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FACULTEIT GENEESKUNDE EN LEVENSWETENSCHAPPEN
master in de revalidatiewetenschappen en de kinesitherapie

Masterproef

The prevalence of Benign Paroxysmal Positional Vertigo and its impact on gait and balance problems in elderly subjects from nursing homes

Promotor :
dr. Joke SPILDOOREN

Laura Pensart , Lisa Stiers
Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie

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This master thesis would not have been possible without the support, time and effort of a number of people who helped realize the work. Our sincere appreciations go out to our promoter, Prof. dr. Joke Spildooren. Her tireless guidance and dedication inspired us to put all possible effort into this thesis.

We would also like to thank the managing board of the Sint-Elisabeth nursing home in Hasselt for the excellent cooperation. Special thanks go out to our colleague physiotherapists at the nursing home, who kindly and generously provided us with all the needed information.

We would especially like to thank our amazing friends and family for the love, support, and constant encouragement we have got over the past two years.

Since this thesis was a duo thesis, we would also like to thank each other for the excellent teamwork. It was the groundwork for a new friendship. We are convinced that our combined efforts bring more insight and interest to this thesis.

Bilzen-Nieuwerkerken, 06-06-2017 L.P. - L.S.

Research context

This paper was written as part of our master thesis at the master program Rehabilitation Sciences and Phsyiotherapy at Uhasselt University. The research can be situated in two specific domains of physiotherapy, namely the geriatric and neurological rehabilitation. The completion of our master thesis consisted of two parts conducted during the first and second master year, respectively. The first part was a literature study focussing on the most appropriate and effective treatment of Benign Paroxysmal Position Vertigo (BPPV) in elderly patients above 60 years old. The second part consisted of a research on the prevalence of BPPV and its impact on gait and balance problems in elderly subjects from nursing homes aged 70 and above. The latter will be discussed into detail in this paper.

When overviewing the current available scientific evidence the assumption that the elderly generation is often more susceptible to BPPV rises. There is also evidence that BPPV at an older age can lead to an increased fall risk, associated physical and psychosocial decline, negative financial consequences for society and a higher risk of being institutionalized. Together with the rapidly aging population, this makes BPPV detection and treatment of rising interest. Unfortunately research on BPPV is lacking, especially in institutionalized older adults aged 70 and above. Therefore the aim of this present study is to investigate the prevalence of Benign Paroxysmal Positional Vertigo and to determine the impact of BPPV on gait and balance problems in elderly subjects aged 70 and above from nursing homes.

Dr. Joke Spildooren mostly designed the research protocol, but in consultation with us a few adjustments were made. The protocol was conducted at the Belgium nursing home Sint-Elisabeth in Hasselt under her supervision. Furthermore this thesis is a duo thesis; all the work from recruitment of the participants, data acquisition and data processing to the academic writing process was done together with guidance from our promotor.

The prevalence of Benign Paroxysmal Positional Vertigo and its impact on gait and balance problems in elderly subjects from nursing homes

Abstract

Background: Research on BPPV in institutionalized older adults aged 70 and above is lacking, even though they are at a higher risk of falling and frequently have balance problems.

Objectives: The aim of this present study is to investigate the prevalence of Benign Paroxysmal Positional Vertigo and to determine the impact of BPPV on gait and balance problems in elderly subjects from nursing homes aged 70 and above.

Participants: This cohort trial study was conducted at the Belgium nursing home Sint-Elisabeth in Hasselt. The sample included participants of both genders, who where aged 70 and above and where institutionalized for at least 3 months. They had to be able to understand and follow simple instructions and to stand independently for 30 seconds. Participants were enrolled in this study from September 2016 until December 2016.

Measurements: Participants were submitted to a balance test battery, which consisted of a free walk the Timed Up and Go (TUG) test, a 360° turn, the Four Test Balance Scale (FTBS) and the Romberg test. During this test battery the static and dynamic balance was determined by using 5 inertial measurement units, called the APDM-Sensors. Secondary outcome measures are the score on the Dizziness Handicap Inventory (DHI), the Geriatric depression scale (GDS) and the Falls Efficacy Scale International (FES-I). After determining these outcome measures all the participants underwent vestibular diagnostic tests to classify them into the non-BPPV group or the BPPV group.

Results: A BPPV prevalence of 26.8% was found in a sample of 41 institutionalized elderly aged 75 and above. Most of the primary and secondary outcome measures showed no significant differences between the BPPV group and the non-BPPV group. Only a significant difference in sway velocity is found during the Romberg test a, confirming a faster sway velocity (m/s) in the BPPV group ($p=0.005$).

Conclusion: There is a high BPPV prevalence of 26.8% in institutionalized elderly aged 75 and above. The impact of BPPV on gait and balance problems in elderly subjects remains unknown, therefore more high quality studies with a large sample size are needed.

Introduction

Benign Paroxysmal Positional Vertigo (BPPV) is one of the most common disorders of the vestibular system, located in the inner ear. (Froehling, Silverstein, Mohr, et al., 1999) Patients with BPPV often complain of vertigo or dizziness with a change in head position, getting out of bed, lying down to a supine position, bending over or rolling in bed. Other common symptoms caused by BPPV are: nystagmus, nausea and postural instability. These signs and symptoms can occur suddenly and usually last up to one minute. (Parnes, Agrawal and Atlas, 2003)

In BPPV the calcium carbonate crystals that are normally located on the otolithic membrane detach and get displaced (Parnes et al., 2003). We call these displaced crystals otoconia. With certain changes in head position, these otoconia cause an abnormal signal to the central nervous system (CNS), which in turn leads to short-term symptoms.

Positional tests such as the Dix-Hallpike maneuver, the side-lying test and the supine roll test (dependent on the involved semicircular canal) are the golden standard for diagnosis of BPPV. (Dix & Hallpike, 1952; Cohen, 2004; Baloh, Jacobson and Honrubia, 1993) A positional test is considered positive with the appearance of a nystagmus. To insure a good observation of the nystagmus and to avoid fixation of the eyes, video-oculoscopy (Vitte & Semont, 1995) or Frenzel goggles (Frenzel, 1965) can be used during the vestibular diagnostic tests.

The treatment of BPPV is relatively easy and can be done by a physican or physical therapist. There are several effective repositioning maneuvers to treat BPPV, with each maneuver more or less suitable for each affected semicircular canal. For an involvement of the posterior and/or anterior semicircular canal the Epley maneuver, the Semont maneuver and Brandt-Daroff exercises are possible treatments. (Epley, 1992; Semont, Freyss and Vitte, 1988; Brandt & Daroff, 1980) The Bar-B- Que-roll treatment (the Lempert maneuver), forced prolonged position and the Gufoni maneuver are used to treat horizontal canal BPPV. (Lempert and Tiel-Wilck, 1996; Vannucchi, Giannoni and Pagnini, 1997; Ciniglio, Catania and Gagliardi, 2001)

The lifetime incidence of BPPV is approximately 2.4%, with a probability that increases for elderly people, reaching a cumulative incidence of almost 10% at the age of 80. (Von Brevern et al., 2007) Von Brevern et al. (2007) also found in their epidemiology study that after 1 year of follow up the prevalence is almost seven times higher among elderly people (60+) than in the younger group (18-39year). Another study found a BPPV prevalence of 11% in 75-year old community dwelling elderly. (Kollén, Frändin, Möller M., Fagevik, Möller C., 2012) Hence the elderly generation is often more susceptible to BPPV. Some auteurs assume that age-related degeneration of the otoconia contributes this higher prevalence of BPPV. (Jang, Hwang, Shin, Bae and Kim, 2006)

Special attention should be given to the presence of BPPV in elderly, since the manifestation of this vestibular disorder is often different. BPPV in elderly is characterized by less vertigo and more dizziness and balance problems, therefore the expression of symptoms is more disguised. It is possible that this could lead to a higher rate of undiagnosed BPPV in the elderly population. (Plodpai, Atchariyasathian and Khaimook, 2014) Furthermore the experienced dizziness in older people can lead to a decreased functional balance and a higher rate of falls. (Gazzola, Perracini, Ganança M., Ganança F. 2006) A fall at an older age can entail some unpleasant physical (eg. sprains, lacerations, fractures), psychosocial (eg. a fear of falling, loss of self-esteem, depression, social isolation and greater care dependency) or economic (eg. higher costs, admission to nursing home) consequences. (Masud & Morris, 2001) In addition Prata and Scheicher (2012) found a relation between age, balance and daily activity. This means that older people with a better balance are able to keep a good level of independence and are less likely to be institutionalized into a nursing home. When overviewing this scientific evidence it is possible to assume that there is a higher prevalence of BPPV in institutionalized older adults aged 70 and above. This could partially explain why residents of nursing home often have a higher fall incidence and more balance problems.

Luckily Ganança et al. (2010) found that the by BPPV induced higher rates of falls could be significantly reduced by a reposition maneuver. To reduce the increased fall risk, the associated physical and psychosocial decline, the financial consequences for society and the risk of being institutionalized, it is very important to detect BPPV early and to give patients the appropriate treatment.

Unfortunately research on BPPV in institutionalized older adults aged 70 and above is lacking, even though as previously mentioned they are at a higher risk of falling and frequently have balance problems. Therefore the aim of this present study is to investigate the prevalence of Benign Paroxysmal Positional Vertigo and to determine the impact of BPPV on gait and balance problems in elderly subjects from nursing homes.

Method

This cohort trial study was conducted at the Belgium nursing home Sint-Elisabeth in Hasselt and was approved by the Ethics Committee of the University of Hasselt and KU Leuven (Belg. Regnr: B322201629379, 31/08/2016). The sample included participants of both genders, who where aged 70 and above and where institutionalized for at least 3 months. They had to be able to understand and follow simple instructions and to stand independently for 30 seconds. Also the exclusion criteria comprehended the following: a diagnosis of progressive neurological diseases resulting in a fast decline within 3 months (i.e. ALS), a neurological or orthopaedic incident still in the rehabilitation phase, contra-indications for the Hallpike or Epley maneuver (i.e. vertebrobasilar insufficiency) and psychosocial problems (i.e. anxiety). Participants were enrolled in this study from September 2016 until December 2016.

The clinical characteristics (gender, age and the use of a walking aid), the Functional Ambulation Categories (FAC) (Holden, Gill, et al., 1984) and the Mini-mental state examination (MMSE) (Folstein M.F., Folstein S.E. and McHugh, 1975) were registered for all participants.

- With the FAC the amount of self-efficacy in walking of the subject is determined by an ordinal 6-point scale (0-5 points), going from not functional (0) to unlimited independently (5).
- The MMSE is a questionnaire consisting of 30 items, which is used to measure cognitive impairment. Any score greater than or equal to 24 points (out of 30) indicates a normal cognition. Below this, scores can indicate severe (≤9 points), moderate (10–18 points) or mild (19–23 points) dementia.

Participants were submitted to a balance test battery, which consisted of a free walk (walking for an undetermined distance) the Timed Up and Go (TUG) test (Podsiadlo and Richardson, 1991; Large and Gan, 2006), a 360° turn, the Four Test Balance Scale (FTBS) (Gardner, Buchner, Robertson and Campbell, 2001; Rossiter-Fornoff, Wolf, Wolfson and Buchner, 1995) and the Romberg test (standing with feet together and eyes closed) (Rogers, 1980). During this test battery the static and dynamic balance was determined by using 5 inertial measurement units, called the APDM-Sensors (Mobility Lab, www.apdm.com).

These sensors (including an accelerometer, magnetometer and gyroscope) were specially developed for gait and balance research and work together with the analysis software Mobility Lab. In this study 2 ankle sensors, two wrist sensors and one lumbar sensor were used. They register body movements in 3 axes (vertical, transversal and sagittal) and thereby enable the registration of different outcomes parameters.

- The free walk is a test in which the participant is requested to walk a short distance of maximum 10 meters, turn around and walk back. If needed the participant may use a walking aid. In this test the following output measures of the APDM-Sensors were analysed: mean cadence (steps/min), mean double support (%GTC), mean elevation at midswing (cm), mean gait speed (m/s), mean single limb support (%GTC), mean step duration (s), mean stride length (m), mean upper limb swing velocity (°/s) and mean number of steps (#). These are specific gait parameters that cannot be measured during the TUG because of the short duration of this test.
- The Timed Up and Go test starts by having the participant sit back in a regular arm chair (± 50 cm high). The time that a person takes to rise from a chair, walk a standard three meters, turn around, walk back tot the chair, and sit down is measured. A lower score can indicate a higher risk of falling. For example: an older adult who takes ≥12 seconds to complete the TUG is at high risk for falling (Wall, Bell, Campbell and Davis, 2000). During the TUG test participants can use a walking aid if needed. All participants were allowed to try 3 times and the average of all parameters was taken. The primary outcome measures of interest for the TUG test were: duration (s), sit to stand (s), stand to sit (s) and turn duration (s).
- During the 360° turn the participant is asked to turn 360° without help or the use of a walking aid. Only the turn velocity (°/s) was measured. The participant was allowed to choose the direction of his/her turn and to try 2 times. The average of these 2 measurements was than used.

- The Four Test Balance Scale is a test to measure the static balance. The test consists of four progressively more challenging positions. The participant is not allowed to use an assistive device. The positions are standing with feet together, semi-tandem, tandem and standing on one leg. If the participant is able to hold the position for ten seconds without moving their feet or needing support, they proceed to the next position. Patients aged 65 years or older who cannot proceed to the tandem stance or cannot hold this stance for at least ten seconds are at increased risk of falling. (Rossiter-Fornoff, Wolf, Wolfson and Buchner, 1995) Within the FTBS sway area (m^2/s^4), mean velocity (m/s) and path length (m/s^2) were measured. Also the total duration (s) of the test was calculated. This means that the time in which patients are able to hold each of the four positions is added (maximum 10 seconds per position, total score between 0 and 40). For example, if a patient is able to complete the first position (10 seconds) but is not able to complete the second position (only 4 seconds) the total duration of this persons test is 14 seconds.
- To perform the Romberg test, the participants need to stand with their feet together and eyes closed for at least 30 seconds. During this test the following measures were of interest: sway area (m^2/s^4), mean velocity (m/s) and path length (m/s^2). All participants were allowed to try 2 times and the average of all parameters was then used.

To these primary outcome measures the score on the Dizziness Handicap Inventory (DHI) (Vereeck, Truijen, Wuyts and Van De Heyning, 2007 & 2006) was added to establish the participant's functionality.

- The purpose of the DHI is to evaluate the self-perceived handicapping effects of vestibular disease and its impact on quality of life. The questionnaire consists of 25 items to which the subject has to answer with 'no', 'sometimes', or 'yes'. Each item is then assigned with 0, 2, or 4 points accordingly. In this study, the total DHI score was observed, which lies between 0 and 100 points. A higher score is associated with higher frequency of dizziness (Jacobson and Newman, 1990).

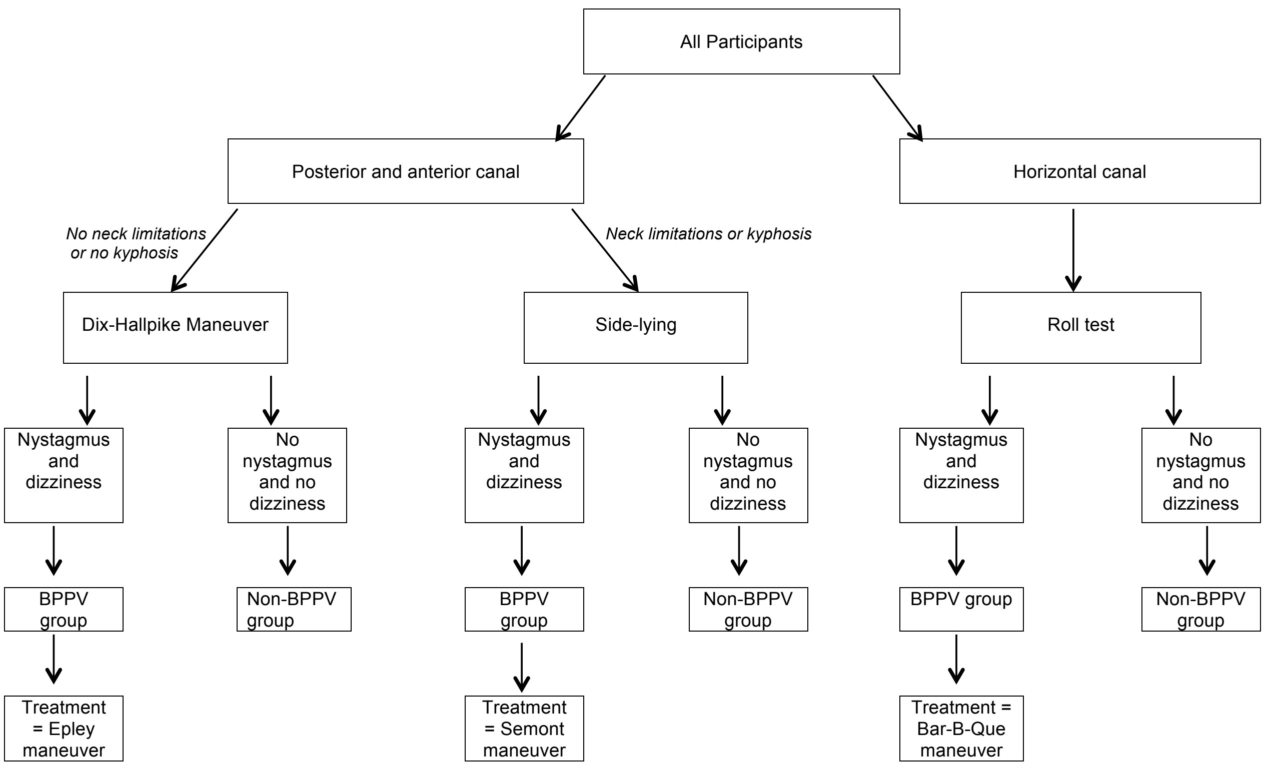
To determine depression rate and fear of falling as secondary outcome measures the scores on the following questionnaires were used: the Geriatric depression scale (GDS) (Sheikh and Yesavage, 1986) and the Falls Efficacy Scale International (FES-I) (Kempen , Zijlstra and van Haastregt, 2007).

- The GDS is a 30-item questionnaire used to determine depression in elderly. The participant has to answer every question with ‘yes’ or ‘no’, respectively a score of 1 or 0. The total GDS score was used in the study. A higher score is correlated to symptoms of depression. The following cut of scores can be used to qualify the severity: normal (0-9), mildly depressed (10-19) and severely depressed (20-30).
- The FES-I is a 16-point survey used to determine the fear of falling in the elderly population and their perception of balance and stability during activities of daily living. Each question is rated from 1 (“very confident”) to 4 (“not confident at all”). The total FES-I score ranges from 16 to 64.

To classify all the participants into the non-BPPV group or the BPPV group, they were subjected to vestibular diagnostic tests for both anterior or posterior canal BPPV and horizontal canal BPPV (Flowchart 1). To examine the anterior and posterior canal of the vestibular organ, the Dix-Hallpike maneuver (Dix & Hallpike, 1952) or the side-lying test (Semont, Freyss and Vitte, 1988) was used. A Dix-Hallpike maneuver was mostly conducted to clinically diagnose BPPV, but if participants had neck pain, limited neck extension or extensive thoracic kyphosis the side-lying test was used. To make a differentiation between an anterior or a posterior canal involvement, the same test was conducted but during this test de direction of the nystagmus was taken into account. The fast fase of the nystagmus with a posterior canal involvement has an upbeating component while for an anterior canal involvement this is a downbeating component. To examine the horizontal canal the roll test was performed (Baloh, Jacobson and Honrubia, 1993). The corresponding diagnosis of BPPV was made if the participant experienced a nystagmus and dizziness during the tests. If participants only experienced dizziness during the tests, the source of this symptom was sought out to be identified. For a good observation of the nystagmus and to avoid fixation of the eyes, Frenzel goggles were used. (Frenzel, 1965) If there was no observation of a nystagmus, the participant was classified into the non-BPPV group.

To avoid interference of the induced dizziness with the balance test battery and the questionnaires, the participants underwent this clinical examination only after determining the previously mentioned outcome measures. Consequently the participants were assigned to their corresponding study groups after completing the full clinical examination.

All of the patients in the BPPV group whom whish to be treated, get a treatment maneuver specified to their affected canal (Flowchart 1). The Epley maneuver (Epley, 1992) without the use of a bone vibrator is the treatment of choice in patients with anterior or posterior canal BPPV, but again if participants have neck pain or limited neck extension the Semont maneuver is used. Whereas the Bar-B-Que maneuver (Lempert and Tiel-Wilck, 1996) is conducted for the horizontal canal BPPV. Patients have repeated treatment sessions until vertigo and positional nystagmus disappear and the number of sessions needed is registered.



Flowchart 1

All variables were submitted to statistical analysis with SAS JMP software (SAS Institute Inc., 1989). For every outcome measure the 2 groups were compared (i.e. the BPPV-group and the non-BPPV group). In case of normality and homoscedasticity of the data the parametric T-test was used. When homoscedasticity was rejected but a normality of the data was present a Welch test was performed. If normality of the data was rejected a non-parametric Wilcoxon test was performed. To compare the data of the clinical characteristics (gender and the use of a walking aid) a Chi^2 test was conducted. A level of significance of 5% was adopted in all tests. For all outcome parameters the direction of difference between the scores of the BPPV group and the non-BPPV group was predictable with the aid of previous studies and a one sided test was sufficient.

Results

Participant characteristics

From the forty-four participants who were initially found eligible for this study, three were excluded because of psychosocial problems (n=2) or not being able to stand for 30 seconds (n=1) (Flowchart 2). This composed a final sample of 41 participants, of which 11 were diagnosed with BPPV (26.8%) and categorized in the BPPV group and 30 participants (73.2%) were categorized in the non-BPPV group (Table 1). Both groups were found to be homogenous with regard to gender, age, the use of a walking aid, the MMSE and the FAC.

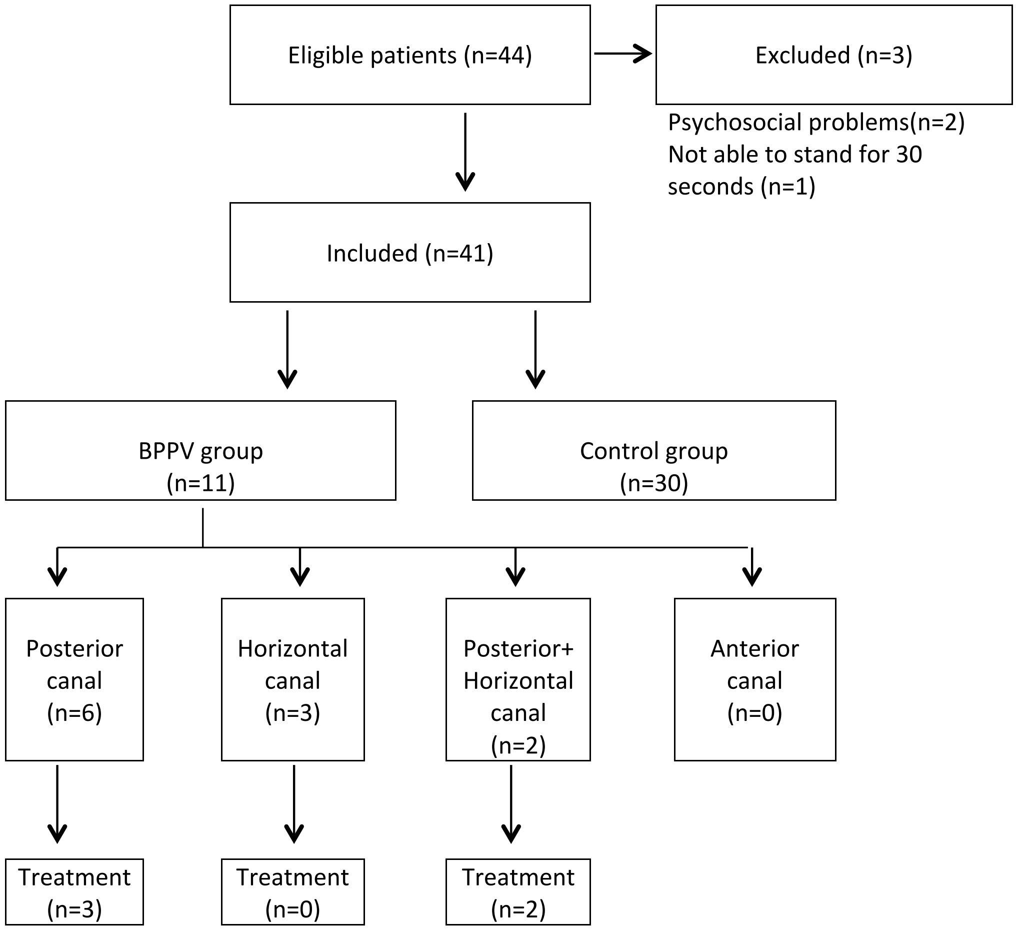
Table 1. Participant characteristics presented as mean (SD)

Subject characteristics	BPPV group (n=11)	Non-BPPV group (n=30)	p-value *
Gender (M/F)	2/9	9/21	0.69
Age (years)	87.36 (2.91)	86.37 (6.35)	0.50
Walking aid(yes/no)	6/5	15/15	1
MMSE	22.82 (5.23)	23.83 (4.81)	0.27
FAC	4.36 (0.81)	4.33 (0.71)	0.42

* Statistically significant difference (P-value < 0.05)

BPPV group characteristics and treatment

From the 11 participants with BPPV, the posterior canal was affected in six of them. The horizontal canal was affected in 3 patients. Two had both posterior and horizontal canal BPPV. None of the participants had an involvement of the anterior canal. From the total of 11 patients who where diagnosed with BPPV only five patients were treated. Six patients did not wish to be treated and one patient died before any treatment maneuver could take place (cause of death was unrelated to this study). None of the patients to be treated had neck pain or limited neck extension, therefore the Epley maneuver was the treatment of choice with posterior canal involvement (n=4). The Bar-B-Que maneuver was conducted with the two patients who also had horizontal canal involvement. The patients had repeated treatment sessions until vertigo and positional nystagmus disappeared and the number of sessions needed was registered. All patients were found to be free of vertigo and positional nystagmus after only one treatment session per involved semicircular canal.



Flowchart 2

360° Turn

With regards to the turn velocity (°/s) during the 360° turn no significant difference is found between the two groups.

Free walk and TUG

Non of the measured variables during the walk (gait velocity (m/s), single limb support (%GCT), double limb support (%GCT), stride length (m), less steps in a turn (#), cadence (steps/min), elevation at midswing (cm) and the step duration (s)) were found to be significantly different between the two groups. Only the variable elevation at midswing (cm) showed a trend towards significance (p=0.06). The other outcome parameters of interest during the TUG test (sit to stand (s), stand to sit (s), total duration (s) and turn duration (s)) were also not significantly different for the BPPV group in comparison with the non-BPPV group.

Four Test Balance Scale test and Romberg test

In the results from the four test positions of the FTBS, all of the parameters are not significant. Due to the fact that the test positions progressively become more difficult the sample size in the most challenging position (standing on one leg) is very low (n=4). For this reason only one person was able to perform the position "standing on one leg" in the BPPV-group, so no standard deviation can be given for these measurements. For the variable path length (m/s^2) in the position semi-tandem a trend towards significance is found (p=0.06). When overviewing the results of the Romberg test a significant difference in sway velocity is found, indicating a faster sway velocity (m/s) in the BPPV group (p=0.005). For the variables sway area (m^2/s^4) a trend towards significance is found (p=0.05). The variable path length (m/s^2) was not found to be significant.

Questionnaires

The scores on the DHI, FES-I and GDS were not found to be significantly different between the two groups.

Table 2. Mean test results BPPV group and Non-BPPV group (SD)

	BPPV (mean SD)	Non-BPPV (mean ±SD)	p-value *
360° Turn			
- Turn velocity (°/s)	111.11 (32.30)	110.39 (47.35)	0.28
TUG			
- Duration (s)	24.94 (10.79)	25.41 (10.04)	0.46
- Sit to stand (s)	1.27 (0.31)	1.27 (0.23)	0.48
- Stand to sit (s)	0.97 (0.19)	0.96 (0.20)	0.34
- Turn duration (s)	3.28 (0.78)	2.96 (0.69)	0.12
Four Test Balance Scale			
- Standing with feet together			
o Sway area (m^2/s^4)	0.09 (0.05)	0.13 (0.21)	0.33
o Sway velocity (m/s)	0.08 (0.04)	0.08 (0.05)	0.23
o Path length (m/s^2)	11.62 (5.32)	15.24 (16.58)	0.42
- Semi-tandem			
o Sway area (m^2/s^4)	0.09 (0.08)	0.11 (0.09)	0.34
o Sway velocity (m/s)	0.09 (0.05)	0.08 (0.05)	0.29
o Path length (m/s^2)	12.34 (4.58)	18.62 (16.58)	0.06
- Tandem			
o Sway area (m^2/s^4)	0.83 (1.25)	0.32 (0.48)	0.21
o Sway velocity (m/s)	0.17 (0.12)	0.11 (0.11)	0.15
o Path length (m/s^2)	45.35 (32.69)	23.89 (20.30)	0.23
- Standing on one leg			
o Sway area (m^2/s^4)	0.10 (/)	0.16 (0.07)	0.19
o Sway velocity (m/s)	0.08 (/)	0.12 (0.04)	0.19
o Path length (m/s^2)	20.21 (/)	29.53 (9.66)	0.19
- Total score	27.45 (10.39)	27.73 (8.56)	0.47
Romberg test			
- Feet together eyes closed			
o Sway area (m^2/s^4)	0.55 (0.33)	0.40 (0.55)	0.05
o Sway velocity (m/s)	0.44 (0.18)	0.29 (0.22)	0.005*
o Path length (m/s^2)	21.30 (10.19)	22.78 (16.09)	0.36
Free walk			
- Cadence (steps/min)	87.31 (16.86)	94.95 (17.55)	0.09
- Double support (%GCT)	33.15 (5.33)	33.88 (8.64)	0.63
- Elevation at midswing (cm)	0.78 (0.44)	1.11 (0.58)	0.06
- Gait velocity (m/s)	0.49 (0.17)	0.53 (0.24)	0.27
- Single limb support (%GTC)	33.56 (2.75)	33.83 (4.29)	0.41
- Step duration (s)	0.71 (0.15)	0.66 (0.14)	0.10
- Stride length (m)	0.64 (0.14)	0.65 (0.22)	0.42
- Velocity (°/s)	72.10 (55.56)	96.78 (58.63)	0.09
- Steps in turn (#)	4.64 (1.50)	4.86 (2.08)	0.37
Questionnaires			
- DHI	8.91 (8.96)	8.00 (14.57)	0.11
- FES-I	0.37 (0.11)	0.40 (0.14)	0.23
- GDS	4.72 (5.10)	5.33 (3.67)	0.16

* Statistically significant difference (p-value < 0.05)

/ No standard deviation available

Discussion

The aim of this study was to investigate the prevalence of Benign Paroxysmal Positional Vertigo and to determine the impact of BPPV on gait and balance problems in elderly from nursing homes. The lifetime incidence of BPPV is estimated at a cumulative incidence of almost 10% at the age of 80. (Von Brevern et al., 2007) This is supported by another study, which showed a BPPV prevalence of 11% in 75-year old community dwelling elderly. (Kollén et al., 2012) In this study, a BPPV prevalence of 26.8% was found in a sample of 41 institutionalized elderly aged 75 and above. With the aid of a Chi^2 test the prevalence found in this study was compared with the prevalence found in Kollén et al. (2012). Through this a statistical significant difference was found (p=0.005). This leads to the conclusion that the prevalence of BPPV is more than 2 times higher in institutionalized older adults compared to community dwelling elderly. It is possible that this can be explained by the lack of research on BPPV in institutionalized older adults and elderly persons aged 70 and above. The assumption can be made that older people with BPPV have a decreased functional balance and a higher rate of falls due to the dizziness experienced with BPPV, which in turn makes them more likely to be institutionalized into a nursing home. This could lead to a higher prevalence of BPPV in nursing homes in comparison to the community dwelling elderly. Results from previous studies support this assumption (Gazzola et al., 2006 and Prata et al., 2012). In addition to this Bazoni J., et al. (2014) found that regular physical activity has the potential to decrease the risk of BPPV in elderly women. Since it is assumable that elderly people from nursing homes take part in minor physical activities and often are bedridden, this could also explain the higher prevalence of BPPV in nursing homes.

This brings us to the second hypothesis of this study, namely that BPPV could partially explain why residents of nursing home often have a higher fall incidence and more gait and balance problems. Within most of the parameters measured during the balance test battery conducted in this study, no significant differences were found between the BPPV group and the non-BPPV group. During the 360° turn it was expected that the turn velocity (°/s) would be slower in patients with BPPV (Dewey et al., 2014) because of the involvement of the vestibular organ, but this is not confirmed in the results. The most studied outcome measure in the literature (Vaz, Gazzola, Lança, Dorigueto and Kasse, 2013) for the TUG test is the total duration (s), as it gives an indication of fall risk. It could have been expected that patients with BPPV had a longer duration of the test (Vaz et al., 2013). However, in the results there is no significant difference between the two groups. Also non of the variables measured during the walk were found to be significantly different between the two groups. Although in patients with BPPV a slower gait velocity (m/s) is expected (Vaz et al., 2013), possibly resulting in less single limb support (%GCT) and more double limb support (%GCT). Furthermore a shorter stride length (m) and more steps in a turn (#) were expected (Dewey et al., 2014). In patients with BPPV it is possible to assume a larger sway area (m^2/s^4) (Dewey et al., 2014), a higher sway velocity (m/s) (Chang, Hsu, Yang & Wang, 2006 and Silva et al., 2016) and lager path length (m/s^2) (Dewey et al., 2014) during the FTBS and the Romberg test, due to the vestibular problem, the disequilibrium and the faster loss of balance. However all of the parameters from the four test positions of the FTBS, are not significant. When overviewing the results of the Romberg test a significant difference in sway velocity is found, confirming a faster sway velocity (m/s) in the BPPV group ($p=0.005$). For the variable sway area (m^2/s^4) a trend towards significance is found ($p=0.05$). The Romberg test is the only test during which a significant difference and a trend toward significance was found between the BPPV and the non-BPPV group. This can be explained by a disruption in the sensory organization through a dysfunction in one of the three involved systems: the somatosensory system, the vestibular system and the visual system. During this test the visual system is excluded and only the vestibular and the somatosensory interaction is preserved to maintain the balance. In case of a dysfunction in the vestibular system, as with BPPV, this test is much more difficult to perform and balance problems will present themselves faster.

Finally the influence of the experienced dizziness with BPPV on the quality of life and depression, the fear of falling and its handicapping effects were examined. Patients with BPPV are expected to have higher scores on the DHI (Silva et al., 2016), the GDS and the FES-I. However the scores from this study were not found to be significantly different between the two groups. The manner of scoring of the FES-I proposed a problem for this study. Many elderly people weren't able or didn't have to perform some of the activities used in the items. Therefore some items had to be removed from the questionnaire for some of the subjects. In order to be able to still compare subject with one another, the final score on the survey was converted into a percentage. There is great need for an institutionalized elderly-specific instrument to assess the fear of falling.

Since the research on BPPV on elderly is lacking, a prediction of the direction of difference between the BPPV and the non-BPPV group was difficult. For some outcome parameters BPPV studies were available, if so they are mentioned in the previous paragraph. If this was not the case the hypotheses were based on the large-scale previous study of Dewey et al. (2014) with Parkinson patients.

As previously mentioned most of the investigated parameters were not significant. This was in contrast with the expectations. Several reasons can cause this lack of significance. First of all this study has a small sample size of only 41 participants. For future research it could be an advantage to perform a power analysis, also a larger sample size can be recommended. Furthermore the test positions from the FTBS become progressively more difficult, therefore the sample size in the most challenging position (standing on one leg) is very low (n=4). This could compromise the generalisation of the results. In addition sometimes participants were not able to complete the full balance test battery, since no correct registration of data could take place for that specific test item they were left out of the statistical analyses of that item. The fact that only participants from one specific nursing home were included could cause a sample bias. This undermines the external validity of the study. To avoid interference of the induced dizziness with the balance test battery and the questionnaires, the participants underwent the clinical examination only after determining the previously mentioned outcome measures. Consequently the participants were assigned to their corresponding study groups after completing the full clinical examination. To avoid an observer bias both the balance test battery and the clinical examination were performed by 2 therapists. Furthermore the exact data of the different balance tests were not available at the time of the diagnostic tests. But based on the observed performance of these test, both therapists could have gotten an impression of the participant's gait and balance problems and could have unintentionally influenced the results of the vestibular diagnostic tests. Therefore the study design is not double blind and it is still possible that an observer bias occurred.

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Auteursrechtelijke overeenkomst

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The prevalence of Benign Paroxysmal Positional Vertigo and its impact on gait and balance problems in elderly subjects from nursing homes

Richting: **master in de revalidatiewetenschappen en de kinesitherapie-revalidatiewetenschappen en kinesitherapie bij musculoskeletale aandoeningen**
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