure 4.

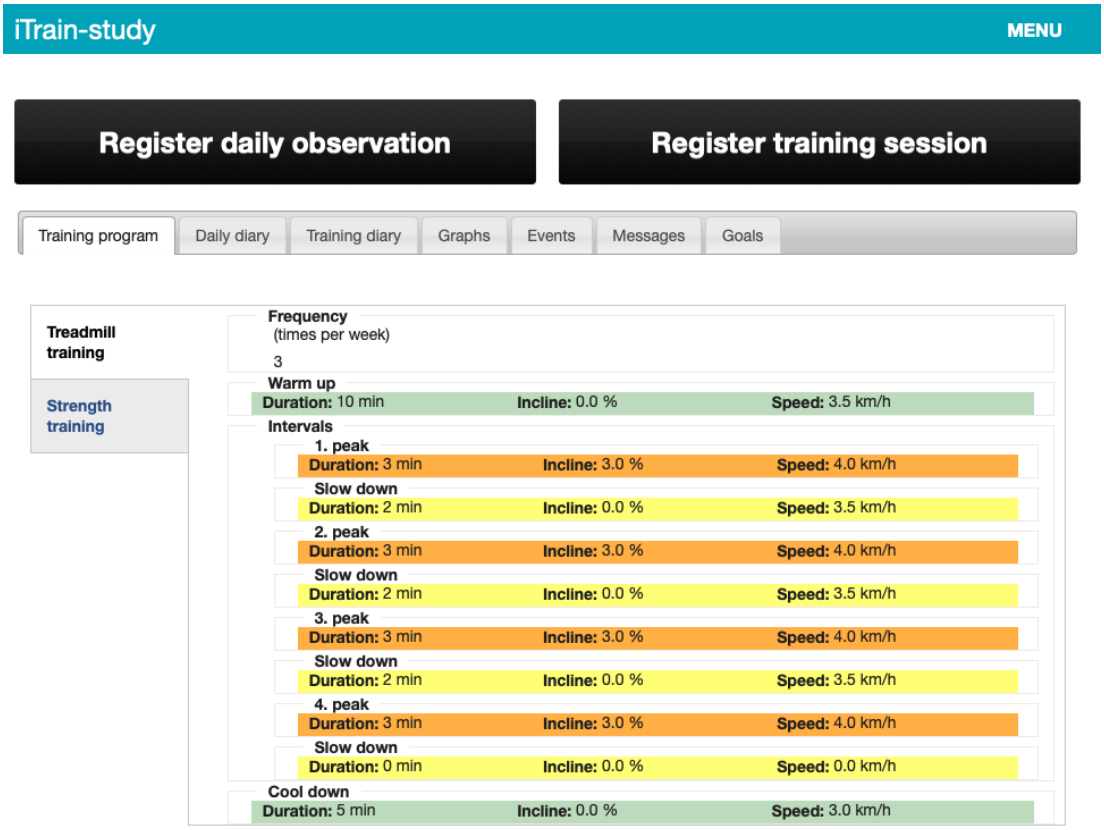


Figure 4: View of webpage from patient´s view.

By clicking on the “register daily observation”, they can enter their personal data as input in daily diary. Such as registration date, oxygen saturation before exercise training, pulse at rest, condition of breathing, cough and sputum (BCS). The view of daily diary webpage is shown in Figure 5.

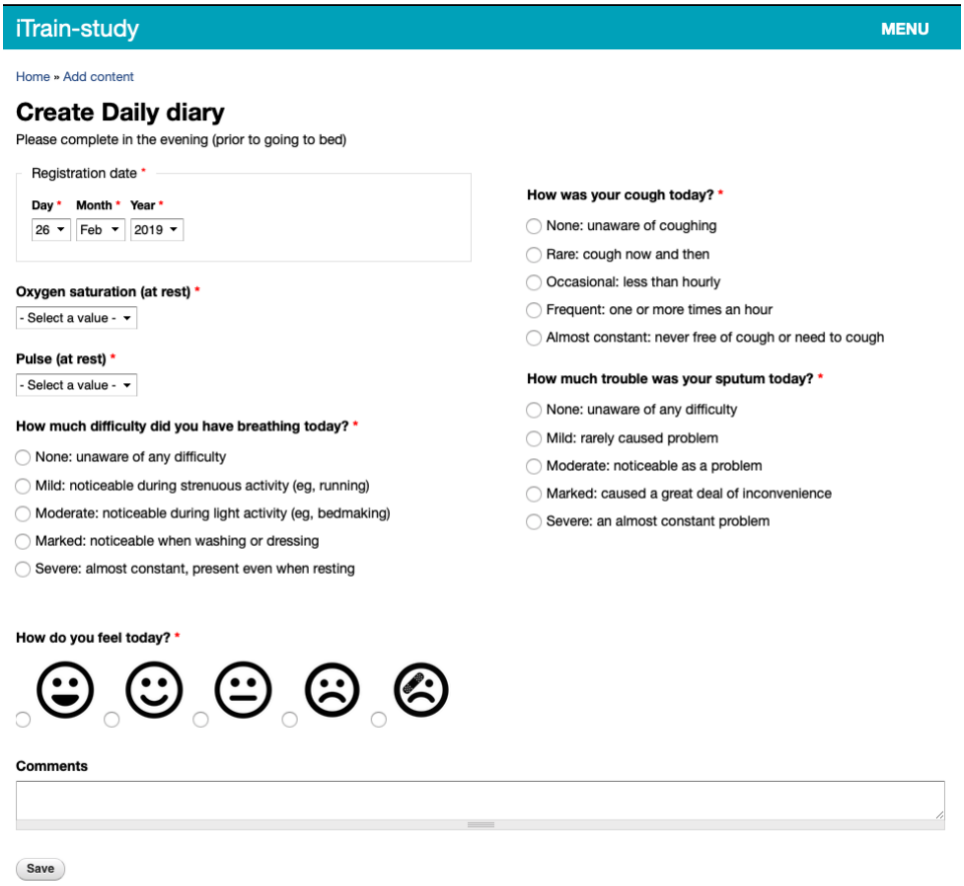


Figure 5: View of daily diary from patient´s view.

When patient click on "register training session", he can give input about date and duration of exercise, oxygen saturation, pulse, fatigue and dyspnoea after performing the exercise. This can be seen in Figure 6.

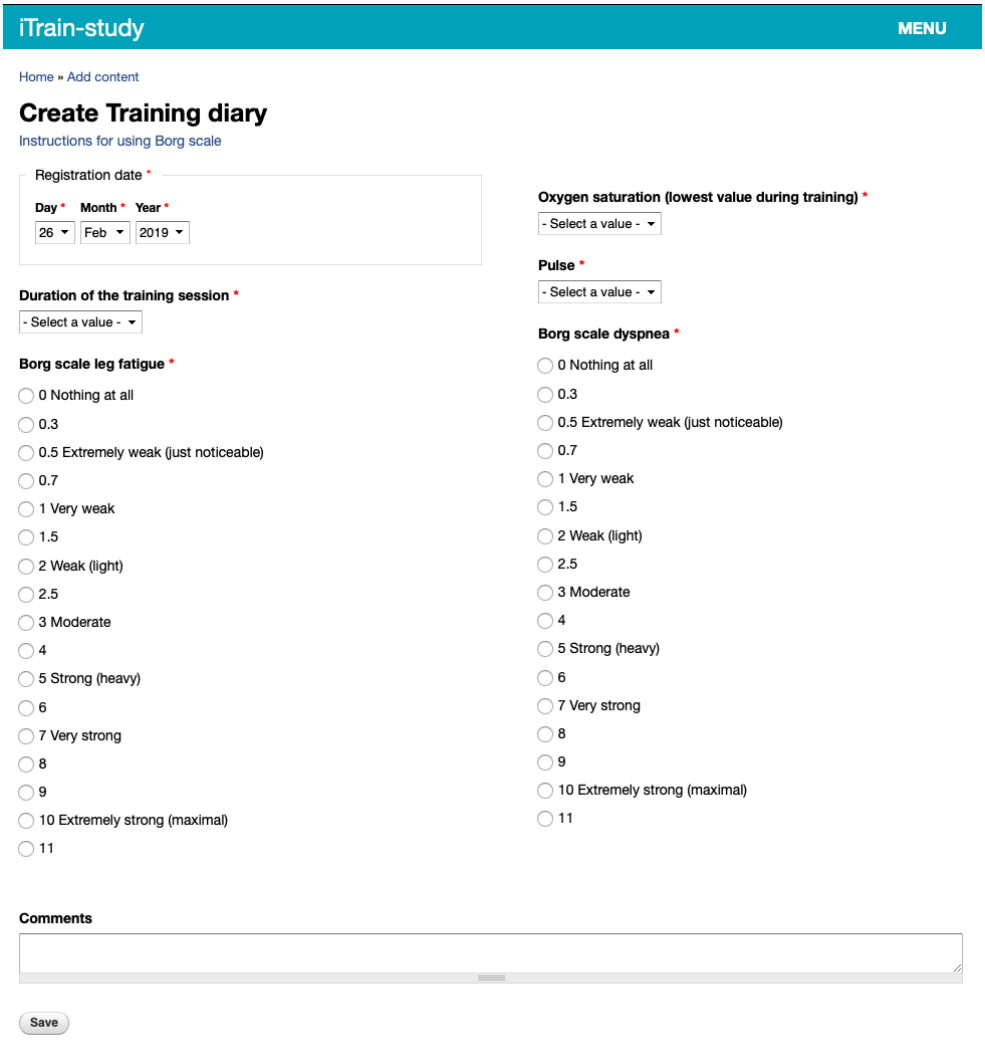


Figure 6: View of training diary from patient´s view.

Patients can also look at the history of daily registration inputs given by them by clicking on the “Daily measurements”. The view of the webpage can be seen in Figure 7.

Dato	Oksygensaturasjon	Puls	Tungpust	Hoste	Slimdannelse	BCSS	Status	Kommentarer
19.02.2019	96%	78	2	2	2	6	Bra	Lungebetennelse som...
15.02.2019	94%	78	2	2	2	6	Nøytralt	Lungebetennelse og...
10.02.2019	95%	64	2	1	1	4	Bra	4,4 og 2,05 km en...
30.01.2019	96%	87	2	1	1	4	Bra	4;3 og 2,5 km
30.01.2019	96%	87	2	1	1	4	Bra	4;3 og 2,5 km
30.01.2019	96%	87	2	1	1	4	Bra	4;3 og 2,5 km
29.01.2019	98%	87	2	1	1	4	Bra	4,4 og 2,02 km
24.01.2019	96%	68	1	1	2	4	Bra	2,02km og fart 4,3...
23.01.2019	97%	83	2	1	2	5	Nøytralt	Bare 4,0 fart og 2...
21.01.2019	96%	68	2	1	1	4	Bra	Kaldt vær men ok å...
20.01.2019	95%	76	2	1	1	4	Bra	K dag på mølla 4,3...
17.01.2019	96%	85	2	1	1	4	Bra	4;3 og 2 km ellers...
17.01.2019	96%	85	2	1	1	4	Bra	4;3 og 2 km ellers...
16.01.2019	96%	85	2	1	1	4	Bra	Bra å gå idag men...
13.01.2019	94%	78	2	1	1	4	Nøytralt	Sliter med ryggonde...
12.01.2019	96%	75	2	1	1	4	Nøytralt	Ryggonde så jeg...
10.01.2019	92%	83	2	1	1	4	Bra	Føler meg bra -det...
07.01.2019	92%	78	2	2	2	6	Nøytralt	Mye slimdannelse i...
07.01.2019	92%	78	2	2	2	6	Nøytralt	Mye slimdannelse i...
06.01.2019	95%	79	3	2	2	7	Nøytralt	4,3 og 1,84 km...
05.01.2019	96%	86	1	1	2	4	Nøytralt	Det er tungt å...
02.01.2019	93%	82	2	2	1	5	Bra	4,3 og 1,7 km idag.
31.12.2018	96%	80	2	1	1	4	Bra	Årets siste på...
30.12.2018	94%	82	1	1	1	3	Bra	Idag var det tungt...
28.12.2018	98%	81	2	1	1	4	Bra	Regn hålkeføre og...
27.12.2018	94%	81	2	1	1	4	Bra	Foreten og tung i...
25.12.2018	93%	78	2	0	2	4	Bra	Tungt å pustte idag...
22.12.2018	96%	78	1	1	2	4	Bra	Ok å gå idag mens...
16.12.2018	96%	76	2	1	1	4	Bra	Kaldt pent vær ute...
11.12.2018	97%	82	2	1	1	4	Bra	Fart 4,5 og 1,5 km...
06.12.2018	98%	80	2	0	1	3	Bra	1,3 km og fart 4,5...
04.12.2018	94%	71	2	1	1	4	Bra	Tungt idag bare 4,3...
02.12.2018	94%	82	2	2	1	5	Bra	Grei dag 4,4 og 1 km
27.11.2018	93%	73	2	1	1	4	Bra	1,5 km med fart 4,...
25.11.2018	93%	85	2	1	2	5	Bra	Bra men lenge siden...
15.11.2018	94%	74	2	1	2	5	Bra	1 km og fart på 4,4...
12.11.2018	94%	73	2	2	2	6	Veldig bra	4,6 fart, 2,03 km...
10.11.2018	94%	71	3	3	3	9	Nøytralt	Tungt rtter en...
03.11.2018	97%	80	2	1	2	5	Bra	20 minutt og 1,5 km...
30.10.2018	95%	79	2	0	2	4	Bra	Skrekkelig...
28.10.2018	96%	75	2	1	1	4	Bra	Lett å gå idag 2,1...
26.10.2018	94%	79	2	1	1	4	Bra	Greit å gå idag.det...
20.10.2018	94%	65	2	1	1	4	Bra	Det går greit 4,5...
18.10.2018	96%	80	2	1	1	4	Bra	Det ble en kort tur...
17.10.2018	93%	79	2	1	2	5	Bra	Det går greit, men...
16.10.2018	93%	64	1	1	1	3	Bra	Idag ble det 2 km...
14.10.2018	95%	76	2	1	1	4	Bra	
14.10.2018	95%	75	2	1	1	4	Nøytralt	Farkens tungt å gå...
10.10.2018	95%	80	2	1	1	4	Bra	4,5 og 1,5 km idag...
09.10.2018	93%	76	2	1	1	4	Bra	Endelig på mølla,...

1 2 3 4 5 6 7 8 9 neste › siste »

Figure 7: View of historical data of daily diary, from patient´s view.

Similarly, Patients can look on their training history by clicking on the “training book” tab. The view of the webpage can be seen in Figure 8.

Dato	Borg skala tungpustethet	Borg skala leggtretthet	Oksygensaturasjon	Tid	Puls	Kommentar
19.02.2019	4	4	92%	30 minutes	100	
15.02.2019	4	4	92%	30 minutes	91	Lavt blodtrykk både...
10.02.2019	4	4	93%	30 minutes	84	
30.01.2019	4	4	90%	30 minutes	91	
29.01.2019	4	4	92%	30 minutes	100	
24.01.2019	4	4	89%	30 minutes	88	
23.01.2019	4	4	90%	30 minutes	91	Har vondt i svangen...
21.01.2019	4	4	91%	20 minutes	85	
20.01.2019	3	4	91%	30 minutes	88	
17.01.2019	3	4	91%	30 minutes	90	Ok dag på mølla
16.01.2019	4	4	91%	25 minutes	90	
13.01.2019	4	4	90%	30 minutes	89	
12.01.2019	4	4	91%	20 minutes	78	
10.01.2019	4	4	90%	20 minutes	102	
07.01.2019	4	4	89%	20 minutes	92	Ok dag men prøver...
06.01.2019	5	5	90%	25 minutes	89	
05.01.2019	4	4	90%	20 minutes	102	
05.01.2019	4	4	90%	20 minutes	102	
02.01.2019	4	4	90%	25 minutes	92	
31.12.2018	4	4	93%	20 minutes	96	
30.12.2018	4	4	91%	20 minutes	93	Årets nestsiste dag...
28.12.2018	4	4	92%	20 minutes	91	
27.12.2018	4	4	91%	20 minutes	92	
25.12.2018	4	4	91%	20 minutes	97	
22.12.2018	4	4	87%	20 minutes	90	Normalt.
16.12.2018	4	4	93%	20 minutes	94	
11.12.2018	4	4	93%	20 minutes	107	Høye verdier idag...
06.12.2018	4	4	90%	20 minutes	89	
04.12.2018	3	4	91%	20 minutes	92	
02.12.2018	3	4	91%	15 minutes	90	
27.11.2018	4	3	91%	20 minutes	94	Stort sett ok dag...
25.11.2018	4	4	91%	20 minutes	89	
15.11.2018	4	4	90%	15 minutes	91	Ganske bra 2800...
12.11.2018	4	4	92%	25 minutes	88	Greit idag også
10.11.2018	6	4	92%	20 minutes	76	Håper det blir...
03.11.2018	4	4	92%	20 minutes	90	Har mye seigt i...
30.10.2018	5	3	91%	30 minutes	93	
28.10.2018	3	4	93%	30 minutes	96	Det er kaldt,klart...
26.10.2018	4	4	91%	30 minutes	94	Fart 4,5 nesten...
21.10.2018	4	4	92%	30 minutes	89	Plages med nettet...
20.10.2018	4	4	92%	30 minutes	91	Stort sett det...
18.10.2018	4	4	92%	15 minutes	90	
17.10.2018	4	4	92%	30 minutes	96	Ok å gå flere dager...
16.10.2018	4	3	91%	30 minutes	90	
14.10.2018	3	4	91%	20 minutes	92	
14.10.2018	3	4	91%	20 minutes	92	
10.10.2018	4	4	92%	20 minutes	94	Stort sett som...
09.10.2018	4	4	89%	20 minutes	90	
09.10.2018	4	4	89%	20 minutes	90	
30.09.2018	3	4	89%	15 minutes	96	

1 2 3 4 5 6 7 8 9 neste › siste »

Figure 8: View of historical data of training diary, from patient´s view.

By clicking on the “Graph” tab, patients can look on their previous frequency of trainings on weekly basis (Figure 9).

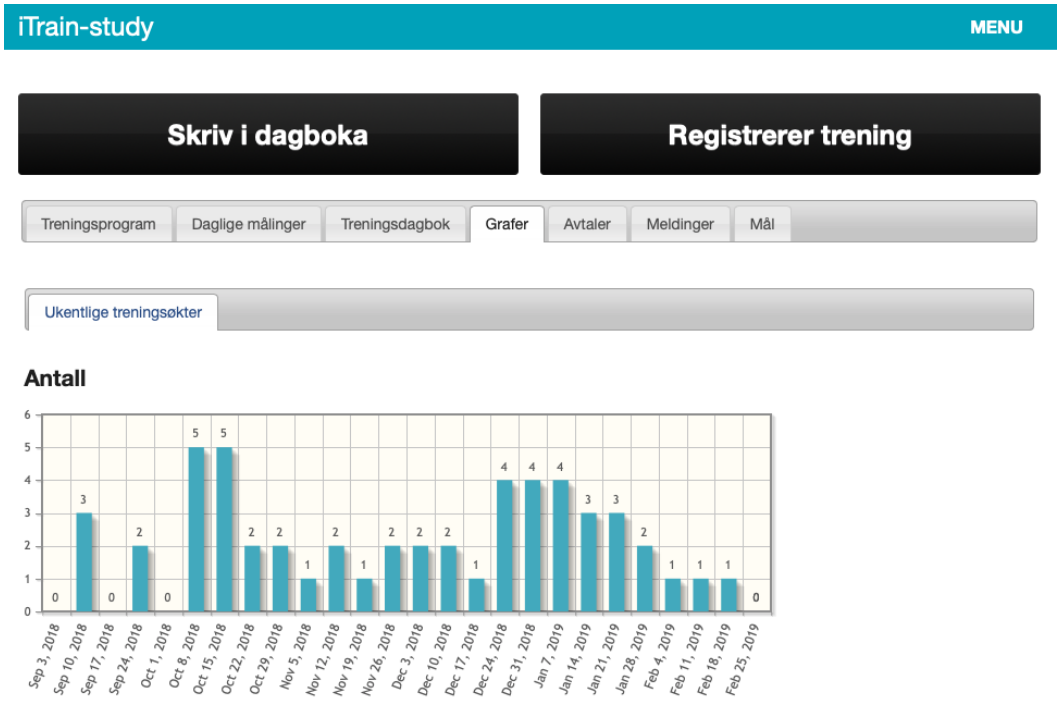


Figure 9: View of graphs for weekly work out, from patient´s view.

A message tab was also made in iTrain webpage, so that participants can give away messages to their physiotherapist. Physiotherapist monitors and interpret these messages on a weekly basis. The view of the webpage can be seen in Figure 10.

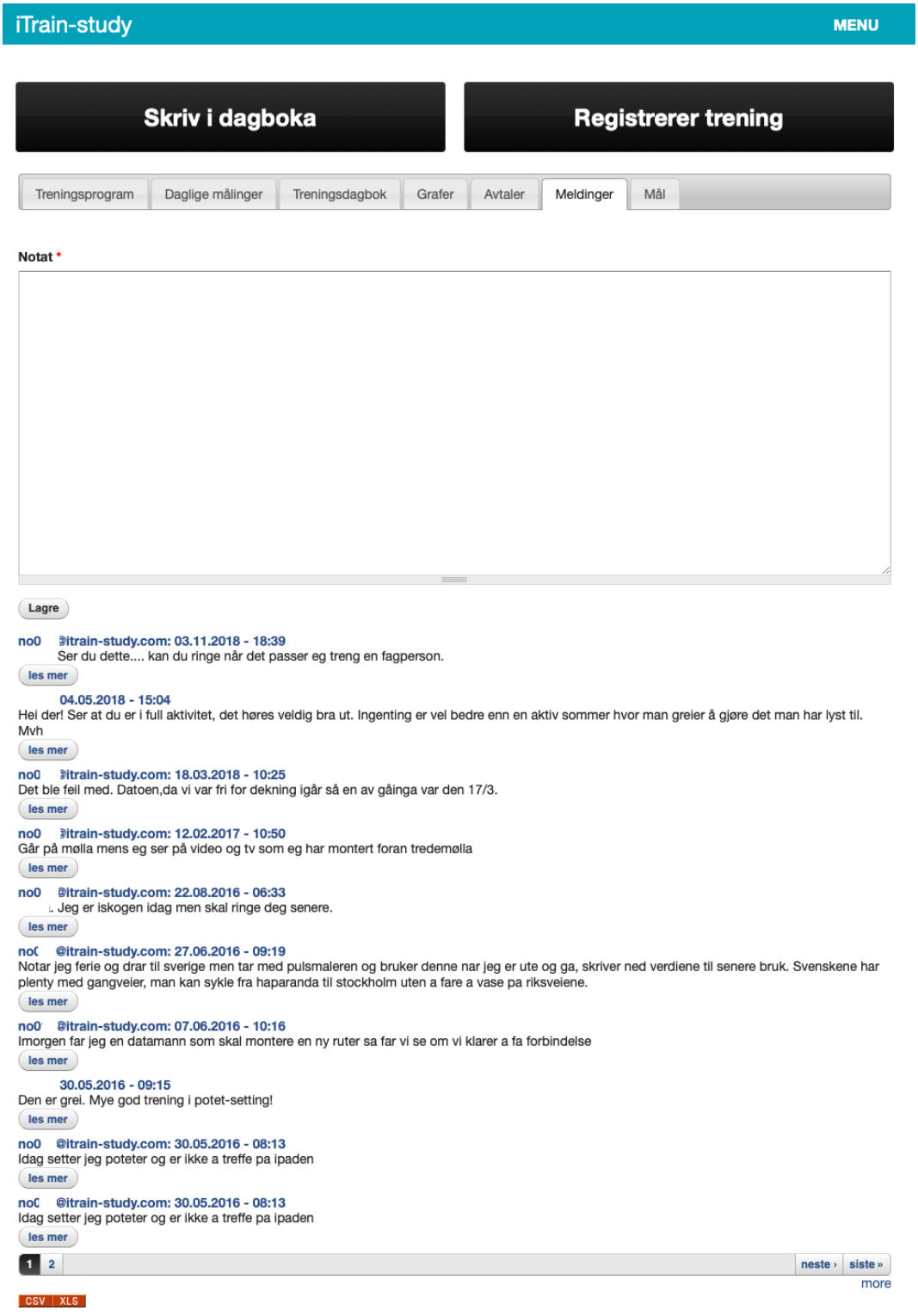


Figure 10: View of electronic message exchange, from patient´s view.

Goal making was an important part of iTrain. Participants were encouraged to make goal for themselves during videoconferencing as well. The goal setting has a deadline for

achieving the goal and expected changes to be felt. After the deadline, these goals were later evaluated by physiotherapist. This can of the webpage be seen in Figure 11.

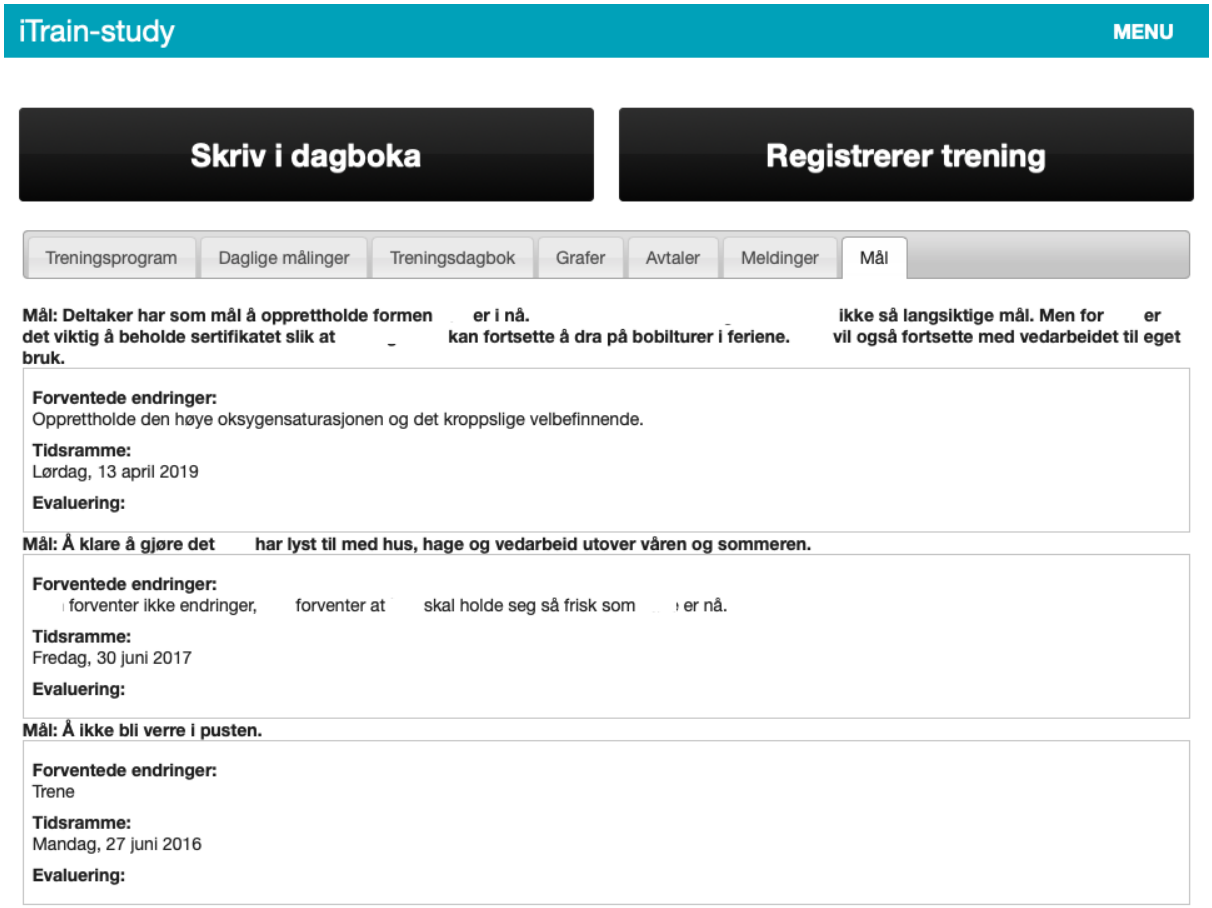


Figure 11: View of goal setting, from patient´s view.

Webpage from physiotherapist´s view

A physiotherapist can assess to all the information about the participants assigned to them. For example, if a participant has id of "no0**@itrain-study.com". The physiotherapist will open the iTrain webpage with his own id and click to the id of participant, he is interested to work on. The view of the webpage would be as shown in Figure 12.

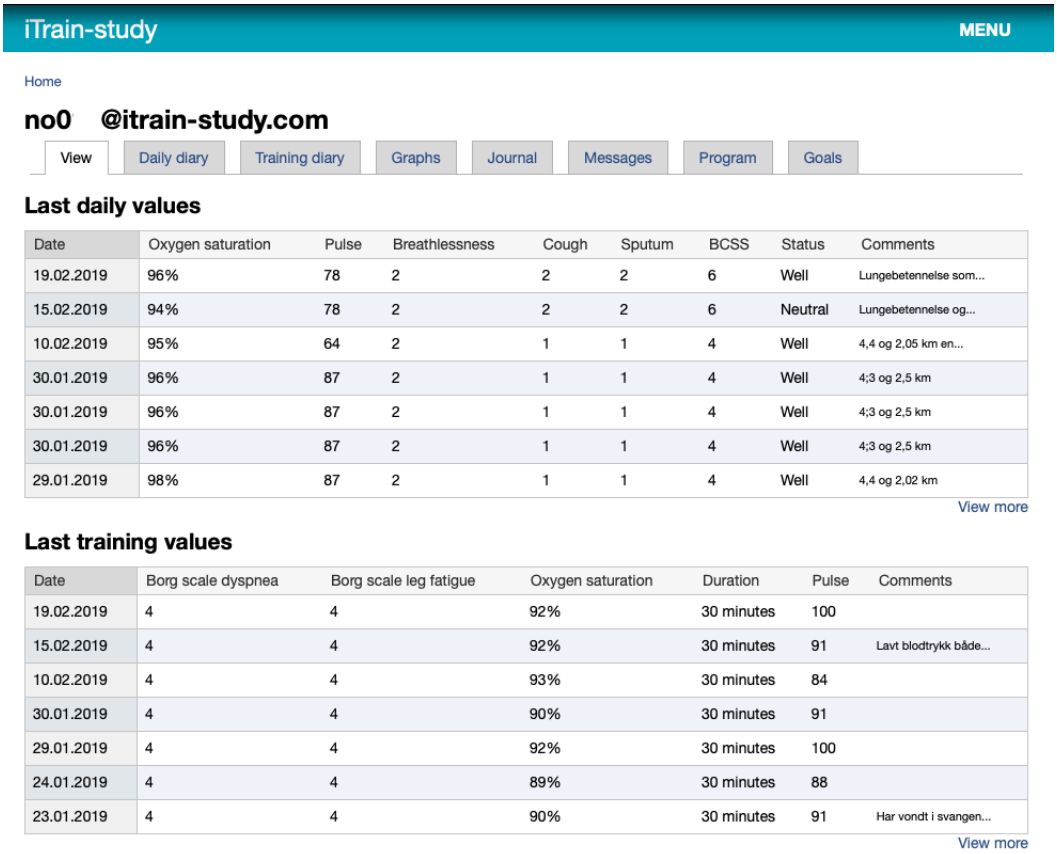
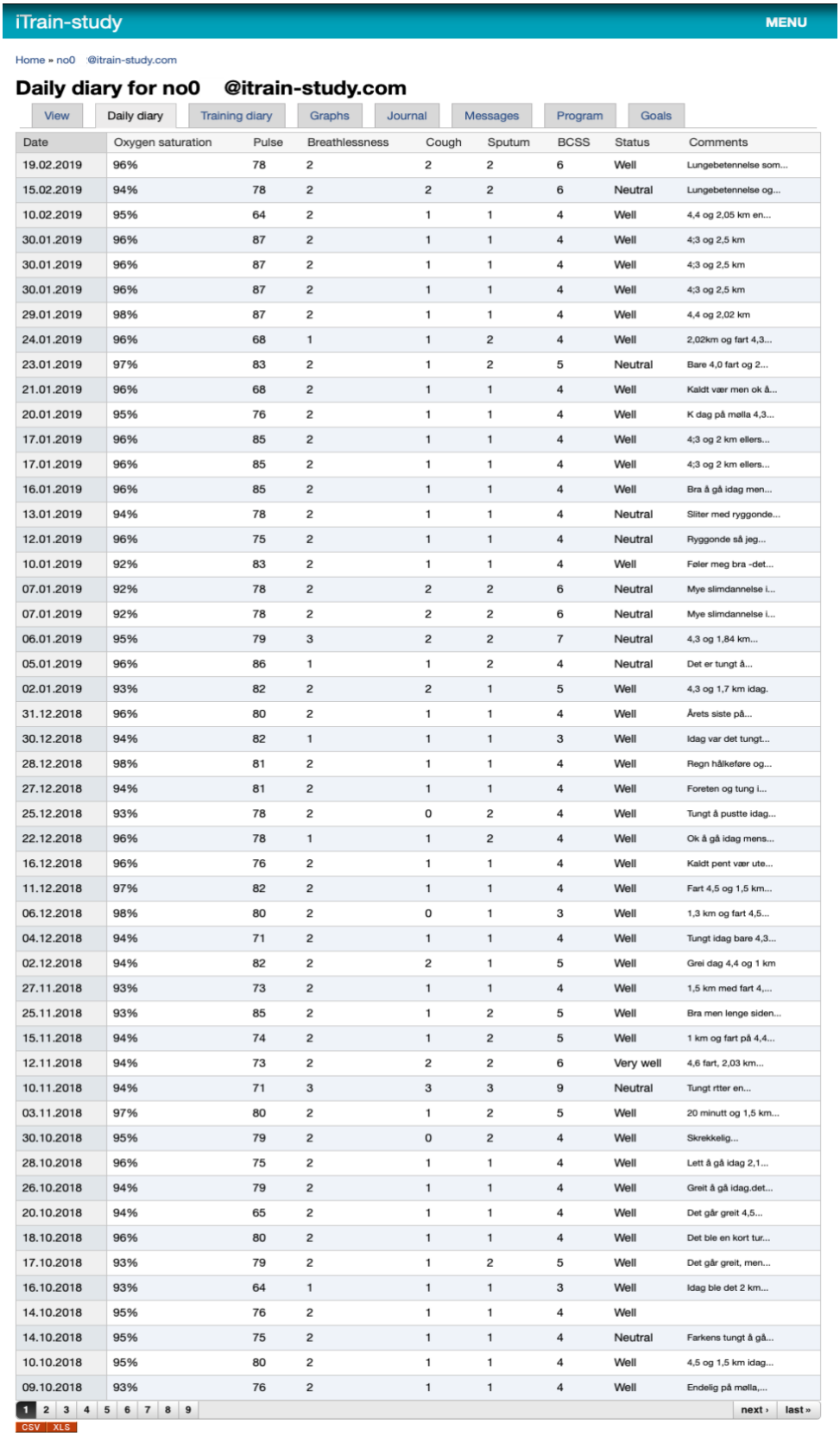


Figure 12: View of iTrain webpage from physiotherapist´s view.

When physiotherapist will click on the view tab, he can see last seven daily and training values on the page. In order to access the whole history of participant´s daily diary, physiotherapist will click on “Daily diary” tab. The view of the webpage can be seen in Figure 13.



Date	Oxygen saturation	Pulse	Breathlessness	Cough	Sputum	BCSS	Status	Comments
19.02.2019	96%	78	2	2	2	6	Well	Lungebetennelse som...
15.02.2019	94%	78	2	2	2	6	Neutral	Lungebetennelse og...
10.02.2019	95%	64	2	1	1	4	Well	4,4 og 2,05 km en...
30.01.2019	96%	87	2	1	1	4	Well	4;3 og 2,5 km
30.01.2019	96%	87	2	1	1	4	Well	4;3 og 2,5 km
30.01.2019	96%	87	2	1	1	4	Well	4;3 og 2,5 km
29.01.2019	98%	87	2	1	1	4	Well	4,4 og 2,02 km
24.01.2019	96%	68	1	1	2	4	Well	2,02km og fart 4,3...
23.01.2019	97%	83	2	1	2	5	Neutral	Bare 4,0 fart og 2...
21.01.2019	96%	68	2	1	1	4	Well	Kaldt vær men ok å...
20.01.2019	95%	76	2	1	1	4	Well	K dag på mølla 4,3...
17.01.2019	96%	85	2	1	1	4	Well	4;3 og 2 km ellers...
17.01.2019	96%	85	2	1	1	4	Well	4;3 og 2 km ellers...
16.01.2019	96%	85	2	1	1	4	Well	Bra å gå idag men...
13.01.2019	94%	78	2	1	1	4	Neutral	Sliter med ryggonde...
12.01.2019	96%	75	2	1	1	4	Neutral	Ryggonde så jeg...
10.01.2019	92%	83	2	1	1	4	Well	Føler meg bra -det...
07.01.2019	92%	78	2	2	2	6	Neutral	Mye slimdannelse i...
07.01.2019	92%	78	2	2	2	6	Neutral	Mye slimdannelse i...
06.01.2019	95%	79	3	2	2	7	Neutral	4,3 og 1,84 km...
05.01.2019	96%	86	1	1	2	4	Neutral	Det er tungt å...
02.01.2019	93%	82	2	2	1	5	Well	4,3 og 1,7 km idag.
31.12.2018	96%	80	2	1	1	4	Well	Årets siste på...
30.12.2018	94%	82	1	1	1	3	Well	Idag var det tungt...
28.12.2018	98%	81	2	1	1	4	Well	Regn hålkeføre og...
27.12.2018	94%	81	2	1	1	4	Well	Foreten og tung i...
25.12.2018	93%	78	2	0	2	4	Well	Tungt å pustte idag...
22.12.2018	96%	78	1	1	2	4	Well	Ok å gå idag mens...
16.12.2018	96%	76	2	1	1	4	Well	Kaldt pent vær ute...
11.12.2018	97%	82	2	1	1	4	Well	Fart 4,5 og 1,5 km...
06.12.2018	98%	80	2	0	1	3	Well	1,3 km og fart 4,5...
04.12.2018	94%	71	2	1	1	4	Well	Tungt idag bare 4,3...
02.12.2018	94%	82	2	2	1	5	Well	Grei dag 4,4 og 1 km
27.11.2018	93%	73	2	1	1	4	Well	1,5 km med fart 4,...
25.11.2018	93%	85	2	1	2	5	Well	Bra men lenge siden...
15.11.2018	94%	74	2	1	2	5	Well	1 km og fart på 4,4...
12.11.2018	94%	73	2	2	2	6	Very well	4,6 fart, 2,03 km...
10.11.2018	94%	71	3	3	3	9	Neutral	Tungt rtter en...
03.11.2018	97%	80	2	1	2	5	Well	20 minutt og 1,5 km...
30.10.2018	95%	79	2	0	2	4	Well	Skrekkelig...
28.10.2018	96%	75	2	1	1	4	Well	Lett å gå idag 2,1...
26.10.2018	94%	79	2	1	1	4	Well	Greit å gå idag.det...
20.10.2018	94%	65	2	1	1	4	Well	Det går greit 4,5...
18.10.2018	96%	80	2	1	1	4	Well	Det ble en kort tur...
17.10.2018	93%	79	2	1	2	5	Well	Det går greit, men...
16.10.2018	93%	64	1	1	1	3	Well	Idag ble det 2 km...
14.10.2018	95%	76	2	1	1	4	Well	
14.10.2018	95%	75	2	1	1	4	Neutral	Farkens tungt å gå...
10.10.2018	95%	80	2	1	1	4	Well	4,5 og 1,5 km idag...
09.10.2018	93%	76	2	1	1	4	Well	Endelig på mølla,...

Figure 13: View of daily diary from physiotherapist´s view.

Similarly, physiotherapist can access to the whole participant´s history of training exercises and related information by clicking on "Training diary" tab (Figure 14).

Date	Borg scale dyspnea	Borg scale leg fatigue	Oxygen saturation	Duration	Pulse	Comments
19.02.2019	4	4	92%	30 minutes	100	
15.02.2019	4	4	92%	30 minutes	91	Lavt blodtrykk både...
10.02.2019	4	4	93%	30 minutes	84	
30.01.2019	4	4	90%	30 minutes	91	
29.01.2019	4	4	92%	30 minutes	100	
24.01.2019	4	4	89%	30 minutes	88	
23.01.2019	4	4	90%	30 minutes	91	Har vondt i svangen...
21.01.2019	4	4	91%	20 minutes	85	
20.01.2019	3	4	91%	30 minutes	88	
17.01.2019	3	4	91%	30 minutes	90	Ok dag på mølla
16.01.2019	4	4	91%	25 minutes	90	
13.01.2019	4	4	90%	30 minutes	89	
12.01.2019	4	4	91%	20 minutes	78	
10.01.2019	4	4	90%	20 minutes	102	
07.01.2019	4	4	89%	20 minutes	92	Ok dag men prøver...
06.01.2019	5	5	90%	25 minutes	89	
05.01.2019	4	4	90%	20 minutes	102	
05.01.2019	4	4	90%	20 minutes	102	
02.01.2019	4	4	90%	25 minutes	92	
31.12.2018	4	4	93%	20 minutes	96	
30.12.2018	4	4	91%	20 minutes	93	Årets nestsiste dag...
28.12.2018	4	4	92%	20 minutes	91	
27.12.2018	4	4	91%	20 minutes	92	
25.12.2018	4	4	91%	20 minutes	97	
22.12.2018	4	4	87%	20 minutes	90	Normalt.
16.12.2018	4	4	93%	20 minutes	94	
11.12.2018	4	4	93%	20 minutes	107	Høye verdier idag...
06.12.2018	4	4	90%	20 minutes	89	
04.12.2018	3	4	91%	20 minutes	92	
02.12.2018	3	4	91%	15 minutes	90	
27.11.2018	4	3	91%	20 minutes	94	Stort sett ok dag...
25.11.2018	4	4	91%	20 minutes	89	
15.11.2018	4	4	90%	15 minutes	91	Ganske bra 2800...
12.11.2018	4	4	92%	25 minutes	88	Greit idag også
10.11.2018	6	4	92%	20 minutes	76	Håper det blir...
03.11.2018	4	4	92%	20 minutes	90	Har mye seigt i...
30.10.2018	5	3	91%	30 minutes	93	
28.10.2018	3	4	93%	30 minutes	96	Det er kaldt,klart...
26.10.2018	4	4	91%	30 minutes	94	Fart 4,5 nesten...
21.10.2018	4	4	92%	30 minutes	89	Plages med nettet...
20.10.2018	4	4	92%	30 minutes	91	Stort sett det...
18.10.2018	4	4	92%	15 minutes	90	
17.10.2018	4	4	92%	30 minutes	96	Ok å gå flere dager...
16.10.2018	4	3	91%	30 minutes	90	
14.10.2018	3	4	91%	20 minutes	92	
14.10.2018	3	4	91%	20 minutes	92	
10.10.2018	4	4	92%	20 minutes	94	Stort sett som...
09.10.2018	4	4	89%	20 minutes	90	
09.10.2018	4	4	89%	20 minutes	90	
30.09.2018	3	4	89%	15 minutes	96	

Figure 14: View of training diary from physiotherapist´s view.

Graphs can also be assessed by clicking on “Graphs” tab. Graphs are of three types. These are graphs for the number of weekly workout sessions, graphs on the basis of daily values and graphs on the basis of training values. The view of the webpage can be seen in Figure 15, 16 and 17.

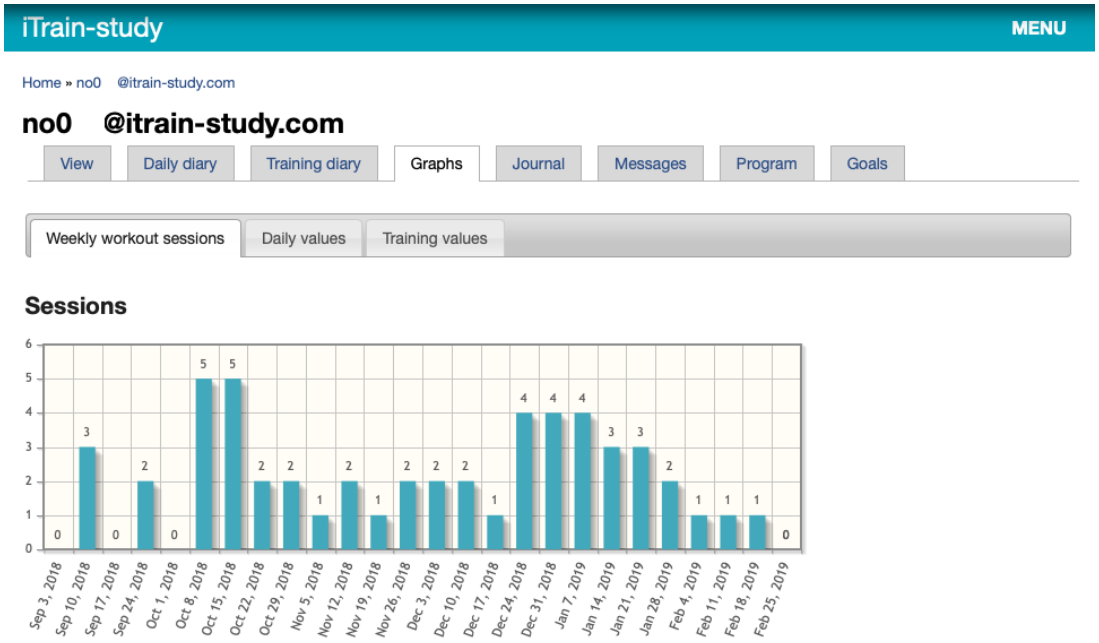


Figure 15: View of graphs for weekly work out, from physiotherapist´s view.

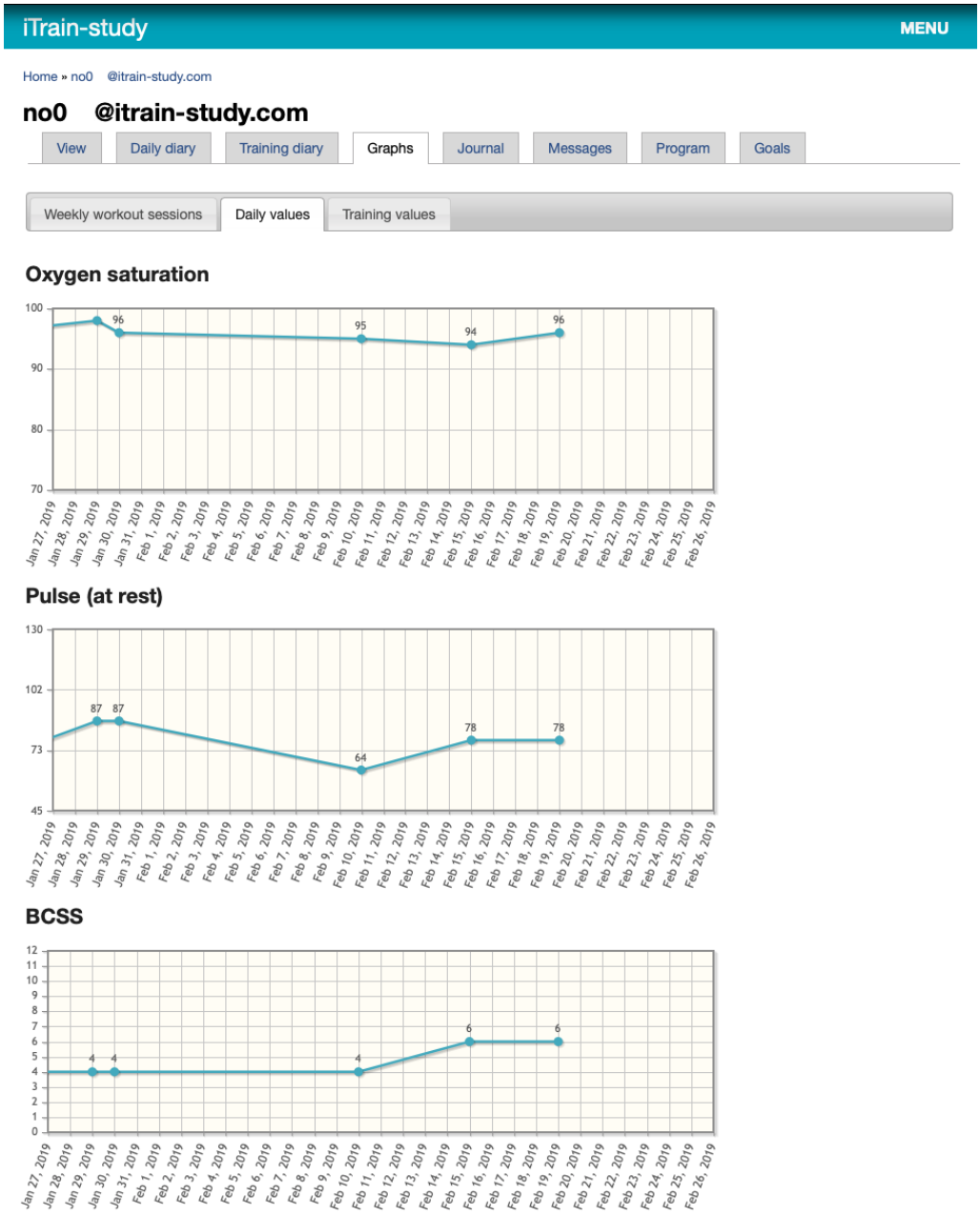


Figure 16: View of graphs for daily vales, from physiotherapist´s view.

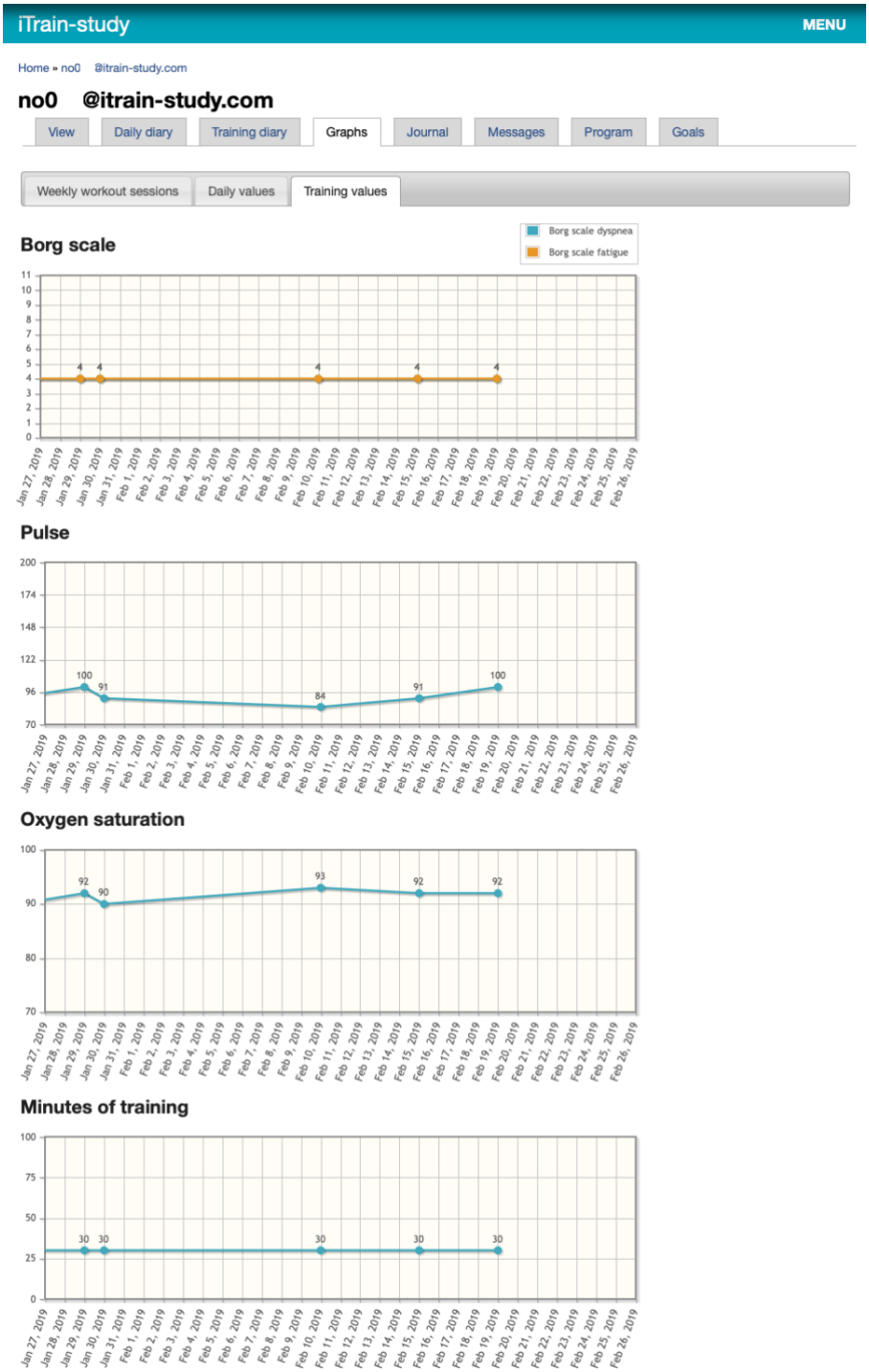


Figure 17: View of graphs for training values, from physiotherapist´s view.

Participant´s journals made from physiotherapist are very useful tool for health workers. It helps them to remind previous health condition and progress way of a participant. There was a tab of "Journals" as well. This can only be seen and viewed by physiotherapist or other health care manager. The view of journal as example is given in Figure 18.

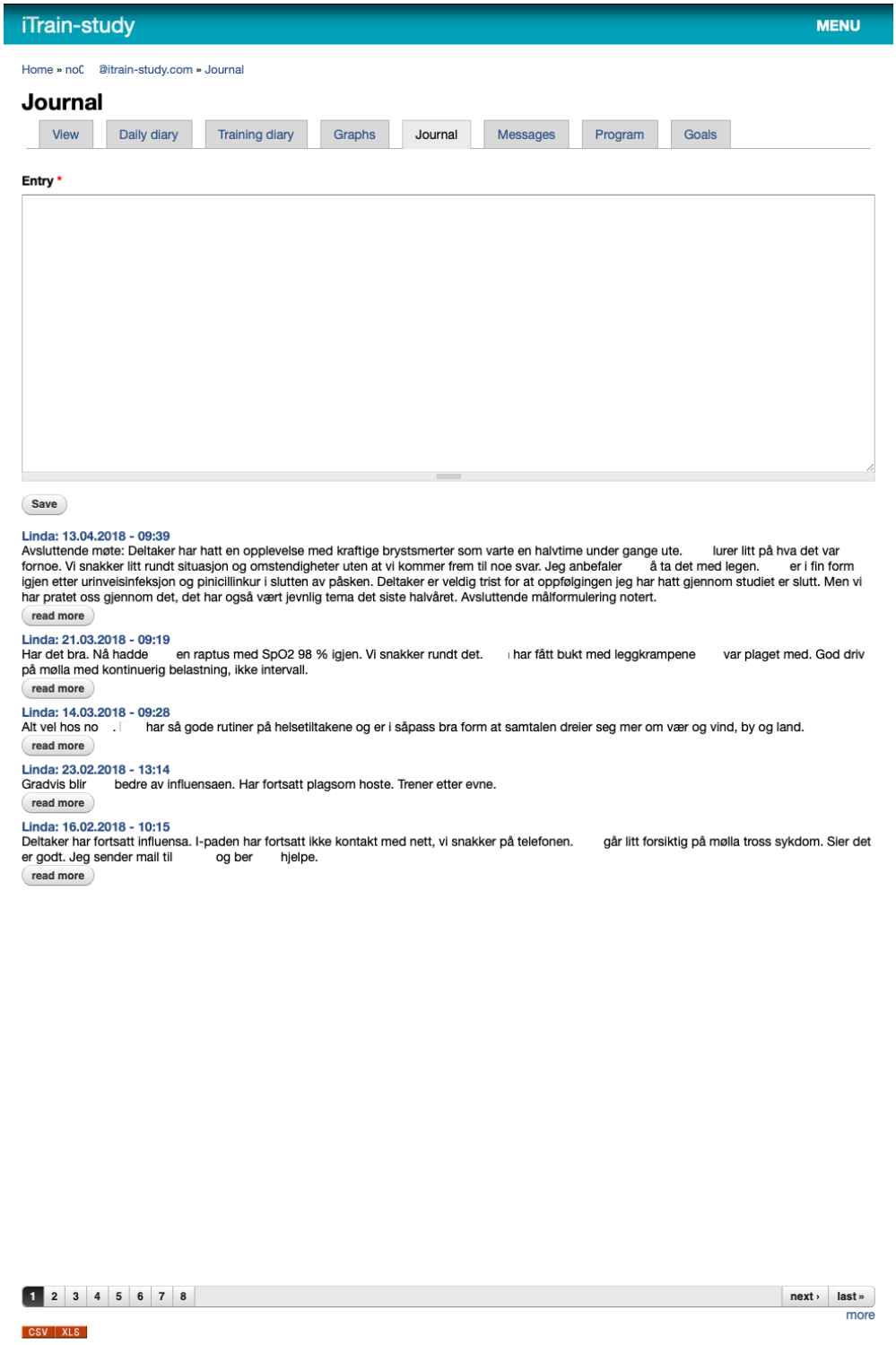


Figure 18: View of journals from physiotherapist´s view.

Physiotherapist and participant can have contact with each other on electronic messages other than videoconferencing. Usually a physiotherapist replies on weekly basis (Figure 19).

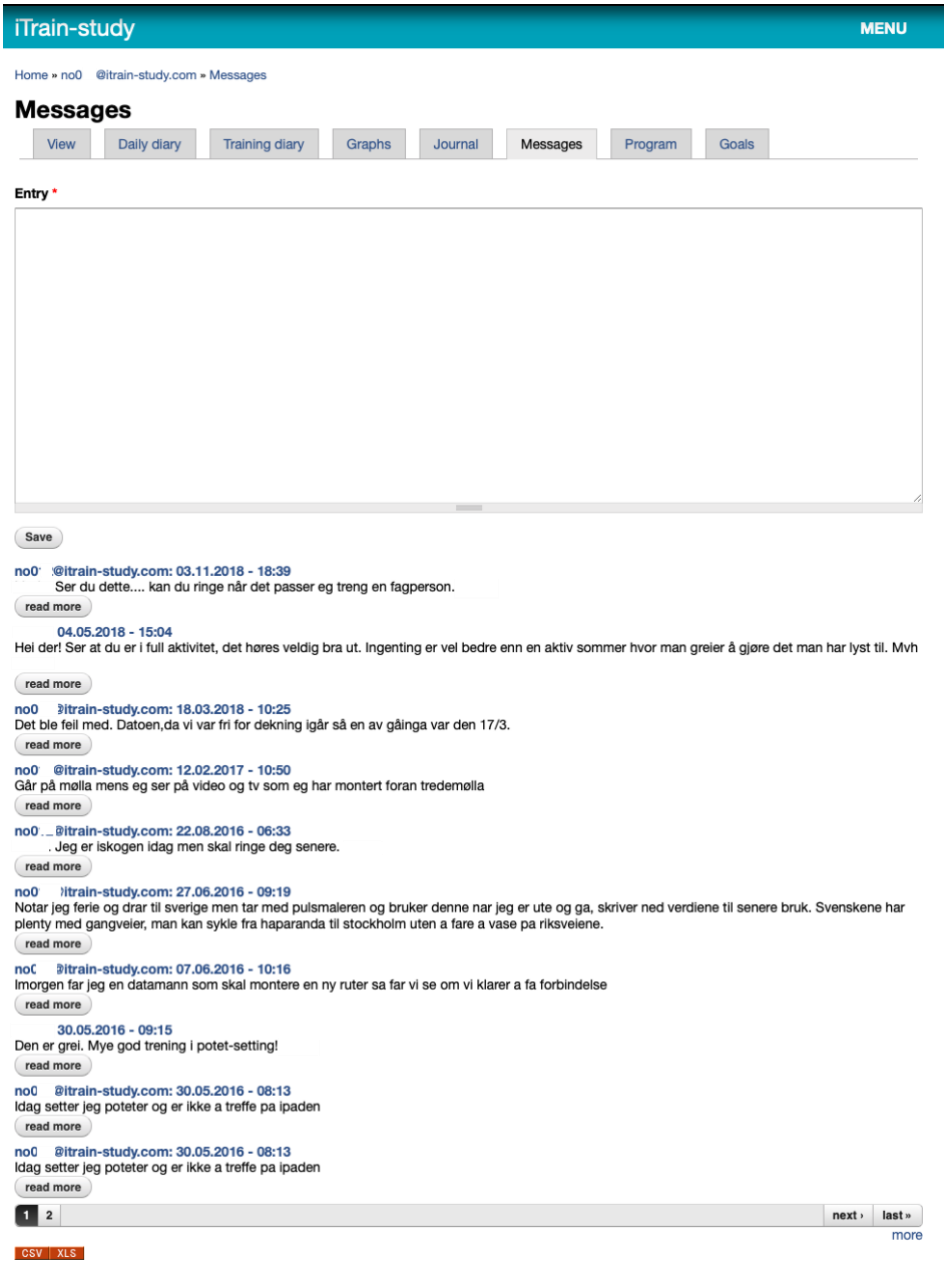


Figure 19: View of messages, from physiotherapist´s view.

By clicking on programme tab, physiotherapist can create and edit recommended exercise training for a particular participant (Figure 20).

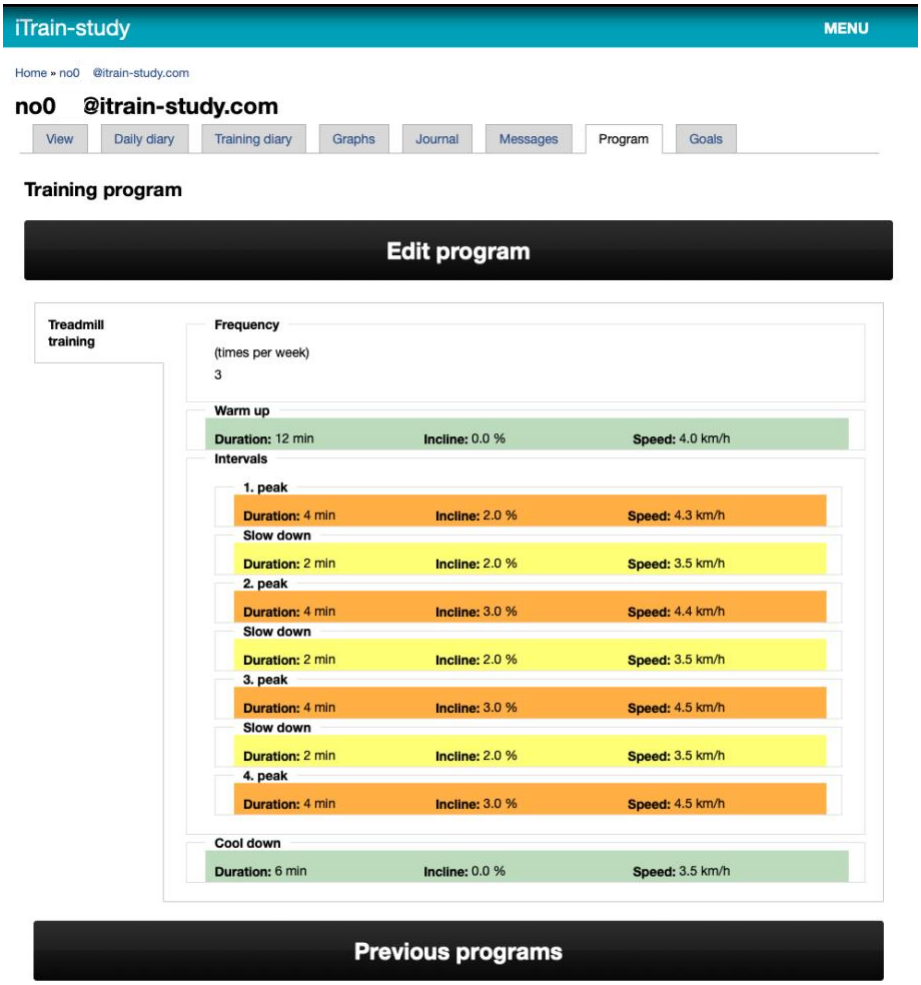


Figure 20: View of programme for individual training exercise prescription, from physiotherapist´s view.

There was a "Goal" tab also. In this tab, physiotherapist will set goals for individual participant while stating expected change by a certain time. This can be seen in Figure 21.

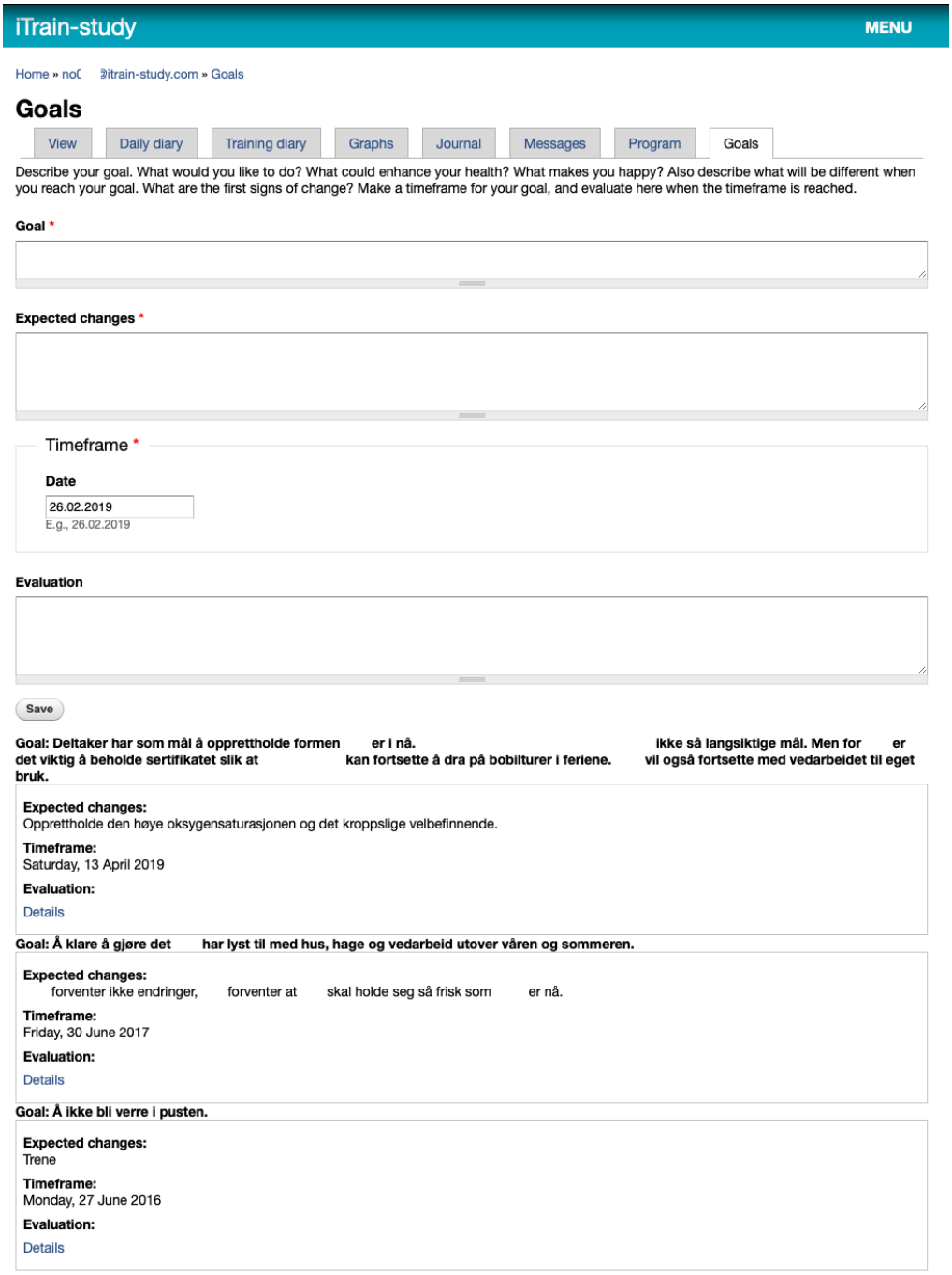


Figure 21: View of goals, from physiotherapist´s view.

Quantitative Analysis

Data collection

First of all, logs from iTrain webpage were downloaded. This data were limited to the telerehabilitation arm. Two logs were downloaded in ".xls" (Microsoft Excel) format, one with data from "Daily Diary" and another with data from "Training Diary". I used the excel files and arranged the data first by date, then by patient ID by using filter function of

Microsoft excel. In this thesis, the aim was to analyse telerehabilitation for the first year only. So the data for the second year were placed in another spread sheet of Microsoft excel file. Data were then arranged data by date and patient ID for the first year of iTrain.

Data processing

Removing duplicates

We observed that there were a lot of duplicates in the activity logs of patients. So, we removed duplicates by applying a formula. That formula works by writing "Duplicates" if and only the two rows in a spread sheet are exactly the same. These duplicated were then moved, one by one, to another spreadsheet with a name "Real duplicate". There were 174 real-duplicates in training diary and 425 in daily diary. Real duplicates seemed to appear because of unknown technical errors.

After removing "Real-duplicates", we could see some more duplicates. These duplicates were not exactly the same. They had some minor differences. So, we optimized these duplicated by setting up four criteria:

1. the sum of the minutes of all recordings
2. the lowest value of oxygen saturation
3. the highest values for the two Borg scales
4. the most meaningful comment

After optimizing these duplicates, we cut and paste them, one by one, into another sheet and named it as "Non-Real Duplicate". There were 541 non-real duplicates in training diary and 515 in daily diary. Now we had Training and Daily Diaries with no duplicates. We also check duplicates presence by using Microsoft excel built in duplicate option under data tab.

Data Analysis

Measuring Adherence for first Year

Adherence was measured in terms of frequency of registrations on the webpage (Hoaas et al., 2016). I copied data of patient ID and registering dates from both training and daily diary and copied it on another excel sheet and named this sheet as "Adherence in first year". Then we entered the inclusion date of each participant in 3rd column. Then we entered dated in new columns by 1-month interval using formula, *"$C2+30" or "$C2+31"*, according to the numbers of days in a month. This can be seen in figure below.

Figure 22: Training Diary excel data showing one-month interval.

D2 =$C2+30

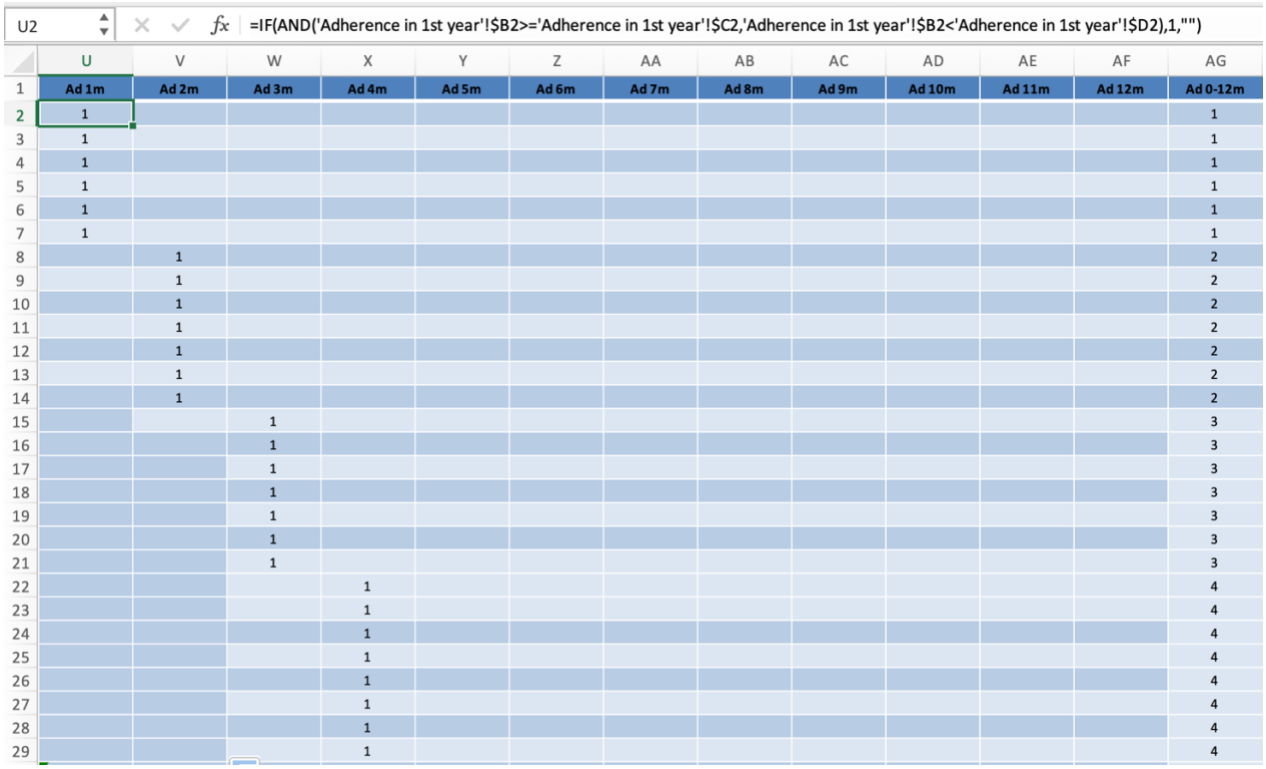
Patient_ID	Date	Inclusion Date	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m
au001	17/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	25/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	27/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	28/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	29/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	30/04/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	03/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	09/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02-Jan-16	02/02/2016	02/03/2016	02/04/2016
au001	13/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	14/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	15/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016
au001	18/05/2015	02-Apr-15	02/05/2015	02/06/2015	02/07/2015	02/08/2015	02/09/2015	02/10/2015	02/11/2015	02/12/2015	02/01/2016	02/02/2016	02/03/2016	02/04/2016

Then we measured 3 months adherence in the form of measuring adherence in 1st, 2nd, 3rd and 4th 3 months. We used If and formula of excel and create a formula which was *"=IF(AND($B2>=$C2,$B2<$F2),1,"")"*. This formula means that write "1" if the registration date comes after than the inclusive date of participant and before the end of 3rd month of participation, if this is not the case, then let the cell be empty. Similar formula was applied to the other three months intervals. This can be seen in figure below

AG15 =IF('Adherence in 1st year'!$U15=1,1,I

AD in 1st 3m	AD IN 2ND 3M	AD in 3rd 3m	AD in 4th 3m	Column1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
1				1
	1			2
	1			2
	1			2
	1			2

By using the similar formula, we find adherence in every month. This can be seen in the figure below



U2 =IF(AND('Adherence in 1st year'!$B2>='Adherence in 1st year'!$C2,'Adherence in 1st year'!$B2<'Adherence in 1st year'!$D2),1,"")

	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	Ad 1m	Ad 2m	Ad 3m	Ad 4m	Ad 5m	Ad 6m	Ad 7m	Ad 8m	Ad 9m	Ad 10m	Ad 11m	Ad 12m	Ad 0-12m
2	1												1
3	1												1
4	1												1
5	1												1
6	1												1
7	1												1
8		1											2
9		1											2
10		1											2
11		1											2
12		1											2
13		1											2
14		1											2
15			1										3
16			1										3
17			1										3
18			1										3
19			1										3
20			1										3
21			1										3
22				1									4
23				1									4
24				1									4
25				1									4
26				1									4
27				1									4
28				1									4
29				1									4

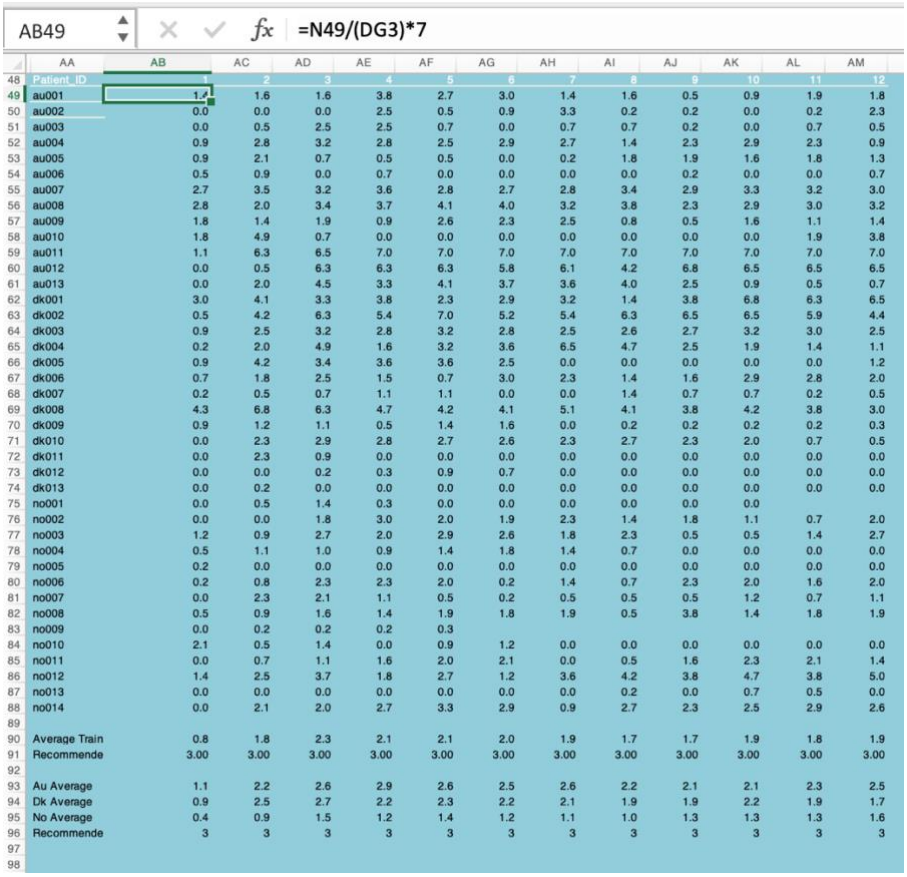
Here “Ad 1m” mean adherence in 1st month of iTrain.” Ad 0-12m” means adherence in the first 12 months. In this column, 1 mean that this registration was registered in the first month after joining this project.

We used this way of measuring adherence in both training and daily diary. We make this data in the form of table for our own ease. Now we copy this data in another spread sheet with a name “Untabled adherence in 1st year” and de-tabled it. Now we add column “Delay days” by using formula *“B2-F2”* which is registration date minus inclusion date. We also made “Drop out” column. This was done in both training and daily diaries data.

Pivot table

We used pivot table in Microsoft excel to count the number of adherence in a particular month.

We obtained the adherence to both training and daily diaries, by a particular participant in a particular month. We then divided this attendance in a month by the number of days in a month by multiplying by 7 (as there are 7 days in a week). In this way we obtained weekly attendance of a participant.

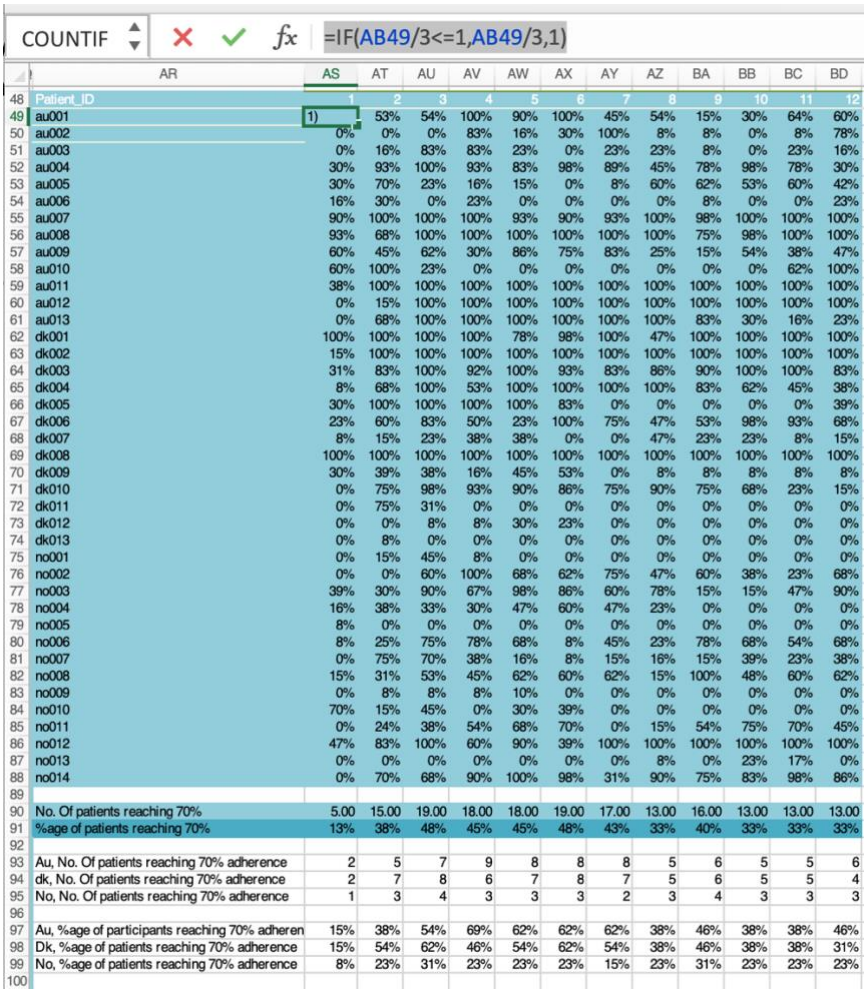


AB49 =N49/(DG3)*7

	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
48	Patient_ID	1	2	3	4	5	6	7	8	9	10	11	12
49	au001	1.4	1.6	1.6	3.8	2.7	3.0	1.4	1.6	0.5	0.9	1.9	1.8
50	au002	0.0	0.0	0.0	2.5	0.5	0.9	3.3	0.2	0.2	0.0	0.2	2.3
51	au003	0.0	0.5	2.5	2.5	0.7	0.0	0.7	0.7	0.2	0.0	0.7	0.5
52	au004	0.9	2.8	3.2	2.8	2.5	2.9	2.7	1.4	2.3	2.9	2.3	0.9
53	au005	0.9	2.1	0.7	0.5	0.5	0.0	0.2	1.8	1.9	1.6	1.8	1.3
54	au006	0.5	0.9	0.0	0.7	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.7
55	au007	2.7	3.5	3.2	3.6	2.8	2.7	2.8	3.4	2.9	3.3	3.2	3.0
56	au008	2.8	2.0	3.4	3.7	4.1	4.0	3.2	3.8	2.3	2.9	3.0	3.2
57	au009	1.8	1.4	1.9	0.9	2.6	2.3	2.5	0.8	0.5	1.6	1.1	1.4
58	au010	1.8	4.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8
59	au011	1.1	6.3	6.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
60	au012	0.0	0.5	6.3	6.3	6.3	5.8	6.1	4.2	6.8	6.5	6.5	6.5
61	au013	0.0	2.0	4.5	3.3	4.1	3.7	3.6	4.0	2.5	0.9	0.5	0.7
62	dk001	3.0	4.1	3.3	3.8	2.3	2.9	3.2	1.4	3.8	6.8	6.3	6.5
63	dk002	0.5	4.2	6.3	5.4	7.0	5.2	5.4	6.3	6.5	6.5	5.9	4.4
64	dk003	0.9	2.5	3.2	2.8	3.2	2.8	2.5	2.6	2.7	3.2	3.0	2.5
65	dk004	0.2	2.0	4.9	1.6	3.2	3.6	6.5	4.7	2.5	1.9	1.4	1.1
66	dk005	0.9	4.2	3.4	3.6	3.6	2.5	0.0	0.0	0.0	0.0	0.0	1.2
67	dk006	0.7	1.8	2.5	1.5	0.7	3.0	2.3	1.4	1.6	2.9	2.8	2.0
68	dk007	0.2	0.5	0.7	1.1	1.1	0.0	0.0	1.4	0.7	0.7	0.2	0.5
69	dk008	4.3	6.8	6.3	4.7	4.2	4.1	5.1	4.1	3.8	4.2	3.8	3.0
70	dk009	0.9	1.2	1.1	0.5	1.4	1.6	0.0	0.2	0.2	0.2	0.2	0.3
71	dk010	0.0	2.3	2.9	2.8	2.7	2.6	2.3	2.7	2.3	2.0	0.7	0.5
72	dk011	0.0	2.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73	dk012	0.0	0.0	0.2	0.3	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0
74	dk013	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	no001	0.0	0.5	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0		
76	no002	0.0	0.0	1.8	3.0	2.0	1.9	2.3	1.4	1.8	1.1	0.7	2.0
77	no003	1.2	0.9	2.7	2.0	2.9	2.6	1.8	2.3	0.5	0.5	1.4	2.7
78	no004	0.5	1.1	1.0	0.9	1.4	1.8	1.4	0.7	0.0	0.0	0.0	0.0
79	no005	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	no006	0.2	0.8	2.3	2.3	2.0	0.2	1.4	0.7	2.3	2.0	1.6	2.0
81	no007	0.0	2.3	2.1	1.1	0.5	0.2	0.5	0.5	0.5	1.2	0.7	1.1
82	no008	0.5	0.9	1.6	1.4	1.9	1.8	1.9	0.5	3.8	1.4	1.8	1.9
83	no009	0.0	0.2	0.2	0.2	0.3							
84	no010	2.1	0.5	1.4	0.0	0.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0
85	no011	0.0	0.7	1.1	1.6	2.0	2.1	0.0	0.5	1.6	2.3	2.1	1.4
86	no012	1.4	2.5	3.7	1.8	2.7	1.2	3.6	4.2	3.8	4.7	3.8	5.0
87	no013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.7	0.5	0.0
88	no014	0.0	2.1	2.0	2.7	3.3	2.9	0.9	2.7	2.3	2.5	2.9	2.6
89													
90	Average Train	0.8	1.8	2.3	2.1	2.1	2.0	1.9	1.7	1.7	1.9	1.8	1.9
91	Recommende	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
92													
93	Au Average	1.1	2.2	2.6	2.9	2.6	2.5	2.6	2.2	2.1	2.1	2.3	2.5
94	Dk Average	0.9	2.5	2.7	2.2	2.3	2.2	2.1	1.9	1.9	2.2	1.9	1.7
95	No Average	0.4	0.9	1.5	1.2	1.4	1.2	1.1	1.0	1.3	1.3	1.3	1.6
96	Recommende	3	3	3	3	3	3	3	3	3	3	3	3
97													
98													

Before this we also managed to calculate the number of days in a month precisely according to participant inclusion date to this project using pivot table. Then we also calculated the average number of training exercise in a week. This was a multinational project, so we also took average of participants of 3 different countries separately.

As the recommended training exercise was 3 times a week, so we divided the value of exercise attendance per week by 3 and applied the formula "*=IF(AB49/3<=1,AB49/3,1)"*. In this way we calculated percentage of recommended exercise attended. This can be seen below.



	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
48	Patient_ID	1	2	3	4	5	6	7	8	9	10	11	12
49	au001	1)	53%	54%	100%	90%	100%	45%	54%	15%	30%	64%	60%
50	au002	0%	0%	0%	83%	16%	30%	100%	8%	8%	0%	8%	78%
51	au003	0%	16%	83%	83%	23%	0%	23%	23%	8%	0%	23%	16%
52	au004	30%	93%	100%	93%	83%	98%	89%	45%	78%	98%	78%	30%
53	au005	30%	70%	23%	16%	15%	0%	8%	60%	62%	53%	60%	42%
54	au006	16%	30%	0%	23%	0%	0%	0%	0%	8%	0%	0%	23%
55	au007	90%	100%	100%	100%	93%	90%	93%	100%	98%	100%	100%	100%
56	au008	93%	68%	100%	100%	100%	100%	100%	100%	75%	98%	100%	100%
57	au009	60%	45%	62%	30%	86%	75%	83%	25%	15%	54%	38%	47%
58	au010	60%	100%	23%	0%	0%	0%	0%	0%	0%	0%	62%	100%
59	au011	38%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
60	au012	0%	15%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
61	au013	0%	68%	100%	100%	100%	100%	100%	100%	83%	30%	16%	23%
62	dk001	100%	100%	100%	100%	78%	98%	100%	47%	100%	100%	100%	100%
63	dk002	15%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
64	dk003	31%	83%	100%	92%	100%	93%	83%	86%	90%	100%	100%	83%
65	dk004	8%	68%	100%	53%	100%	100%	100%	100%	83%	62%	45%	38%
66	dk005	30%	100%	100%	100%	100%	83%	0%	0%	0%	0%	0%	39%
67	dk006	23%	60%	83%	50%	23%	100%	75%	47%	53%	98%	93%	68%
68	dk007	8%	15%	23%	38%	38%	0%	0%	47%	23%	23%	8%	15%
69	dk008	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
70	dk009	30%	39%	38%	16%	45%	53%	0%	8%	8%	8%	8%	8%
71	dk010	0%	75%	98%	93%	90%	86%	75%	90%	75%	68%	23%	15%
72	dk011	0%	75%	31%	0%	0%	0%	0%	0%	0%	0%	0%	0%
73	dk012	0%	0%	8%	8%	30%	23%	0%	0%	0%	0%	0%	0%
74	dk013	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
75	no001	0%	15%	45%	8%	0%	0%	0%	0%	0%	0%	0%	0%
76	no002	0%	0%	60%	100%	68%	62%	75%	47%	60%	38%	23%	68%
77	no003	39%	30%	90%	67%	98%	86%	60%	78%	15%	15%	47%	90%
78	no004	16%	38%	33%	30%	47%	60%	47%	23%	0%	0%	0%	0%
79	no005	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80	no006	8%	25%	75%	78%	68%	8%	45%	23%	78%	68%	54%	68%
81	no007	0%	75%	70%	38%	16%	8%	15%	16%	15%	39%	23%	38%
82	no008	15%	31%	53%	45%	62%	60%	62%	15%	100%	48%	60%	62%
83	no009	0%	8%	8%	8%	10%	0%	0%	0%	0%	0%	0%	0%
84	no010	70%	15%	45%	0%	30%	39%	0%	0%	0%	0%	0%	0%
85	no011	0%	24%	38%	54%	68%	70%	0%	15%	54%	75%	70%	45%
86	no012	47%	83%	100%	60%	90%	39%	100%	100%	100%	100%	100%	100%
87	no013	0%	0%	0%	0%	0%	0%	0%	8%	0%	23%	17%	0%
88	no014	0%	70%	68%	90%	100%	98%	31%	90%	75%	83%	98%	86%
89													
90	No. Of patients reaching 70%	5.00	15.00	19.00	18.00	18.00	19.00	17.00	13.00	16.00	13.00	13.00	13.00
91	%age of patients reaching 70%	13%	38%	48%	45%	45%	48%	43%	33%	40%	33%	33%	33%
92													
93	Au, No. Of patients reaching 70% adherence	2	5	7	9	8	8	8	5	6	5	5	6
94	dk, No. Of patients reaching 70% adherence	2	7	8	6	7	8	7	5	6	5	5	4
95	No, No. Of patients reaching 70% adherence	1	3	4	3	3	3	2	3	4	3	3	3
96													
97	Au, %age of participants reaching 70% adheren	15%	38%	54%	69%	62%	62%	62%	38%	46%	38%	38%	46%
98	Dk, %age of patients reaching 70% adherence	15%	54%	62%	46%	54%	62%	54%	38%	46%	38%	38%	31%
99	No, %age of patients reaching 70% adherence	8%	23%	31%	23%	23%	23%	15%	23%	31%	23%	23%	23%
100													

Then we calculated number of patients reaching 70% adherence each month by applying formula "*COUNTIF(AS49:AS88,">0.6999")*". We also calculated the percentage of patients reaching 70% attendance by dividing number of patients reaching 70% adherence by 40 (as there were total 40 participants in the telerehabilitation arm). The same was calculated on different countries also.

All of this procedure was also done simultaneously in daily diary as well.

Descriptive Statistics

We used SPSS statistics 25 to calculate descriptive analysis. We used built-in functions in SPSS.

Qualitative analysis

Factors affecting adherence and practical challenges were measured qualitatively through semi-structured interviews. We conducted a total of eight semi-structured

interviews with eight professionals working in the management of the iTrain project: two from Australia, three from Norway and three from Denmark.

Framework Method

For the analysis of quantitative data, we chose to use the framework method analysis. It yields systematic modelling for the management and mapping of the data under study. It is appropriate for medical and health related research especially when it is mixed methods and multi-disciplinary. It fits well for the analysis of interview, where it is sensible to generate themes in order to compare them between or within cases. And also it has been most commonly used for analysis of semi-structured interviews (Gale, Heath, Cameron, Rashid, & Redwood, 2013).

Framework analysis facilitates the management of large data by using matrix form, which provides an overview of summarized data in a structured way. It works by approaching similarities and differences in a qualitative data. Its matrix outputs have rows and column. Usually, rows represent cases (for example, an interviewee) while columns represent codes. The cells of the matrix provide summarized data which gives structure to the data in a meaningful way.

Elements of Framework method

Key elements in a framework method is following:

Analytical framework

First of all, codes are generated by researcher (in this case, by me) and then organized into relevant categories. These codes will be later use for organization and management of data.

Categories

While analysing the data, we grouped codes into clusters of interrelated or similar concepts and ideas. A tree diagram is formed of these codes and categories.

Indexing

It is the “systematic application of codes from the agreed analytical framework to the whole dataset”.

Themes

Themes are the interpretive concepts or explanations of the data aspects. Usually some categories come under a theme or subtheme.

Transcript

It is a written verbatim, that is word by word, account of verbal interaction. For example a conversation or interview (Gale et al., 2013).

Procedure for Framework Analysis

Step 1: Transcription

Interviews were recorded in audio form in our case. I did use “Temi” for verbatim transcription (i.e. word to word conversion of audio form into written form). Temi is a software available for online transcription ("Temi,").

Step 2: Familiarisation with interviews

If the interviews are conducted by a person who is not supposed to analyse data, then the person analysing the data must listen the interview a few times in order to get familiarize with the data. In our case, it was the same person, so we skipped this part.

Step 3: Coding

After getting familiarization with the interview, researcher creates codes. He/she reads the transcript line by line and then label the line or paragraph according to their interpretation. We also did so. We read all transcripts of interviews and label relevant information with codes. In inductive studies, “open coding” is use while in deductive studies, codes are mostly pre-defined in a certain area of interest. In our case, it was more of inductive studies.

Step 4: Developing analytical framework

After coding of some transcripts, researchers gather to give their mutual verdict about suitable codes, which is later applied on all other transcripts. These codes are then later group together under the roof of categories (a tree diagram). Me and my supervisor did this work together.

Step 5: Applying the analytical framework

The analytical framework (codes and categories) developed earlier is then applied by the indexing of relevant transcripts. NVivo12 is specifically very useful in this step. This

software package helps in saving time on management as well as retrieval of data later. It does not analyse data but is an efficient way to sort and organize the data. In this way the data become easily assessible when needed while performing qualitative analysis.

Step 6: Charting data in framework matrix

Qualitative data are usually voluminous and making them short and meaningful is vital part of qualitative analysis. Usually a spreadsheet in excel is used for matrix generation and data is summarized in accordance with the category made earlier. This process is known as charting. This part is done automatically, if we use Nvivo12.

Step 7: Interpretation of data

It is a useful if researchers write down his own expressions, interpretation and ideas on a paper or in a separate word file. These analytical memos can help later to come up with interesting ideas, potential themes or concepts (Crotty & Unwin, 2012).

INTERVIEW GUIDE

PRACTICAL CHALLENGES OF LONG-TERM TR BY PATIENTS WITH COPD

1. Which practical challenges* have been encountered by participants and/or by service delivers?
    - practical issues (e.g. usability, confidence with exercise, social support, time)
    - logistic issues (e.g. delivery of the equipment, space available at home)
    - technical issues (e.g. videoconferencing, Internet, technical problems with equipment)
    - organizational issues (e.g. scheduling of videoconferences, availability of study personnel, turnover)
    - other issues (e.g. health related problems, exacerbations, periods of absence, holidays)
2. How do practical challenges (mentioned above) affect use and adherence to the intervention?
    - Suggestions for improvement?

3. Which other factors (e.g. country, weather, time, disease progression, background variables such as gender, age, computer literacy) might affect adherence?
4. Which are the key requirements to support scalability and future implementation?
5. How do practical challenges (mentioned above) affect use and adherence to the intervention?
    - Suggestions for improvement?
6. Which other factors (e.g. country, weather, time, disease progression, background variables such as gender, age, computer literacy) might affect adherence?
7. Which are the key requirements to support scalability and future implementation?

RESULTS

As we have done analysis of logs of webpage quantitatively. We made graphs from the analysed data.

Results for quantitative analysis

Graphs for Training Diary

For training exercise, recommended weekly exercise frequency was three times a week. We have found that participants performed training exercise 1.8 times a week on average on annual basis. The trend of exercise training by participant was relatively stable and can be seen in the Figure 23.

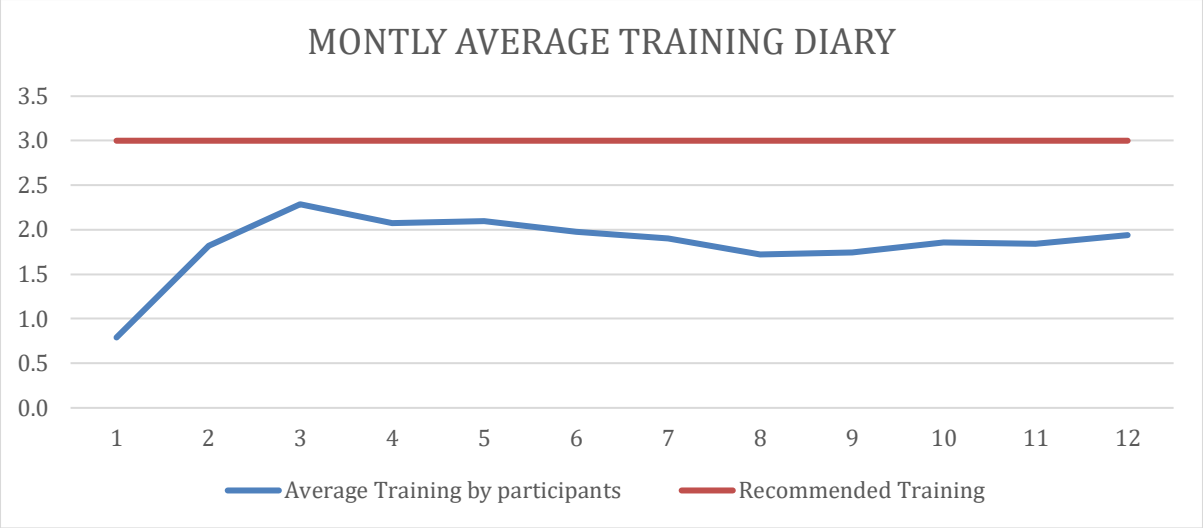


Figure 23: Graph for monthly average training diary.

iTrain was conducted in three different countries. We also measured the average training exercise attendance in the three countries and found that adherence to exercise training was higher among Australians (2.3 exercise training/week), followed by Danes (2.0 exercise training/week) and Norwegians (1.2 exercise training/week). The trend of attending home-based exercise can be seen in Figure 24.

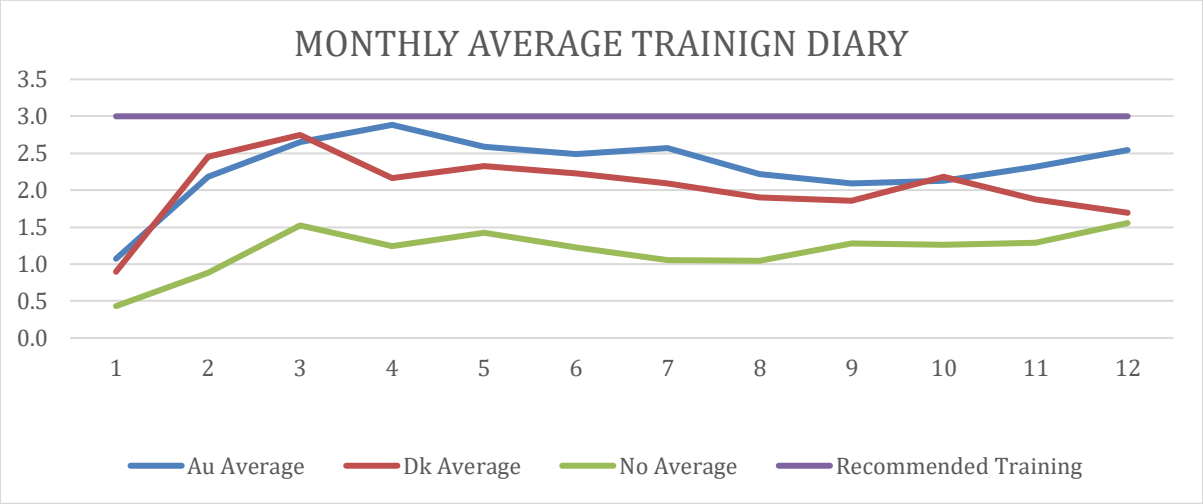


Figure 24: Graph for monthly average training diary in three different countries.

We considered a participant to be adherent to exercise training only if he/she performed 70% of the recommended exercise (Cox et al., 2018). As a consequence, we also calculated the percentage of participants reaching 70% adherence in training exercise, which was

found to be 37% on an annual basis. Out of this, 47% of Australians, 45% of Danes and 22% of Norwegians remained adherent to the intervention in the first year. The trend of adherence to exercise training for participants in iTrain for the first year can be seen in Figure 25. The participants' adherence kept on increasing during the first three to four months, it remained almost stable for further four months, but after that it declined to an extent.

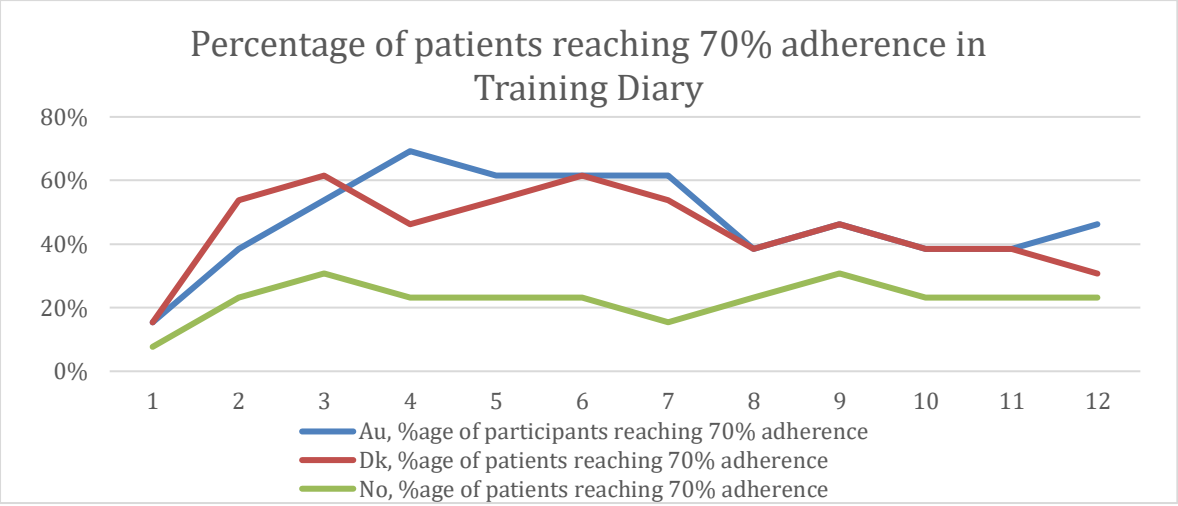
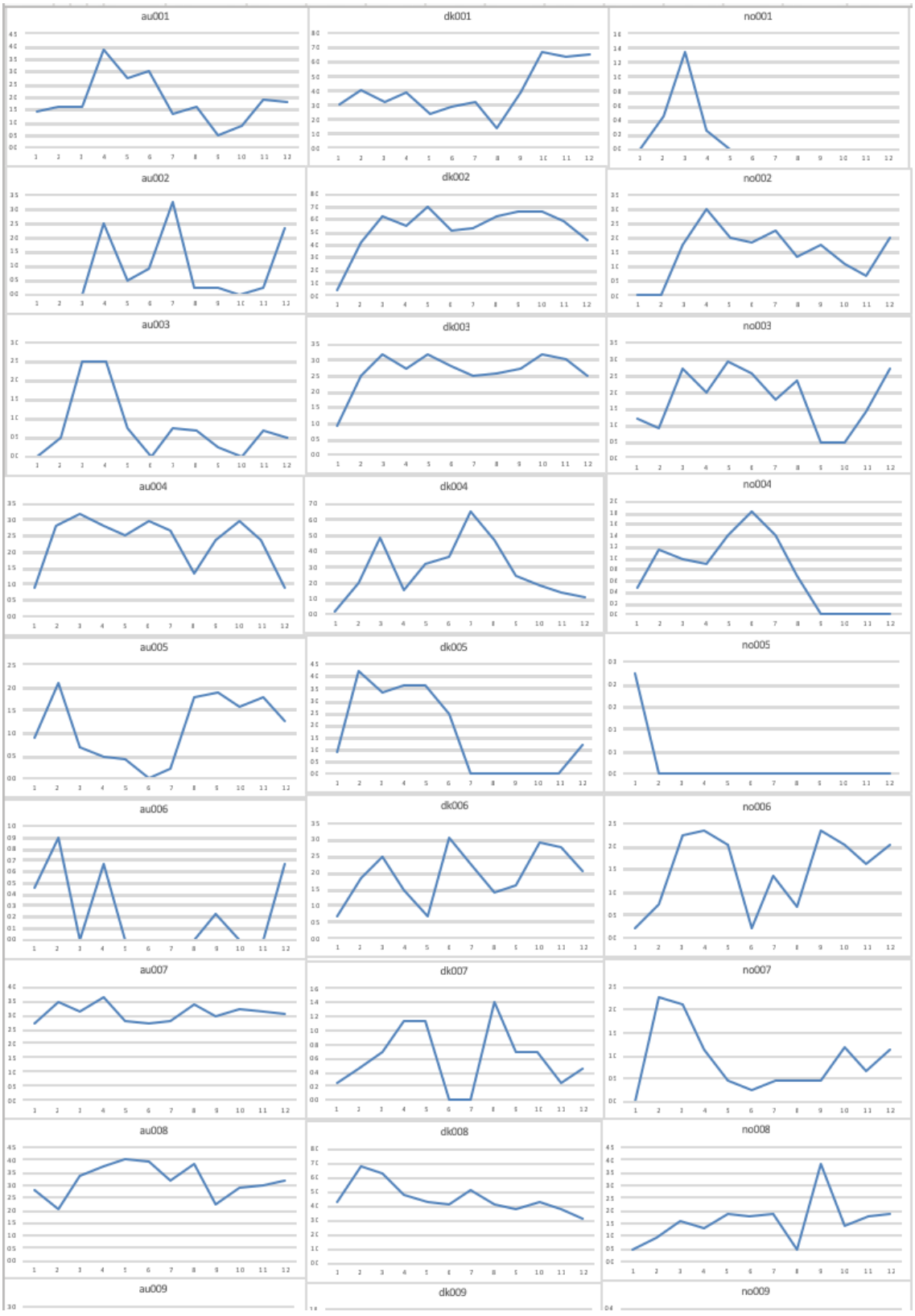


Figure 25: Graph for percentage of patients reaching 70% adherence in Training Diary.

There were found to have a lot of individual variations in exercise attendance trend among participants. This means that every participant took the same service but performed differently. This can be seen in Figure 26.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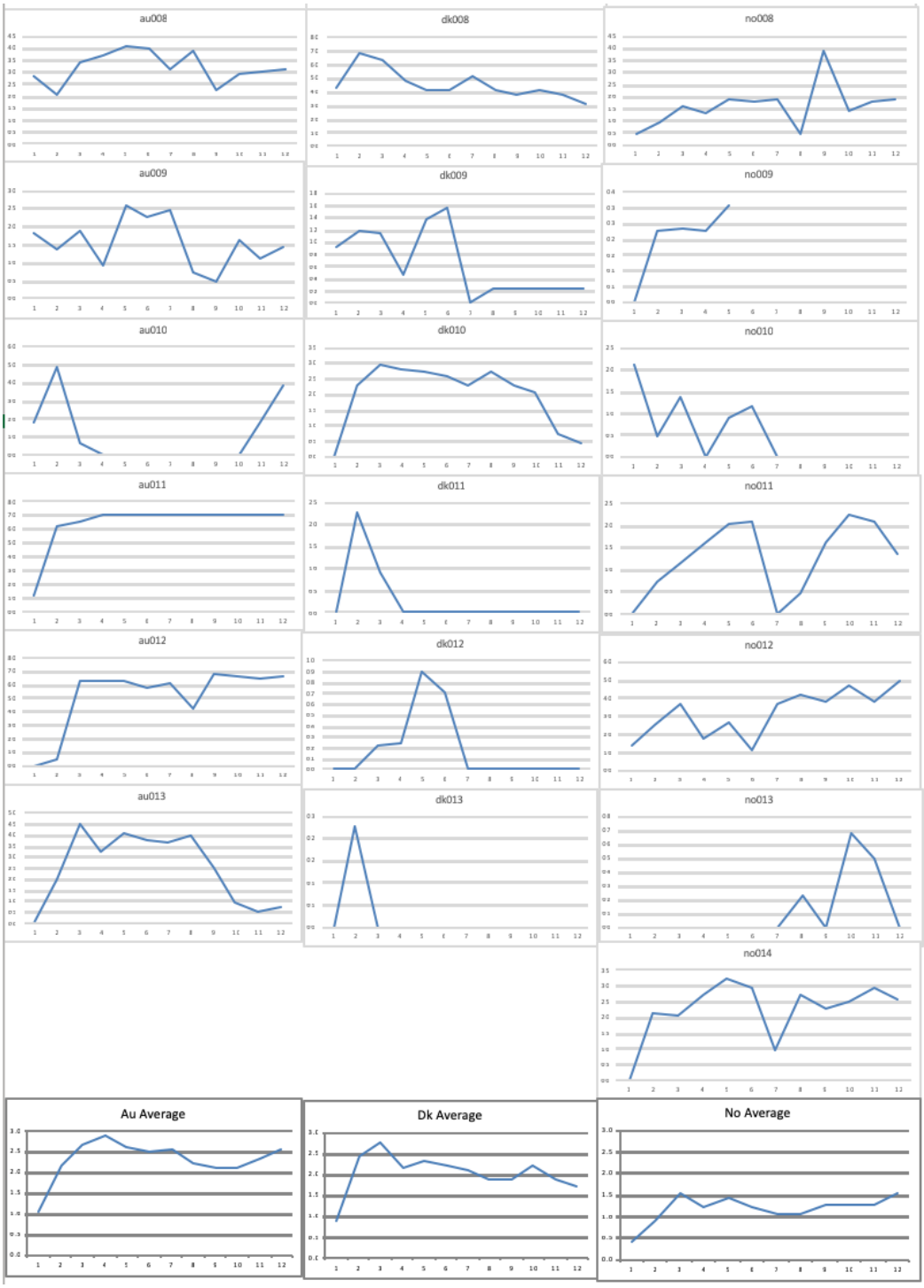


Figure 26: Variation of training attendance among participants.

Descriptive statistics for Training Exercise

Descriptive statistics for training diary can be seen in Figure 27. This shows that the mean of recommended training exercise was 25.3% for first month, 49.8% for second month, 60.3% for third month (highest value), 56.4% for fourth month, 56.7% for fifth month,

54% for sixth month, 47.7% for seventh month, 43.9% for eighth month, 44.5% for ninth month, 45.3% for 10 month, 45.5% for eleventh month and 48.5% for twelfth month.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1 month	40	0.00%	100.00%	25.3000%	30.77478%
2 month	40	0.00%	100.00%	49.8750%	35.84810%
3 month	40	0.00%	100.00%	60.2750%	37.61477%
4 month	40	0.00%	100.00%	56.4000%	39.46618%
5 month	40	0.00%	100.00%	56.6750%	39.71978%
6 month	40	0.00%	100.00%	53.9750%	42.27110%
7 month	40	0.00%	100.00%	47.7250%	42.84677%
8 month	40	0.00%	100.00%	43.8750%	40.24488%
9 month	40	0.00%	100.00%	44.4750%	41.21799%
10 month	40	0.00%	100.00%	45.2750%	41.31368%
11 month	40	0.00%	100.00%	45.4500%	40.25429%
12 month	40	0.00%	100.00%	48.5500%	38.77479%
Valid N (listwise)	40				

Figure 27: Descriptive statistics for training diary.

Graphs for Daily Diary

For daily diary, recommendation for giving inputs was seven times a week (i.e. daily). We calculated that participants were filling the daily diary 2.9 times a week on average on annual basis. The trend of filling up daily diary by participant was relatively stable and can be seen in the Figure 28.

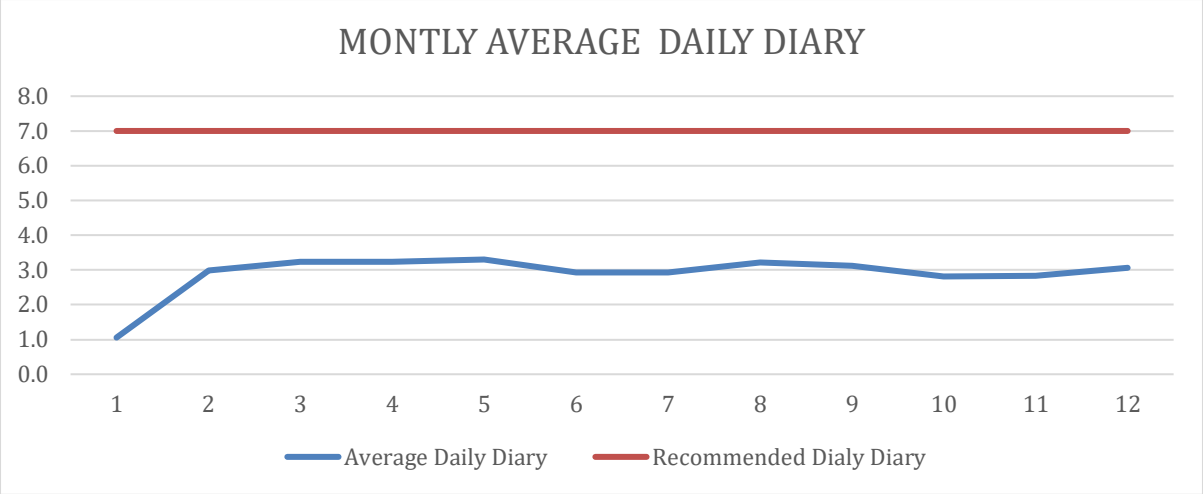


Figure 28: Graph for monthly average daily diary.

iTrain was conducted in three different countries. We also calculated the average of daily diary fulfilment in three different countries and found that Australians were more active in using the daily diary electronically (3.6 daily diary/week), followed by Danes (3.1 daily diary/week) and Norwegians (1.9 daily diary /week). The trend of daily diary fulfilment attendance can be seen in Figure 29.

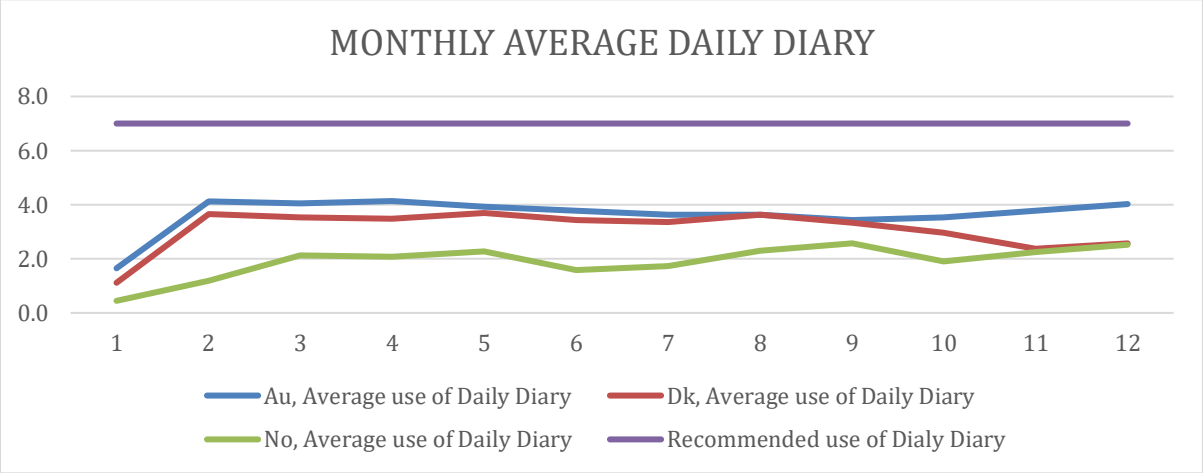


Figure 29: Graph for monthly average daily diary in three different countries.

We considered a participant to be adherent to daily diary only if he/she performed at least 70% of the recommended exercise (Cox et al., 2018). For this reason, we also calculated the percentage of participant reaching 70% adherence in the daily diary, which was found to be 28% on an annual basis. Out of this, 41% of Australians, 34% of Danes and 11% of Norwegians remained adherent to the daily diary in the first year. The trend of adherence of participants to daily diary in iTrain for the first year can be seen in Figure

30. The participants adherence kept on increasing in the first two to three months, then it remained relatively stable for further six to seven months, but after that it declined to a certain extent in most cases.

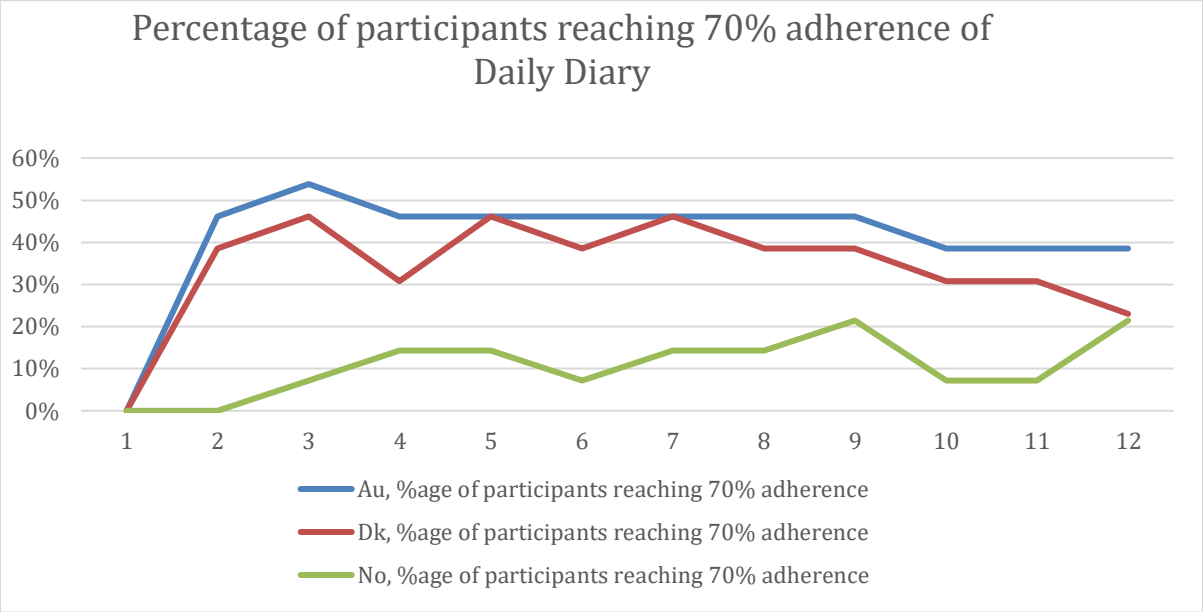
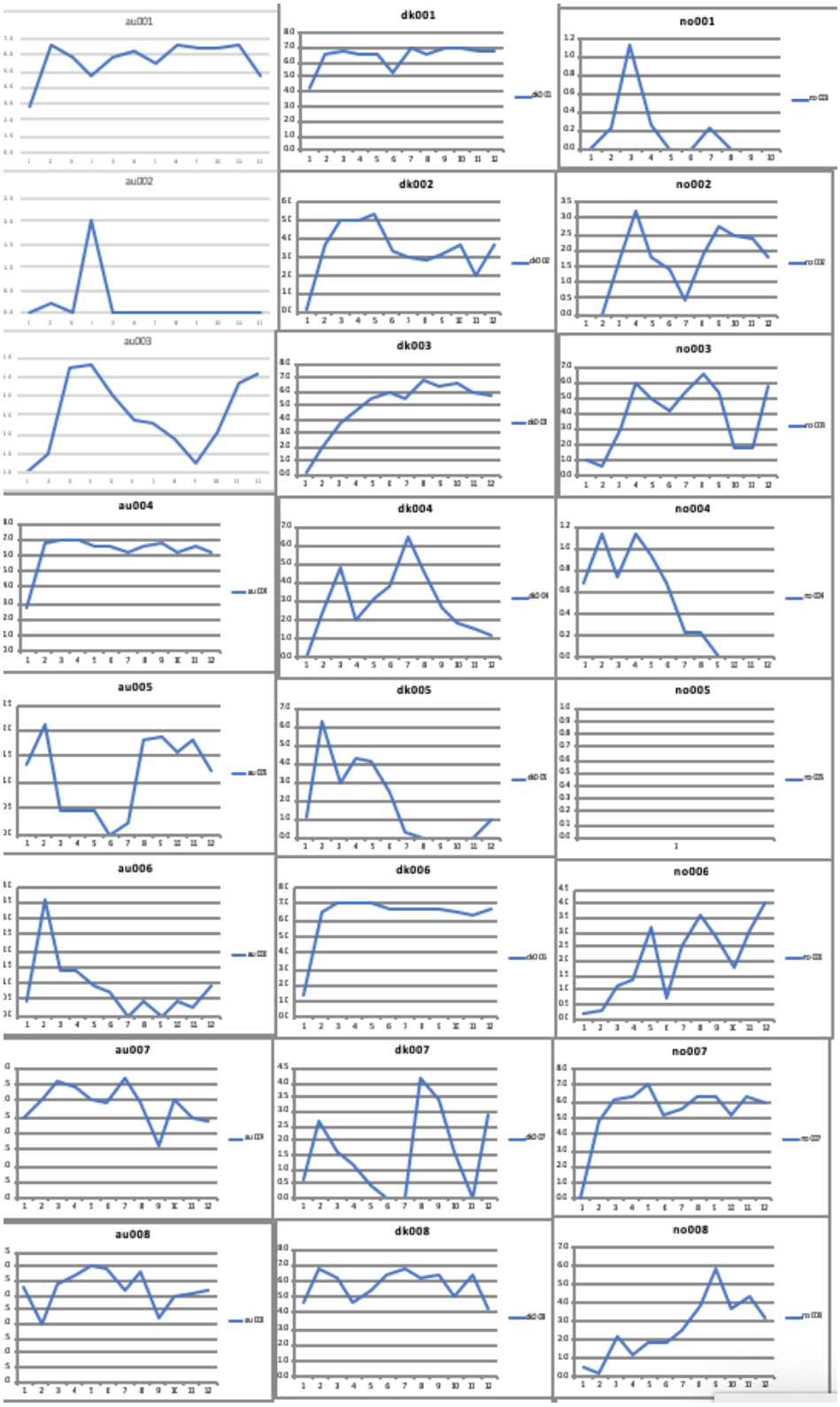


Figure 30: Graph for percentage of participants reaching 70% adherence of Daily Diary.

As we have seen in Figure 26, there were a lot of individual variations in performing exercise among participants. A similar trend was found for daily diary registrations. This can be seen in Figure 31.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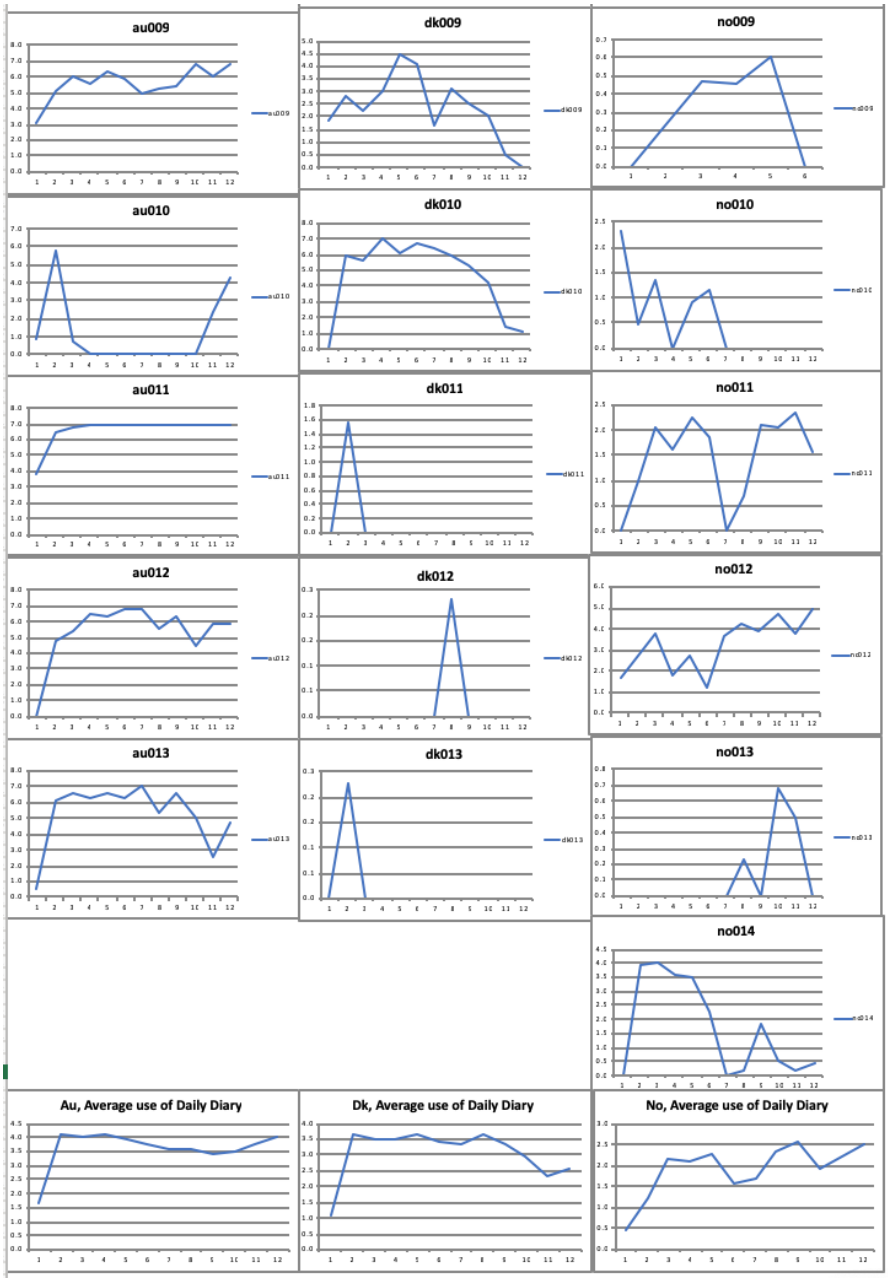

Figure 31: Variations in daily registrations among participants.

Descriptive statistics for Daily Diary

Descriptive statistics for daily diary can be seen in Figure 32. This shows that the mean of recommended daily registrations was 31.6% for first month, 62.3% for second month, 66.9% for third month (highest value), 64.9% for fourth month, 65.7% for fifth month, 59% for sixth month, 53.9% for seventh month, 61.2% for eighth month, 59.9% for ninth month, 58.3% for 10 month, 56% for eleventh month and 60% for twelfth month.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1 month	40	0%	100%	31.61%	37.838%
2 month	40	0%	100%	62.31%	41.373%
3 month	40	0%	100%	66.85%	39.732%
4 month	40	0%	100%	64.85%	41.317%
5 month	40	0%	100%	65.74%	42.990%
6 month	40	0%	100%	59.06%	43.862%
7 month	40	0%	100%	53.86%	47.745%
8 month	40	0%	100%	61.18%	45.728%
9 month	40	0%	100%	59.87%	45.293%
10 month	40	0%	100%	58.27%	43.180%
11 month	40	0%	100%	55.97%	43.762%
12 month	40	0%	100%	59.56%	44.386%
Valid N (listwise)	40				

Figure 32: Descriptive statistics for daily diary.

Both in training diary and in daily diary, the highest adherence levels were reported in the 3rd month, with values of 60.3% and 66.9%, respectively.

Results for qualitative analysis

We identified 6 categories from the analysis of our interviews:

1. Acceptance of telerehabilitation by participants and professionals.
2. Characteristics of participants
3. Ethical and privacy related issues
4. Logistic issues
5. Suggestions for improvement
6. Technical issues

We generated a list of codes, which was included into an analytical framework from NVIVO 12 automatically. This can be seen below.

Description of Codes

Description of categories and codes can be seen in Table 3. The column interview tells the number of interviewees mentioning the code, the reference column tells the number of times an interviewee has talked about the code.

Table 3: Codes and its description

Categories and codes	Description	Interview	References
Acceptance of telerehabilitation by participants and professionals.	Adoption and integration of telerehabilitation by COPD patients and project managers.		
2-year commitment of patients	Participants commitment to do exercise for two years.	2	3
Drop-outs	Termination of participants.	1	1
Patient satisfaction with videoconferencing or telerehabilitation.	Contentment of participants with video-conferencing with physiotherapist.	1	2
Positive feedback of telerehabilitation.	Constructive and optimistic response for iTrain.	5	9
Attraction for participation in iTrain	Appealing factors for participants in iTrain.	1	1
Happy feeling after exercise	Delighted emotions after exercise.	2	2
Safe intervention	Secure experimental project.	1	1
Satisfied telerehabilitation professionals	Pleased and proud project heads.	3	6
Telerehabilitation, easier to approach	Telerehabilitation is more convenient to get started and use.	2	5
Characteristics of participants	Different features and aspects of persons taking part in the telerehabilitation service.		
Age	Age of participants.	3	6
Computer literacy of patients	Know-how of participants with digital gadgets.	1	1
Exacerbations	Worsening of a disease for a short duration of time.	4	4
Exacerbation, not a problem	Worsening of disease of participants for short duration was not a big issue.	1	1
Motivation	Keep the will to do exercise as recommended.	5	9
Demotivating factor	Obstacles to maintain the will to keep adhere to exercise recommended.	1	1
Patients with different behavior	Different response by different patients.	1	1
Selection of right patient for telerehabilitation	Optimization of participants for the project.	3	7
Ethical and privacy related issues	Problems related to morality and confidentiality of personal information.	0	0

Categories and codes	Description	Interview	References
Ethic committee approval	Approval of a project from a country´s ethical committee.	1	4
People´s privacy	Protection of people´s personal information.	1	1
Logistic issues	Issues with transport of things.	2	2
Big size of treadmill	Large size of treadmill.	2	2
Delivery time of equipment	Time consumed to bring equipment to a particular place.	2	2
Traveling difficulties for patients	Transport difficulties for patients.	1	1
Traveling difficulties for professionals.	Barriers faced by project heads in terms of transportations.	1	2
Suggestions for improvement	Recommendations to make the project even better.	1	2
Benefit for meeting participants of telerehabilitation.	Advantages if participants meet with physiotherapist in advance or before starting iTrain project.	2	3
Exercise suggestion without using treadmill	Exercising without using any equipment.	2	3
Good network infrastructure	Wide and efficient ground work to spread broad-band internet.	1	2
Municipalities for scale up itrain in Norway	Municipalities in Norway were supposed to scale-up iTrain project within the country.	0	0
Social meetings of patients	Social gatherings of participants.	1	1
Telerehabilitation and PR	Relationship between PR and TR (Telerehabilitation).	3	3
Technical issues	Concerns and problems relating to technology.	3	4
Getting started use of treadmill	Using treadmill for the first time.	1	2
Internet issues	Problems related to internet.	6	9
IPAD program	Specially designed software program for iTrain.	1	1
Videoconferencing challenge by health professionals	Difficulties faced while performing videoconferencing.	3	6
Need for exclusive technician	A full-time person to address technology related problems.	3	5
Maintenance of treadmill	To keep the equipment in working form.	1	2
Webpage	Page on internet.	5	10

Categories and codes	Description	Interview	References
Difficulties with webpage	Problems with webpage.	1	1
Selection method on webpage	Way to find and press a button on a page on internet.	1	1

Analytical Framework Matrix

An analytical framework matrix was generated using NVIVO 12. This matrix can be seen in Table 4. This matrix shows the number of references from different interviewees for different codes.

Table 4: Analytica framework matrix.

Categories and Codes	I1 (Aus)	I2 (Denmark	I3 (Aus)	I4 (Norway)	I5 (Norway)	I6 (Norway)	I7 and 8 (Denmark)
Acceptance of telerehabilitaion by participants and professionals.	0	0	0	0	0	0	0
2 year commitment of patients	0	2	0	0	0	0	1
Drop-outs	0	1	0	0	0	0	0
Patient satisfaction with video conferencing or iTrain	0	0	2	0	0	0	0
Positive feedback of iTrain	1	0	3	1	1	3	0
Attraction for participation in iTrain	1	0	0	0	0	0	0
Happy feeling after exercise	0	0	0	0	0	1	1
Safe intervention	0	0	0	1	0	0	0
Satisfied iTrain professionals	4	1	1	0	0	0	0
Telerehab, more easy to approach	4	0	0	0	0	0	1
Characterristics of participants	2	5	4	7	1	4	5
Age	0	0	3	0	0	2	1
Comupter literacy of patients	0	0	0	0	0	1	0
Exacerbations	1	1	0	1	0	0	1
Exacerbation, not a prob	0	0	1	0	0	0	0
Motivation	1	3	0	1	1	0	3
Demotivationg factor	0	0	0	1	0	0	0
Patients with different behaviour	0	0	0	0	0	1	0
Selection of right patient for iTrain	0	1	1	5	0	0	0
Ethical and privacy related issues	0	0	0	0	0	0	0
Ethic Commetiee approval	4	0	0	0	0	0	0
People´s privacy	1	0	0	0	0	0	0
Logistic issues	1	0	0	1	0	0	0
Big size of treadmill	0	1	0	0	0	0	1
Delivery time of equipment	0	0	1	1	0	0	0
Traveling difficulties for patients	0	0	0	1	0	0	0
Traveling difficulties for professionals.	0	0	0	2	0	0	0
Suggestions for improvement	0	0	0	2	0	0	0
Benefit for meeting participants of telerehab	0	0	2	0	1	0	0
Exercise suggestion without using treadmil	0	2	0	1	0	0	0
Good network infrastructure	0	0	0	0	0	2	0
Commune for scale up iTrain in Norway	0	0	0	0	1	0	0
Social meetings of patients	0	0	0	1	0	0	0
Telerehab and PR	1	0	0	1	1	0	0
Technical issues	1	0	2	0	0	0	1
Getting started use of treadmill	2	0	0	0	0	0	0
Internet issues	1	0	2	2	1	2	1
IPAD program	1	0	0	0	0	0	0
Videoconferencing challenge by health professionals	2	0	0	0	3	0	1
Need for exclusive Technician	1	0	2	0	0	2	0
Maintainance of treadmill	2	0	0	0	0	0	0
Website	4	1	3	1	0	0	1
Difficulties with website	0	0	1	0	0	0	0
Selection method on website	1	0	0	0	0	0	0

Hierarchy for codes and categories

By looking at the tree map of hierarchy for codes and categories, one can see that most of the interviewees have talked about technical issues, followed by characteristics of participants and acceptance of telerehabilitation by patients. People have also talked about suggestions for future implementation, logistical, ethical and privacy issues.

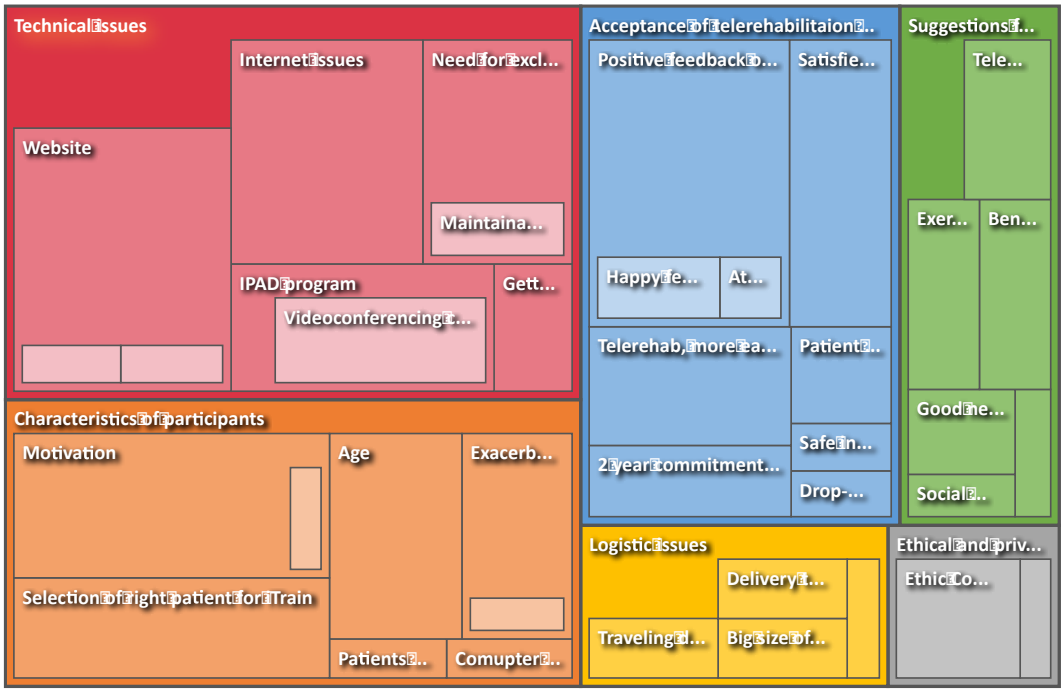

Figure 33: Hierarchy for codes for qualitative studies.

Interpretation of data

1. **Acceptance of telerehabilitation by participants and professionals.**

   Under this category, we gathered those nodes which show that participants and professionals are willing to adopt the intervention.

   Two interviewees talked about the duration of service and thought that 2 years was a long time to commit.

   > *"[…] only a challenge in the beginning. Can I maintain for it two years? Yes. Can I keep up my motivation? But they liked it."* [I2]

One interviewee told that participants liked to be in the project. They were satisfied with videoconferencing and telerehabilitation.

> *"Most of those who agreed to participate in this study, I think they were really keen to the telerehab. They really liked it. Then they found it very promising, I think."* [I3]

Most of the interviewees said that they received positive feedback from the participants of telerehabilitation service.

> *"[…] some of them call me several time and they would really really happy with the project they would like to thank us for providing this for them and one patient said that he could only walk for one minute and then he needed to rest and during the project here he could walk for half an hour for up to 40 minutes on the treadmill and I know such improvement."* [I4]

> *"I think more patients, got or felt that this project, helped them to get better and feel better."* [I6]

Getting a free treadmill was also an incentive to participate to this service especially in Australia, one interviewee mentioned. Participants used to feel good and happy after doing exercise, which motivated them doing more exercise. Some health professionals said that they were able to manage all the process effectively.

> *"[…] it works for the people cause I mean we, yeah, the people we ended up with the intervention arm that we're getting the video conferencing and um, I actually think you know, that it works quite smoothly."* [I1]

TR was very easy to approach as compared to PR. Patients could do it at their home at any time. Professionals were also seemed to appreciate this intervention.

> *"I just think of, you know, it was a medium that enabled us to do something that we, uh, otherwise would not have been able to offer. I think it was a really powerful tool actually."* [I1]

2. **Characteristics of participants**

Age, gender and computer literacy did not seem to have an effect on adherence to training diary and daily diary. It was the willingness to learn new things and their way of taking illness which matter, and this varies from person to person.

> *"[…] not everyone, not every patient and take the illness by the same way they take it by very different ways, for someone, for someone. It's no hope. It will never, someone felt I can never be better. What's, what's, what's ever you try to do with me? I know that I will never be better. And for some, Oh! That can maybe help me. I should try. I shall do my best to, yeah, to help myself. and I am very thankful that you are starting this project because I can see the light in the tunnel. So they have different views on the same problem."* [I6]

Whenever participants had exacerbations, they were able to manage it. No adverse events had occurred. We can therefore say that TR is a safe intervention. Motivation of participants affects their adherence to exercise routine. Especially participants remained motivated by videoconferencing with the physiotherapist. They tried to boost participants to try more and more to accomplish their target. Some participants lost motivation early in the project, while others were really committed to their commitments and did what they were supposed to do most of the time.

Selection of right patient appeared to be an important thing. Three interviewees talked about it and considered it challenging as well.

> *"[…] another patient we thought would benefit a lot but also she dropped out from the study so I think maybe that was the most surprising thing for me that I couldn't tell which one would benefit and which one couldn't."* [I4]

3. **Ethical and privacy related issues**

Approval for TR from ethical committee was challenging especially in Australia. Their ethical laws do not clearly reflect technology related to health. Professionals managed to

convince the Ethics committee for safety and privacy of people while working on TR, and use of "FaceTime" was ethically approved in Australia.

4. Logistic issues

One of the main challenging factors in the smooth application of TR service was logistic issues. These included size of treadmill (which was especially a problem in Denmark), delivery of equipment, travelling difficulties for professionals to the participant´s house and travelling difficulties for patients (for baseline and every 6-month check-up.

> *"[…] it was a long travel distance for us to deliver the equipment, logistics was more a challenge for us."* [I4]

5. Suggestions for improvement

Professionals who worked with TR service also gave some suggestions on how to improve the service. These were about visualization of goal achievement in an animated way, checking of mental cognitive wellbeing of participant, benefit for meeting of participant with physiotherapist in the beginning of TR service.

> *"I think having that face to face assessment is very important. Before you know, providing the telerehab afterwards. I think in my opinion as a physiotherapist like the face to face assessment. It's like very important, crucial."* [I3]

Some suggested to use programs which use exercise aids other than treadmills, such as stationary bicycles. Other suggested to use exercises which do not require any specific training equipment.

Assurance of good Internet broadband and stable local Internet infrastructure was also a suggestion. One said that municipalities should take up this responsibility to implement it in future in Norway.

Social meetings of participants were thought to be potentially useful. In this way, they could share their stories and probably find some solutions from other participants who have similar health issues. TR can support PR. This means that a patient could first attend PR, if possible, and then join a long-term TR program.

1. Technical issues

Technical issues were one of the most challenging issues while delivering TR. Technical problems occurred mostly during the first few months, but their frequency decreased over time as people get used to the technology.

> *"I think one factor that influence really affects adherence was recurrence of, frequent, technical issues."* [I3]

Difficulties in using the webpage was reported extensively.

> *"Um, I do think that the diary, the, the webpage was probably the thing people found hardest in terms of the daily diary and the training diary, their separate pages and understanding the point of both of those things."* [I1]

Another suggested that the webpage and the videoconferencing software should be in one application. In this way it would be easy for participants. Some professionals thought that the webpage needed to be more user friendly. They have to spend a lot of time while describing the webpage use. While other thought that it was simple and easy to use.

Internet issues were reported by almost all participants, especially in the start of the service while finding the best possible Internet solution for participants which can support continuous videoconferencing with physiotherapist.

> *"We did use you know, 4G technology at that time. Uh, and there were a few parts of the city that there's the delivery of the 4G was not that stable and then probably 10% of the participant had problem with Internet connection."* [I3]

There were some challenges for physiotherapists as well, as they were unable to touch participants when needed. So, they changed their way of conveying their message be being more verbatim.

> *"I had to change my way of teaching. the only thing was my voice and my knowledge."* [I5]
>
> *"[…] the challenges. I think it was sometimes too difficult to help them because i was not in the same room. A, it was not*

that easy for me to correct them, eh, Eh, I did not have the possibility to put the hands on something in, it was just like talking to them. Yeah. But I think that's the, yeah, the most important difference. A challenge." [I7/I8]

Some of the professionals mentioned that they needed a person who could deal only with technical issues, such as maintenance of treadmill, especially for the first few months. This was supported by another interviewee.

"I was involved in project as, as technology person. And important thing in project like that is to have time and to reserve time for support. To support people and, if the project people reserve time to support people in some period, everything get better. Every kind of support. Regardless of what, every time they call you, you need to have time for that. If you do that in three or four months, then after that everything goes in the better way" [I6]

DISCUSSION

Telerehabilitation is an emerging intervention in the twenty-first century. It facilitates the integration of exercise routine effectively not only as an alternative to PR but also as a maintenance strategy in people suffering with COPD. Telerehabilitation is available as well as effectively applicable into people´s daily routine.

Participants performed training exercise regularly and then registered training sessions in a webpage. We downloaded the dataset from the webpage and analyzed it. While working with the analysis of the quantitative data, we can come across many duplicates. Removal of duplicates from a dataset is necessary as their presence may lead to incorrect calculation of adherence. We first removed all duplicates manually and then double check them by a built-in function in Microsoft Excel. There may be many reasons for duplicates. For example, if a participant is not sure whether the registration process is complete, he/she may try to register it again. The webpage can also hang up thus causing multiple registrations. Such problems, considered as technical issues, need to be addressed in

order to calculate accurately measurements such as adherence and use and, as a consequence, to make right decisions for the future.

iTrain was conducted simultaneously in three countries, Australia, Denmark and Norway. Participants in Australia seemed to be more committed and motivated than those in Denmark and in Norway. The reason for greater exercise and daily registration adherence in Australia was maybe due to the attractiveness of free equipment provided in this project. This is also mentioned by an interviewee, who stated that the allotment of such equipment is not traditional or in practice. A project of this type was relatively new in Australia and this might also have contributed to attract participants. However, Denmark and Norway also performed well.

Adherence to training exercise was observed to be high in the start, it remained stable for some months and then it increases again. A similar trend was observed by Hoaas et al. (Hoaas et al., 2016). They worked on COPD TR and observed that adherence increased in first five months, then it gets stable for next six months and then it declined after that. However, in our case, adherence to training exercise increased again, which is a very positive outcome. In the starting months, there were low levels of adherence, which may be due to the fact that people were in a learning phase of using the new system. They might have needed some time to get used to all the processes of performing exercise training and entering registrations in the webpage. Many professionals mentioned in their interview that participants got better and better over time. Another reason for the low adherence in the very first months of TR was maybe due to the fact that order and delivery of the equipment and setting up of the whole system may take some weeks. Some interviewees mentioned that it may take from 14 days to 3 weeks to set up the whole system at the patient´s home (i.e. logistical issues).

Participants faced some technical issues, but they were mostly not persistent. They learnt the system gradually and eventually everything got smooth. The webpage was perceived as user friendly by participants in Denmark and Norway. But it was not the case in Australia, where participants felt that it was difficult to learn. They did not like the format of the webpage and the approach of the tab selection in the webpage. This might be due to cultural differences. Norway and Denmark have similar cultural and regional

relationships, but Australia is a little different in that case, with English as native language. Sinesen et. al. found that lack of learning local culture is identified as a problem in the process of co-innovation. Innovation such as TR.

Adherence to daily dairy was observed to be constant over time which is a positive thing. Hoaas et. al. found a trend of adherence similar to what we found in the training diary: an increase in first three months, then a stable trend and a decrease after 11 months (Hoaas et al., 2016). This means that participants in iTrain were more conscious about the registration of daily observations and managed to better integrate this routine in their daily life. We can say that participants became better at self-management of their disease. In many chronic disease, self-management is a very effective strategy and, in such cases, TR has more potential than traditional care settings (Brienza & McCue, 2013).

The characteristics of participants, such as age, gender and computer literacy, did not affect adherence. However, the behaviour of percepting their disease was an important factor when it comes to adherence. This was also supported by many interviewees while conducting qualitative study. There was large variability among the behaviour of participants. Dinesen et. al. studied the "Attitudes of COPD patients towards tele-rehabilitation" and found that patients usually have four types of attitudes: motivation for doing training exercises, indifference, feeling of insecurity, and learning as everyday life situation. Patients alternate between these attitudes while performing training exercises, depending upon their emotional and physical state (Dinesen, Huniche, & Toft, 2013).

Many suggestions were proposed by professionals. For example, more stable Internet connection, availability of a full-time technician who can visit the patient´s home if needed, improvement of the website and social meetings among participants. Physiotherapists also mentioned that it became very easy for them to understand patients' conditions if they meet them before TR. Some suggested that exercises can be done by many means other than on treadmill, or also without equipment. This may help in facing the logistic issues.

The selection of the right patients was a question raised by many interviewees. They thought that they needed to understand the process of finding the most appropriate patients for this intervention in order to make the intervention successful. This idea is supported by Dinesen et. al., as they said that there is a need to design useful stratification tools which can identify most appropriate candidate for this intervention (Dinesen et al., 2013).

Limitations

A paper-based diary was provided to the participants enrolled in the other intervention group (treadmill) of the study. However, the data collected from the treadmill group was often incomplete or missing for many participants and thus not sufficient to calculate adherence. As a consequence, adherence for the telerehabilitation group could not be compared with that of the treadmill group.

CONCLUSION

Adherence to prescribed training exercise and daily diary was measured to be 1.8 and 2.9 times/week respectively, while recommendation to training exercise and daily registration was 3 days/week and 7 days/week, respectively. Professionals faced technical, logistical and Internet-related issues, along with ethical and privacy-related issues. Both participants and professionals accepted and appreciated TR. Participants managed to integrate TR into their everyday life.

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