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Comparison of two fall risk screening tools in elderly care

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ABSTRACT

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The objective of this thesis was to study in what ways the data of two different fall risk screening tools, FROP-Com screen and VTT's mobile fall risk assessment solution, was co-directional when used in the elderly. In addition, attention was paid towards the similarities and differences in the usability and usefulness of these two tools during the testing.

This study was made in co-operation with The Technical Research Centre in Finland Ltd (VTT) which is one of Europe's leading research institutions and the developer of the novel mobile fall risk assessment solution. The empirical part of the study was conducted in elderly support and assessment ward Kurjensiipi 2 which is run by the welfare division of the city of Turku.

This thesis was a mixed method study in which the quantitative data was collected by testing the fall risk of 20 voluntary elderly participants with FROP-Com screening tool and VTT's mobile fall risk assessment solution which is based on an accelerometer and mobile application. The participants were guided through both fall risk screening tests and the results were marked in a table. The fall risk data was analysed using descriptive and correlational methods. During the testing attention was paid towards the similarities and differences in the usability and usefulness of these two tools. This qualitative data was written down for later deductive content analysis.

Both tools could identify the individuals at risk of falling. Despite of the different action mechanism and score system of these two screening tools there was a positive moderate correlation between the results. Meaning changes in other fall risk screening tool were related to the same type of changes in other fall risk screening tool. Usability and usefulness observation gave an understanding about the need of a fall risk screening tool that is objective, easy and quick to use and suitable for elderly with and without memory impairments.

This thesis gives an insight about the use of sensing technology in fall risk screening. It also explains the meaning of usability and usefulness in fall risk screening. The results can help VTT to enable product development.

Keywords: falls, fall risk screening, fall prevention, elderly, FROP-Com Screen, VTT's mobile fall risk assessment solution, usability, usefulness

CONTENTS

1 INTRODUCTION

Falls are common and can be seen as a major public health problem all over the world. Falls happen in all age groups, but older age is one of the key risk factors. Elderly have the highest risk of death and serious injury and they are also in a major risk for subsequent long-term-care and institutionalisation. (WHO, 2021.) Falls don't only pose a major threat to the well-being and quality of the life of the elderly, but they also have an economic impact to the individual and society (Lord & Close, 2018; WHO, 2007.) There are different strategies to prevent falls, however in individual level it is crucial to identify the individuals at risk of falling (Pfortmueller et al,2014, p. 280). Over the years several different fall risk screening and assessment tools have been developed to answer this challenge.

This thesis compares the data of two fall risk screening tools. It aims to explore the way in which the data of FROP-Com (Fall Risk For Older People in the Community) screening tool and VTT's (Technical Research Centre in Finland) mobile fall risk assessment solution are co-directional with each other when used on the elderly. In addition, during the testing period the usability and usefulness of these two fall risk screening tools is observed and evaluated. This thesis is made in co-operation with The Technical Research Centre of Finland Ltd (VTT) which is one of Europe's leading research institutions and the developer of the novel mobile fall risk assessment solution. The empirical part of the study is conducted in elderly support and assessment ward Kurjensiipi 2 run by the welfare division of the city of Turku.

This thesis is a mixed method study including both quantitative and qualitative data. The purpose of the study is to produce information for VTT of their novel mobile fall risk assessment solution in order to enable product development,

and to discuss whether this kind of new technology could detect and analyse the elderly in a risk of falling in more objective manner.

2 FALL RISK ASSESSMENT IN ELDERLY CARE

2.1 Falls

A fall is an event that results in a person coming to rest on the ground without intending to or by an accident. Falls are that common that they can be seen as a major public health problem worldwide. Falling is the second leading cause of unintentional injury death after road traffic injuries with an estimated 648 000 fatal falls occurring globally each year. In addition to fatal falls, 37,3 million falls every year are serious enough to require medical attention. (WHO, 2021.)

Although falls happen in all age groups, older age is one of the key risk factors (WHO, 2021). The elderly or older age in this thesis refers to chronological age of 65 years or older (Orimo, 2006, p. 149). The higher fall risk in older population can be explained by physical, sensor and cognitive changes related to ageing combined with environments that are not adapted for ageing population. Alongside with the highest risk of death and a serious injury this age group has also a major risk for subsequent long-term-care and institutionalization. (WHO, 2021.)

Falls have an economic impact to family, community, and society. Fall incurred costs are divided in two categories: in direct cost such as health care provider consultation, treatment, and rehabilitation, and in indirect cost such as loss of productivity of the individual or family care givers due to the fall related injuries (loss of income) (WHO, 2007, p. 6-7). In the EU there are 2,3 million older people (over 65 years) fall related emergency department visits each year in which 1,4 million are admitted to the hospital and around 36 000 older people are reported to be fatally injured from the falls. Treating fall related injuries in

the EU costs estimated 25 billion euros yearly, the cost is high both to the individual and society. (Turner et al., 2015, p. 1.) In United States medical cost related to older people non-fatal falls is about $50 billion and the cost of fatal falls is $754 million each year (Florence et al., 2018, p. 693). In Finland in 2015 older people fall related injuries health care costs were 200 million euros. The cost of care per hip fracture is 30 000 Euros during the following year of the occurred fall. If the older person is institutionalised, it doubles the expenses. (UKK institute, 2021.) It is notable the population of older people (65 and above) in EU is expected to grow by 60% by 2050. This will lead to increase in fall related injuries, deaths and in fall related costs unless additional measures are taken to prevent falls in older population. (Turner et al., 2015, p. 1.)

A fall rarely occur due to one specific reason; more often it is a complex interaction of several risk factors (WHO, 2007, p. 4-6). The main risk factors according to WHO are: biological, behavioural, environmental, and socioeconomic. These risks are depicted in Figure 1. The risk of falling and being injured is higher when the exposure to these factors increases.

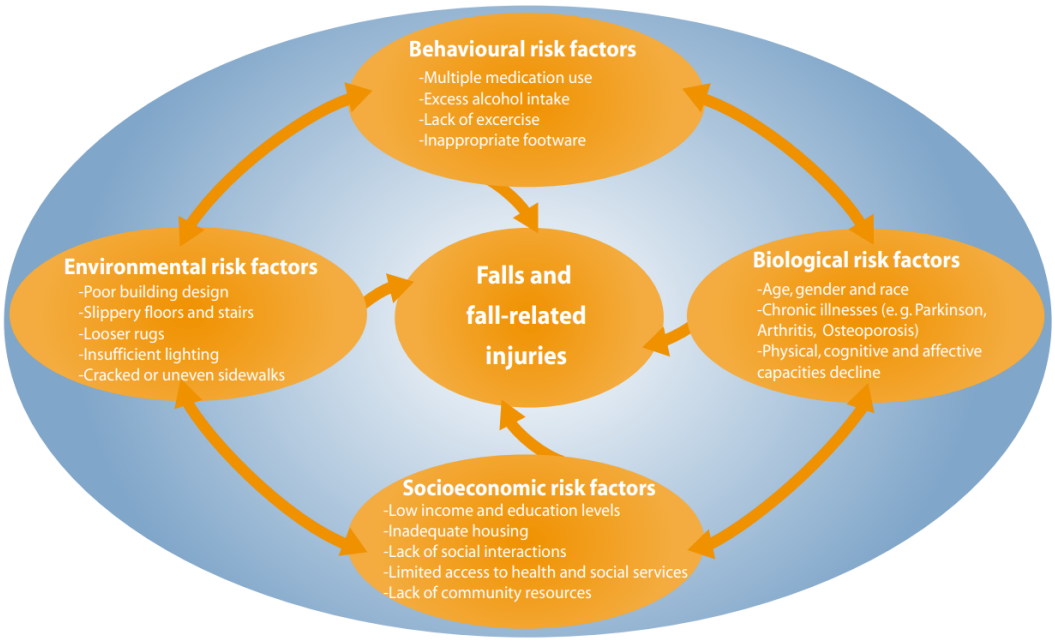

Figure 1: Risk factor model for falls in older age by WHO (WHO, 2007, p. 5).

Biological factors such as age, gender, and race are non-modifiable factors related to human body. These can, however, be affected with chronic illnesses and the decline of physical, cognitive, and affective capacities due to the ageing. Behavioural risk factors consist of emotions, actions, and daily choices, these are potentially modifiable with interventions. Socioeconomic risk factors include social conditions and economic status as well as the communities' capabilities to challenge them. Components such as low income and education level, inappropriate living conditions, loneliness and limited access to health and social services or lack of the resources in the community are included in this category. Environmental factors cause falls mostly in interaction between the other factors. The key role is in the interplay with individual's physical conditions and the surrounding environment at home or in the public such as poor building design, slippery floors, loose rugs, and uneven surfaces. (WHO, 2007, p. 4-6.)

2.2 Fall prevention

Falls are a major threat to the well-being and quality of life of the elderly. In addition to physical injuries, disability, and fear, falling can trigger a decline in physical function and loss of autonomy. (Lord & Close, 2018, p. 492.) Over the years the attitudes towards falls have changed from seeing them as an inevitable consequence of ageing towards understanding the ability and importance of prevent them (Close & Lord, 2022, p. 1). Not all falls can be prevented however despite of the multifactorial nature of the falls there are different strategies to avoid most of them (Strini et al., 2021, p.440).

In society level, fall prevention strategies should focus on education, training, creating safer environments, prioritising fall-related research, and creating effective policies to reduce the risk of falling (WHO, 2021). In individual level, it is crucial to recognise the individuals at risk of falling. Elderly population should be screened routinely for relevant risk factors and possible interventions need to be tailored to their needs (Pfortmueller et al., 2014, p. 280). Identifying the fall risk and recognizing the type of event is important since these will affect to

the type of strategy put on place to avoid future accidents. Preventative action can be applied as a single action or combination of strategies depending on the root cause of the falls. The nature of interventions and strategies depends on the professional and material resources available. (Nascimento, 2018, p. 2020.) Interventions can be such as strength and balance training, environmental modification, medical care, removing or reducing risk factors and reduction of poly pharmacy. However, these are only successful if managed to change the beliefs, attitudes, and behaviour of the older persons themselves. It is crucial to notify the psychological and social factors in lifestyle changes. (WHO, 2007, p. 20.)

2.3 Screening and assessing the fall risk

Interventions to prevent falls among elderly depends on the individual's characters and whether the person is located at home, nursing home or in the hospital. Generally elderly living at home benefit from exercising, home assessment and modifications and a reduce of psychotropic drugs. Elderly living in the care facilities or staying in the hospital benefit more from multifactorial interventions that include fall risk assessment and targeted interventions. This is due to the elderly being a diverse group in the terms of risk factors, age, and medical and personal histories. The fall risk of hospitalised elderly can change rapidly due to the health conditions and delirium. (WHO, 2021, p. 89-104.)

Fall risk is generally measured for three purposes: to raise the individual's awareness, to screen individual's risk of falling and to assess the individual's fall risk profile. Fall risk awareness tools are usually in a form of a checklist and are self-administered. They aim to alert the person to take actions or seek professional advice. The difference between screening and assessment tools is not definitive. Screening can be seen as a process that is less detailed and can lead up to an assessment. Typically, a screen consists of a small number of questions that are based on presence or absence of a risk factor. Screening is the minimum process to identify the elderly at risk of falling. Assessment, however, is more detailed process. It identifies the modifiable factors that affect

to the person's risk of falling and helps to develop an individualised plan to prevent the falls. Early identification and intervention usually lead to better outcome. (Queensland health, 2008, p. 51-52.)

Several different screening tools have been developed to identify an individual's risk of falling. However due to the multidimensional nature of falling risk, there is no "ideal" tool that can measure the risk perfectly or a tool that can be used in any context. For better and more valid results a simultaneous application of multiple tools and thorough analysis by healthcare professional is needed. (Strini et al., 2021, p.440.) Typically fall risk screening tools are based on observation, interviewing the client and physical tests. However, these days the recent advancement in sensing technology has a potential to provide a possibility for objective, easy to implement and low-cost option in fall risk screening (Sun & Sosnoff, 2018, p. 9).

New technological solutions and aspects have potential to identify and prevent falls effectively and improve the quality of life among the elderly. These solutions include at-home monitoring via wearable sensors, smart phone technologies and big data; exercise programs involving step training via smart phone applications and exergames, and low-impact safe flooring in the hospital settings to prevent fall related injuries. (Lord & Close, 2018, p. 492-497.) There have been studies demonstrating that it is feasible to monitor the activity of elderly with wearable sensors. Automated fall detection and remote fall assessment are possible via smart phone applications that can accurately perform long-term activity monitoring. However, this type of wearable fall detection devices are still not reliable, mainly due to their inability to recognise falls from other activities. (Lord & Close, 2022, p. 3-4.)

Elderly walking speed is known to be a sensitive marker of overall health and survival. As simple as walking seems, the individual gait pattern is a complex interplay of nervous, muscles and cardiorespiratory system. Age, mood, personality, and sociocultural background all have an influence on individual's gait pattern. Gait dysfunction can be a result of neurological, orthopaedic, medical, and psychiatric conditions. The older the individual is the more common the

multifactorial etiology becomes. (Pirker & Katzenschlager, 2017, p. 81-95.) Gait dysfunction is one of the key risk factors for falls, thus understanding the gait strategies of the elderly fallers may lead to effective intervention and prevention of the falls (Kwon et al, 2018, p. 434).

One way to observe and understand the gaits affect to the fall risk of the elderly is a wearable accelerometer and a mobile application for collecting, analysing, and visualising the data that has been created by The Technical Research Centre of Finland Ltd (VTT). Their solution can distinguish normal gait from dragging and slow gaits, however, to adjust the application parameters appropriately more comprehensive data must be collected in older adults. (Similä et al., 2018, p. 1530.)

This thesis is focusing on comparing the data from two fall risk screening tools: Falls Risk for Older People in the Community (FROP-Com) Screen which is a more traditional fall risk screening tool based on interviewing and observing the client and VTT's novel mobile fall risk assessment solution that represents the potential newer sensing technology in fall risk screening. The next two sections will give a deeper insight into these two tools and how they work.

2.3.1 FROP-Com Screen

The falls risk for older people in the community (FROP-Com) was developed in 2001 by National Ageing Research Institute and it covers 13 risk factors to identify the fall risks of community-dwelling older people (Russel et al., 2008, p.634). However, an abbreviated version was needed to suit the practical use in busy clinical settings. The FROP-Com Screen was developed based on the three most fall predictive risk factors from the original FROP-Com. The idea of the shorter screening tool is to identify those at greatest risk of future falls and determine if a full FROP-Com assessment or other more detailed falls risk assessments are required. (National Ageing Research Institute, 2009, p.1.) FROP-Com Screen has a moderate level capacity to predict falls and its'

reliability is good. It requires no equipment and can be applied without specialist knowledge and can be performed quickly in 1-2minutes. (Russel et al., 2009, p. 44-45.)

As seen on Appendix 1 the FROP-Com Screen consists of three different categories including the number of falls in the last 12 months, assistance required to perform activities of daily living and observation of balance. The total scores of these three categories will identify the risk factor for falls and offer possible interactions for the healthcare professionals to reduce the patient's risk of falling in the future. (National Ageing Research Institute, 2009, p.6.) In this thesis the fall risk is analysed based on a Finnish translation of the original FROP-Com Screen. This document is found as an Appendix 2. The Finnish translation is made by the Finnish institute for health and welfare (THL) and this version of FROP-Com Screen is widely used in Finland. It is notable that in this thesis the fall risk classification follows the scoring system seen in THL version on Appendix 2. The three different fall risk categories in the THL's FROP-Com Screen and in this thesis are: low risk (0-3 points), medium risk (4-7 points) and high risk (8-9 points).

2.3.2 Mobile fall risk assessment solution by VTT

The Technical Research Centre of Finland Ltd (VTT) has created a novel mobile solution for fall risk assessment. It combines a wearable accelerometer and a mobile application for collecting, analysing, and visualizing the data. The solution is targeted both for older population for independent use and for nurses for a quick fall risk screening of their clients. (Similä et al., 2018, p. 1530.)

The solution is based on an Android application that uses acceleration sensor data received over Bluetooth LE connection. The application guides the user through a short walk test, analyses the acceleration data measured from the accelerometer attached to the lower back and gives feedback about the fall risk for the user. (Similä et al., 2018, p. 1530.) Acceleration data is received

from Movesense device that is manufactured by Suunto. It is ideal for wearing due its' small size 36,6 mm x 36,6 mm x 10,6 mm and light weight, only 10g with a battery. The phone application is made easy to use for a basic user and the interface gives instructions for the user step by step. The current language options for the interface are Finnish and English. Since all the data and measurements are user-specific the user needs to define an individual username that is used to log in to the application. After this an available Movesense device is selected and connected. The required device configuration is made automatically by the application, once it is completed the user interface provides a push button for starting the measurement. The measurement can be stopped by the user with a simple stop push button or automatically when the pre-set duration or collected data size is achieved. This collected data is then analysed by the application and fall risk index (FRI) is determined. (Similä et al., 2018, p. 1531.) The basic functions of the solution are depicted in Figure 2.

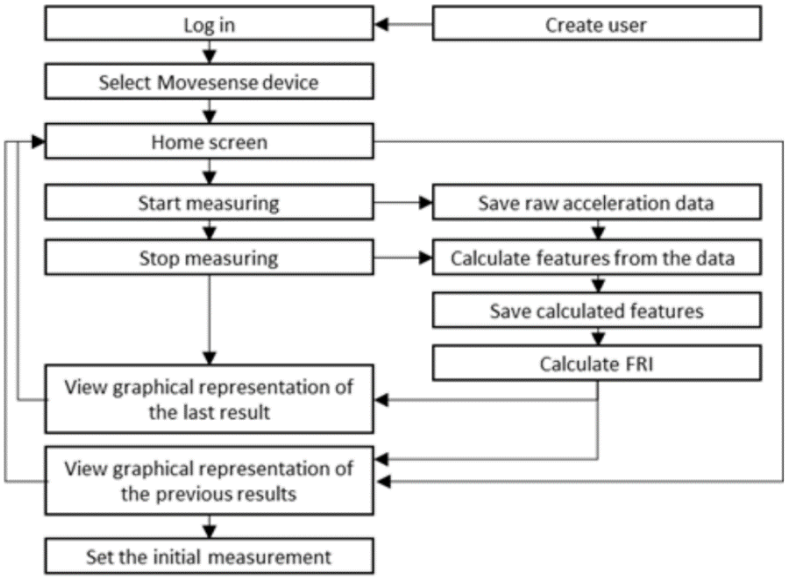

Figure 2. Basic functions (Similä et al., 2018, p.1531).

Figure 3 visualises the feedback the application gives to user after finishing the walking test. There are three different categories based on the fall risk index: fall risk not increased (a), slightly increased (b) and clearly increased (c). The application also highlights these results with green, yellow, and red colour

helping the user to detect the fall risk index explanation easier. On the last picture (d) all the previous results are visualised as a trend plot.

Figure 3. Feedback for the user after the walk test (Similä et al., 2018, p.1531).

2.4 Usability and usefulness

While digitalization has changed the work life and leisure time, the focus from the reduction of physical exertion has shifted towards to the reduction of mental exertion of the user when using the devices (Matern & Büche, 2011, p.59). In literature usability is described as a qualitative attribute that simply indicates how easy the device is to use (Matern & Büche, 2011) or as the feature of the product which describes the extent to which a product can be utilized by users in particular context to achieve specific goals efficiently, effectively, and satisfactorily (ISO 9241-11, 2018.) Effectiveness measures the accuracy and completeness with which user can reach the goal: can the goal of the user be fully achieved? Efficiency focuses on the resources needed to achieve the goal: what needs to be done to achieve the goal? And satisfaction is about comfort and acceptability of use: what reaction does the device raise in the user? (ISO 9241-11, 2018.)

Usability can affect whether the user engages with a system or not. It goes hand in hand with utility, whether the solution provides features that are

needed. Together they form the usefulness of the product. Both are equally important since a perfectly usable solution can't engage the user if it does not provide the needed features, on the other hand a system that can potentially answer to your need means very little if the usability is poor. A usable and useful system has a potential to engage users and thus lead to increase in profits, registered users, employee productivity or improvements in any other key performance indicator set for the project. (Nielsen, 2012.)

In medical field usability is strongly linked to safety aspects. Incorrect use of a device or a potential faulty operation of a system or device can lead to a danger of a user, other individuals, and objects. To ensure the safe use of medical devices there are guidelines for achieving and testing the usability in health care field and international valid standards for the safety of medical devices. (Matern & Büche, 2011, p.59-60.) Usability of a product can be studied, tested, and improved. The goal of usability testing is to identify problems in the design of the product, find opportunities to improve the product and learn about the target user's behaviour and preferences. (Moran, 2019.)

Usability and usefulness play an important role in fall risk screening. Fall risk screening needs to be consistent, tools need to be safe, simple, easy to use and meet the set goal for them in busy clinical settings without risking the validity or reliability of the results. As noted, there are no ideal fall risk assessment tool that gives a perfect risk assessment in every context (Strini et al., 2021.) However, the need for quicker assessments have been recognized (National Ageing Research Institute, 2009.) When considering the professionals willingness to engage with fall risk screening tools, usability and usefulness can be one of the key factors in it (Nielsen, 2012.) A usable and useful fall risk screening tool should be simple and intuitive to operate, it should meet the user's goal fully, operate with minimal resources and be comfortable to use. A usable tool or system should not distract the user's attention away from the actual task (Matern & Büche, 2011, p.59.)

User-centered design is an approach to evaluate how users experience the interaction with a technical system. It aims to make systems usable and useful

by keeping the focus on the needs and requirements of the users. (ISO 9241-210, 2010.) Subjective impressions and emotions may differ from usability-oriented approach and thus focusing on user experience (UX) is the key to success for many technical devices (Minge et al., 2016, p.2693). UX includes multiple aspects, in addition to usability and usefulness related issues, it considers aesthetics, personal values, emotional stimulation and motivational support for using and reusing the product (Minge et al., 2016, p. 115).

There are multiple valid tools to measure UX but most of them are focusing on certain component leading the researchers to choose and combine different scales, formats, and instructions to achieve a comprehensive view of the product's UX. To answer this challenge a Modular evaluation of key Components of User Experience (meCUE) questionnaire was developed. It assesses all the UX components together in unified way. (Minge et al., 2016, p. 115-116.) The questionnaire consists of five separate modules I. usefulness and usability, II: visual aesthetics, status, and commitment, III: positive and negative emotions, IV: product loyalty and intention to use and V: overall evaluation. The total of 34 questions and use of Likert-scale makes it easy and efficient to use. (meCUE 2.0, 2022.) In this thesis the usability and usefulness data of the two fall risk screening tools is analysed based on the usefulness and usability module of the meCUE questionnaire.

3 PURPOSE AND OBJECTIVES

The aim of the thesis is to compare the data of FROP-com screening tool and VTT's mobile fall risk assessment solution, and to find out the way in which the data is co-directional when used in the elderly. In addition, during the testing period observations will be made regarding the usability and usefulness of these tools.

The purpose is to produce information for VTT of their novel mobile fall risk assessment solution to enable product development, and to discuss whether this kind of new technology could detect and analyse the elderly in a risk of falling in more objective manner.

This thesis is looking for answer to following questions:

1. In what ways the results of FROP-Com screening tool and VTT's mobile fall risk assessment solution are codirectional with each other in elderly clients?
2. What kind of similarities and differences in the usability and usefulness of these two tools are detected during the testing period?

4 MATERIAL AND METHODS

4.1 Research methodology

In order to answer the research questions and meet the aim and purpose of this thesis the data needed to be collected with quantitative and qualitative methods. For this purpose, a mixed method study was chosen as a research method.

Mixed method study is defined as a study where quantitative and qualitative research techniques, methods, approaches, or concepts are mixed or combined into a single study (Johnson & Onwuegbuzie, 2004, p. 17-18). The idea of these kind of multi-method designs is generally to supplement one information source with another or triangulate on an issue by using different data sources for understanding the phenomenon from different point of view (Spratt et al., 2014, p.7-8). Mixed method study is an expansive and creative form of research; however, it is important that research methods are following the research questions in a way that offers the best chance to obtain useful answers. In many cases mixed method study can answer the research questions in the best and most fully way. (Johnson & Onwuegbuzie, 2004, p.17-18.)

4.2 Data collection

The study was conducted in co-operation with VTT, the developer of the novel mobile fall risk assessment solution. Data was collected anonymously in elderly support and assessment ward Kurjensiipi 2, which is part of the elderly services the City of Turku is offering to its residents. Data was collected during the winter 2022-2023. The only criteria for participants was to be able to walk with or without a walking aid. No age limit was set. Participation was voluntary and all the testing was conducted during clients' stay in Kurjensiipi 2 ward.

Kurjensiipi 2 is a support and assessment ward for the elderly. Most of the clients live at home with a help of home care or a family caregiver. To enter

the ward elderly need to have a referral for the care. (Varsinais-Suomen hyvinvointialue, 2023.) During the stay at the ward the physical and social performance of the elderly is evaluated and rehabilitation plan is adjusted to their needs. All elderly clients have different challenges from memory impairments to physical restrictions and health issues. Their fall risk is evaluated throughout the whole stay with different methods. This includes multiprofessional aspect in which nurses, physiotherapist and doctor are working together to prevent falls and find the root cause for them. Clients' balance, cognition and moving is observed and the doctor evaluates the medication and does needed changes to it. If the client has fallen at home or falls during the stay in the ward their fall risk is assessed by using Falls Risk Assessment Tool (FRAT) which is a quick 4 questioned tool for sub-acute and residential care aiming to give guidance on specific factors affecting to the individuals fall risk (Health.vic, 2021). Other fall prevention strategies include a suitable lightning, proper footwear, keeping areas clear form obstructions and reporting the fall incidents through Haipro system which helps to support the development of procedures withing the unit.

Despite of the Kurjensiipi 2 ward assessing the fall risk with FRAT this fall risk assessment tool was not used in this thesis due to it focusing more on the specific risk factors that affect to the individual's fall risk. For using this assessment tool, a special knowledge about the client's medication, behaviour, and memory needs to be known. The chosen tool for this thesis was FROP-Com screening tool which does not require this kind of knowledge and focuses on recognising those at risk of falling that are in a need of more detailed assessment.

The testing was scheduled for November 2022. However, due to the limited number of clients in the ward and seasonal epidemics the testing was divided in two sets, the end of November 2022 and the beginning of January 2023. This ensured the clients had swapped in between the testing and there was as little personal protective equipment (PPE) used as possible to facilitate effective communication with the participants. However, due to the Covid-19 a surgical mask was needed for the researcher while being with the participants.

The collected data was both quantitative and qualitative. Quantitative numerical data was collected using VTT´s mobile fall risk assessment solution and FROP-Com Screen. Qualitative data was gathered by observing the usability and usefulness of these two fall risk screening tools during the testing.

Permission to conduct the study in Kurjensiipi 2 ward was applied from the City of Turku. An ethical review statement was not needed since the study design did not deviate from the principle of informed consent, did not interfere with participants physical integrity, did not expose participants to exceptionally strong stimuli, did not involve minors under 15 years old as participants and there was no risk of causing mental harm or physical threat to participants safety (Tutkimuseettinen neuvottelukunta, 2019, 14-16).

An information sheet about the nature of the research was printed for each participant (Appendix 3). Due to the vision and memory impairments of the participants the content was discussed with them. Participants understood they had the right to refuse participation and they could withdraw at any time without consequences. The anonymity of participants was guaranteed by not collecting information about names or personal details. Since participants did not have any other limitation except to be able to walk 10 meters, the nurses working in the ward kindly pointed out the clients who did not fill this requirement or had acute health issues and were not able to take part in the study.

Testing started with FROP-Com Screen translated in Finnish by THL as presented in Appendix 2. For testing was needed a pen, FROP-Com Screen document, a chair and calm environment with enough space to conduct a short walking test. Participants first answered to the questions about their living status, the number of falls in the last 12 months and assistance required to perform activities of daily living. Lastly their balance was tested with the short walking test included in the question battery. Points were calculated and marked anonymously in excel table. The details about name, date of birth, address and room number were left out of the study.

After finishing the FROP-Com Screen the participant conducted a walking test with VTT's mobile assessment solution. For this in addition to the chair and calm and spacious environment an accelerometer sensor and a mobile with Fall Risk Meter-application was needed. First the background information was collected, participants gave details such as their age, gender, and experienced balance. After that, Suunto Movesense sensor with elastic waist band was attached on their lower back by the researcher. Participants then walked 10 meters wearing the sensor and results visualised by the application were saved on the same excel table with FROP-Com Screen points for later quantitative analyse.

The qualitative data regarding the usability and usefulness of these two tools was collected during the testing period. After each participant the aspects and observations were written down as notes. Observation was focusing on the testing situation, testing environment, the tools itself and the elderly participants as a tester group. Each notice was written down only once, even if the same aspect repetitively occurred.

All collected data regarding this research was anonymous and stored to OneDrive with a protection of additional password. After the thesis is published the research data will be permanently disposed. The data collected with VTT's mobile fall risk assessment application was deleted from the mobile after it was first transferred to the excel table and stored in OneDrive.

4.3 Data analytics

The collected data needs to be analysed with suitable methods. The methods depend on the data, whether it is qualitative or quantitative and in which way the data has been collected. (Kananen, 2015, p.83.) In this mixed method study the quantitative data collected through evaluating the fall risk of the participants was analysed with descriptive and correlational methods. The usability and usefulness related data collected by observing the participants was analysed with content analysis. The chosen method was deductive analysis due

to the framework for the analyse being based on MeCUE's usability and usefulness module.

4.3.1 Analysis of the fall risk data

Quantitative data is in numerical form and the research process aims to find quantifies, correlations, and causations. Data analysing method depends on the research questions and in which way the data has been collected. Descriptive analyse can be used if the research problem is focusing on descripting the phenomenon. This analysing method describes, demonstrates, and summarizes the data points. In the simplest form the data is presented in percentages in a table. (Kananen 2011, p. 85-86.)

Quantitative data in this thesis was the data based on participants screened with FROP- Com screening tool and the mobile fall risk assessment solution by VTT. All gathered data from these two tools was put in an excel table as presented on Appendix 4. At first the excel sheet was created. Participants were anonymous but they were marked in the rows with a number between 1-20 to ensure data staying comparable. The columns were formed of the questions of both fall risk screening tools, including the results of the walking tests and the information whether the participant needed to use a walking aid or not. The averages of gender and age were calculated, and results were visualised with tables, bar charts, line charts and scatterplot charts as depicted in the next chapter. To examine the relationship and correlation between these two tools correlation (r) was calculated using the correlation function in Excel.

4.3.2 Analysis of the usability and usefulness observation

Qualitative data describes qualities or characteristics of the phenomenon and can be broad. The goal of qualitative analysis is to organise the data and give structure to the material in order to the researcher being able to find the conclusions that can be drawn from it. (Kananen, 2008, p. 88-91.) Material from the usability and usefulness observation was analysed using deductive

analysis in which the classification of the material is based on previous knowledge and theories (Kananen, 2008, p.91). The framework used for the analysis was based on usability and usefulness module on MeCUE questionnaire as follows:

- The product is easy to use.
- The functions of the product are exactly right for my goals.
- It is quickly apparent how to use the product.
- I consider the product extremely useful.
- The operating procedures of the product are simple to understand.
- With the help of this product, I will achieve my goals.

Observations regarding the usability of these two fall risk screening tools were written in a form of notes during the testing. For the deductive analysis this written material of both tools was then simplified in a form it was easier to process. Simplified observations were then classified. Classification was based usability and usefulness module of the MeCUE. Thus, there was two main categories: usability and usefulness. Subcategories were formed from the questions of the usability and usefulness module. Subcategories were as follows:

- Easy to use (usability)
- Right functionalities (usefulness)
- Learnability (usability)
- Usefulness (usefulness)
- Simple operating procedures (usability)
- Supports goals (usefulness)

Results were visualised in a table. To get a clearer understanding of the results main categories and subcategories were organised. In the table usability linked subcategories and simplifications are presented first and after that usefulness related subcategories and simplifications are depicted.

5 RESULTS

The total of 20 (N= 20) elderly clients participated to the study. The participants were 15 women and 5 men, ages between 68-94 years average age being 84 years. All the participants were living at home with the support of home care services. 60 % (n= 12) of them were using a walking aid. The original results from both fall risk assessment solutions are visualised side by side in excel table on Appendix 4 of this paper.

5.1 Results of FROP-Com Screen

All the participants started their testing by answering the question of living arrangements, falls in the past 12 months and the amount of assistance in daily activities (ADL-status). These were then followed by the balance walking test, where participants stood up, walked few meters, turned around and sat back down. All 20 participants were able to answer the asked questions and took part to the balance-walking test. However, some of the participants had difficulties to answer the questions due to their memory impairments.

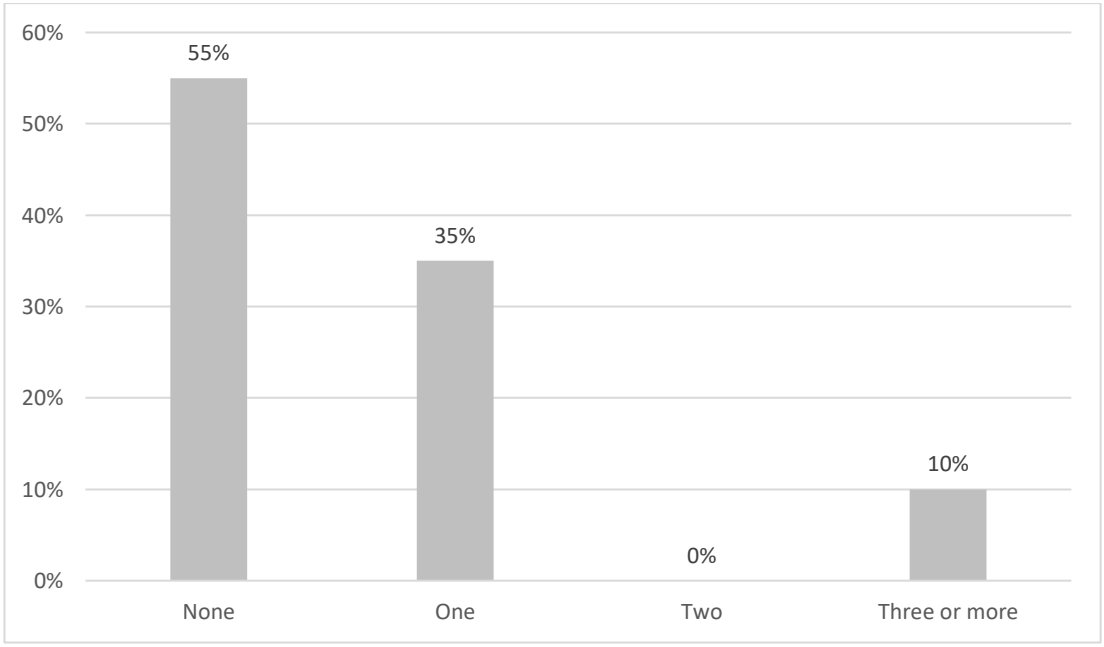

Figure 4. The number of falls in the past 12 months.

As depicted in Figure 4, 55% (n=11) had not fallen during the last 12 months, 35 % (n=7) of the participants had fallen in the past 12 months at least once, 10% (n=2) them stated they had fallen at least 3 times or even more. 60% (n=12) of the participants were using a walking aid, in which 11 were regular rollators and one a rollator with an elbow support. All participants were living at home with a help of home care services. 90% (n=18) of them had highest points possible in the ADL-status meaning they were highly dependable in others help in cooking, cleaning, laundry, and other housework. 10% (n=2) of the participants told they were still able do a lot at home and only needed supervision or occasional help (Figure 5).

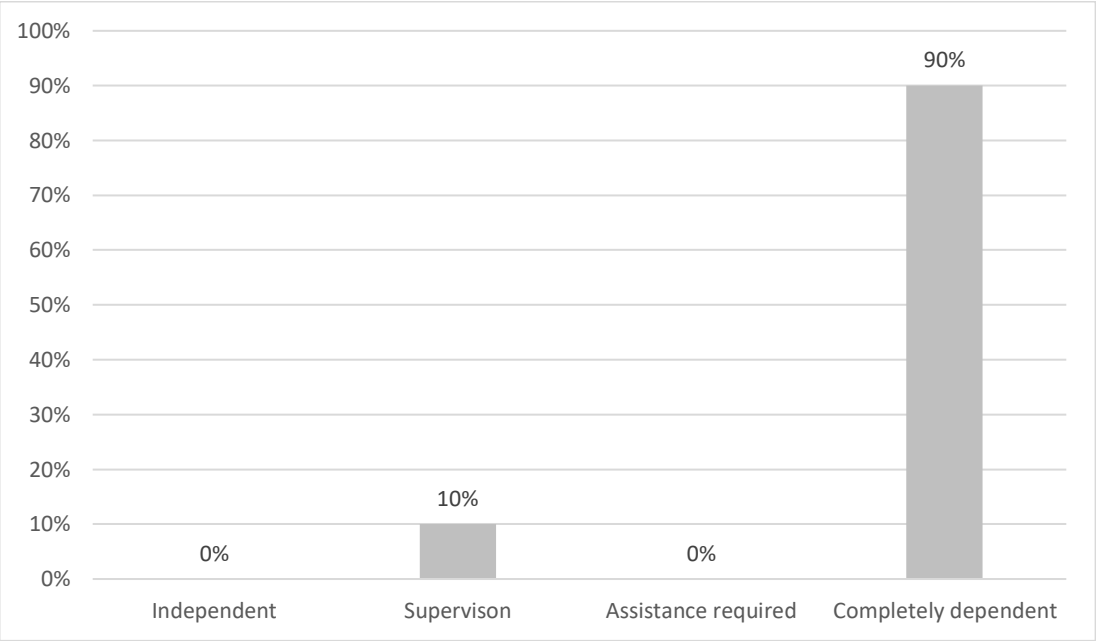

Figure 5. ADL-status. The amount of assistance in daily activities.

Figure 6 shows the results of balance walking test. 10% (n=2) of the participants had no visible unsteadiness, 15% (n=3) had minimal unsteadiness, 70% (n=14) had moderate unsteadiness and 5% (n=1) was consistently and severely unsteady. It is notable that if a participant was using a walking aid they were automatically put into a category of “moderate unsteady” even if the balance and walking itself did not look unsteady. The official instructions were followed fully.

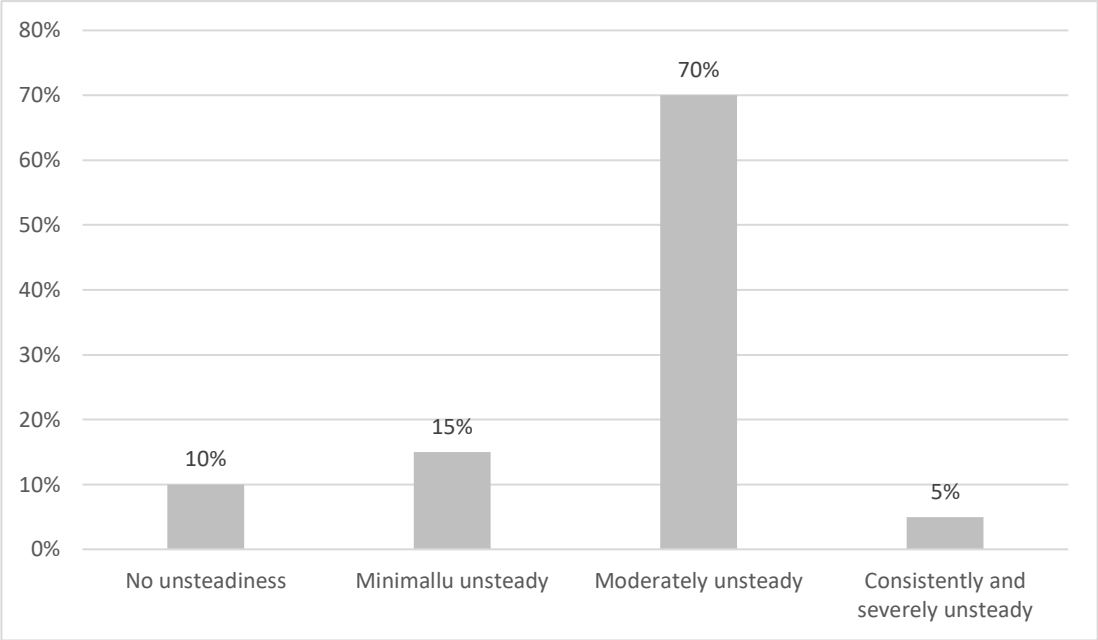

Figure 6. Observed balance in balance-walking test.

In total scores 25% (n=5) were in a low fall risk (0-3 points), 60% (n=12) in medium fall risk (4-7 points) and 15% (n=3) in high fall risk (8-9 points) as seen in Figure 7.

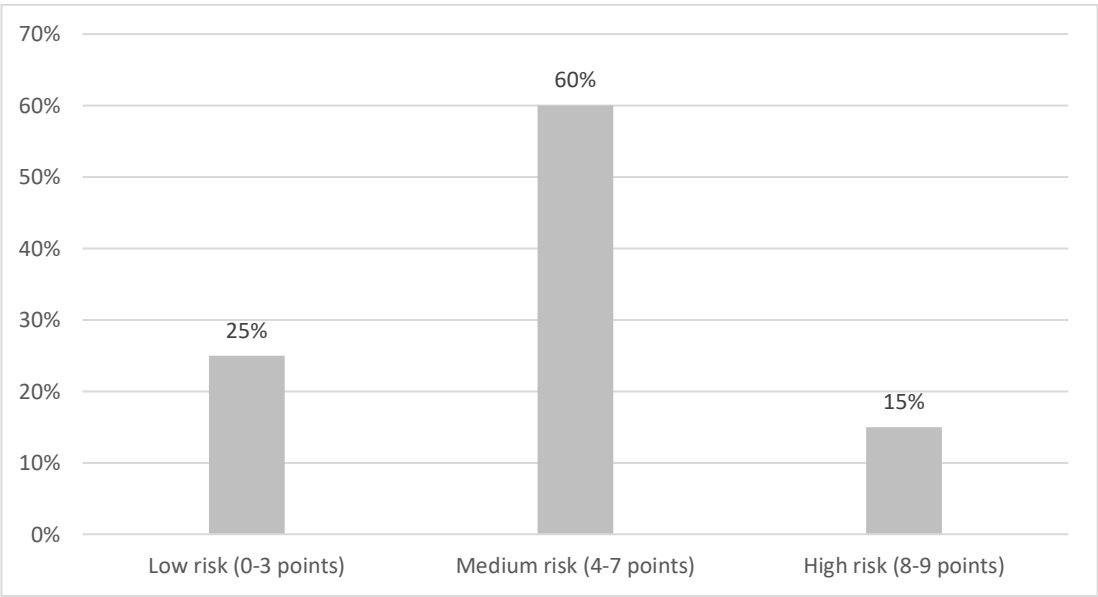

Figure 7. FROP-Com screen results.

5.2 Results of VTT's mobile fall risk assessment solution

Straight after the FROP-Com Screen test participants were tested with VTT's fall risk assessment solution. Participants conducted a 10 meters walking test wearing a sensor on their lower back and answered questions about their age, gender, and experienced balance. All 20 participants were able to answer the asked questions, however some of them needed help to calculate their age based on the year they were born. Walking test was passed successfully by 19 of the participants, unfortunately one participant was left without a result despite of multiple tries.

As can be seen from the background details 75% (n=15) of the participants (N=20) were women and 25% (n=5) of them men. Ages varied between 68 and 94, average age being 84 years and median 84 years. Experienced balance was evaluated by the participants in a scale "very good", "quite good", "moderate good", "quite bad" and "bad". As described in Figure 8, in total of 20 participants (N=20): 5% (n=1) experienced their balance being very good, 30% (n=6) stated it being quite good, 40% (n=8) experienced it being moderate good, 15% (n=3) stated it being quite bad and 10% (n=2) were experiencing their balance being very bad. The experienced balance of the participants differed from their fall risk index. Experienced balance could be "quite good" despite of the fall risk index stating the participant being in a clearly elevated risk of falling. On the other hand, a participant who did not have an elevated risk of falling could experience the balance being only on a level "moderate".

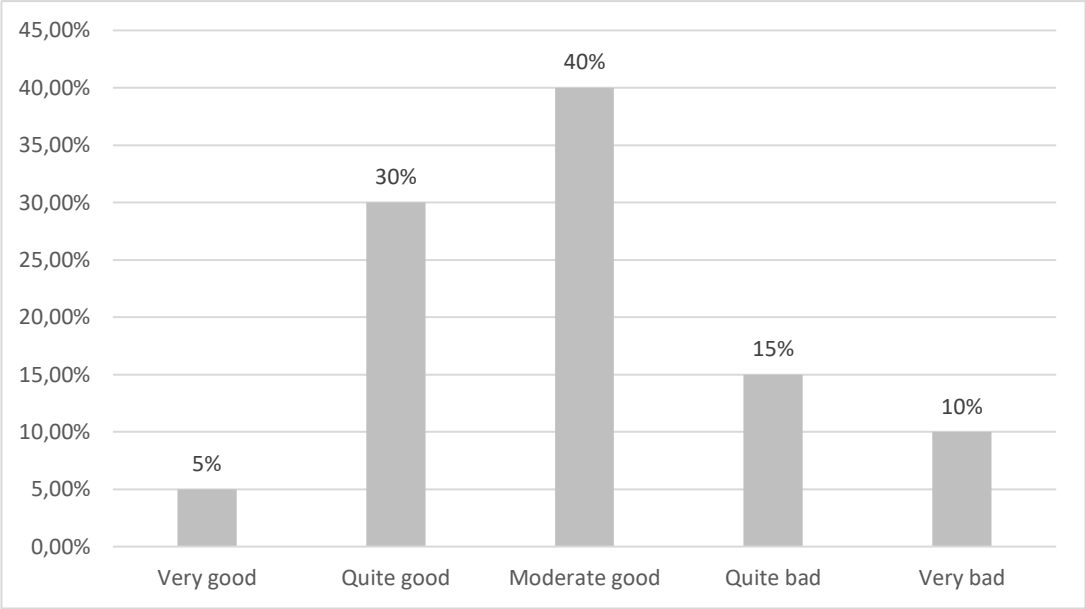

Figure 8. Experienced balance.

One participant of the total 20 participants was left without a result in walking test. The fall risk index stated that of the 19 participants (N=19) 5,3% (n=1) did not have an elevated risk of falling, 26,3% (n=5) had slightly elevated risk of falling and 68,4% (n=13) had clearly elevated risk of falling as visualised in Figure 9.

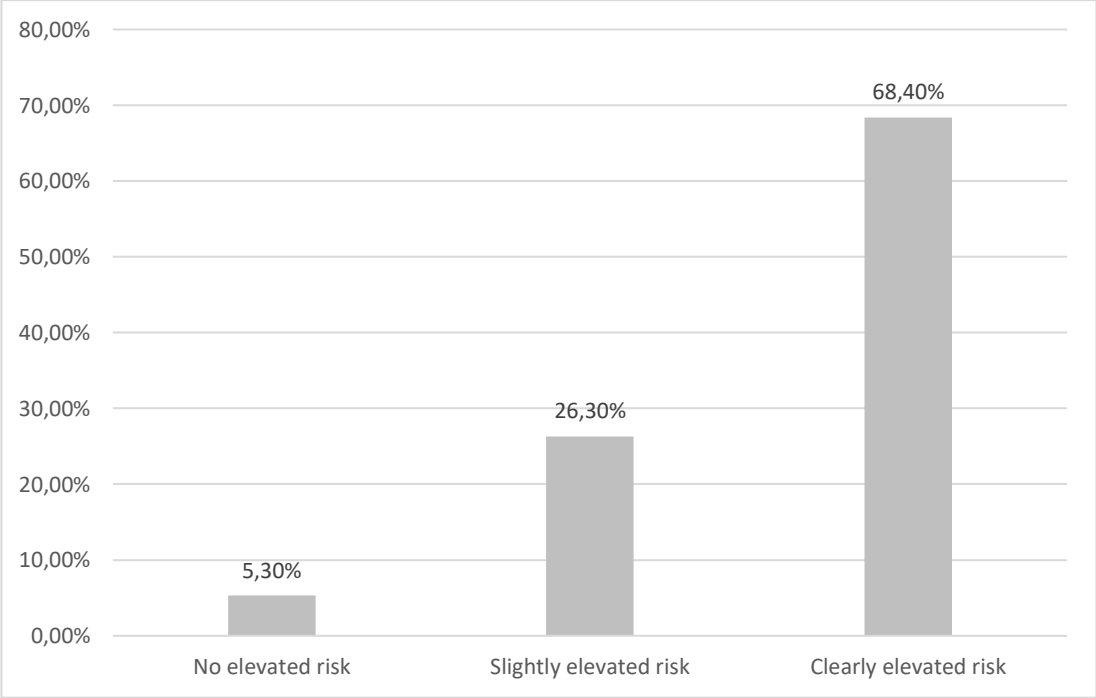

Figure 9. Fall risk index by VTT's mobile fall risk assessment solution.

5.3 Comparison of the results

FROP-Com Screen and VTT's mobile fall risk assessment solution are different from their action mechanism thus the scoring and fall risk classification system differs as well. Comparison of each participant's final results is visualised in Table 1.

Table 1. Comparison of the results of each participant.

Participant	**FROP-com screen results** (Points)	**VTT's fall risk group** (Fall risk index)
#01	Medium risk (5)	Cleary elevated risk (5,6942)
#02	Medium risk (4)	Slightly elevated risk (4,6237)
#03	Low risk (3)	Slightly elevated risk (5,2987)
#04	Medium risk (5)	Clearly elevated risk (6,4513)
#05	Medium risk (5)	Clearly elevated risk (5,9332)
#06	Medium risk (5)	Clearly elevated risk (6,8831)
#07	Medium risk (5)	Clearly elevated risk (6,2472)
#08	Low risk (2)	Slightly elevated risk (4,2091)
#09	High risk (8)	**No result**
#10	Medium risk (6)	Clearly elevated risk (6,3092)
#11	High risk (8)	Clearly elevated risk (6,2725)
#12	Low risk (4)	Slightly elevated risk (4,8053)
#13	Low risk (2)	Slightly elevated risk (4,0314)
#14	Medium risk (5)	Clearly elevated risk (6,0937)
#15	Low risk (3)	No elevated risk (3,5198)
#16	Medium risk (7)	Clearly elevated risk (6,6281)

#17	Medium risk (7)	Clearly elevated risk (5,4703)
#18	Medium risk (6)	Clearly elevated risk (6,8439)
#19	Medium risk (5)	Clearly elevated risk (6,0363)
#20	High risk (8)	Clearly elevated risk (7,1471)

FROP-Com Screen classified the participants in three different group based on the scores collected from each of the three questions. Scores between 0-3 indicated a low risk of falling, 4-7 a medium risk of falling and 8-9 a high risk of falling. VTT's mobile fall risk assessment solution had a similar classification based on the fall risk index calculated by the phone application. However, for the user it is not visible how this fall risk index is calculated. Based on the fall risk index the participant was either in no elevated, slightly elevated or in clearly elevated fall risk. Both fall risk screening tools seemed to recognise the individuals that were in a risk of falling. If comparing the results side by side based on the fall risk classification of each tool VTT's mobile fall risk assessment solution calculated the participants more often in higher fall risk group compared to FROP-Com screen, this is visualised in Figure 10.

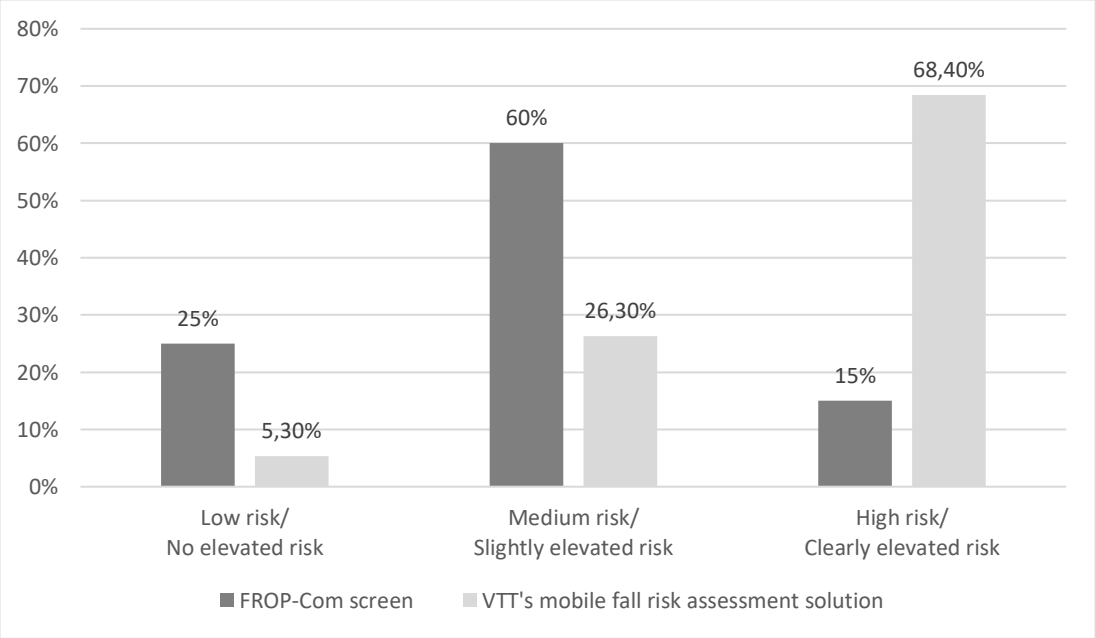

Figure 10. Results as percentages side by side.

25% of the participants (N=20) were in a low fall risk based on FROP-Com Screen results meanwhile only 5,3% (N=19) of the participants were classified as no elevated fall risk according to VTT's mobile fall risk assessment solution. In the next category can see that majority of participants (60%) were in medium fall risk according to FROP-Com Screen meanwhile only 26,3% were in a slightly elevated risk based on VTT's mobile fall risk assessment solution. FROP-Com Screen evaluated only 15% of participants being in a high fall risk whereas VTT's mobile fall risk assessment solution categorised majority of the participants (68,4%) being in a clearly elevated fall risk.

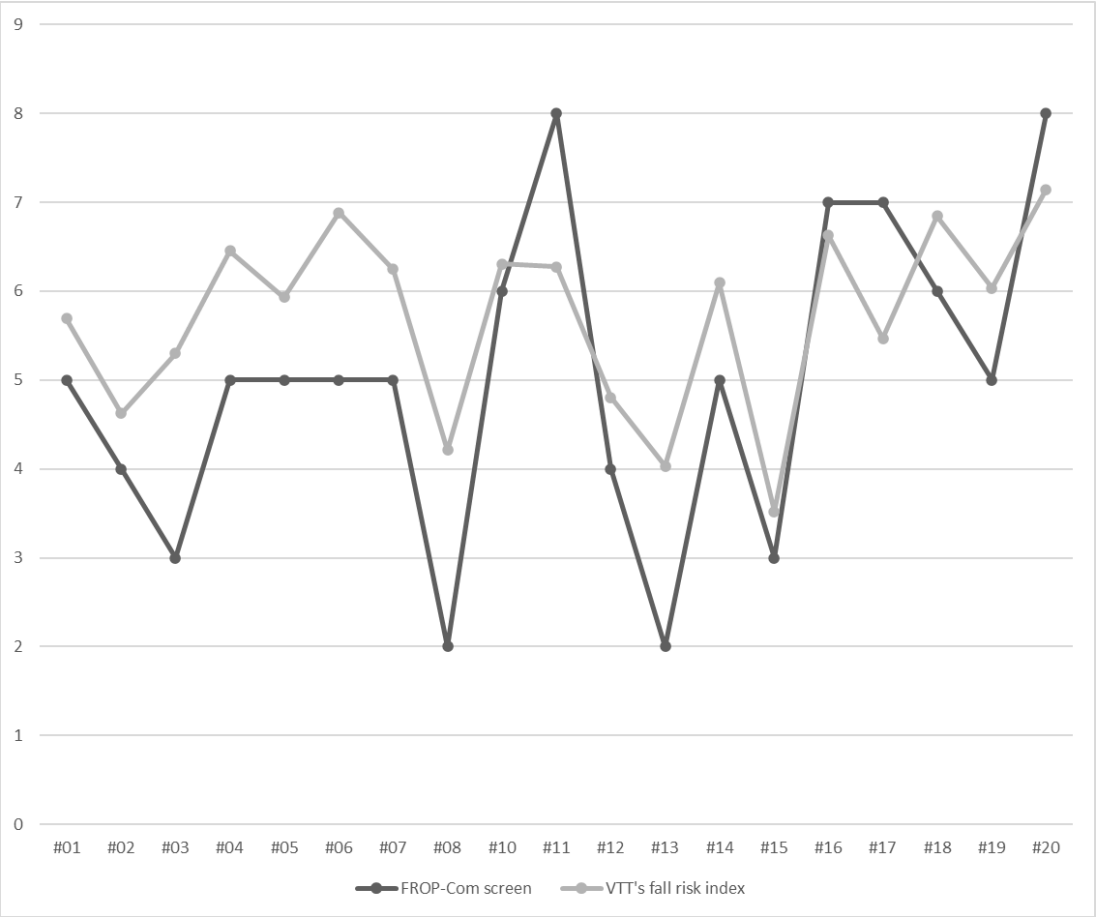

Figure 11. Results as a line chart.

Figure 11 visualises the results as a line chart in which the participants are in the x-axis and results in y-axis. The results of participant #09 were not included in this chart due to insufficiency. As seen on the figure the lines have similarities on them. In the previous figure VTT's classification seemed generally to score the participants in higher risk groups compared to FROP-Com screen.

However, in the Figure 11, the participants that got 7-9 points with FROP-Com Screen seem have gotten less points with VTT's fall risk assessment solution.

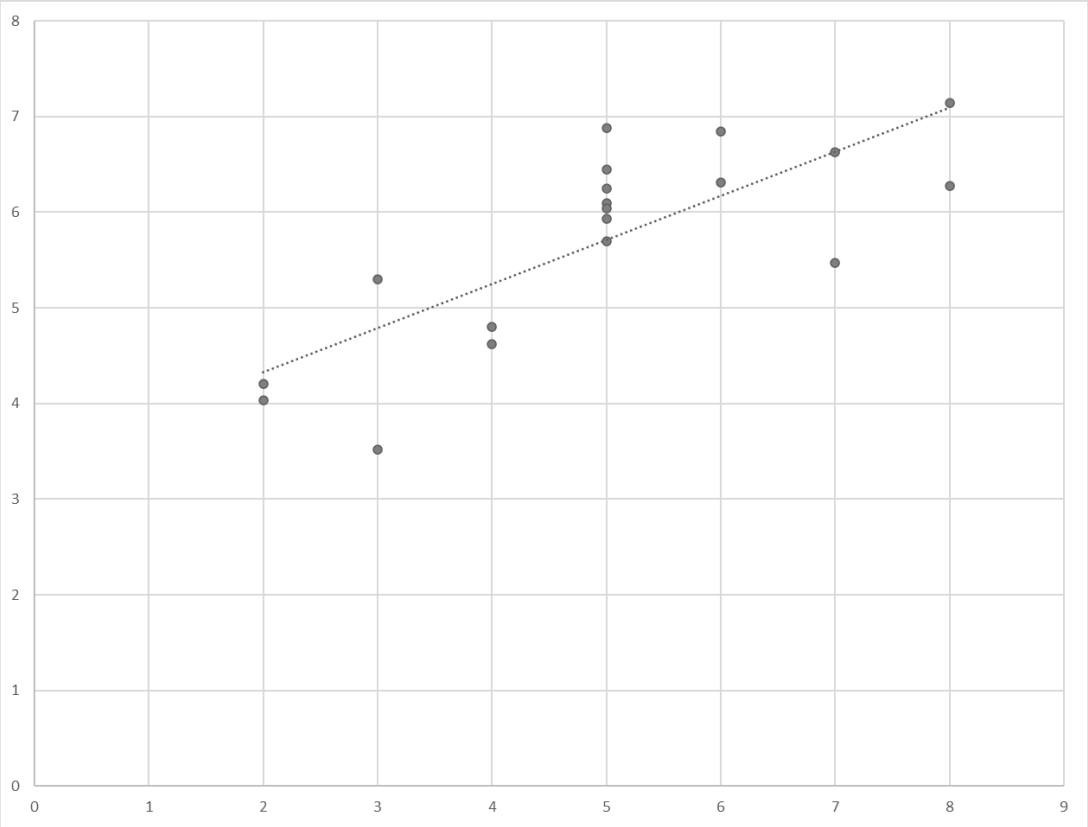

Figure 12. Results as a scatterplot.

In figure 12 results are visualised as a scatterplot in which FROP-Com Screen results are in x-axis and VTT's fall risk index in y-axis. This figure depicts the relationship between these two fall risk screening tools. Correlation can tell if two variables have a linear relationship and how strong it is. Correlation is measured in a scale +1- (-1), in which +1 indicates a perfect positive correlation and -1 perfect negative correlation. The strength of correlation analysed as follows: 0,8 > = strong correlation, 0,4-0,8 = moderate correlation and 0,4 < = no correlation. (Kananen, 2011, p.109-111.) In the figure dots are not perfectly on the trend line but there is a positive correlation between them. Correlation (r) was calculated being + 0,781788015. This can confirm there being a moderate (almost strong) positive correlation which means the changes in other fall risk screening tool will relate to the same type of changes in other fall risk screening tool.

5.4 Results of the usability and usefulness observation

Observations regarding the usability and usefulness of both fall risk screening tools were made during the whole testing period. Observations were written down as they appeared. The results after simplification and classification are presented in Table 2.

Table 2. Usability and usefulness observation results.

FROP-Com Screen				**VTT**
Observation	**Sub-category**	**Main category**	**Sub-category**	**Observation**
"All instructions included" "Minimal equipment needed" "Does not need a lot of space"	Easy to use	**Usability**	Easy to use	"Technical devices needed" "Quick to use" "Needs more space"
"Overwhelming amount of information on single sheet" "Simple to use for anyone"	Learnability	**Usability**	Learnability	"Understanding of technical devices needed" "Application is simple to use" "Start and stop buttons clear and visible"
"Recommended actions based on results for professionals"	Simple operating procedures	**Usability**	Simple operating procedures	"Guides user through the testing step by step" "Visualises results clearly"
"Walking test based on observation of the tester" "Observation depends on opinion of the tester" "Background/medical history of the clients need to be known"	Right functionalities	**Usefulness**	Right functionalities	"Testing is objective" "No need to know any background/ other details of the client"

“Does not work well in clients with memory impairments”	Usefulness	**Usefulness**	Usefulness	“Works in all kinds of clients” “Possibility to compare earlier results”
“Validity of the results in case of client having a memory impairment?” “Can recognise the individuals in a risk of falling”	Supports goals	**Usefulness**	Supports goals	“Memory impairments do not affect the results” “Can recognise the individuals in a risk of falling”

Both tools aim to fulfill the same goal: to recognise the individuals at risk of falling. The difference in the action mechanism of these tools can be noticed in usability and usefulness results: FROP-Com Screen is a questionnaire on a paper and VTT’s mobile fall risk assessment solution is based on technology. Both can be considered easy to use. FROP-Com Screen needs less equipment and is simple for anybody to use. For VTT’s mobile fall risk assessment solution technical devices need to be purchased and to start the screening process the mobile and sensor need to be paired via Bluetooth. Once all the setup is done VTT’s mobile fall risk assessment solution is quicker in testing the participants, however it does require a bigger testing area compared to FROP-Com Screen. Learnability wise VTT’s mobile fall risk assessment solution is more challenging although the use of the application and the testing is simple after all the setup is completed. Compared to FROP-Com Screen the user needs to have understanding towards technology (application setup and Bluetooth pairing). Despite the overwhelming amount of information on FROP-Com Screen document it is quite quick to learn to use it. Observations regarding the operating procedures showed that FROP-Com Screen gives recommended actions for professionals based on the result. VTT’s mobile fall risk assessment solution on the other hand has a very clear way to guide the user through the testing and visualise the results.

Usefulness observation of the tools pointed out the fact of memory impairments affecting greatly the usefulness of FROP-Com Screen with this client group. When focusing on the functionalities it is notable that while VTT’s mobile

fall risk assessment solution measures the fall risk in objective way and no medical history about the client needs to be known, the walking test in FROP-com screen is based on the tester's observation and opinion about the balance. If the client has a memory impairment it is necessary to know the client's medical history to be able to answer the questions truthfully. This makes the use of FROP-Com Screen a lot slower. When considering the usefulness of the tools VTT's mobile fall risk solution works with every client meanwhile FROP-Com Screen does not work well with clients that have memory impairments. Technically both tools support the goal: they can identify the individuals at a risk of falling, however with this client group the possible memory impairments make it more uncertain, difficult, and slower to achieve the goal with FROP-Com Screen.

6 DISCUSSION

6.1 Discussion of the results

This study focused on comparing the data, usability, and usefulness of two different fall risk screening solutions. The purpose was to produce information for VTT of their novel mobile fall risk assessment solution to enable product development, and to discuss whether this kind of new technology could detect and analyse the elderly in a risk of falling in more objective manner. The research questions guiding the research process were: In what ways the results of FROP-Com screening tool and VTT's mobile fall risk assessment solution are codirectional with each other in elderly clients? And what kind of similarities and differences in the usability and usefulness of these two tools are detected during the testing period?

As mentioned earlier the fall risk screening solutions used in this study were different in their action mechanism but the purpose of them was the same, both aimed to recognise the elderly at risk of falling. The classification and scoring

system differed FROP-com screen evaluated the clients to be in low, medium, or high fall risk while VTT's mobile fall risk assessment solution assessed the clients with no elevated, slightly elevated, and clearly elevated risk of falling. In the results FROP-Com Screen evaluated most of the participants in medium fall risk category while VTT's mobile fall risk assessment solution showed most of the participants being in a clearly elevated risk of falling. In general, FROP-Com Screen classified the participants mostly in low and medium fall risk rather than in high while VTT's mobile fall risk assessment stated the participants being mostly in elevated fall risk and clearly elevated fall risk. The similarities between the results of the tools could be seen in the line chart, where despite of the different classification and score system the tools seemed to react similarly to the changes between the participants. Results visualised as a scatterplot and calculated correlation confirmed there being a moderate positive correlation between these tools. Meaning changes in other fall risk screening tool were related to the same type of changes in other fall risk screening tool.

This study was comparing the usability and usefulness of very different fall risk assessment solutions that aimed to fulfil the same goal. Usability and usefulness related observation detected two important notices regarding the final scores of FROP-Com screening tool. The results may not be valid if the participant has a memory impairment, this applies especially in the question about the number of falls in the past 12 months. Since FROP-Com Screen only consist of the total of 3 questions, the fact of possibly not being able to answer truthfully to one or two of the questions may affect to the end results remarkably. The other concern regarding FROP-com Screen scores was the balance-walking test where researcher needed to observe the participants possible balance issues. The overall balance may have appeared nice and steady despite of the gait being slow, shortened or lowered. The previous studies have shown slow walking speed and changes in the gait pattern being a risk factor for falls (Kwon et al., 2018, Pirker & Katzenschlager 2017, Ambrose et al., 2015) these factors were not taken in consideration in FROP-Com Screen.

As presented in previous chapter both solutions were easy to use but VTT's mobile fall risk assessment solution needed more actions done before being

able to start the screening process. An understanding of technical devices or education how to use this technical solution is a must (application set up and Bluetooth pairing). The functions of these tools were different and as noted previously the possible memory impairments of the clients may have affected to the FROP-Com Screen results as well as the researcher's opinion about the balance of the participants. Thus, VTT's mobile fall risk solution had better functions to reach the wanted goal with this client group due to its more objective and technical nature of collecting the data. With both screening tools it was quickly apparent of how to use them, but the instructions needed to be read first. The operating procedures were easy to understand in both, but in general there was a smaller risk for user errors in VTT's mobile fall risk assessment solution due to the application guiding the user smoothly through the whole testing one step at a time. Both fall risk screening tools can be found useful since they fulfil the goal of recognising the individual at risk of falling. However, with this client group VTT's mobile fall risk assessment solution seemed more practical to use due to its results not being affected by the client's possible memory impairments. In other words, using the VTT's mobile fall risk assessment solution the clients can be "unknown" there is no need to know the medical background or use patient record system to confirm any information the client has given. This makes the screening not only more reliable but also quicker for the user. The challenging part in using the VTT's fall risk assessment solution was to ensure the testing area was spacious enough and there were no other clients or staff members entering in it during the testing.

Fall risk screening is beneficial for individuals and society. The challenge is to administer a suitable screening or assessment method to certain group of individuals (children, adults, or elderly) in certain settings (home, hospital, care facilities). (WHO, 2021, p 87-124.) There is no perfect screening or assessment method that works for everybody and in every setting. It is challenging to create a tool that would be objective, consider all the risk factors for falling biological, behavioural, socioeconomic, and environmental (WHO, 2007, p. 5), while keeping the testing reasonably short, quick, simple, achievable, and easy for everybody to conduct. It is necessary to divide the tools in screening tools and assessment tools in which the screening tools are quick to administer and

only aim to identify the individuals at fall risk. Assessment tools can then be used for recognising the risk factors affecting to the fall risk.

Physical screening environment can limit the options when choosing a fall risk screening tool. If the tool is based on walking tests and requires a lot of space for testing, the tool is most likely not practical at home settings. However, there is a wide selection of fall risk screening tools for different patient groups and different settings. Studies have summarised the existing tools that are available and ready to use. With already existing tools there should be little need for facilities to develop their own tools: developing a unique screening and assessment tool for individual facility makes it more difficult to compare the results and scores across other facilities (Perell et al., 2001.) Thus, it is important that organisations and facilities use valid and tested fall risk screening and assessment tools that make the results comparable not only within the facilities but also possibly with earlier test results of the individual.

Body-worn sensors have a potential to improve fall risk screening. Fall risk can be evaluated based on risk screening tools, the experienced balance of the elderly, the judgement of the nurses or a combination of all. A study concluded in Hamburg indicates that a use of fall risk assessment tool in nursing homes does not lead in better outcomes than relying on nurse's clinical judgement alone. The study suggests ensuring that the used fall risk assessment tools have demonstrated clinical superiority compared to nurse's judgement, otherwise the use of the fall risk assessment tools can lead in wasting the nursing resources. (Meyer et al., 2009, p. 371-423.) A common question in the fall risk screening tools is the amount of the falls in the previous 12 months. This kind of question is difficult for the elderly to answer due to the possible memory impairments. For the nurses it wastes the resources to try to find the information from patient record system that does not have a standard practise of keeping a record of the falls. The results of this thesis showed that elderlies experienced balance differed from the fall risk index given for them by VTT's mobile fall risk assessment solution. These facts kept in mind an objective fall risk screening method with a wearable sensor could improve screening and save resources.

Considering the professionals workload, fall risk screening needs to operate with minimal resources. Thus, it needs to be quick, and the tool needs to be suitable for the certain client group to meet the goal. Usability is known to be one of the key factors for professionals to be willing to engage with products (Nielsen, 2012), the chosen fall risk screening tool can affect to the consistency of the screening and attitudes towards it. It is not efficient for the elderly or the professionals if the tool does not have the needed features and it does not meet the set goal or in other words the tool is not useful. This study did not take in consideration the attitudes of the participants towards these fall risk screening tools. However, during the testing the elderly seemed to enjoy the social interaction with the researcher and did not mind wearing the VTT's acceleration sensor on their waist.

The increase of aging population will challenge the healthcare in the future. Fall related injuries are costly but also put pressure on professionals working in the healthcare field. (Turner et al., 2015, p. 1.) In Finland the healthcare system already has a shortage of registered nurses, and the system is battling under financial pressure (Valtioneuvosto, 2022, p.1-29). In health care services this can lead to bigger patient ratio for nurses and slower services for patients. Thus, procedures need to be fluent and efficient. In elderly care preventing falls will remain important for the individuals' quality of life but also to maintain the balance in healthcare services and to lower the financial pressure.

6.2 Validity and reliability

The guidelines of good scientific research and ethical thinking were followed throughout the whole thesis process. A research permit was applied and accepted from the City of Turku. Participation for the study was voluntary and this was explained to each participant verbally and in written document. The data was collected as planned and VTT's technical devices functioned as expected, despite one of the participants being left without a fall risk index. The data collected through the fall risk screening tools and observation was studied

carefully and results were reported truthfully. The background of the thesis was examined thoroughly, and sources and authors were cited accordingly.

However, there was limitations in this thesis. Firstly, the sample size ended up being relatively small, 20 participants. Secondly, the participants had memory impairments which may have affected to the results in FROP-Com screen and thus to the validity of the results. The differences in the scoring and fall risk classification system of these fall risk screening tools made it challenging to arrive in convincing conclusion based on the quantitative results. However, the visualisation of the results and calculated correlation were able to describe the similarities and the strength of the relationship between these two tools. In the end the results can create understanding about the importance and need of measuring the fall risk in the elderly in more objective manner.

7 CONCLUSIONS

This thesis aimed to compare the data of FROP-Com screening tool and mobile fall risk assessment solution by VTT and to find out in which ways the results were codirectional with each other in elderly clients. In addition, during the testing period observations were made to analyse the usability and usefulness of these two fall risk screening tools. The research questions set for the thesis were as follows: In what ways the results of FROP-Com screening tool and VTT's mobile fall risk assessment solution are codirectional with each other in elderly clients? And what kind of similarities and differences in the usability and usefulness of these two tools are detected during the testing period? The results can help VTT to enable product development and create an understanding about the need of an easy, quick, and objective way of detecting and analyse the elderly in a risk of falling.

The results of this thesis confirmed that both FROP-Com screening tool and the mobile fall risk assessment solution by VTT could detect the elderly that

were at risk of falling and in need of a further assessment and actions taken to decrease their fall risk. Despite of these two screening tools being very different from their action mechanism and score system there was a positive moderate correlation between the results. Meaning changes in other fall risk screening tool were related to the same type of changes in other fall risk screening tool. Usability and usefulness observations gave an understanding about the need of a fall risk screening tool that is suitable for elderly with and without memory impairments. This is important not only for the validity of the results but to decrease the workload of the nurses by making the fall risk screening process straightforward and quick. The mobile fall risk assessment solution by VTT is not based on assumptions or the tester's personal point of view. These facts kept in mind VTT's mobile fall risk assessment solution is capable to offer a screening method that is objective and suitable for most of the elderly. However, this tool is not suitable to be used in home settings due to the 10 meters walking requirement which is not realistic in small apartments.

Fall risk screening is important for the individual itself but also in society level. Recognising the individuals at risk of falling and assessing a care plan suitable for their needs can lead in less falls, less injuries and better quality of life. In other words, fall risk screening can save lives and save money.

This research piqued the interest of the professionals working in the elderly support and assessment ward towards the VTT's mobile fall risk assessment solution. In the future, it would be interesting to research the attitudes and feelings of the healthcare professionals towards the VTT's fall risk assessment solution. Despite of there not being a perfect fall risk screening tool for every context, the mobile fall risk assessment solution by VTT has good features to answer for the need of simple, quick, and objective fall risk screening in the elderly if the testing environment is suitable for walking 10 meters without disturbance.

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APPENDIX 1: FROP-COM SCREEN BY NARI

NARI
NATIONAL AGEING RESEARCH INSTITUTE LTD
Bringing research to life

(Affix Patient ID Label)

UR No _____
Surname: _____
Given Name _____
DOB _____

Falls Risk for Older People in the Community (FROP-Com) Screen

Screen all people aged 65 years and older (50 years and older Aboriginal & Torres Strait Islander peoples)

Date of screen: / /

FALLS HISTORY		**SCORE**
1. Number of falls in the past 12 months?	o None (0) o 1 fall (1) o 2 falls (2) o 3 or more (3)	[ ]
FUNCTION: ADL status		
2. Prior to this fall, how much assistance was the individual requiring for instrumental activities of daily living (eg cooking, housework, laundry)? • *If no fall in last 12 months, rate current function*	o None (completely independent) (0) o Supervision (1) o Some assistance required (2) o Completely dependent (3)	[ ]
BALANCE		
3. When walking and turning, does the person appear unsteady or at risk of losing their balance? • *Observe the person standing, walking a few metres, turning and sitting. If the person uses an aid observe the person with the aid. Do not base on self-report.* • *If level fluctuates, tick the most unsteady rating. If the person is unable to walk due to injury, score as 3.*	o No unsteadiness observed (0) o Yes, minimally unsteady (1) o Yes, moderately unsteady (needs supervision) (2) o Yes, consistently and severely unsteady (needs constant hands on assistance) (3)	[ ]

Total Risk Score	[ ]

Total score	0	1	2	3	4	5	6	7	8	9
Risk of being a faller	0.25		0.7		1.4		4.0		7.7	
Grading of falls risk	0 - 3 Low risk				4 – 9 High risk					
Recommended actions	Further assessment and management if functional/balance problem identified (score of one or higher)				Perform the Full FROP-Com assessment and / or corresponding management recommendations					

Date: / /

APPENDIX 2: FROP-COM SCREEN BY THL

IKINÄ

TERVEYDEN JA HYVINVOINNIN LAITOS

Kotona asuvat iäkkäät
LYHYT KAATUMISVAARAN ARVIOINTI (FROP-Com Screen, Falls Risk for Older People)

Nimi:						
Syntymäaika:						
Osoite / osasto / huone:						
Asumismuoto: yksin / itsenäisesti / tuetusti						
	Arvioinnin tekijä					
	Arviointipäivämäärä (pv/kk/vv)					
		ARVIOINTIPISTEET				
KAATUMISHISTORIA						
Kaatumiset edeltävän 12 kk aikana	Ei yhtään	(0 p.)				
	Yksi kaatuminen	(1 p.)				
	Kaksi kaatumista	(2 p.)				
	Kolme kaatumista tai enemmän	(3 p.)				
PÄIVITTÄINEN TOIMINTAKYKY						
Kuinka paljon henkilö tarvitsee apua päivittäisissä toimissa kotona (ruuanlaitto, siivous, pyykki yms. kotityöt)? *Jos kaatunut, kirjataan tilanne ennen kaatumista.*	Täysin itsenäinen	(0 p.)				
	Selviytyy vähäisen avun turvin	(1 p.)				
	Tarvitsee paljon apua	(2 p.)				
	Tarvitsee apua lähes kaikissa toiminnoissa (3)	(3 p.)				
TASAPAINOKYKY						
Henkilöä pyydetään nousemaan istumasta seisomaan, kävelemään muutaman metrin eteenpäin, kääntymään ja palaamaan takaisin istumaan. *Jos apuväline käytössä, tehdään suoritus sen kanssa.* *Jos tasapainokyky vaihtelee suorituksen eri vaiheissa, pisteytys heikoimman vaiheen suorituksen mukaan.*	Ei havaittavaa tasapainon heikkoutta	(0 p.)				
	Jonkin verran tasapainon heikkoutta	(1 p.)				
	Selvästi heikentynyt tasapaino (tarvitsee hieman apua tai käyttää apuvälinettä)	(2 p.)				
	Tarvitsee jatkuvasti apua tai ei pysty lainkaan suoritukseen	(3 p.)				
PISTEET YHTEENSÄ						

Pisteet	0	1	2	3	4	5	6	7	8	9
Kuinka paljon suurentunut kaatumisvaara	0,25 kertainen		0,7 kertainen		1,4 kertainen		4,0 kertainen		7,7 kertainen	
Kaatumisvaara	0–3 lievästi kohonnut				4–7 kohonnut				8–9 erittäin korkea	
Toimenpiteet	Tasapainokyvyn ylläpitäminen Liikuntakyvyn ylläpitäminen				Kaatumisvaaran kokonaisvaltainen arviointi ja yksilöllisten ehkäisytoimien toteutus				Välitön kaatumisvaaran kokonaisvaltainen arviointi ja toimenpiteiden käynnistäminen	

Lähde: Australian Guideline, community care. FROP-COM Screen (Mukaeltu). Russell MA, Hill KD, Blackberry I, Day LM, Dharmage SC. The reliability and predictive accuracy of the falls risk for older people in the community assessment FROP-Com Screen (Falls Risk for Older People) tool. Age Ageing. 2008 Nov;37(6):634-9. Suomenkielisen käännöksen ©THL, IKINÄ, www.tapaturmat.fi

SUORITUSOHJE
- Arvioinnin tekijä kullakin arviointikerralla merkitsee lomakkeeseen arviointipäivämäärän ja omat nimikirjaimensa.
- Jokaisesta arvioitavasta kohdasta valitaan yksi, arvioitavan henkilön tilaa parhaiten kuvaava vaihtoehto.
  - jos henkilön tila vaihtelee, valitaan heikointa tilannetta/toimintakykyä vastaava vaihtoehto.
- Lasketaan yhteen osioiden pisteet, määritellään kaatumisvaara ja jatkotoimet.

APPENDIX 3: INFORMATION FOR PARTICIPANTS

TIEDOTE TUTKIMUKSESTA

Comparison of two fall risk screening tools in elderly care

Pyyntö osallistua tutkimukseen
Teitä pyydetään mukaan tutkimukseen, jossa selvitetään kahden erilaisen kaatumisriskin arviointimittarin tulosten samasuuntaisuutta sekä mittareiden käytettävyyttä. Olemme arvioineet, että sovellutte tutkimukseen, koska olette iän ja fyysisen kuntonne puolesta tutkimuksen kohderyhmää. Tämä tiedote kuvaa opinnäytetyötä ja teidän osuuttanne siinä. Perehdyttyänne tähän tiedotteeseen teillä on mahdollisuus esittää kysymyksiä vastuutaholle. Perehtymisen jälkeen teiltä pyydetään suullinen suostumus tutkimukseen osallistumisesta.

Vapaaehtoisuus
Tutkimukseen osallistuminen on täysin vapaaehtoista. Kieltäytyminen ei vaikuta oikeuksiinne, kohteluunne tai saamaanne hoitoon Kurjensiipi 2 osastolla. Voitte myös keskeyttää osallistumisen koska tahansa syytä ilmoittamatta. Mikäli keskeytätte tai peruutatte suostumuksen, teistä keskeyttämiseen ja suostumuksen peruuttamiseen mennessä kerättyjä tietoja ja näytteitä voidaan käyttää osana opinnäytetyötä.

Tutkimuksen tarkoitus
Tutkimuksen tarkoituksena on selvittää kahden erilaisen kaatumisriski arviointimittarin tulosten samasuuntaisuutta sekä mittareiden käytettävyyttä. Valitut mittarit ovat FROP Com Screen sekä Valtion Teknillisen Tutkimuslaitoksen kehittämä mittari, joka koostuu kiihtyvyysanturista ja mobiilisovelluksesta.

Tutkimuksen toteuttajat
Tutkimus toteutetaan osana Master of welfare technology koulutuksen opinnäytetyötä. Taustalla on yhteistyö Satakunnan ammattikorkeakoulun sekä Valtion Teknillisen Tutkimuslaitoksen (VTT) kanssa. VTT on toivonut raporttia heidän kehittämäänsä kaatumisriskin arviointi mittarin, kiihtyvyysanturi-mobiilisovelluksen, käyttöön liittyen. Tutkimusympäristönä toimii Kurjensiipi 2 osasto.

Tutkimusmenetelmät ja toimenpiteet
Tutkimus toteutetaan Kurjensiipi 2 osastolla syksyn 2022 aikana. Osallistuminen tutkimukseen on vapaaehtoista ja vie osallistujalta noin 20 minuuttia. Tutkimus koostuu kahdesta eri kaatumisriskin arviointimittarista, sisältäen lyhyen haastatteluosuuden sekä kaksi kävelytestiä. Kävelytestit voidaan suorittaa ilman apuvälinettä tai apuvälineen kera. Kerätty tieto tallennetaan anonyymisti tutkimuskäyttöön, nimeä tai henkilötietoja ei kysytä eikä talleteta missään kohtaa tutkimusta. Näiden mittausten lisäksi tutkimustilanteen aikana tutkija tekee muistiinpanoja mittareiden käytettävyydestä, tällä pyritään selvittämään mittareiden tehokkuutta, vaikuttavuutta, sekä yleistä tyytyväisyyttä mittareiden toiminnasta.

Tutkimuksen mahdolliset hyödyt
Tutkimus suoritetaan asiakkaan kuntoutus- ja arviointijakson aikana, asiakas saattaa saada tutkimukseen osallistumalla lisää tietoa kaatumisriskistään.

Tutkimuksesta mahdollisesti seuraavat haitat ja epämukavuudet
Tutkimus ei tule aiheuta haittaa osallistujalle. Turvallisuus huomioidaan tutkimuksen aikana, ja mahdolliset turvallisuusriskit minimoidaan.

Kustannukset ja niiden korvaaminen
Tutkimukseen osallistuminen ei maksa teille mitään. Osallistumisesta ei myöskään makseta erillistä korvausta.

Tutkittavien vakuutusturva
Tutkimuksen aikana osallistujilla on voimassa potilasvahinkolain mukaiset vakuutukset.

Tutkimustuloksista tiedottaminen
Testaustilanteen jälkeen osallistujille annetaan tiedoksi, onko heillä mittausten perusteella matala, keskisuuri vai suuri kaatumisriski. Tutkimustulokset käsitellään opinnäytetyössä, joka on julkaisemisen jälkeen vapaasti luettavissa Theseus-tietokannassa.

Tutkimuksen päättyminen
Tutkimus keskeytetään osallistujan näin halutessa. Tutkimus voidaan myös keskeyttää, mikäli turvallisuusriskejä ilmenee tai terveydentilassa tapahtuu äkillinen muutos kesken tutkimuksen.
Jokainen osallistuja saa henkilökohtaiset mittaustulokset tietoonsa testaustilanteen päättyessä. Tutkimuksen tulokset ovat luettavissa julkaistusta opinnäytetyöstä. Tutkimus suoritetaan anonyymisti, nimiä tai henkilötietoja ei kerätä. Osallistujaa ei voida tunnistaa kerätyn tiedon perusteella. Tutkimuksessa kerätty tieto säilötään ja lopulta hävitetään asiaan kuuluvalla tavalla.

Lisätiedot
Pyydämme teitä tarvittaessa esittämään tutkimukseen liittyviä kysymyksiä tutkijalle/tutkimuksesta vastaavalle henkilölle.

Tutkijoiden yhteystiedot

Tutkija / opinnäytetyötekijä
Nimi: Juulia Koskinen
Puh.
Sähköposti:

Tutkimuksesta vastaa / opinnäytetyön ohjaaja
Titteli:
Nimi:
Yksikkö:
Puh.
Sähköposti:

APPENDIX 4: FULL TABLE OF RESULTS

Participant	**Frop-com screen total scores** (Low risk 0-3, Medium risk 4-7, High risk 8-9)	Total score	Living arrangements (alone/ independent/ supported)	Number of falls in the past 12 months (none 0p, one 1p, two 2p, three or more 3p)	ADL status- amount of assistance in daily activities (independent 0p, supervision 1p, assistance required 2p, completely dependent 3p)	Balance - walking test: sit-stand-walk-turn-walk-sit (no unsteadines 0p, minimally unsteady 1p, moderate unsteady 2p, consistently and severely unsteady 3p)	Walking aid (Yes/No)	**VTT`s mobile fall risk assessment solution- Fall risk group** (No elevated, Slightly elevated, Clearly elevated)	Fall risk index	Age	Gender	Experienced balance
#01	Medium	5	Supported	0	3	2	No	Cleary	5,6942	80	Woman	Moderate good
#02	Medium	4	Supported	0	3	1	No	Slightly	4,6237	87	Woman	Quite good
#03	Low	3	Supported	0	3	0	No	Slightly	5,2987	84	Woman	Quite good
#04	Medium	5	Supported	0	3	2	No	Clearly	6,4513	89	Man	Quite good
#05	Medium	5	Supported	0	3	2	No	Clearly	5,9332	89	Woman	Quite good
#06	Medium	5	Supported	0	3	2	Yes	Clearly	6,8831	78	Woman	Moderate good
#07	Medium	5	Supported	0	3	2	Yes	Clearly	6,2472	93	Woman	Quite bad
#08	Low	2	Supported	0	1	1	No	Slightly	4,2091	81	Man	Quite good
#09	High	8	Supported	2	3	3	Yes	No result	No Result	82	Woman	Moderate good
#10	Medium	6	Supported	1	3	2	Yes	Clearly	6,3092	86	Man	Moderate good
#11	High	8	Supported	3	3	2	Yes	Clearly	6,2725	94	Woman	Very bad
#12	Low	4	Supported	0	3	1	No	Slightly	4,8053	69	Man	Quite good
#13	Low	2	Supported	0	2	0	No	Slightly	4,0314	88	Woman	Very good
#14	Medium	5	Supported	0	3	2	Yes	Clearly	6,0937	81	Woman	Moderate good
#15	Low	3	Supported	0	1	2	Yes	No elevated	3,5198	84	Woman	Moderate good
#16	Medium	7	Supported	2	3	2	Yes	Clearly	6,6281	90	Woman	Very bad
#17	Medium	7	Supported	2	3	2	Yes	Clearly	5,4703	68	Woman	Moderate good
#18	Medium	6	Supported	1	3	2	yes	Clearly	6,8439	74	Woman	Bad
#19	Medium	5	Supported	0	3	2	yes	Clearly	6,0363	92	Woman	Moderate good
#20	High	8	Supported	3	3	2	yes	Clearly	7,1471	82	Man	Bad