UHASSELT

KNOWLEDGE IN ACTION

Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The influence of benign paroxysmal positional vertigo (BPPV) and positional nystagmus on postural balance in older aduls living in nursing homes

Lotte Haegemans
Sanne Vounckx

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij kinderen

PROMOTOR :

Prof. dr. Joke SPILDOOREN

BEGELEIDER :

Mevrouw Laura CASTERS

UHASSELT
KNOWLEDGE IN ACTION

www.uhasselt.be
Universiteit Hasselt
Campus Hasselt:
Martelarenlaan 42 | 3500 Hasselt
Campus Diepenbeek:
Agoralaan Gebouw D | 3590 Diepenbeek

2021
2022

UHASSELT

KNOWLEDGE IN ACTION

Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The influence of benign paroxysmal positional vertigo (BPPV) and positional nystagmus on postural balance in older aduls living in nursing homes

Lotte Haegemans
Sanne Vounckx

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij kinderen

PROMOTOR :

Prof. dr. Joke SPILDOOREN

BEGELEIDER :

Mevrouw Laura CASTERS

Acknowledgement

We hereby take a moment to express our gratitude to Prof. Dr. Joke Spildooren, the promoter of this study and Ms. Laura Casters, the supervisor of this study, for sharing their clinical expertise with us. We would also like to express our appreciation to the University of Hasselt, the staff of the nursing home and assisted living facilities “Leopoldspark” and the participants of this study.

Erkestraat 5
3910 Pelt
België

Lotte Haegemans

Merelstraat 70/1
3630 Maasmechelen
België

Sanne Vounckx

Research Context

This master thesis is part of an ongoing research project done by the Rehabilitation Sciences department of Hasselt University. More specifically, it is part of the PhD research project 'Benign Paroxysmal Positional Vertigo (BPPV) in nursing home facilities: effectiveness of treatment and impact on balance, gait, and falls'. This project is being conducted by Ms. Laura Casters under the supervision of Prof. Dr. Joke Spildooren. This master thesis consists of a cross-sectional study examining the postural balance of nursing home residents with either BPPV, positional nystagmus (PN) or without nystagmus.

BPPV is a disorder of the vestibular system. It is regarded as the most frequently occurring vestibular disorder, with a higher prevalence in older adults. During certain postural changes or head movements, people with BPPV experience nystagmus which may cause dizziness and balance problems (Bhattacharyya et al., 2017; Instrum & Parnes, 2019). Balance problems in the older adults are the cause of an increased risk of falls and gait problems. This can lead to increased risk of fractures (and therefore hospitalization), depression, anxiety, decreased quality of life and increased mortality. It is therefore important that these balance problems are identified in time and the appropriate treatment can be initiated (Cuevas-Trisan, 2017; Rubenstein, Josephson, & Robbins, 1994). PN presents itself, like BPPV, when the head is placed in certain positions. People with PN report in general no other symptoms. Relatively little research has been done on the impact of PN and there has not always been a clear distinction between BPPV and PN in previous studies (Geisler, Bergenius, & Brantberg, 2000; Martens, Goplen, Nordfalk, Aasen, & Nordahl, 2016; Roberts, Bittel, & Gans, 2016). Until now, the impact of BPPV and PN has never been studied specifically in residents of nursing homes.

Both students chose the research design in consultation with the supervisor. The students had no part in determining the method since this study was developed within an ongoing research project. Both students participated in the recruitment and data acquisition during several periods in July, August and September 2021 and had a small part in the data processing in September 2021. Both students had equal input in the writing process and did this independently with feedback from the supervisor.

1. Abstract

Background: Benign Paroxysmal Positional Vertigo (BPPV) is a peripheral vestibular disorder and is the leading cause of vestibular vertigo. The prevalence of BPPV rises with age. Another symptom of BPPV is postural balance problems. Symptoms arise suddenly and are caused by changes in head position. Positional nystagmus (PN) can also be triggered by changes in head position. PN can occur without any other symptoms besides the nystagmus. The incidence of balance problems increases with age. Balance problems are the leading cause of falls in older adults and the fall risk is especially high for people living in nursing homes.

Objectives: This study examined the differences in balance between adults living in nursing homes with BPPV, PN or without nystagmus.

Participants: All 40 participants are residents of the same nursing home. Eleven participants were classified into the no-nystagmus group, 23 into the PN group and six into the BPPV group

Measurements: The m-CTSIB measured the static balance and the TUG, 10MWT and 360° turn test measured the dynamic balance of all participants. The DHI and the FES-I were conducted as secondary outcome measures.

Results: A significant difference (ρ=0.016) between the three groups was found in the TUG, parameter 'time from stand to sit (s)'. Post hoc tests showed a significant difference between the no-nystagmus group and the BPPV group (ρ=0.043), between the no-nystagmus group and the PN group (ρ=0.048) and between the BPPV group and the PN group (ρ=0.036). The other measurements did not result in a significant difference between the groups.

Conclusion: This study reports, except for one parameter, no difference in balance between older adults living in nursing homes with BPPV, PN or without nystagmus.

Keywords: benign paroxysmal positional vertigo, positional nystagmus, nursing home, static balance, dynamic balance, healthy control group

2. Introduction

Benign Paroxysmal Positional Vertigo (BPPV) is the leading cause of vestibular vertigo (Bhattacharyya et al., 2017). It is estimated that the lifetime prevalence of BPPV is 3.2% for women and 1.6% for men (von Brevern et al., 2007). People of all ages can develop BPPV. However, the prevalence of BPPV rises with age (Bhattacharyya et al., 2017).

BPPV is a peripheral vestibular disorder caused by otoliths detaching from the utricle and then descending in one or multiple semicircular canals (SCC). This causes the SCC to send an abnormal signal which can result in the illusion of motion, called vertigo (Instrum & Parnes, 2019; von Brevern et al., 2007). The inner ear has three SCC; the posterior, anterior and horizontal SCC. BPPV can occur in any one of them, although it occurs predominantly in the posterior SCC. Between 85% and 95% of all BPPV cases occur in the posterior SCC. The horizontal SCC accounts for 5% to 15% of all BPPV cases. Anterior SCC BPPV occurs rarely (Bhattacharyya et al., 2017). There are two forms of BPPV: canalithiasis and cupulolithiasis. If the otoliths float freely in the SCC, it is canalithiasis. If the otoliths attach to the cupula in the SCC, it is cupulolithiasis (Instrum & Parnes, 2019; von Brevern et al., 2007). One of the causes of the rising prevalence in older adults is the degeneration of the otolithic membrane (Balatsouras, Koukoutsis, Fassolis, Moukos, & Apris, 2018).

BPPV can, besides vertigo, also cause nystagmus, nausea, dizziness and postural balance problems. These symptoms arise suddenly, caused by changes in head position (Bhattacharyya et al., 2017). Despite it being the most common cause of vestibular vertigo, BPPV is frequently misdiagnosed. Especially in the older population, as the symptoms are often attributed to age-related changes or multimorbidity. This leads to unnecessary diagnostic tests and possibly treatments for disorders they do not have (Bhattacharyya et al., 2017; Palmeri & Kumar, 2022). Vertigo is the main complaint in younger BPPV patients, whereas older BPPV patients report more postural balance problems and dizziness, which may lead to a higher fall risk and falls (Balatsouras et al., 2018).

Osoba, Rao, Agrawal, and Lalwani (2019) define postural balance as the capacity to maintain the center of gravity within the stability limits. Older adults have a higher incidence of postural balance problems. This is caused by age related changes since vestibular and sensory systems deteriorate with age. In addition, there is also a decrease in muscle mass and strength. Postural balance has a crucial role in a person's health and well-being since postural balance

problems are the leading cause of falls in older adults, which results in 70% of accidental deaths in people older than 75 years (Balatsouras et al., 2018; Cuevas-Trisan, 2017; Osoba et al., 2019). The fall risk is especially high for people living in nursing homes; Rapp, Becker, Cameron, König, and Büchele (2012) reported an average of 2.18 falls per year for men and 1.49 falls per year for women. Most falls only result in minor injuries, however between 10 and 25% of the falls result in a fracture and/or hospitalization. In addition, BPPV can lower the quality of life and increase the risk of depression and a sedentary lifestyle (von Brevern et al., 2007).

During the diagnostic tests for BPPV, the clinicians check for vertigo and nystagmus. There is a danger of misdiagnosis since these tests may also trigger positional nystagmus. PN occurs in healthy adults who report no other symptoms (Martens et al., 2016). In current literature on positional nystagmus, no consensus has yet been found on the prevalence, which ranges between 7.5% and 88% for healthy subjects without a history of vestibular or central nervous system disorders. Adults from all age groups have been diagnosed with PN (Geisler et al., 2000; Roberts et al., 2016).

Multiple studies have reported on the postural balance of BPPV patients. However, previous studies have not examined the consequences of BPPV for older adults living in nursing homes. Furthermore, no study has yet examined the differences in postural balance between older adults living in nursing homes with BPPV, PN or without nystagmus. Since BPPV may cause balance problems, it was hypothesized that the participants with BPPV have more balance problems than the participants without nystagmus. It was also hypothesized that participants with PN have more balance problems than the participants without nystagmus since the nystagmus is caused by an abnormality in the vestibular system (Roberts et al., 2016).

3. Methods

3.1. Research Question

"What is the influence of benign paroxysmal positional vertigo (BPPV) and positional nystagmus on postural balance in older adults living in nursing homes?"

3.2. Medical Ethics Committee

This study was approved by the medical ethics committee of the university of Hasselt on 28 May 2021. The code of this study is CME2020/053. The full document can be found in Appendix A.

3.3. Design

This study has a cross-sectional study design. It is part of the PhD project of Ms Laura Casters, entitled 'Benign Paroxysmal Positional Vertigo (BPPV) in nursing home facilities: effectiveness of treatment and impact on balance, gait, and falls'. The supervising principal investigator of this PhD project is Prof. Dr. Joke Spildooren. At this moment, this project is ongoing.

3.4. Participants

3.4.1. Recruitment

Participants were recruited from the nursing home and assisted living facilities "Leopoldspark" situated in Leopoldsburg, Flanders, Belgium from July 2021 until December 2021. All residents received written information (a letter) about the study. Furthermore, residents who met the inclusion criteria, based on available patient records, were personally asked to participate in the study. Subsequently, a convenience sample was conducted.

3.4.2. Selection criteria

Residents could be included in the study if they lived in the nursing home or assisted living facilities for over three months. They had to be able to understand simple, basic instructions such as 'keep your eyes closed' and 'remain still for the next 30 seconds'. Furthermore, all participants had to be able to stand still for ten seconds with or without a walking aid. Residents with a diagnosis of a progressive neurological disorder resulting in a rapid deterioration within three months (for example ALS) were excluded from the study. Other exclusion criteria were: participating in a rehabilitation program for a pathology of less than six months, heart failure, anxiety and spontaneous nystagmus.

3.4.3. Groups

All participants were tested for BPPV and positional nystagmus. Following this, the participants were classified into one of three groups. Participants with a positive BPPV test were classified into the 'BPPV group' and participants with PN were classified into the 'PN group'. Participants without a positive BPPV test and without PN were classified into the 'no-nystagmus group'.

3.5. Procedure

The participants signed an informed consent at the beginning of the study. Firstly, all participants' baseline characteristics were logged. Secondly, all participants underwent BPPV tests and PN tests. Thirdly, balance tests were performed followed by both the Dizziness Handicap Inventory (DHI) and the Falls Efficacy Scale International (FES-I). A schematic representation of the procedure can be found in Figure 1.

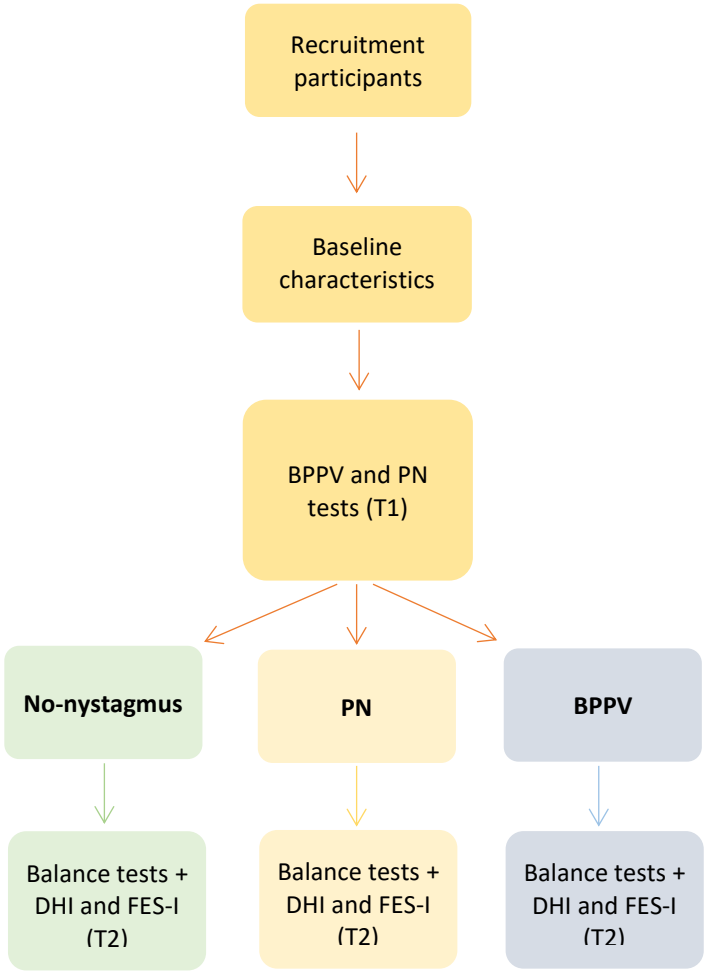


Figure 1. Schematic representation procedure

3.5.1. Baseline characteristics

The following baseline characteristics of all participants were collected: age, gender, walking aid and number of comorbidities. The Montreal Cognitive Assessment (MOCA) was used to evaluate the cognitive capacity of all participants.

3.5.2. BPPV tests

The participant's neck mobility was evaluated before the BPPV tests were performed. Participants had to be able to rotate their head at least 45° to both sides and bend their head 30° towards flexion and extension. The presence of spontaneous nystagmus was evaluated using videonystagmography (VNG) goggles. If this was excluded, the BPPV tests were carried out. Before and during the BPPV tests, participants were asked to keep their eyes wide open and to answer questions by talking and not by nodding their heads. The participants wore VNG goggles during the tests to detect nystagmus. These goggles projected the eye movements on a computer screen and were calibrated before every test. The computer program recorded the eye movements, allowing for a detailed analysis afterwards. The side-lying test was performed to both the left and right side to detect posterior and anterior canal BPPV. Next, the supine roll test was performed to detect horizontal canal BPPV. During each test, the participants were asked if they experienced vertigo and how long it lasted. The same examiners performed all these tests.

Side Lying test

According to the practice guideline of Bhattacharyya et al. (2017), the Dix-Hallpike test is the gold standard to detect posterior canal BPPV. If it is not possible to carry out this test, the side-lying test can be used as an alternative. The head is moved 20° beyond the horizontal in a rapid movement during the Dix-Hallpike test. This movement can result in neck complaints, especially in older adults. Because of this, only the Side Lying test was used in this study, with which the diagnosis of posterior and anterior canal BPPV was made. This test started with the participant sitting in an upright position on the edge of the table. The head was rotated 45° to the contralateral side of the canal that was being tested. While maintaining the rotation of the head, the examiner laid the participant down with a rapid maneuver on his homolateral side. This position was maintained for at least 30 seconds. For example, to test the right posterior or anterior canal, the head was rotated 45° to the participant's left side and the participant was laid on his right side. Possible vertigo was questioned and possible nystagmus was evaluated on the computer screen. For both posterior and anterior canal BPPV, when the

vertigo and the nystagmus lasted less than 60 seconds, it was classified as canalithiasis. When the vertigo or the nystagmus lasted longer than 60 seconds, it was classified as cupulolithiasis (Bhattacharyya et al., 2017; von Brevern et al., 2015).

Vertigo in combination with rotatory (towards the lower ear), upbeating nystagmus during the Side Lying test was used to define posterior canal BPPV. The nystagmus' latency period lasted from one to a few seconds after the test was performed. Both the vertigo and the nystagmus had a duration of less than two minutes (von Brevern et al., 2015). To define anterior canal BPPV, vertigo in combination with downbeating nystagmus had to be present. It was possible that the nystagmus had a rotatory component (towards the lower ear), but this was not necessary to define anterior canal BPPV. The nystagmus' latency period started immediately or one or a few seconds after performing the test. Again, both the vertigo and the nystagmus had a duration of less than two minutes (von Brevern et al., 2015).

Supine Roll test

The Supine Roll test was used to detect horizontal canal BPPV. This test started with the participant in supine position on the table. The head was placed on a pillow with 30° of neck flexion. Firstly, the head of the participant was rotated by the examiner in a rapid maneuver to one side. After this, the examiner rotated the participant's head in a rapid maneuver back to neutral position. This was followed by rotating the head to the opposite side and back to the neutral position in the same manner. Every position was maintained for at least one minute. The side towards which the head was turned was the side that was tested. Possible vertigo was questioned and possible nystagmus was evaluated on the computer screen during every position. When both sides had a positive result, the side in which the nystagmus was most severe was considered the affected side. (von Brevern et al., 2015).

Vertigo and geotropic (towards the lower ear), horizontal beating nystagmus with a duration of less than one minute had to be present to define horizontal canal canalithiasis BPPV. The nystagmus had no or a brief latency period after performing the test (von Brevern et al., 2015).

Vertigo and ageotropic (towards the upper ear), horizontal beating ageotropic nystagmus had to be present to define horizontal canal cupulolithiasis BPPV. Both the vertigo and the nystagmus had a duration of more than one minute, but less than two minutes. The nystagmus had no or a brief latency period (von Brevern et al., 2015).

3.5.3. PN tests

The presence of PN was evaluated during the BPPV tests (Side Lying test and Supine Roll test). One of the following three conditions had to be present to classify the participants in the PN group. Firstly, the nystagmus should not match the nystagmus expected in BPPV. For example, the Side Lying test elicited horizontal nystagmus. Secondly, the nystagmus should last more than two minutes. Thirdly, the nystagmus should match the nystagmus expected in BPPV, but the slow-phase velocity of the nystagmus was six degrees or more per second (Martens et al., 2016).

3.5.4. Balance tests

The participants wore four APDM sensors while performing the balance tests. One sensor was placed on the sternum, one on the lower back (L5) and one on the dorsal side of each foot. The APDM sensors are a valid and reliable system (ICC 0.91-0.99) in measuring gait and balance parameters according to the studies of Washabaugh, Kalyanaraman, Adamczyk, Claflin, and Krishnan (2017), Hou, Wang, Li, Komal, and Li (2021) and Sankarpandi, Baldwin, Ray, and Mazzà (2017). All tests were performed in the same space and were conducted by the same examiners. The participants performed the tests with their shoes on. There were no specific guidelines on the type of shoes the participants were allowed to wear. The participants had to be able to walk without the assistance of another person during the dynamic balance tests. When they used a walking aid during their daily life they were allowed to use this aid during the dynamic balance tests.

Static balance test: modified Clinical Test of Sensory Interaction on Balance (m-CTSIB)

The sensors measured the performance time (s), sway area (m^2/s^4), mean sway velocity (m/s), path length (m/s^2), coronal path length (m/s^2) and sagittal path length (m/s^2) during every test condition. Each participant performed the four test conditions of the m-CTSIB. During the first test condition, the participants were instructed to stand on a flat, firm surface with their eyes open for 30 seconds. The second test condition also consisted of standing on a flat, firm surface, but with their eyes closed for 30 seconds. During the third test condition the participants were instructed to stand on an Airex Balance-pad (50cm x 41cm x 6cm) with their eyes open for 30 seconds. The fourth test condition also consisted of standing on the foam surface, but with their eyes closed for 30 seconds. The test conditions were always performed in this order and each condition was performed once. The participants had to perform each test condition with their feet at hip width apart and their arms hanging next to their bodies.

At least one researcher stood always close to the participants during the test to ensure their safety. The participants had a guardrail in front of them as well which they could grab if they lost their balance during a test. A chair or the participant's wheelchair was also placed behind them so that they could sit down in case they had lost their balance and so they could sit down between the different test conditions. The test stopped immediately if the participants grabbed the guardrail, sat down on the chair, took a step or when the researcher had to intervene to prevent the participant from falling. The test conditions in which the participants had to close their eyes were also stopped if the participant opened his eyes. According to Watson and Trudelle-Jackson (2021), the m-CTSIB has a good to excellent test-retest reliability (ICC 0.76-0.91) in older adults.

Dynamic balance test: TUG

Before the test took place, the three-meter distance was measured with a measuring tape. Pieces of tape indicated the starting point and ending point. The front legs of the chair were placed on the starting point. The participants started the TUG by sitting on a chair with their back against the backrest. When the researcher gave the start signal they got up, walked three meters, turned around and walked back to the chair and ended the test by sitting down. A researcher performed the test once as an example. The participants were instructed to perform the test three times as fast as possible, but in a safe manner. The best attempt was used in the statistical analysis. Sensors measured the performance time (s), the turn duration (s), the maximal turn velocity (°/s), the time from sit to stand (s) and the time from stand to sit (s) of each attempt of the participants. The same chair was used for every participant. The TUG has a high test-retest reliability (ICC 0.74-0.99) and a high interrater reliability (ICC 0.91-0.99) in older adults according to the systematic review of Rydwik, Bergland, Forsén, and Frändin (2011). According to the systematic review of Langley and Mackintosh (2007), the TUG has an excellent inter-rater reliability (ICC 0.98-0.99) and an excellent intra-rater reliability (0.97-0.98) in community dwelling older adults.

Dynamic balance test: 360° turn test

The participants were instructed to turn 360° at their own pace and in the direction of their choosing. They got three attempts and the best attempt was used in the statistical analysis. The sensors recorded the performance time (s) and turn velocity (°/s) of each attempt. The maximal turn velocity was used in the statistical analysis. The study of Tager, Swanson, and Satariano (1998) found an excellent test-retest reliability (ICC 0.92) in older adults. According

to the study of Berg (1989), the 360° turn test has a high intra-rater reliability (ICC 0.89-0.94) and a high inter-rater reliability (ICC 0.71-0.99) in older adults.

Dynamic balance test: 10MWT

Like the TUG, the ten-meter distance was measured beforehand with a measuring tape and pieces of tape indicated the starting point and ending point. A researcher instructed the participants to walk the ten-meter distance at their own pace. They started from a standing position. The sensors started recording the time when they started walking. They had one attempt. The sensors recorded the performance time (s), the cadence (steps/min), the gait speed (m/s), the percentage of double support, stance and swing during the gait cycle (%GCT), the stride length (m) and the lateral step variability. The study of Peters, Fritz, and Krotish (2013) found an excellent test-retest reliability (ICC 0.96-0.98) and an excellent validity (ICC 0.99) of the 10MWT in older adults.

3.5.5. Secondary outcome measures

The DHI was used as a questionnaire to assess the severity of possible dizziness and its impact on daily life. This questionnaire consists of 25 statements regarding the previous month, which the participant had to answer with 'never', 'sometimes' or 'always'. The answer 'never' resulted in zero points, 'sometimes' in two points and 'always' in four points. In other words, a higher score relates to more dizziness. The FES-I was used as a questionnaire to assess the fear of falling of all participants. This questionnaire consisted of 16 statements which the participant had to answer with 'not worried at all' (one point), 'a little worried' (two points), 'quite worried' (three points) or 'very worried' (four points). In other words, a higher score relates to a greater fear of falling.

3.6. Statistical Analysis

Statistical analysis was performed using the JMP Pro 16 software. The data of the no-nystagmus group, the PN group and the BPPV group were compared to each other. The null hypothesis proposed that no difference existed between the three population averages. The alternative hypothesis proposed that a difference existed between the three population averages. It therefore follows that a two-tailed test was used. Firstly, the numeric data were examined for independence, normality and homoscedasticity. Normality was examined using the Shapiro-Wilks test and homoscedasticity using the Brown-Forsythe test. ANOVA was used as statistical test when the assumptions of normality and homoscedasticity were met. However, the Kruskal-Wallis test was used when the assumption normality was not met and

the Welch's ANOVA test when the assumption homoscedasticity was not met. When both assumptions were not met, no statistical analysis was carried out. Post hoc tests were carried out using the Wilcoxon method for nonparametric comparisons for each pair. Regarding the categorical data, the Fisher's Exact test was used to perform the statistical analysis. A ρ-value of <0.05 was considered significant in all cases. The complete statistical decision tree can be found in Appendix B for the numeric data and in Appendix C for the categorical data.

4. Results

4.1. Participants

Up until now, 50 participants were tested for BPPV and positional nystagmus. Table 1 represents the prevalence of the no-nystagmus, PN and BPPV participants. Of these 50 participants, 40 agreed to participate in the balance tests. As a result, this study had a sample size of 40 participants. Eleven participants were classified into the no-nystagmus group, 23 into the PN group and six into the BPPV group. Table 2 represents the BPPV forms and the involved SCC of all six BPPV participants. The posterior SCC was involved in three participants, the horizontal SCC in the other three participants. Two BPPV participants with horizontal canal BPPV had cupulolithiasis, the other BPPV participants had canalithiasis.

Table 1
Prevalence

	Total	No-nystagmus	PN	BPPV
n	50	18	26	6
%	100%	36%	52%	12%

Table 2
BPPV-group – BPPV forms and involved SCC

	Canalithiasis (n)	Cupulolithiasis (n)	Total (n)
Posterior SCC			3
Left side	2	-	-
Right side	-	-	-
Both sides	1	-	-
Horizontal SCC			3
Left side	1	1	-
Right side	-	1	-

4.2. Baseline characteristics

The three groups were compared in terms of age, gender, walking aid and number of comorbidities. No significant difference was found between the groups in the baseline characteristics. Table 3 represents the numeric baseline characteristics in terms of median (interquartile range) and Table 4 represents the categorical baseline characteristics in terms of number of participants.

Table 3
Results numeric baseline characteristics

Variable	Statistical test	Median (IQR)			ρ-Value
		No-nystagmus (n=11)	**PN (n=23)**	**BPPV (n=6)**	
Age (years)	KW	88 (6)	86 (8)	88 (10.50)	0.588
MOCA	KW	17 (5)	16 (8)	19.50 (9.25)	0.746
Comorbidities (n)	KW	3 (2)	2 (4)	3.50 (3.75)	0.308

'IQR' = Inter Quartile Range, 'KW' = Kruskal Wallis test

Table 4
Results categorical baseline characteristics

Variable	Statistical test	Number			ρ-Value
		No-nystagmus (n=11)	**PN (n=23)**	**BPPV (n=6)**	
Gender	FE	-	-	-	0.238
Male	-	7	8	2	-
Female	-	4	15	4	-
Walking aid	FE	-	-	-	0.613
None	-	1	4	1	-
Walker	-	10	18	4	-
Wheelchair	-	0	1	1	-

'FE' = Fisher's Exact test

4.3. Balance tests

4.3.1. Static balance test: m-CTSIB

Table 5 represents the results of the four test conditions of the m-CTSIB. All results are represented in terms of median (interquartile range) per examined parameter and per group as both statistical tests used were nonparametric (Kruskal-Wallis test and Welch's test). No significant differences were found between the three groups. The statistical analysis of the eyes open on firm surface test condition with parameters sway area and mean sway velocity were not carried out as the assumptions of both normality and homoscedasticity were not met.

4.2.2. Dynamic balance tests: TUG, 10MWT, 360° turn test

Table 6 represents the results of the dynamic balance tests. The results are presented in terms of median (interquartile range) per examined parameter and per group when a nonparametric statistical test (Kruskal-Wallis test) was used. Moreover, when a parametric statistical test (ANOVA) was used, the results are presented in terms of mean (standard deviation) per examined parameter and per group. A significant difference (ρ=0.016) between the three groups was found in the TUG, parameter 'time from stand to sit (s)'. A significant difference was found between the no-nystagmus group and the BPPV group (ρ=0.043), between the no-

nystagmus group and the PN group (ρ=0.048) and between the BPPV group and the PN group (ρ=0.036). However, in the other TUG parameters and in the other dynamic balance tests no significant differences were found between the three groups.

Table 5
Results static balance test: m-CTSIB

m-CTSIB condition	Statistical test	Median (IQR) **No-nystagmus (n=11)**	**PN (n=23)**	**BPPV (n=6)**	ρ-Value
EO, firm					
Time (s)	KW	30 (0)	30 (0)	30 (1.70)	0.059
Sway area (m^2/s^4)	/	/	/	/	/
Mean sway velocity (m/s)	/	/	/	/	/
Path length (m/s^2)	KW	12.10 (6.63)	10.20 (6.24)	13.85 (17.21)	0.722
Coronal path length (m/s^2)	KW	7.07 (3.70)	6.12 (4.92)	7.45 (9.55)	0.982
Sagittal path length (m/s^2)	KW	8.97 (5.41)	7.30 (5.46)	9.85 (7.29)	0.513
EC, firm					
Time (s)	KW	30 (10.40)	30 (0)	30 (5.06)	0.325
Sway area (m^2/s^4)	KW	0.13 (0.26)	0.11 (0.12)	0.09 (0.49)	0.751
Mean sway velocity (m/s)	KW	0.18 (0.36)	0.17 (0.13)	0.23 (0.61)	0.305
Path length (m/s^2)	KW	22.40 (19.17)	11.60 (10.30)	11.85 (13.25)	0.766
Coronal path length (m/s^2)	KW	8.79 (10.66)	7.18 (5.98)	5.66 (5.90)	0.739
Sagittal path length (m/s^2)	KW	14.90 (11.72)	8.54 (6.17)	9.67 (12.42)	0.457
EO, foam					
Time (s)	KW	30 (0)	30 (0)	30 (20.84)	0.111
Sway area (m^2/s^4)	KW	0.17 (0.10)	0.24 (0.22)	0.17 (0.20)	0.620
Mean sway velocity (m/s)	KW	0.22 (0.19)	0.28 (0.21)	0.13 (0.28)	0.072
Path length (m/s^2)	KW	14.10 (2.90)	17 (13.30)	13.65 (21.45)	0.445
Coronal path length (m/s^2)	KW	8.27 (4.57)	10.20 (7.31)	8.26 (13.67)	0.282
Sagittal path length (m/s^2)	W	10 (3.84)	10.70 (8.33)	8.69 (14.59)	0.574
EC, foam					
Time (s)	KW	10.68 (23.35)	8.70 (7.07)	6.21 (13.11)	0.304
Sway area (m^2/s^4)	KW	0.73 (0.72)	0.75 (1.01)	0.67 (0.39)	0.863
Mean sway velocity (m/s)	KW	0.27 (0.30)	0.22 (0.25)	0.21 (0.27)	0.803
Path length (m/s^2)	KW	39.25 (36.10)	35.90 (41)	42.80 (35.63)	0.966
Coronal path length (m/s^2)	KW	8.27 (4.57)	10.20 (7.31)	8.26 (13.67)	0.282
Sagittal path length (m/s^2)	W	10 (3.84)	10.70 (8.33)	8.69 (14.59)	0.574

'IQR' = Inter Quartile Range
'EO' = eyes open condition, 'EC' = eyes closed condition
'firm' = firm surface condition, 'foam' = foam surface condition
'KW' = Kruskal Wallis test, 'W' = Welch's test

Table 6

Results dynamic balance tests: TUG, 360° turn test, 10MWT

Test	Statistical test	**No-nystagmus (n=11)**		**PN (n=23)**		**BPPV (n=6)**		ρ-Value
		Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	
TUG								
Time (s)	KW	19.20 (8.80)	-	17.40 (9.40)	-	30.15 (20.83)	-	0.144
Turn duration (s)	ANOVA	-	3.82 (0.87)	-	3.45 (0.87)	-	3.23 (1.30)	0.401
Turn max. velocity (°/s)	ANOVA	-	84.87 (22.25)	-	101.70 (29.54)	-	100.60 (57.13)	0.376
Time sit-stand (s)	KW	1.52 (0.41)	-	1.22 (0.34)	-	1.15 (1.87)	-	0.131
Time stand-sit (s)	KW	1.13 (0.44)	-	0.95 (0.13)	-	0.87 (0.14)	-	0.016*
360° turn								
Time (s)	ANOVA	-	6.15 (1.37)	-	5.77 (2.05)	-	5.90 (2.66)	0.875
Max. velocity (°/s)	ANOVA	-	98.25 (37.45)	-	111.92 (43.49)	-	90.23 (62.02)	0.516
10MWT								
Time (s)	KW	17.90 (8)	-	18.85 (6.30)	-	25.35 (15.05)	-	0.383
Cadence (steps/min)	KW	95.70 (21.80)	-	99.30 (26.71)	-	89.83 (18.29)	-	0.208
Gait speed (m/s)	ANOVA	-	0.57 (0.19)	-	0.62 (0.21)	-	0.50 (0.26)	0.486
Double support (%GCT)	ANOVA	-	29.35 (6.76)	-	29.83 (5.32)	-	35.46 (9.26)	0.139
Stance (%GCT)	KW	64.90 (2.75)	-	64.65 (2.97)	-	69.10 (6.95)	-	0.226
Swing (%GCT)	KW	35.10 (2.75)	-	35.18 (3.47)	-	30.90 (6.99)	-	0.363
Stride length (m)	ANOVA	-	0.76 (0.23)	-	0.73 (0.18)	-	0.66 (0.26)	0.622
Lateral step variability	KW	1.72 (0.86)		1.68 (1.11)	-	1.50 (1.70)	-	0.883

'IQR' = Inter Quartile Range, 'SD' = Standard Deviation

'KW' = Kruskal Wallis test

'%GCT' = percentage of gait cycle

'*' = ρ-Value <0.05

4.4. Secondary outcome measures

Table 7 represents the results of the secondary outcome measures (DHI and FES-I). The results are presented in terms of median (interquartile range) per questionnaire and per group as a nonparametric statistical test (Kruskal-Wallis test) was used. No significant differences were found between the three groups.

Table 7
Results secondary outcome measures: DHI and FES-I

Test	Statistical test	Median (IQR)			ρ-Value
		No-nystagmus (n=11)	**PN (n=23)**	**BPPV (n=6)**	
DHI	KW	2 (12)	0 (8)	20 (33.50)	0.073
FES-I	KW	15 (7)	16 (7)	18 (16.25)	0.876

'IQR' = Inter Quartile Range
'DHI' = Dizziness Handicap Inventory, 'FES-I' = Falls Efficacy Scale International

5. Discussion

This is the first study that compared the static and dynamic balance of nursing home residents with BPPV, PN or without nystagmus. Residents of nursing homes have a high fall risk (Rapp et al., 2012; Rubenstein et al., 1994). Therefore it is important to know if older adults with BPPV or PN have more balance problems than older adults without nystagmus. Additionally, it is important that the distinction is made between BPPV and PN. BPPV is frequently misdiagnosed (Bhattacharyya et al., 2017; Palmeri & Kumar, 2022). A significant difference (ρ=0.016) between the three groups was found in the TUG, parameter 'time from stand to sit (s)'. The other measurements did not result in a significant difference between the groups.

In this study the prevalence of BPPV was 12%, contrastively to that of PN, which was 52%. The prevalence of PN is consistent with the findings of previous studies (Geisler et al., 2000; Lynch, Nayak, & Isaacs, 1985). The prevalence of BPPV is rather low compared to other studies that reported the prevalence of BPPV in older adults (Balatsouras et al., 2018; Moreira, Costa, Melo, & Marchiori, 2014). Studies that diagnosed BPPV solely by the presence of nystagmus during the Dix-Hallpike test or another BPPV test may have mistaken PN for BPPV (Moreira et al., 2014). If PN was mistaken for BPPV in previous studies regarding balance problems, the treatment effect would be lower. It would have seemed as if BPPV patients had no balance problems.

5.1. Static Balance

This study found no significant difference between the three groups during the m-CTSIB. These findings are in contrast to findings of previous studies. These previous studies used the m-CTSIB to compare the static balance between a BPPV group and a healthy control group. They found in general a significant difference during the test condition eyes closed, on a foam surface. The BPPV group always had more balance problems than the healthy control group (Adelsberger, Valko, Straumann, & Tröster, 2015; Celebisoy, Bayam, Güleç, Köse, & Akyürekli, 2009; Chang, Hsu, Yang, & Wang, 2006; Cohen-Shwartz, Nechemya, & Kalron, 2020; Cohen, Mulavara, Peters, Sangi-Haghpeykar, & Bloomberg, 2014; D'Silva, Kluding, Whitney, Dai, & Santos, 2017; Monteiro, Ganança, Ganança, Ganança, & Caovilla, 2012; Nair, Mulavara, Bloomberg, Sangi-Haghpeykar, & Cohen, 2018). This significant difference could be explained by the fact that people must use their vestibular system to maintain their balance while standing with their eyes closed on a foam surface. It could be expected that people with BPPV

have more difficulties with this since BPPV is a disorder that affects the vestibular system (Bhattacharyya et al., 2017). It is possible that this study found no significant difference between the BPPV group and no-nystagmus group because the subjects were all nursing home residents. The previous mentioned studies used participants of all ages. Older adults, even those without vestibular problems, have experienced a deterioration of vestibular system due to age related changes (Balatsouras et al., 2018; Osoba et al., 2019). Additionally, it is possible that no significant difference was found since the BPPV group had only six participants. A power analysis was done using nQuery software. The sample size was calculated to detect a between-group difference of 0.285 for the eyes open, firm surface test condition of the m-CTSIB. The significance level was set at 0.05 and the power was set at 80%. Hence, it became evident that a sample size of at least 28 participants in each group was needed to find the minimal detectable change. Moreover, there was a loss of power due to the fact that non-parametric tests had to be used. Additionally, a comparison was made between three groups instead of two, which also caused a loss of power.

The static balance of the PN group was not significantly different from the no-nystagmus group. These findings correspond to the findings of Lynch et al. (1985). This study tested ten healthy adults between 69 and 76 years old. Four of the participants tested positive for positional nystagmus and showed no balance problems.

5.2. Dynamic balance

No significant differences were found between the groups except for the time (s) from stand to sit during the TUG. Both the BPPV group and PN group performed worse than the no-nystagmus group regarding this parameter. Two previous studies that examined dynamic balance by conducting the TUG found significantly more balance problems in the BPPV group. These studies only measured the time of the entire test (Cohen-Shwartz et al., 2020; Vaz, Gazzola, Lança, Dorigueto, & Kasse, 2013).

This study found no significant difference between the groups during the 360° turn test and 10MWT. The studies of Cohen-Shwartz et al. (2020), Cohen, Mulavara, Peters, Sangi-Haghpeykar, and Bloomberg (2012) and Zhang et al. (2021) found a significant decrease in walking speed during walking tests for their BPPV group. As mentioned before, no significant difference may have been found between the groups because of the deterioration of the vestibular system caused by age related changes in older adults and the small sample size. No previous studies have conducted dynamic balance tests on people with positional nystagmus.

5.3. Strengths and limitations

There is a risk of selection bias, as all the participants came from the same nursing home. They decided whether they wanted to participate in the study and whether they only participated in the BPPV tests or also in the balance tests. This could have led to non-participation bias and healthy user bias. Only the results of participants who participated in both the BPPV tests and the balance tests were included in this study. It follows that the findings of this study may not be generalizable to all older adults living in nursing homes. The risk of examiner bias was negated by having the same examiners perform the BPPV and balance tests. Confounding bias was avoided as best as possible by considering all possible influencing factors (baseline characteristics). A statistical analysis showed that there was no difference between the three groups considering the baseline characteristics. The balance tests that were conducted had good psychometric properties (Berg, 1989; Chan & Pin, 2019; Langley & Mackintosh, 2007; Peters et al., 2013; Rydwik et al., 2011; Tager et al., 1998).

The sample size of this study was small. This is due to the fact that this study is part of an ongoing research project. Furthermore, there was a big difference in sample size between the three groups that were tested. This may have affected the precision of the statistical analysis to detect group differences. It is possible that if the groups had been larger, more significant differences had been found. All the different parameters that the APDM sensors were able to measure during the balance tests were included in this study. Due to technical problems with the sensors, some participants had no reliable measurements during the 360° test. This made the sample size even smaller.

A statistical analysis was only conducted if the assumptions of normality and homoscedasticity were met. This had as a consequence that the statistical analysis of two parameters in the m-CTSIB test condition eyes open on a firm surface could not be carried out.

5.4 Recommendations for future studies

While all the balance tests used in this study had good psychometric properties, it is recommended that future studies first research the existing literature to determine which tests are the best for measuring balance in people with vestibular disorders. The researchers also recommend future studies to use bigger sample sizes.

6. Reference List

Adelsberger, R., Valko, Y., Straumann, D., & Tröster, G. (2015). Automated Romberg testing in patients with benign paroxysmal positional vertigo and healthy subjects. *IEEE Trans Biomed Eng, 62*(1), 373-381. doi:10.1109/tbme.2014.2354053

Balatsouras, D. G., Koukoutsis, G., Fassolis, A., Moukos, A., & Apris, A. (2018). Benign paroxysmal positional vertigo in the elderly: current insights. *Clin Interv Aging, 13*, 2251-2266. doi:10.2147/cia.S144134

Berg, K. (1989). Measuring balance in the elderly: Preliminary development of an instrument. *Physiotherapy Canada, 41*, 304-311. doi:10.3138/ptc.41.6.304

Bhattacharyya, N., Gubbels, S. P., Schwartz, S. R., Edlow, J. A., El-Kashlan, H., Fife, T., . . . Corrigan, M. D. (2017). Clinical Practice Guideline: Benign Paroxysmal Positional Vertigo (Update). *Otolaryngol Head Neck Surg, 156*(3_suppl), S1-s47. doi:10.1177/0194599816689667

Celebisoy, N., Bayam, E., Güleç, F., Köse, T., & Akyürekli, O. (2009). Balance in posterior and horizontal canal type benign paroxysmal positional vertigo before and after canalith repositioning maneuvers. *Gait Posture, 29*(3), 520-523. doi:10.1016/j.gaitpost.2008.12.002

Chan, W. L. S., & Pin, T. W. (2019). Reliability, validity and minimal detectable change of 2-minute walk test, 6-minute walk test and 10-meter walk test in frail older adults with dementia. *Exp Gerontol, 115*, 9-18. doi:10.1016/j.exger.2018.11.001

Chang, W. C., Hsu, L. C., Yang, Y. R., & Wang, R. Y. (2006). Balance ability in patients with benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg, 135*(4), 534-540. doi:10.1016/j.otohns.2005.10.001

Cohen-Shwartz, Y., Nechemya, Y., & Kalron, A. (2020). Canalith repositioning procedure improves gait and static balance in people with posterior semicircular canal benign paroxysmal positional vertigo. *J Vestib Res, 30*(5), 335-343. doi:10.3233/ves-200713

Cohen, H. S., Mulavara, A. P., Peters, B. T., Sangi-Haghpeykar, H., & Bloomberg, J. J. (2012). Tests of walking balance for screening vestibular disorders. *J Vestib Res, 22*(2), 95-104. doi:10.3233/ves-2012-0443

Cohen, H. S., Mulavara, A. P., Peters, B. T., Sangi-Haghpeykar, H., & Bloomberg, J. J. (2014). Standing balance tests for screening people with vestibular impairments. *Laryngoscope, 124*(2), 545-550. doi:10.1002/lary.24314

Cuevas-Trisan, R. (2017). Balance Problems and Fall Risks in the Elderly. *Phys Med Rehabil Clin N Am, 28*(4), 727-737. doi:10.1016/j.pmr.2017.06.006

D'Silva, L. J., Kluding, P. M., Whitney, S. L., Dai, H., & Santos, M. (2017). Postural sway in individuals with type 2 diabetes and concurrent benign paroxysmal positional vertigo. *Int J Neurosci, 127*(12), 1065-1073. doi:10.1080/00207454.2017.1317249

Geisler, C., Bergenius, J., & Brantberg, K. (2000). Nystagmus findings in healthy subjects examined with infrared videonystagmoscopy. *ORL J Otorhinolaryngol Relat Spec, 62*(5), 266-269. doi:10.1159/000027757

Hou, Y., Wang, S., Li, J., Komal, S., & Li, K. (2021, 23-25 Oct. 2021). *Reliability and Validity of a Wearable Inertial Sensor System for Gait Assessment in Healthy Young Adults.* Paper presented at the 2021 14th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI).

Instrum, R. S., & Parnes, L. S. (2019). Benign Paroxysmal Positional Vertigo. *Adv Otorhinolaryngol, 82*, 67-76. doi:10.1159/000490273

Langley, F. A., & Mackintosh, S. F. (2007). Functional balance assessment of older community dwelling adults: a systematic review of the literature. *Internet Journal of Allied Health Sciences and Practice, 5*(4), 13.

Lynch, S. J., Nayak, U. S., & Isaacs, B. (1985). Positional and optokinetic nystagmus in healthy old people. *Age Ageing, 14*(2), 122-124. doi:10.1093/ageing/14.2.122

Martens, C., Goplen, F. K., Nordfalk, K. F., Aasen, T., & Nordahl, S. H. (2016). Prevalence and Characteristics of Positional Nystagmus in Normal Subjects. *Otolaryngol Head Neck Surg, 154*(5), 861-867. doi:10.1177/0194599816629640

Monteiro, S. R., Ganança, M. M., Ganança, F. F., Ganança, C. F., & Caovilla, H. H. (2012). Balance Rehabilitation Unit (BRU™) posturography in benign paroxysmal positional vertigo. *Braz J Otorhinolaryngol, 78*(3), 98-104.

Moreira, M. D., Costa, V. D. S. P., Melo, J. J., & Marchiori, L. L. D. M. (2014). Prevalência e associações da vertigem posicional paroxística benigna em idosos. *Revista CEFAC, 16*(5), 1533-1540. doi:10.1590/1982-021620149513

Nair, M. A., Mulavara, A. P., Bloomberg, J. J., Sangi-Haghpeykar, H., & Cohen, H. S. (2018). Visual dependence and spatial orientation in benign paroxysmal positional vertigo. *J Vestib Res, 27*(5-6), 279-286. doi:10.3233/ves-170623

Osoba, M. Y., Rao, A. K., Agrawal, S. K., & Lalwani, A. K. (2019). Balance and gait in the elderly: A contemporary review. *Laryngoscope Investig Otolaryngol, 4*(1), 143-153. doi:10.1002/lio2.252

Palmeri, R., & Kumar, A. (2022). Benign Paroxysmal Positional Vertigo. In *StatPearls*. Treasure Island (FL): StatPearls Publishing

Peters, D. M., Fritz, S. L., & Krotish, D. E. (2013). Assessing the reliability and validity of a shorter walk test compared with the 10-Meter Walk Test for measurements of gait speed in healthy, older adults. *J Geriatr Phys Ther, 36*(1), 24-30. doi:10.1519/JPT.0b013e318248e20d

Rapp, K., Becker, C., Cameron, I. D., König, H. H., & Büchele, G. (2012). Epidemiology of falls in residential aged care: analysis of more than 70,000 falls from residents of bavarian nursing homes. *J Am Med Dir Assoc, 13*(2), 187.e181-186. doi:10.1016/j.jamda.2011.06.011

Roberts, R. A., Bittel, S. N., & Gans, R. E. (2016). Positional Nystagmus in Patients Evaluated for Dizziness and Imbalance. *Advances in Otolaryngology, 2016*.

Rubenstein, L. Z., Josephson, K. R., & Robbins, A. S. (1994). Falls in the nursing home. *Ann Intern Med, 121*(6), 442-451. doi:10.7326/0003-4819-121-6-199409150-00009

Rydwik, E., Bergland, A., Forsén, L., & Frändin, K. (2011). Psychometric Properties of Timed Up and Go in Elderly People: A Systematic Review. *Physical & Occupational Therapy in Geriatrics, 29*, 102-125. doi:10.3109/02703181.2011.564725

Sankarpandi, S. K., Baldwin, A. J., Ray, J., & Mazzà, C. (2017). Reliability of inertial sensors in the assessment of patients with vestibular disorders: a feasibility study. *BMC Ear Nose Throat Disord, 17*, 1. doi:10.1186/s12901-017-0034-z

Tager, I. B., Swanson, A., & Satariano, W. A. (1998). Reliability of physical performance and self-reported functional measures in an older population. *J Gerontol A Biol Sci Med Sci, 53*(4), M295-300. doi:10.1093/gerona/53a.4.m295

Vaz, D. P., Gazzola, J. M., Lança, S. M., Dorigueto, R. S., & Kasse, C. A. (2013). Clinical and functional aspects of body balance in elderly subjects with benign paroxysmal positional vertigo. *Braz J Otorhinolaryngol, 79*(2), 150-157. doi:10.5935/1808-8694.20130027

von Brevern, M., Bertholon, P., Brandt, T., Fife, T., Imai, T., Nuti, D., & Newman-Toker, D. (2015). Benign paroxysmal positional vertigo: Diagnostic criteria. *J Vestib Res, 25*(3-4), 105-117. doi:10.3233/ves-150553

von Brevern, M., Radtke, A., Lezius, F., Feldmann, M., Ziese, T., Lempert, T., & Neuhauser, H. (2007). Epidemiology of benign paroxysmal positional vertigo: a population based study. *J Neurol Neurosurg Psychiatry, 78*(7), 710-715. doi:10.1136/jnnp.2006.100420

Washabaugh, E. P., Kalyanaraman, T., Adamczyk, P. G., Claflin, E. S., & Krishnan, C. (2017). Validity and repeatability of inertial measurement units for measuring gait parameters. *Gait Posture, 55*, 87-93. doi:10.1016/j.gaitpost.2017.04.013

Watson, S., & Trudelle-Jackson, E. (2021). Test-Retest Reliability and Minimal Detectable Change of the Instrumented Modified Clinical Test of Sensory Interaction on Balance in Healthy, Older Adults. *J Geriatr Phys Ther, 44*(4), 183-188. doi:10.1519/jpt.0000000000000274

Zhang, Y., Wang, H., Yao, Y., Liu, J., Sun, X., & Gu, D. (2021). Walking stability in patients with benign paroxysmal positional vertigo: an objective assessment using wearable accelerometers and machine learning. *J Neuroeng Rehabil, 18*(1), 56. doi:10.1186/s12984-021-00854-y

Attachments

Appendix A

Approval medical ethics committee of the university of Hasselt

www.uhasselt.be
Campus Hasselt | Martelarenlaan 42 | BE-3500 Hasselt
Campus Diepenbeek | Agoralaan gebouw D | BE-3590 Diepenbeek
T + 32(0)11 26 81 11 | E-mail: info@uhasselt.be

UHASSELT
KNOWLEDGE IN ACTION

Definitief gunstig advies
Amendement 1

Faculteit Geneeskunde en Levenswetenschappen
Comité voor Medische Ethiek
Voorzitter: prof. dr. Ivo Lambrichts
Secretariaat: Marleen Missotten
Tel.: 011 26 85 02
Fax: 011 26 85 99
E-mail: cme@uhasselt.be

ons kenmerk	uw kenmerk	Diepenbeek
CME2020/053		28/05/2021

Titel protocol	**Benigne Paroxysmale Positie Vertigo (BPPV) in woonzorgcentra: effectiviteit van behandeling en de impact op evenwicht, gang en valincidenten.**
Nummer protocol	
Opdrachtgever	Universiteit Hasselt
Eudractnummer	
Belgisch nummer	B1152020000013
Onderzoeker	*Prof. dr. Joke Spildooren, drs. Laura Casters*

Geachte collega,

Op 09/10/2020 keurde het CME UHasselt het bovenvermelde dossier definitief goed.

Op 27/05/2021 werd een amendement ingediend:
- Laura Casters werd vervangen door Gwen Laurent
- Verandering van de rol van Stefanie Smeets, nl. een ondersteunende rol
- Privacy van de persoonsgegevens
- Invoegen van testmoment T3 op maand 6 en T4 na 1 jaar
- Informatieverzameling rond COVID-19
- Behandeling:
    - Aanpassingen Sémont Maneuver
    - Verwijderen van het Lempert Maneuver
- Metingen
    - Toevoeging van een vierde conditie bij de balanstesten
    - Vervanging van de iTUG van 7 meter door de iTUG van 3 meter
    - Meting van Angst door middel van Hospital Anxiety and Depression Scale (HADS)
    - Toevoeging van een objectieve meting van de functionaliteit, nl. de meting van de knie-extensiekracht met een MicroFET hand-held dynamometer.

Het gunstig advies betreft de volgende documenten:
- Protocol, versie 3, dd. 27/05/2021
- Informatie- en toestemmingsformulier, versie 3, dd. 27/05/2021
- Toestemmingsformulier voor de verwerking van persoonsgegevens, versie 3, dd. 27/05/2021
- Korte samenvatting, versie 3, dd. 27/05/2021

Het ethisch comité heeft geen bezwaren tegen de wijzigingen en keurt het amendement goed.

Het Comité voor Medische Ethiek van UHasselt handelt volgens de geldende richtlijnen van de 'International Conference of Harmonization (ICH) Good Clinical Practice (GCP)' en volgens alle geldende en van toepassing zijnde wetten en reglementen.

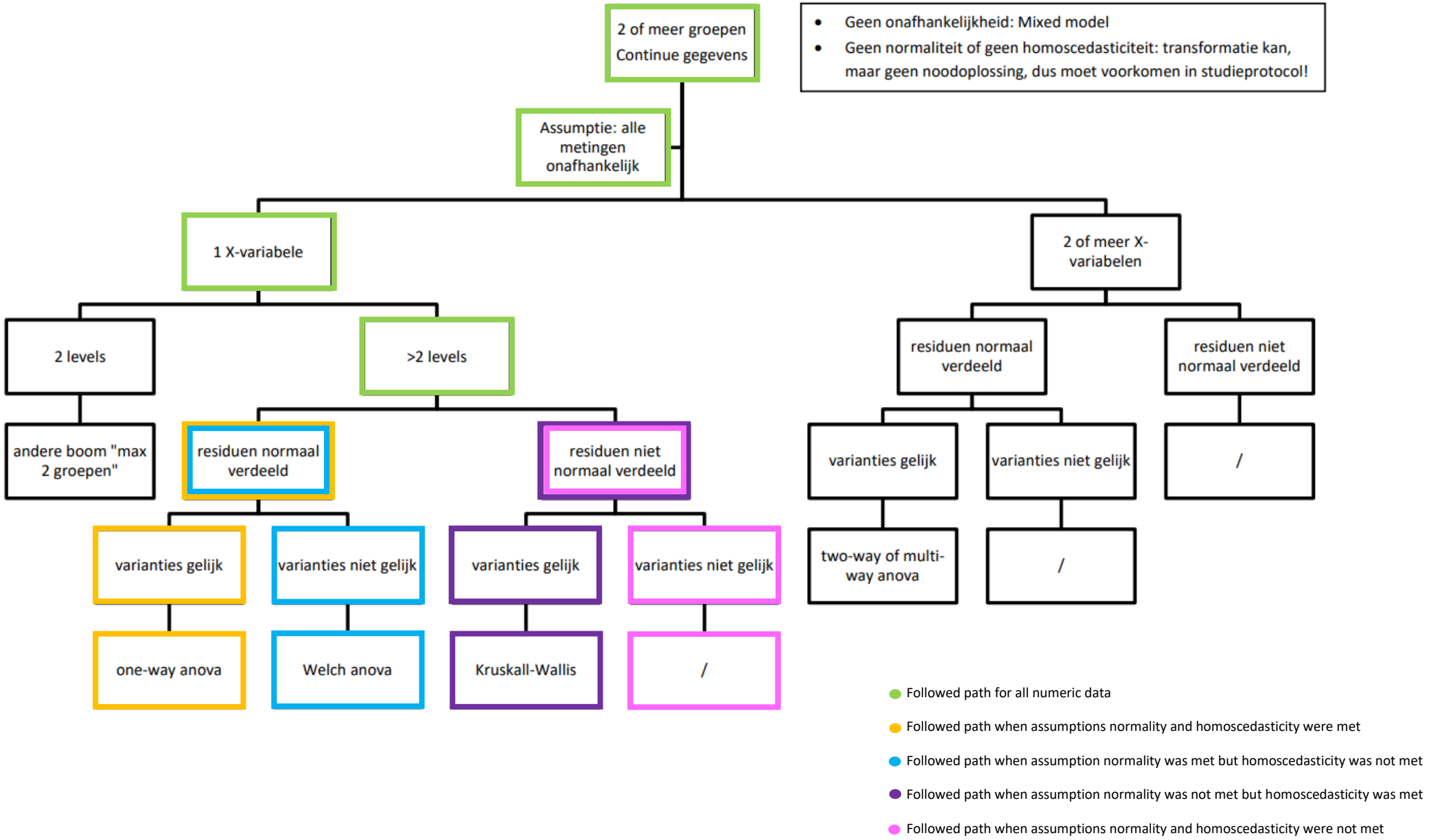
Met oprechte hoogachting,

www.uhasselt.be
Campus Hasselt | Martelarenlaan 42 | BE-3500 Hasselt
Campus Diepenbeek | Agoralaan gebouw D | BE-3590 Diepenbeek
T + 32(0)11 26 81 11 | E-mail: info@uhasselt.be

Prof. dr. Ivo Lambrichts
Voorzitter Comité voor Medische Ethiek

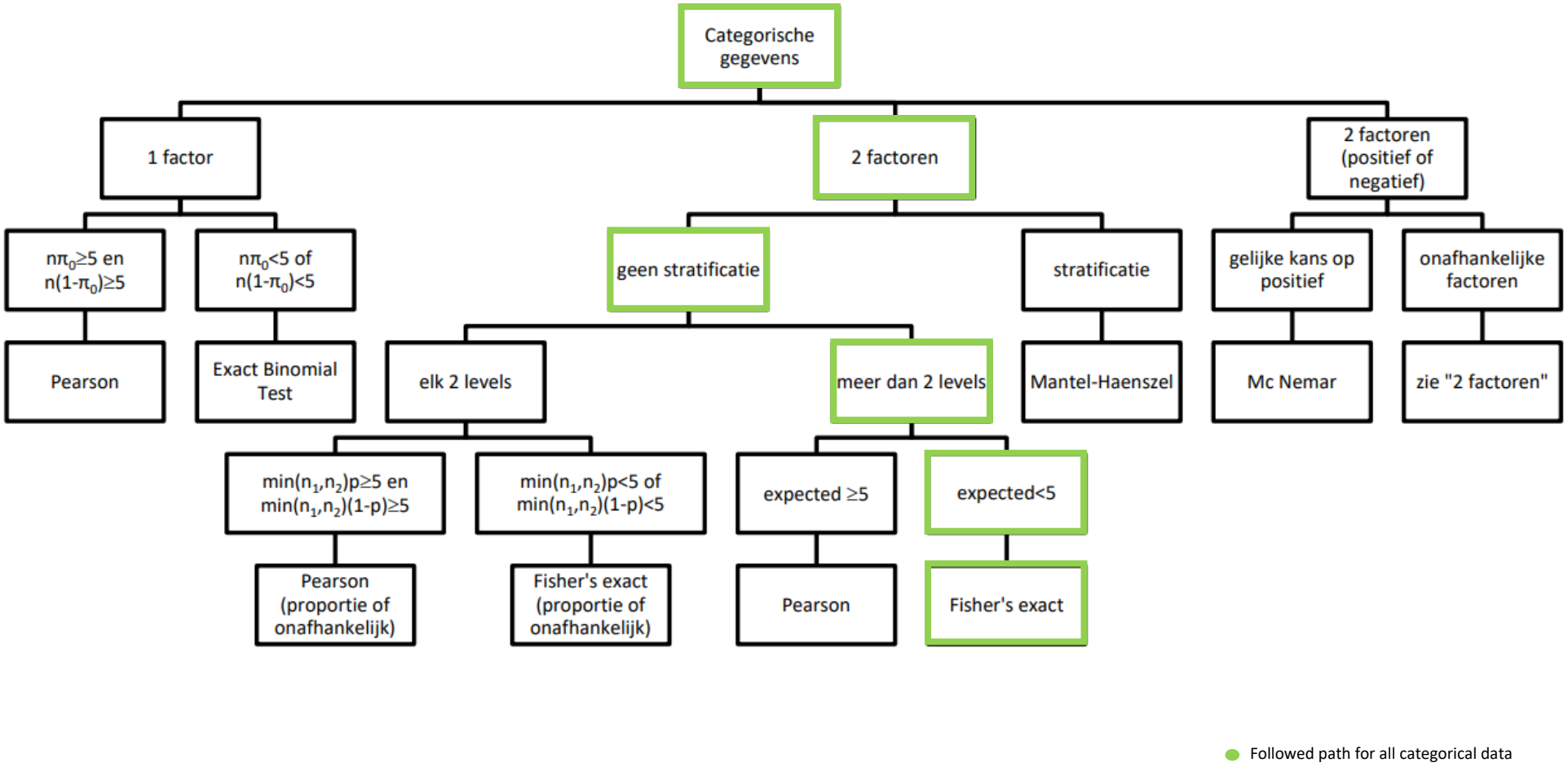
Appendix B

Statistical decision tree numeric data



Appendix C

Statistical decision tree categorical data



Appendix D

Permission to defend the master thesis

UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2021-2022,
Registration form jury Master's thesis academic year 2021-2022,

GEGEVENS STUDENT - *INFORMATION STUDENT*

Faculteit/School: **Faculteit Revalidatiewetenschappen**
Faculty/School: ***Rehabilitation Sciences***

Stamnummer + naam: **1643942 Vounckx Sanne**
Student number + name

Opleiding/*Programme*: **2 ma revalid. & kine kinderen**

INSTRUCTIES - *INSTRUCTIONS*

Neem onderstaande informatie grondig door.

Print dit document en vul het aan met DRUKLETTERS.

In tijden van van online onderwijs door COVID-19 verstuur je het document (scan of leesbare foto) ingevuld via mail naar je promotor. Je promotor bezorgt het aan de juiste dienst voor verdere afhandeling.

Vul luik A aan. Bezorg het formulier aan je promotoren voor de aanvullingen in luik B. Zorg dat het formulier ondertekend en gedateerd wordt door jezelf en je promotoren in luik D en dien het in bij de juiste dienst volgens de afspraken in jouw opleiding.
Zonder dit inschrijvingsformulier krijg je geen toegang tot upload/verdediging van je masterproef.

Please read the information below carefully.

Print this document and complete it by hand writing, using CAPITAL LETTERS.

In times of COVID-19 and during the online courses you send the document (scan or readable photo) by email to your supervisor. Your supervisor delivers the document to the appropriate department.

Fill out part A. Send the form to your supervisors for the additions in part B. Make sure that the form is signed and dated by yourself and your supervisors in part D and submit it to the appropriate department in accordance with the agreements in your study programme.
Without this registration form, you will not have access to the upload/defense of your master's thesis.

LUIK A - VERPLICHT - IN TE VULLEN DOOR DE STUDENT
PART A - MANDATORY - TO BE FILLED OUT BY THE STUDENT

Titel van Masterproef/*Title of Master's thesis:*

☒ behouden - *keep* THE INFLUENCE OF BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV) AND POSITIONAL NYSTAGMUS ON POSTURAL BALANCE IN OLDER ADULTS LIVING IN NURSING HOMES.

☐ wijzigen - *change to*:

/:

O behouden - *keep*

O wijzigen - *change to*:

In geval van samenwerking tussen studenten, naam van de medestudent(en)/*In case of group work, name of fellow student(s)*:

Ø behouden - *keep* HAEGEMANS LOTTE

O wijzigen - *change to:*

LUIK B - VERPLICHT - IN TE VULLEN DOOR DE PROMOTOR(EN)
PART B - MANDATORY - TO BE FILLED OUT BY THE SUPERVISOR(S)

Wijziging gegevens masterproef in luik A/*Change information Master's thesis in part A:*

● goedgekeurd - *approved*

O goedgekeurd mits wijziging van - *approved if modification of:*

Scriptie/*Thesis:*

● openbaar (beschikbaar in de document server van de universiteit)- *public (available in document server of university)*

O vertrouwelijk (niet beschikbaar in de document server van de universiteit) - *confidential (not available in document server of university)*

Juryverdediging/*Jury Defense:*

De promotor(en) geeft (geven) de student(en) het niet-bindend advies om de bovenvermelde masterproef in de bovenvermelde periode/*The supervisor(s) give(s) the student(s) the non-binding advice:*

● te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

● de verdediging is openbaar/*in public*

O de verdediging is niet openbaar/*not in public*

O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK C - OPTIONEEL - IN TE VULLEN DOOR STUDENT, alleen als hij luik B wil overrulen
PART C - OPTIONAL - TO BE FILLED OUT BY THE STUDENT, only if he wants to overrule part B

In tegenstelling tot het niet-bindend advies van de promotor(en) wenst de student de bovenvermelde masterproef in de bovenvermelde periode/*In contrast to the non-binding advice put forward by the supervisor(s), the student wishes:*

O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

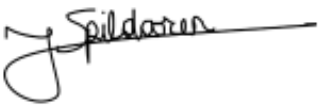
O te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK D - VERPLICHT - IN TE VULLEN DOOR DE STUDENT EN DE PROMOTOR(EN)
PART D - MANDATORY - TO BE FILLED OUT BY THE STUDENT AND THE SUPERVISOR(S)

Datum en handtekening student(en)
Date and signature student(s)

24/05/2022

Datum en handtekening promotor(en)
Date and signature supervisor(s)



30/05/2022

UHASSELT
KNOWLEDGE IN ACTION

Inschrijvingsformulier verdediging masterproef academiejaar 2021-2022,
Registration form jury Master's thesis academic year 2021-2022,

GEGEVENS STUDENT - *INFORMATION STUDENT*

Faculteit/School: **Faculteit Revalidatiewetenschappen**
Faculty/School: ***Rehabilitation Sciences***

Stamnummer + naam: **1642850 Haegemans Lotte**
Student number + name

Opleiding/*Programme*: **2 ma revalid. & kine neuro**

INSTRUCTIES - *INSTRUCTIONS*

Neem onderstaande informatie grondig door.

Print dit document en vul het aan met DRUKLETTERS.

In tijden van van online onderwijs door COVID-19 verstuur je het document (scan of leesbare foto) ingevuld via mail naar je promotor. Je promotor bezorgt het aan de juiste dienst voor verdere afhandeling.

Vul luik A aan. Bezorg het formulier aan je promotoren voor de aanvullingen in luik B. Zorg dat het formulier ondertekend en gedateerd wordt door jezelf en je promotoren in luik D en dien het in bij de juiste dienst volgens de afspraken in jouw opleiding.
Zonder dit inschrijvingsformulier krijg je geen toegang tot upload/verdediging van je masterproef.

Please read the information below carefully.

Print this document and complete it by hand writing, using CAPITAL LETTERS.

In times of COVID-19 and during the online courses you send the document (scan or readable photo) by email to your supervisor. Your supervisor delivers the document to the appropriate department.

Fill out part A. Send the form to your supervisors for the additions in part B. Make sure that the form is signed and dated by yourself and your supervisors in part D and submit it to the appropriate department in accordance with the agreements in your study programme.
Without this registration form, you will not have access to the upload/defense of your master's thesis.

LUIK A - VERPLICHT - IN TE VULLEN DOOR DE STUDENT
PART A - MANDATORY - TO BE FILLED OUT BY THE STUDENT

Titel van Masterproef/*Title of Master's thesis:*

O behouden - *keep* THE INFLUENCE OF BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV) AND POSITIONAL NYSTAGMUS ON POSTURAL BALANCE IN OLDER ADULTS LIVING IN NURSING HOMES

O wijzigen - *change to*:

/:

O behouden - *keep*

O wijzigen - *change to*:

In geval van samenwerking tussen studenten, naam van de medestudent(en)/*In case of group work, name of fellow student(s)*:

O behouden - *keep* SANNE VOUNCKX

O wijzigen - *change to:*

LUIK B - VERPLICHT - IN TE VULLEN DOOR DE PROMOTOR(EN)
PART B - MANDATORY - TO BE FILLED OUT BY THE SUPERVISOR(S)

Wijziging gegevens masterproef in luik A/*Change information Master's thesis in part A:*

● goedgekeurd - *approved*

O goedgekeurd mits wijziging van - *approved if modification of:*

Scriptie/*Thesis:*

● openbaar (beschikbaar in de document server van de universiteit)- *public (available in document server of university)*

O vertrouwelijk (niet beschikbaar in de document server van de universiteit) - *confidential (not available in document server of university)*

Juryverdediging/*Jury Defense:*

De promotor(en) geeft (geven) de student(en) het niet-bindend advies om de bovenvermelde masterproef in de bovenvermelde periode/*The supervisor(s) give(s) the student(s) the non-binding advice:*

● te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

● de verdediging is openbaar/*in public*

O de verdediging is niet openbaar/*not in public*

O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK C - OPTIONEEL - IN TE VULLEN DOOR STUDENT, alleen als hij luik B wil overrulen
PART C - OPTIONAL - TO BE FILLED OUT BY THE STUDENT, only if he wants to overrule part B

In tegenstelling tot het niet-bindend advies van de promotor(en) wenst de student de bovenvermelde masterproef in de bovenvermelde periode/*In contrast to the non-binding advice put forward by the supervisor(s), the student wishes:*

O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

O te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*

LUIK D - VERPLICHT - IN TE VULLEN DOOR DE STUDENT EN DE PROMOTOR(EN)
PART D - MANDATORY - TO BE FILLED OUT BY THE STUDENT AND THE SUPERVISOR(S)

Datum en handtekening student(en)
Date and signature student(s)

24/05/2022

Datum en handtekening promotor(en)
Date and signature supervisor(s)

30/05/2022

Joke SPILDOOREN
aan mij

Beste Sanne en Lotte,

Mits jullie mijn opmerkingen de komende week verder aanpassen, geef ik jullie de toestemming om in eerste zittijd jullie thesis te verdedigen.

Veel succes
Joke Spildooren

Prof. Dr. Joke Spildooren
Assistant professor - Geriatric Rehabilitation
REVAL - Rehabilitation Research

T +32(0)11 26 91 78

www.uhasselt.be
Hasselt University - Campus Diepenbeek
Agoralaan Building A - B-3590 Diepenbeek
Office A0.01

Postal address:
Hasselt University
Martelarenlaan 42
B-3500 Hasselt

Appendix E

Inventory form

www.uhasselt.be
Campus Hasselt | Martelarenlaan 42 | BE-3500 Hasselt
Campus Diepenbeek | Agoralaan gebouw D | BE-3590 Diepenbeek
T + 32(0)11 26 81 11 | E-mail: info@uhasselt.be

UHASSELT
KNOWLEDGE IN ACTION

INVENTARISATIEFORMULIER WETENSCHAPPELIJKE STAGE DEEL 2

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
08/07/2021	Bespreking verloop onderzoeken in woonzorgcentrum.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
29/07/2021	Bespreking verloop onderzoeken in woonzorgcentrum, planning vastleggen, taken verdelen. Bespreking onderzoeksvraag.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
23/11/2021	Bespreking onderzoeksvraag en uitkomstmaten.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
17/03/2022	Bespreking methode en eerste versie van inleiding. Aanpassing onderzoeksvraag.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
08/04/2022	Bespreking beslissingsboom statistiek.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
30/05/2022	Feedback volledige thesis.	Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):

In te vullen door de promotor(en) en eventuele copromotor aan het einde van MP2:

Naam Student(e): Lotte Haegemans, Sanne Vounckx **Datum:** 30/05/2022

Titel Masterproef: The influence of benign paroxysmal positional vertigo (BPPV) and positional nystagmus on postural balance in older adults living in nursing homes.

1) Geef aan in hoeverre de student(e) onderstaande competenties zelfstandig uitvoerde:
   - NVT: De student(e) leverde hierin geen bijdrage, aangezien hij/zij in een reeds lopende studie meewerkte.
   - 1: De student(e) was niet zelfstandig en sterk afhankelijk van medestudent(e) of promotor en teamleden bij de uitwerking en uitvoering.
   - 2: De student(e) had veel hulp en ondersteuning nodig bij de uitwerking en uitvoering.
   - 3: De student(e) was redelijk zelfstandig bij de uitwerking en uitvoering
   - 4: De student(e) had weinig tot geringe hulp nodig bij de uitwerking en uitvoering.
   - 5: De student(e) werkte zeer zelfstandig en had slechts zeer sporadisch hulp en bijsturing nodig van de promotor of zijn team bij de uitwerking en uitvoering.

Competenties	NVT	1	2	3	4	5
Opstelling onderzoeksvraag	O	O	O	●	O	O
Methodologische uitwerking	●	O	O	O	O	O
Data acquisitie	O	O	O	●	O	O
Data management	O	O	O	O	●	O
Dataverwerking/Statistiek	O	O	O	●	O	O
Rapportage	O	O	O	O	●	O

2) Niet-bindend advies: Student(e) krijgt toelating/~~geen toelating~~ (schrappen wat niet past) om bovenvermelde Wetenschappelijke stage/masterproef deel 2 te verdedigen in bovenvermelde periode. Deze eventuele toelating houdt geen garantie in dat de student geslaagd is voor dit opleidingsonderdeel.

3) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) openbaar verdedigd worden.

4) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) opgenomen worden in de bibliotheek en docserver van de UHasselt.

Datum en handtekening Student(e)	Datum en handtekening promotor(en)	Datum en handtekening Co-promotor(en)
Sanne Vounckx Lotte Haegemans 30/05/2022	30/05/2022	

Appendix F
Declaration of honor

Verklaring op Eer

Ondergetekende, student aan de Universiteit Hasselt (UHasselt), faculteit Revalidatiewetenschappen en Kinesitherapie aanvaardt de volgende voorwaarden en bepalingen van deze verklaring:

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en Kinesitherapie, waarbij ik de kans krijg om in het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen en Kinesitherapie aan de UHasselt. Dit onderzoek wordt beleid door Prof. Dr. Joke Spildooren en kadert binnen het opleidingsonderdeel geriatrie. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van geriatrie. (hierna: "De Onderzoeksresultaten").

2. Bij de creatie van De Onderzoeksresultaten doe ik beroep op de achtergrondkennis, vertrouwelijke informatie[1], universitaire middelen en faciliteiten van UHasselt (hierna: de "Expertise").

3. Ik zal de Expertise, met inbegrip van vertrouwelijke informatie, uitsluitend aanwenden voor het uitvoeren van hogergenoemd onderzoek binnen UHasselt. Ik zal hierbij steeds de toepasselijke regelgeving, in het bijzonder de Algemene Verordening Gegevensbescherming (EU 2016-679), in acht nemen.

4. Ik zal de Expertise (i) voor geen enkele andere doelstelling gebruiken, en (ii) niet zonder voorafgaande schriftelijke toestemming van UHasselt op directe of indirecte wijze publiek maken.

5. Aangezien ik in het kader van mijn onderzoek beroep doe op de Expertise van de UHasselt, draag ik hierbij alle bestaande en toekomstige intellectuele eigendomsrechten op De Onderzoeksresultaten over aan de UHasselt. Deze overdracht omvat alle vormen van intellectuele eigendomsrechten, zoals onder meer – zonder daartoe beperkt te zijn – het auteursrecht, octrooirecht, merkenrecht, modellenrecht en knowhow. De overdracht geschiedt in de meest volledige omvang, voor de gehele wereld en voor de gehele beschermingsduur van de betrokken rechten.

6. In zoverre De Onderzoeksresultaten auteursrechtelijk beschermd zijn, omvat bovenstaande overdracht onder meer de volgende exploitatiewijzen, en dit steeds voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding:

   - het recht om De Onderzoeksresultaten vast te (laten) leggen door alle technieken en op alle dragers;
   - het recht om De Onderzoeksresultaten geheel of gedeeltelijk te (laten) reproduceren, openbaar te (laten) maken, uit te (laten) geven, te (laten) exploiteren en te (laten) verspreiden in eender welke vorm, in een onbeperkt aantal exemplaren;

---

[1] Vertrouwelijke informatie betekent alle informatie en data door de UHasselt meegedeeld aan de student voor de uitvoering van deze overeenkomst, inclusief alle persoonsgegevens in de zin van de Algemene Verordening Gegevensbescherming (EU 2016/679), met uitzondering van de informatie die (a) reeds algemeen bekend is; (b) reeds in het bezit was van de student voor de mededeling ervan door de UHasselt; (c) de student verkregen heeft van een derde zonder enige geheimhoudingsplicht; (d) de student onafhankelijk heeft ontwikkeld zonder gebruik te maken van de vertrouwelijke informatie van de UHasselt; (e) wettelijk of als gevolg van een rechterlijke beslissing moet worden bekendgemaakt, op voorwaarde dat de student de UHasselt hiervan schriftelijk en zo snel mogelijk op de hoogte brengt.

- het recht om De Onderzoeksresultaten te (laten) verspreiden en mee te (laten) delen aan het publiek door alle technieken met inbegrip van de kabel, de satelliet, het internet en alle vormen van computernetwerken;
- het recht De Onderzoeksresultaten geheel of gedeeltelijk te (laten) bewerken of te (laten) vertalen en het (laten) reproduceren van die bewerkingen of vertalingen;
- het recht De Onderzoeksresultaten te (laten) bewerken of (laten) wijzigen, onder meer door het reproduceren van bepaalde elementen door alle technieken en/of door het wijzigen van bepaalde parameters (zoals de kleuren en de afmetingen).

De overdracht van rechten voor deze exploitatiewijzen heeft ook betrekking op toekomstige onderzoeksresultaten tot stand gekomen tijdens het onderzoek aan UHasselt, eveneens voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding.

Ik behoud daarbij steeds het recht op naamvermelding als (mede)auteur van de betreffende Onderzoeksresultaten.

7. Ik zal alle onderzoeksdata, ideeën en uitvoeringen neerschrijven in een "laboratory notebook" en deze gegevens niet vrijgeven, tenzij met uitdrukkelijke toestemming van mijn UHasseltbegeleider Prof. Dr. Joke Spildooren.

8. Na de eindevaluatie van mijn onderzoek aan de UHasselt zal ik alle verkregen vertrouwelijke informatie, materialen, en kopieën daarvan, die nog in mijn bezit zouden zijn, aan UHasselt terugbezorgen.

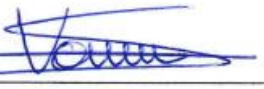
Gelezen voor akkoord en goedgekeurd,

Naam: Vounckx Sanne

Adres: Merelstraat 70/1, 3630 Maasmechelen, België

Geboortedatum en -plaats : 16-01-1998, Genk

Datum: 07-11-2020

Handtekening: 

Verklaring op Eer

Ondergetekende, student aan de Universiteit Hasselt (UHasselt), faculteit Revalidatiewetenschappen aanvaardt de volgende voorwaarden en bepalingen van deze verklaring:

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en kinesitherapie, waarbij ik de kans krijg om in het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen aan de UHasselt. Dit onderzoek wordt beleid door Prof. Dr. Joke Spildooren en kadert binnen het opleidingsonderdeel Wetenschappelijke stage/Masterproef deel 1. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van Geriatrie (hierna: "De Onderzoeksresultaten").

2. Bij de creatie van De Onderzoeksresultaten doe ik beroep op de achtergrondkennis, vertrouwelijke informatie[1], universitaire middelen en faciliteiten van UHasselt (hierna: de "Expertise").

3. Ik zal de Expertise, met inbegrip van vertrouwelijke informatie, uitsluitend aanwenden voor het uitvoeren van hogergenoemd onderzoek binnen UHasselt. Ik zal hierbij steeds de toepasselijke regelgeving, in het bijzonder de Algemene Verordening Gegevensbescherming (EU 2016-679), in acht nemen.

4. Ik zal de Expertise (i) voor geen enkele andere doelstelling gebruiken, en (ii) niet zonder voorafgaande schriftelijke toestemming van UHasselt op directe of indirecte wijze publiek maken.

5. Aangezien ik in het kader van mijn onderzoek beroep doe op de Expertise van de UHasselt, draag ik hierbij alle bestaande en toekomstige intellectuele eigendomsrechten op De Onderzoeksresultaten over aan de UHasselt. Deze overdracht omvat alle vormen van intellectuele eigendomsrechten, zoals onder meer - zonder daartoe beperkt te zijn - het auteursrecht, octrooirecht, merkenrecht, modellenrecht en knowhow. De overdracht geschiedt in de meest volledige omvang, voor de gehele wereld en voor de gehele beschermingsduur van de betrokken rechten.

6. In zoverre De Onderzoeksresultaten auteursrechtelijk beschermd zijn, omvat bovenstaande overdracht onder meer de volgende exploitatiewijzen, en dit steeds voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding:

   - het recht om De Onderzoeksresultaten vast te (laten) leggen door alle technieken en op alle dragers;
   - het recht om De Onderzoeksresultaten geheel of gedeeltelijk te (laten) reproduceren, openbaar te (laten) maken, uit te (laten) geven, te (laten) exploiteren en te (laten) verspreiden in eender welke vorm, in een onbeperkt aantal exemplaren;

[1] Vertrouwelijke informatie betekent alle informatie en data door de UHasselt meegedeeld aan de student voor de uitvoering van deze overeenkomst, inclusief alle persoonsgegevens in de zin van de Algemene Verordening Gegevensbescherming (EU 2016/679), met uitzondering van de informatie die (a) reeds algemeen bekend is; (b) reeds in het bezit was van de student voor de mededeling ervan door de UHasselt; (c) de student verkregen heeft van een derde zonder enige geheimhoudingsplicht; (d) de student onafhankelijk heeft ontwikkeld zonder gebruik te maken van de vertrouwelijke informatie van de UHasselt; (e) wettelijk of als gevolg van een rechterlijke beslissing moet worden bekendgemaakt, op voorwaarde dat de student de UHasselt hiervan schriftelijk en zo snel mogelijk op de hoogte brengt.

- het recht om De Onderzoeksresultaten te (laten) verspreiden en mee te (laten) delen aan het publiek door alle technieken met inbegrip van de kabel, de satelliet, het internet en alle vormen van computernetwerken;
- het recht De Onderzoeksresultaten geheel of gedeeltelijk te (laten) bewerken of te (laten) vertalen en het (laten) reproduceren van die bewerkingen of vertalingen;
- het recht De Onderzoeksresultaten te (laten) bewerken of (laten) wijzigen, onder meer door het reproduceren van bepaalde elementen door alle technieken en/of door het wijzigen van bepaalde parameters (zoals de kleuren en de afmetingen).

De overdracht van rechten voor deze exploitatiewijzen heeft ook betrekking op toekomstige onderzoeksresultaten tot stand gekomen tijdens het onderzoek aan UHasselt, eveneens voor de hele beschermingsduur, voor de gehele wereld en zonder vergoeding.

Ik behoud daarbij steeds het recht op naamvermelding als (mede)auteur van de betreffende Onderzoeksresultaten.

7. Ik zal alle onderzoeksdata, ideeën en uitvoeringen neerschrijven in een "laboratory notebook" en deze gegevens niet vrijgeven, tenzij met uitdrukkelijke toestemming van mijn UHasseltbegeleider Prof. Dr. Joke Spildooren.

8. Na de eindevaluatie van mijn onderzoek aan de UHasselt zal ik alle verkregen vertrouwelijke informatie, materialen, en kopieën daarvan, die nog in mijn bezit zouden zijn, aan UHasselt terugbezorgen.

Gelezen voor akkoord en goedgekeurd,

Naam: Lotte Haegemans

Adres: Erkestraat 5, 3910 Pelt

Geboortedatum en -plaats : 24/03/1998 te Neerpelt

Datum: 07/11/2020

Handtekening: Lotte Haegemans