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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Physical activity engagement in community dwelling chronic stroke survivors in Benin

Lore Evers
Elyne Printemps

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. Peter FEYS

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ACKNOWLEDGEMENT

This master thesis consists of an interesting and innovative subject, namely physical activity engagement in community dwelling chronic stroke survivors. During the past two years, we were part of the neurological research team. During this period, we learned a lot about stroke rehabilitation and improved in conducting scientific research. Therefore, we would like to thank some people who supported us during this process. Firstly, we would like to thank our promotor, prof. dr. Peter Feys, for the excellent guidance and support. He guided us through difficulties and gave feedback on our product. Furthermore, we would like to thank our copromotor dr. Oyéné Kossi and our mentor dra. Sènadé Noukpo for their contribution and feedback. Besides, we went to Benin for three months to follow-up the research of our master thesis. Thereby, we would like to thank all physiotherapy colleagues of the University and Departmental Hospital of Parakou in Benin for a good reception and for ensuring a pleasant stay during our mobility period. Finally, we would like to thank all the participants in this research for their cooperation.

Zonhoven, 05/06/2022 E.L.

Grobbendonk, 05/06/2022 P.E.

RESEARCH CONTEXT

This master thesis is located in the research domain of neurological rehabilitation, more specifically in the domain of stroke research. The majority of stroke survivors suffer from physical disability, this can lead to a low level of physical activity (Billinger et al., 2014; Fini, Holland, Keating, Simek, & Bernhardt, 2017). Moreover, physical inactivity can lead to several health problems and can even lead to more disability (Belfiore, Miele, Gallè, & Liguori, 2018). Therefore, it is important to aim at physical activity in stroke rehabilitation (Billinger et al.). So, to set up an adequate rehabilitation program for stroke survivors, it is important to inventory the level of physical activity. Moreover, it is also interesting to determine the associated exercise facilitators and barriers among people with stroke (Idowu, Adeniyi, Ogwumike, Fawole, & Akinrolie, 2015). Furthermore, there is a need for additional approaches to stimulate physical activity among stroke survivors. Mobile health (mHealth) is an innovative approach for stroke rehabilitation. Mobile applications already showed positive results on physical functioning, physical activity, and quality of life in people with stroke (Rintala et al., 2022). Additionally, mHealth is an easy and low cost approach for the rehabilitation of stroke survivors (Lear et al., 2017). In this way, when using mHealth, the health care access, which is low in low- and middle-income countries, can be increased (Hurt, Walker, Campbell, & Egede, 2016; Urimubenshi, Cadilhac, Kagwiza, Wu, & Langhorne, 2018).

This master thesis consists of two studies. Both studies are part of the doctoral thesis of dra. Sènadé Noukpo at the university of Hasselt (Belgium) in collaboration with the university of Parakou (Benin). Thereby, both studies are performed in the lower middle-income country Benin. The first study is an observational cross-sectional study documenting the level of physical activity in chronic stroke survivors in Benin titled “Physical activity engagement and related factors in community dwelling chronic stroke survivors in a developing West African country: A cross-sectional study”. The data of this observational study was collected from the 1st of October 2021 to the 15th of February 2022. The second study is a feasibility study investigating the WalkWithMe application among chronic stroke survivors in Benin titled “A ten-week community-based walking program using the WalkWithMe application on walking performance in chronic stroke survivors in Benin: A feasibility study”. The data of this feasibility study was collected from the 21st of February to the 22th of May 2022. The

procedure of this study was based on the study of Van Geel, Geurts, Abasıyanık, Coninx, and Feys (Van Geel, Geurts, Abasıyanık, Coninx, & Feys, 2020). The WalkWithMe application was developed by prof. dr. Karin Coninx, dr. Eva Geurts, prof. dr. Peter Feys, and dr. Fanny Van Geel (UHasselt). Since the feasibility study was conducted in the lower-middle income country Benin, there were several local circumstances to take into account. Firstly, mobile technology research was new for the whole local research team, including both students, as well for the stroke participants. Secondly, transport and financial difficulties were present for the participants living in the community resulting in difficulties visiting the University Hospital of Parakou. Thereby, it was not possible to come to weekly follow-up visits and post-testing at the hospital.

This master thesis is written by two students. Both students went to Benin to follow up the studies. The mobility period of the two students to Benin was from the 6st of February to the 6st May 2022. Concerning the first study investigating the physical activity engagement in community dwelling chronic stroke survivors in Benin, the study was already conducted before the students arrived. The students had no input in the study design and method, nor in the recruitment of the participants. So, the students received the raw data and processed these independently in consultation with the promoter team. Regarding the second study investigating the WalkWithMe application among chronic stroke survivors in Benin, the students worked closely together with the local research team. The study design and the study method of the second study were determined by the students in consultation with the promoter team. The students participated in collecting all the data before, during, and after the intervention. Also, the students installed the WalkWithMe application on the participants' smartphones and practiced the application together with the participants. Besides, the students were closely involved in the communication with the participants during the intervention. Afterwards, the students processed all the data independently in consultation with the promoter team. Finally, the students worked closely together when writing both parts of the master thesis.

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MANUSCRIPT PART I:
PHYSICAL ACTIVITY ENGAGEMENT AND RELATED FACTORS IN COMMUNITY DWELLING CHRONIC STROKE SURVIVORS IN A DEVELOPING WEST AFRICAN COUNTRY: A CROSS-SECTIONAL STUDY

1. ABSTRACT

BACKGROUND: After a stroke incident, physical inactivity is very frequent. Moreover, people with stroke perceive several facilitators and barriers influencing physical activity (PA). However, there is a lack of literature concerning the modalities of PA and exercise facilitators and barriers among chronic stroke survivors in low- and middle-income countries.

OBJECTIVES: The aim of this study was to inventory the modalities of PA performed by chronic community dwelling stroke survivors in Benin. Furthermore, the aim was to document the chronic stroke survivors' perceived exercise facilitators and barriers. Additionally, group differences between the inactive and active PA group concerning the participant characteristics and exercise facilitators and barriers were investigated.

PARTICIPANTS: Eighty-one ambulatory chronic stroke survivors were recruited from the University Hospitals of Parakou, Abomey, and Porto Novo in Benin. Thereafter, 76 participants were included in the statistical analyses.

MEASUREMENTS: The primary outcome measures were the International Physical Activity Questionnaire Long Form Benin (IPAQ-LF-Benin) measuring the level of PA of stroke survivors in their community, and the Stroke Exercise Preference Inventory-13 (SEPI-13) assessing the exercise facilitators and barriers of people with stroke.

RESULTS: Almost half (47,37%) of the participants were classified as low physically active. The participant characteristics, marital status, having an insurance, and the degree of disability were significantly different among the PA groups. The highest perceived exercise facilitator was the 'health-wellbeing' factor, followed by the factors 'similar others' and 'supervision-support'. The highest perceived exercise barrier was having a lack of information about exercises.

CONCLUSION: The results of this study showed the need to increase the PA level among chronic stroke survivors in Benin. Moreover, there is a need for additional approaches that consider the individual exercise facilitators and barriers to improve the level of PA in people with chronic stroke.

KEYWORDS: stroke, physical activity, exercise preferences, exercise barriers

2. INTRODUCTION

Stroke is a neurological disorder with a vascular origin in which there is an acute focal injury of the central nervous system (Sacco et al., 2013). According to the Global Burden of Disease, Injuries and Risk Factors Study (2019), stroke is the second-leading cause of death worldwide. Looking at the lower-middle-income country Benin, there is an age-standardized stroke prevalence of 1100-1300 on 100 000 persons in 2019. Comparing this to the age-standardized stroke prevalence of many western European countries, the prevalence in Benin is almost double (Roth et al., 2020). The lower stroke prevalence in many western European high-income countries can possibly be explained by a better cardiovascular risk factor control in these countries (Yusuf et al., 2014).

Stroke is the third-leading cause of disability adjusted life years worldwide in 2019 (Roth et al., 2020). After a stroke incident, physical disability is very frequent and can lead to physical inactivity (Billinger et al., 2014; Fini et al., 2017). Compared to healthy age-matched individuals, people with stroke have lower levels of physical activity (PA) (Fini et al., 2017). Additionally, stroke survivors are significantly more sedentary compared with age-matched healthy controls, resulting in about 25% more sitting time (English et al., 2016). Thereby, improving PA is associated with a lower risk for mortality and major cardiovascular events (Lear et al., 2017). Given the fact that PA has many health benefits, it is important to document the PA levels in people with stroke (English, Manns, Tucak, & Bernhardt, 2014). Besides, patient characteristics like age, sex, fatigue, walking endurance, walking speed, balance, and degree of physical fitness are associated with the level of PA (English et al.; Thilarajah et al., 2018).

People with stroke perceive several barriers and facilitators influencing PA (Nicholson et al., 2014). Identifying the exercise barriers and facilitators for stroke survivors may help to improve engagement in PA by taking care of the perceived barriers and to promote the facilitators (Idowu et al., 2015). Stroke survivors indicate the cost of a training program, no transportation to a training centre, no knowledge of how and where to exercise, a lack of motivation, health concerns, and stroke impairments as common barriers for exercise (Rimmer, Wang, & Smith, 2008). Common facilitators associated with exercise for people

with stroke are social support, the need to be able to perform daily tasks, motivation, and planned activities to fill an empty schedule (Nicholson et al., 2013).

There is a little literature concerning the modalities of PA and exercise facilitators and barriers among people with chronic stroke in low- and middle-income countries. Since there is an inaccessibility for physiotherapy services for the majority of stroke patients in African countries, this can influence the PA level (Norrving & Kissela, 2013; Urimubenshi et al., 2018). Additionally, cultural and environmental aspects, like family support, limited access to health care, and warm climate, can play an important role in the PA modalities and the exercise facilitators and barriers of stroke survivors in African countries (Akinyemi et al., 2021).

This cross-sectional study aimed to make an inventory of the modalities of PA (type, intensity) in chronic community dwelling stroke survivors in the African lower-middle-income country Benin. Furthermore, the study documented the chronic stroke survivors' perceived facilitators and barriers to participate in PA. Additionally, group differences between the inactive and active group concerning the participant characteristics and the exercise facilitators and barriers were investigated.

3. METHOD

3.1. STUDY DESIGN

A cross-sectional study design was applied. From the 1st of October 2021 to the 15th of February 2022, participants were recruited from three university hospitals in Benin. During this period, the data of the participants were collected.

3.2. PARTICIPANTS

Participants were recruited from the University Hospitals of Parakou, Abomey, and Porto Novo in Benin. Inclusion criteria were: (1) stroke survivors in early chronic or chronic stage, at least three months after stroke onset (Cramer, 2018; Rehme, Eickhoff, Rottschy, Fink, & Grefkes, 2012; Wu, Mead, Macleod, & Chalder, 2015), (2) age ≥ 18 years, (3) absence or minimal to moderate disability, but able to walk unassisted corresponding to a modified Ranking Scale (mRS) score ≤ 3 (van Swieten, Koudstaal, Visser, Schouten, & van Gijn, 1988), (4) absence of substantial cognitive impairment with a Community Screening Instrument for Dementia (CSI-D) score ≥ 7 (Hall et al., 2000), and (5) absence of major psychiatric disorders. The exclusion criterion was: (1) a contraindication to PA such as asthma and heart failure.

3.3. ETHICAL CONSIDERATIONS

The study received approval from the Ethics Committee of biomedical research of the University of Parakou (0490/CLERB-UP/P/SP/R/SA, 04/09/2021). Before administering the questionnaires, the objectives and methodology of the study were explained to the participants. Thereafter, the participants signed an informed consent.

3.4. PROCEDURE AND OUTCOME MEASURES

The participants attended visits in one of the three different university hospitals, where the clinical data were collected and the questionnaires were filled out. First, the participant characteristics were collected. This contained the socio-demographic, community environment, and clinical data. Also, the mRS, which determined the severity of the handicap (van Swieten et al., 1988), and CSI-D, which screened for dementia, were conducted to see if the participants met the selection criteria (Hall et al., 2000). Thereafter, the primary outcome measures, the International Physical Activity Questionnaire Long Form Benin (IPAQ-LF-Benin) and the Stroke Exercise Preference Inventory-13 (SEPI-13), were

conducted. All data were completed by eight untrained physiotherapists distributed over the three different hospitals.

3.4.1 IPAQ-LF-BENIN

IPAQ-LF-Benin is a valid questionnaire in Benin for measuring the level of PA of stroke survivors in their community (Honado, 2019). PA was assessed in four domains, including work, transport, domestic and gardening, and leisure time (IPAQ Research Committee, 2005). Also, the questionnaire collected specific information about walking, moderate-intensity, and vigorous intensity PA in each of these four domains. The participants needed to answer the volume of their physical activities in their last week, this volume was computed by weighting each type of activity by its energy requirements defined in metabolic equivalents of task (METs) (IPAQ Research Committee). In this way, a score in MET-minutes per week was given for each domain, each intensity category, and for the total PA. Afterwards, participants were classified in three levels of PA, namely low, moderate, and high (IPAQ Research Committee). Furthermore, IPAQ-LF-Benin measures the time spent in sitting to express the sedentary behaviour (IPAQ Research Committee). Moreover, meeting the World Health Organization (WHO) recommendations for PA for adults living with a disability was checked using the data of the IPAQ-LF-Benin (Bull et al., 2020).

3.4.2 SEPI-13

SEPI-13 is a questionnaire which assessed the exercise preferences and barriers of stroke survivors (Bonner, O'Halloran, Bernhardt, & Cumming, 2016). The questionnaire contains thirteen items on exercise preferences and nine items on exercise barriers (Bonner et al.). For each item, the participants chose a number between 0% (don’t agree at all) and 100% (totally agree) to indicate their level of agreement (Bonner et al.).

3.5. DATA-ANALYSIS

JMP® Pro, Version 16.2 was used to perform the data analysis (SAS Institute Inc., Cary, NC, 1989-2021). Means and standard deviations were used to describe the continuous variables. Categorical variables were expressed in frequencies and percentages. A Pearson Chi-square test was performed to analyse the group differences between the inactive and active group concerning the participant characteristics in case of categorical data with expected values higher than five (Pearson, 1900). If the expected values were less than five, a Fisher’s Exact

test was performed (Fisher, 2010). In case of continuous data, a two-sample t-test was performed for equally distributed variances of the residuals and a Welch ANOVA test for unequal distributed variances of the residuals (Wadhwa & Marappa-Ganeshan, 2022; Welch, 1951). To analyse the group differences between the inactive and active group concerning the exercise facilitators and barriers, a two-sample t-test was performed if the variances of the residuals were equally distributed (Wadhwa & Marappa-Ganeshan). In case of unequal variances of the residuals, Welch ANOVA was performed (Welch). Homoscedasticity was evaluated with the Brown-Forsythe test (Brown & Forsythe, 1974). Normality of the residuals was controlled by the Shapiro-Wilk test (Shapiro & Wilk, 1965). A p-value of less than 0.05 was considered as statistically significant.

4. RESULTS

4.1. PARTICIPANTS

In total, 572 participants were identified for participation based on their medical file in the three University Hospitals in Benin. After screening and checking for eligibility, 81 participants were left and wanted to participate. After collecting the clinical data and the questionnaires, five participants were excluded due to outliers in the IPAQ-LF-Benin data resulting in invalid data. Values which were unreasonable high exceeding the maximum values determined in the IPAQ-LF-Benin guideline were considered as outliers. More detailed information about the selection of the participants can be seen in Figure 1.

The study included 76 participants for statistical analysis, of which 48 men and 28 women. The mean age of the participants was 52.92 years. All participants had a stroke at least three months ago with a mean time after stroke of 15.96 months. Almost 70% experienced an ischemic stroke. Approximately one third received none or less than one month of functional stroke rehabilitation, one third received one to three months of functional stroke rehabilitation, and one third received four or more months of functional stroke rehabilitation. Furthermore, the majority of the participants had a functional ambulation category (FAC) of four or five, this indicates an independent functional ambulation. Regarding the community environment, 72.37% of the participants had dependent children living in their house and 80.27% had family as available support. More detailed information about the participant characteristics can be seen in Table 1.

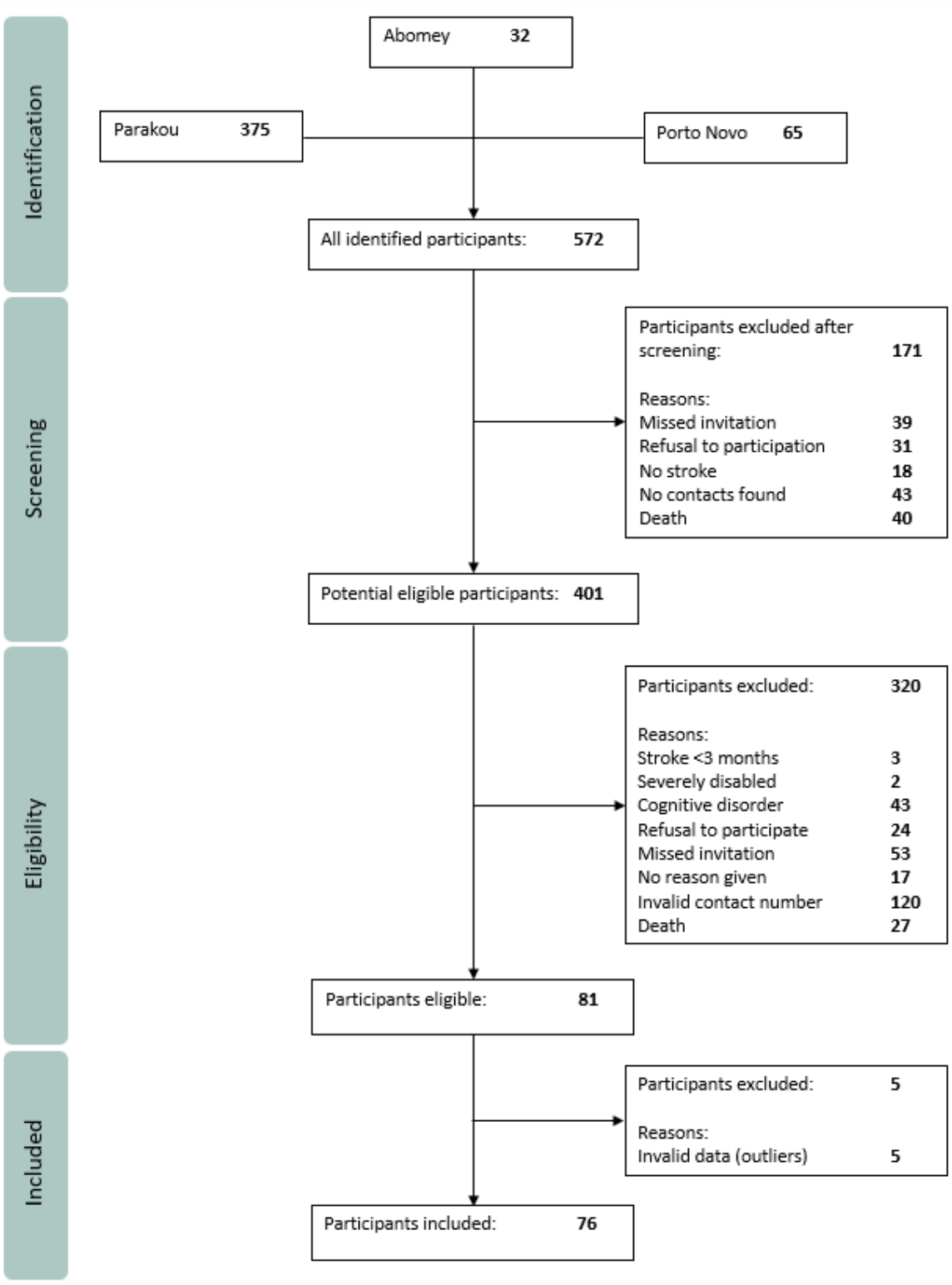

Figure 1. Flowchart selection participants

Table 1

Participant characteristics

	Mean (±SD) / N (%)	Range
Socio-demographic		
Age (years)	52.92 (±10.12)	26 – 74
Sex		
M	48 (63.16)	
F	28 (36.84)	
Marital status		
Married	67 (88.16)	
Single	9 (11.84)	
Profession		
Employed	26 (34.21)	
Independent	20 (26.32)	
Unemployed	6 (7.90)	
Household	13 (17.11)	
Other	11 (14.47)	
Education level		
Illiterate	10 (13.16)	
Primary	24 (31.58)	
Secondary	25 (32.90)	
Superior	17 (22.37)	
Insurance		
Yes	45 (59.21)	
No	31 (40.79)	
Community environment		
Living situation		
Living alone	4 (5.26)	
Dependent children	55 (72.37)	
Living with others	17 (22.37)	
Available support		
Family	61 (80.27)	
Friend	3 (3.95)	
Other	5 (6.58)	
None	7 (9.21)	
Clinical		
Type stroke		
Ischemic	53 (69.74)	
Haemorrhagic	18 (23.68)	
Non determined	5 (6.58)	
Time after stroke (months)	15.96 (±13.38)	3 – 54
Vascular risk factors (before stroke)		
None	11 (14.47)	
1 risk factor	39 (51.32)	
>1 risk factor	26 (34.21)	
Functional rehabilitation after stroke		
<1 month	26 (34.21)	
1-3 months	25 (32.90)	
4-6 months	10 (13.16)	
>6 months	15 (19.73)	
mRS		
<3	51 (67.11)	
≥3	25 (32.90)	
FAC		
<4	13 (17.11)	
≥4	63 (82.90)	
10MWT (s)	26.15 (±40.38)	5 – 240
6MWT (m)	245.03 (±139.54)	10.60 – 551.60
Borg (after 6MWT)	10.86 (±2.54)	7 – 17
TUG (s)	30.31±35.85	5 – 213

Abbreviations: SD, standard deviation; N, number; M, man; F, female; mRS, modified Rankin Scale; FAC, Functional Ambulation Category; 10MWT, ten-metre walk test; s, seconds; 6MWT, six-minute walk test; m, metres; TUG, Timed Up & Go

4.2. PHYSICAL ACTIVITY LEVEL

The PA, measured with IPAQ-LF-Benin, is demonstrated in Table 2. Almost half of the participants (47.37%) was classified as low physically active. Furthermore, 34.21% of the participants was classified as moderate active and 18.42% was classified as high active. Thereby, in further statistical analyses, 52.63% of the participants were defined as physically active (n=40) and 47.37% as physically inactive (n=36). Considering the WHO recommendations, 56.58% of the participants met the guideline of PA for adults living with a disability.

Looking at the specific domains of the IPAQ-LF-Benin, participants were mainly active in the working domain with a mean MET-minutes per week of 775.01. Moreover, participants were least active in the domestic domain with a mean MET-minutes per week of 315.20. Regarding the mean MET-minutes per week per intensity level of the IPAQ-LF-Benin, the walking activity category had the highest mean MET-minutes per week with a value of 891.43. The participants performed the least activity in the vigorous activity category with a mean MET-minutes per week of 396.32.

The sitting time questioned with the IPAQ-LF-Benin demonstrated invalid results. There were inconsistencies between the proportion time spend sitting and the active time.

Table 2
IPAQ-LF-Benin

	N (%) / Mean MET-minutes/week (±SD)
Level of activity	
Low	36 (47.37%)
Moderate	26 (34.21%)
High	14 (18.42%)
WHO recommendations	
Achieved	43 (56.58%)
Not achieved	33 (43.42%)
MET-minutes/week per domain	
Total work	775.01 (±2675.30)
Total transport	481.89 (±813.15)
Total domestic	315.20 (±973.67)
Total leisure	495.19 (±1221.04)
MET-minutes/week per intensity level	
Total walking activity	891.43 (±1474.51)
Total moderate activity	779.54 (±1849.48)
Total vigorous activity	396.32 (±1210.76)
Total physical activity	2067.29 (±3416.84)

Abbreviations: IPAQ-LF-Benin, International Physical Activity Questionnaire Long Form Benin; N, number; MET, metabolic equivalent of task; SD, standard deviation; WHO, World Health Organization

4.2.1 GROUP DIFFERENCES BETWEEN THE INACTIVE AND ACTIVE GROUP CONCERNING PARTICIPANT CHARACTERISTICS

When comparing the inactive and active group concerning the participant characteristics, eight significant differences were present. The socio-demographic characteristics, marital status, and having an insurance, were significantly different among the inactive and active group with respectively a p-value of 0.0305 and 0.0285. Being married and having an insurance were possible associated factors related with a low physical activity level. Regarding the clinical data, mRS (p=0.0420), FAC (p=0.0191), 10MWT (p=0.0207), 6MWT (p<0.0001), BORG (p=0.0146), and TUG (p=0.0375) were significantly different among the inactive and active group. This indicated that participants in the active group had a significantly lower degree of disability compared with the inactive group. Community environment characteristics did not show significant differences among the inactive and active group. More detailed information can be seen in Table 3.

Table 3

Group differences between the inactive and active group concerning participant characteristics

Participant characteristics	Inactive (N=36)	Active (N=40)	Statistical test	P-value
Socio-demographic				
Age (year, ±SD)	54.97 (±9.66)	51.08 (±10.28)	T-test	0.0927
Sex (man) (N, %)	22 (61.11)	26 (65.00)	Pearson Chi-square	0.7256
Marital status (married) (N, %)	35 (97.22)	32 (80.00)	Fisher's Exact (2-Tail)	0.0305*
Education level (superior) (N, %)	4 (11.11)	13 (32.50)	Fisher's Exact (2-Tail)	0.1487
Insurance (yes) (N, %)	26 (72.22)	19 (47.50)	Pearson Chi-square	0.0285*
Community environment				
Living situation (Dependent children) (N, %)	23 (63.89)	32 (80.00)	Fisher's Exact (2-Tail)	0.0827
Available support (family) (N, %)	29 (80.56)	32 (80.00)	Fisher's Exact (2-Tail)	0.9607
Clinical				
Time after stroke (months, ±SD)	17.86 (±13.05)	14.25 (±13.61)	T-test	0.2416
Rehabilitation after stroke (>6 months) (N, %)	8 (22.22)	7 (17.50)	Fisher's Exact (2-Tail)	0.0617
mRS (<3) (N, %)	20 (55.56)	31 (77.50)	Pearson Chi-square	0.0420*
FAC (≥4) (N, %)	26 (72.22)	37 (92.50)	Pearson Chi-square	0.0191*
10MWT (s, ±SD)	38.08 (±54.99)	15.41 (±13.13)	Welch	0.0207*
6MWT (m, ±SD)	180.80 (±121.45)	302.84 (±130.27)	T-test	<0.0001*
BORG (after 6MWT, ±SD)	11.61 (±2.81)	10.18 (±2.07)	T-test	0.0146*
TUG (s, ±SD)	39.34 (±36.72)	22.19 (±33.44)	T-test	0.0375*

Abbreviations: N, number; mRS, modified Rankin Scale; FAC, Functional Ambulatory Category; 10MWT, ten-metre walk test; s, seconds; 6MWT, six-minute walk test; m, metres; TUG, Timed Up & Go

*, significant p-value (<0.05)

4.3. EXERCISE FACILITATORS

In Table 4, the results of the facilitators for PA, measured with SEPI-13, are demonstrated. The highest facilitator was the 'health-wellbeing' factor with a mean percentage of 90.79. This indicates that the participants liked to exercise for health reasons and for a good feeling. Other important facilitators were the 'similar others' and 'supervision-support'

factors, with respectively a mean percentage of 80.26 and 79.08. The factor 'home-alone' scored a little less with a mean percentage of 75.82, indicating that a major part of the participants liked to exercise at home or alone as well. The factors 'confidence-challenge' and 'exercise context' had respectively a mean percentage of 72.83 and 72.57, suggesting that these factors scored less important as facilitators. The lowest facilitator was the 'music-tv' factor with a mean percentage of 45.13. Thereby, listening to music or watching tv during exercise was less facilitating for the participants. In total, the mean percentage for facilitators for PA was 75.99, indicating that participants liked multiple facilitators to stimulate their PA.

Table 4
Exercise facilitators – SEPI-13

Factor label	Item	Mean (±SD) per item	Mean (±SD) per factor
Supervision-support	I like a trained instructor to supervise my exercise	77.24 (±37.22)	79.08 (±25.73)
	I like to get feedback on how I am going with my exercise	80.92 (±31.59)	
Confidence-challenge	I am confident I can stay involved in a regular exercise program	79.34 (±32.01)	72.83 (±29.96)
	I like to be challenged by exercises	66.32 (±37.73)	
Health-wellbeing	I like to exercise for health reasons	91.97 (±20.66)	90.79 (±21.39)
	It is important for me to do exercise that makes me feel good	89.61 (±24.90)	
Exercise context	I like to exercise with family or friends	78.55 (±31.48)	72.57 (±29.86)
	I like to exercise outdoors	66.58 (±38.69)	
Home-alone	I like to exercise at home	78.03 (±30.67)	75.82 (±27.84)
	I like to exercise alone	73.62 (±34.24)	
Similar others	I like to exercise with other people of a similar age	79.34 (±30.08)	80.26 (±27.00)
	I like to exercise with other people who have had a stroke	81.18 (±29.11)	
Music-tv	I like to listen to music or watch TV during exercise	45.13 (±44.86)	45.13 (±44.86)
Total	All items	/	75.99 (±19.47)

Abbreviations: SEPI-13, Stroke Exercise Preference Inventory - 13; SD, standard deviation

4.3.1 GROUP DIFFERENCES BETWEEN THE INACTIVE AND ACTIVE GROUP CONCERNING THE EXERCISE FACILITATOR FACTORS

Comparing the exercise facilitator factors with the level of PA resulted in one significant difference, namely the facilitator factor 'confidence-challenge' (p=0.0041). In this way, being confident and liking to be challenged were exercise facilitators which were more perceived in the active group. Other exercise facilitator factors, shown in Table 5, demonstrated no significant differences.

Table 5
Group differences between the inactive and active group concerning the exercise facilitator factors

Factors	Inactive (N=36), Mean (±SD)	Active (N=40), Mean (±SD)	P-value
Supervision-support	74.17 (±30.06)	83.50 (±20.48)	0.1229
Confidence-challenge	62.36 (±33.80)	82.25 (±22.56)	0.0041*
Health-wellbeing	80.14 (±29.38)	80.38 (±25.05)	0.9702
Exercise-context	87.50 (±26.98)	93.75 (±14.40)	0.2205
Home-alone	77.64 (±27.55)	74.19 (±28.35)	0.5923
Similar others	65.69 (±33.91)	78.75 (±24.49)	0.0612
Music-tv	46.67 (±44.53)	43.75 (±45.67)	0.7790
Total	72.44 (±23.47)	79.18 (±14.58)	0.1428

Abbreviations: N, number; SD, standard deviation
*, significant p-value (<0.05)

4.4. EXERCISE BARRIERS

Regarding the barriers for PA, measured with SEPI-13, participants reported a lack of information about exercises as the highest barrier with a mean percentage of 46.18. Furthermore, fear of falling, getting started to exercise, and getting to places to exercise were reported as the three following highest barriers. The participants worried the least that exercise might cause another stroke, this barrier had a mean percentage of 17.11. The mean percentage for all barriers was 29.46, which was much lower in comparison to the mean percentage for facilitators. More detailed information about the barriers for PA can be seen in Table 6.

Table 6
Exercise barriers – SEPI-13

Barrier item	N 0%	N 1-49%	N ≥50%	Mean (±SD)
I worry that exercise might cause another stroke	56	3	17	17.11 (±32.90)
The exercise I want to do is too expensive	48	1	27	23.29 (±34.00)
I avoid exercise because it causes me pain	45	3	28	25.79 (±36.01)
I don't have enough information about the exercise I should be doing	30	3	43	46.18 (±42.46)
I worry that I'll fall if I exercise	38	6	32	36.58 (±43.59)
I find it hard to get to places where I want to exercise	37	4	35	32.89 (±37.98)
I avoid exercise because its unsafe	48	2	26	22.89 (±33.38)
I feel too tired to exercise	47	1	28	25.00 (±35.61)
Even though I want to exercise I find it hard to get started	38	4	34	35.39 (±41.00)
Total (all items)	13	39	24	29.46 (±26.46)

Abbreviations: SEPI-13, Stroke Exercise Preference Inventory - 13; N, number; SD, standard deviation

4.4.1 GROUP DIFFERENCES BETWEEN THE INACTIVE AND ACTIVE GROUP CONCERNING THE EXERCISE BARRIERS

Comparison analyses resulted in no significant differences between the inactive and active group concerning the exercise barriers, shown in Table 7. Thereby, perceived exercise barriers were experienced similar in both stroke groups.

Table 7

Group differences between the inactive and active groups concerning the exercise barriers

Barrier item	Inactive (N=36), Mean (±SD)	Active (N=40), Mean (±SD)	P-value, Mean (±SD)
I worry that exercise might cause another stroke	16.94 (±31.52)	17.25 (±34.49)	0.9679
The exercise I want to do is too expensive	29.44 (±36.41)	17.75 (±31.09)	0.1388
I avoid exercise because it causes me pain	26.39 (±35.47)	25.25 (±36.93)	0.8914
I don't have enough information about the exercise I should be doing	44.72 (±41.71)	47.50 (±43.60)	0.7774
I worry that I'll fall if I exercise	40.83 (± 44.68)	32.75 (±42.79)	0.4244
I find it hard to get to places where I want to exercise	35.28 (±40.74)	30.75 (±35.69)	0.6097
I avoid exercise because its unsafe	20.56 (±28.68)	25.00 (±37.35)	0.5604
I feel too tired to exercise	28.89 (±37.40)	21.50 (±34.01)	0.3725
Even though I want to exercise I find it hard to get started	40.83 (±44.68)	30.50 (±37.28)	0.2804
Total (all items)	31.54 (±26.23)	27.58 (±26.86)	0.5179

Abbreviations: N, number; SD, standard deviation

5. DISCUSSION

This cross-sectional study reported on the modalities of PA in adult cases with chronic stroke. Besides, the study documented the perceived exercise facilitators and barriers among chronic stroke participants. Additionally, group differences between the inactive and active group concerning the participant characteristics and the exercise facilitators and barriers were investigated. The results of this study can be a guide to set up an adequate exercise program to stimulate PA that meet the needs of chronic stroke survivors in Benin.

The study showed that 47.37% of the chronic stroke survivors is low physically active. Looking at the study of Idowu et al. (2015), 80.20% of the Nigerian chronic stroke participants had a low physical activity level evaluated with the IPAQ. Also, since Nigeria is a neighbouring country of Benin and it is also a lower middle-income country, the results can be compared to some extent. These results show an inconsistency regarding the physical activity level of chronic stroke patients. Additionally, a low physical activity is highly prevalent in stroke patients living in high-income countries (Billinger et al., 2014; Gebruers, Vanroy, Truijen, Engelborghs, & De Deyn, 2010). In current literature, percentages of low physical activity among chronic stroke survivors were ranging from 45.40 to 53.57 in high-income countries which are similar with the results of this study (Ferreira, Aguiar, Martins, & Faria, 2022; Ruescas-Nicolau et al., 2021). In this study, participants were least active in the domestic domain and were most active in the work domain. This can be explained since 36.84% were women and 63.16% were men. In African countries, the woman takes care of domestic activities and the man works outdoors (Adjiwanou & LeGrand, 2014; Owoo & Lambon-Quayefio, 2021). Additionally, 60.53% of the participants was working in daily life resulting in an higher score of physical activity in the work domain. Also, participants performed the least activity in the vigorous intense category, this is also seen in other literature (English et al., 2016).

Regarding the group differences between the inactive and active group concerning participant characteristics, marital status and having an insurance were significantly different. Thereby, marital status and having an insurance are factors that possibly needs to be considered in setting up an exercise program. Concerning these possible related factors with PA, there is a lack of information in the current literature. Furthermore, the physical

disability level was also significantly different among the PA groups. Thereby, physical disability in chronic stroke survivors could be an influencing factor for PA. These significant differences were also found in other studies who investigated the factors associated with PA (Thilarajah et al., 2018). Since 82.90% of the participants in this study was located in FAC four or five, the majority had an independent ambulation without the need of supervision. This can be a reason that the participants were more physically active in comparison to the study of Idowu et al. (2015) (Joseph, Rhoda, & Conradsson, 2020). Concerning the community environmental factors, there were no significant group differences. However, the majority of the current literature demonstrated an influence of environmental factors on PA (Espernberger, Fini, & Peiris, 2021; Miller, Pohlig, & Reisman, 2021; Miller, Pohlig, Wright, Kim, & Reisman, 2021). This inconsistency can be explained by the cultural aspects of Benin, where family support and familial participation is common in the daily life of people living in Benin. This familial living style results in similar environmental factors for every stroke survivor in Benin possibly leading to no significant differences among the PA groups. (Garbusinski et al., 2005). The group differences concerning the participant characteristics showed that socio-demographic (marital status, having an insurance) and physical factors should be considered in the rehabilitation of chronic stroke survivors in Benin to increase PA.

Regarding the exercise facilitators and barriers, the highest facilitator was the 'health-wellbeing' factor with a mean percentage of 90.79. This is similar to current literature showing that facilitators related to physical health are most common (Bonner et al., 2016; Gagnon, Batcho, & Best, 2022). A lack of information about exercises, fear of falling, getting started to exercise, and getting to places to exercise were reported as the highest four exercise barriers in this study. Similar results were found in current literature in low-, middle-, and high-income countries (Débora Pacheco et al., 2021; Gagnon et al.; Idowu et al., 2015; Rimmer et al., 2008). Therefore, it is important to provide sufficient information, accessibility and safety in the development of an exercise program with a focus on health and wellbeing for chronic stroke survivors. Also, a variability in the exercise facilitators and barriers is seen by high standard deviations. This was also found in other literature (Bonner et al.). Thereby, a stroke exercise program should be made individually and should take into account personal exercise facilitators and barriers.

Comparing the exercise facilitator factors with the level of PA resulted in one significant difference, namely the facilitator factor 'confidence-challenge'. In this way, the level of PA can possibly be improved by stimulating self-confidence of the stroke survivor. Furthermore, comparison analyses between the PA groups concerning the exercise barriers resulted in no significant differences. In the current literature, comparing exercise facilitators and barriers with the level of PA has not yet been investigated.

5.1. STRENGTHS AND LIMITATIONS

Concerning the sample of this study, 76 participants were included using a convenience sample. This can cause a sampling bias which can reduce the external validity resulting in a limited generalizability (Tripepi, Jager, Dekker, & Zoccali, 2010). Moreover, eight different physiotherapists from three different university hospitals in Benin completed the clinical data and questionnaires. Additionally, the physiotherapists were not trained in taking the IPAQ-LF-Benin and SEPI-13. Thereby, there was a possible presence of an interobserver bias affecting the assessment (Mahtani, Spencer, & Brassey, 2017). Also, an interview bias by the participant was possibly present when taking the IPAQ-LF-Benin by giving socially desirable answers (Salazar, 1990). Moreover, the sitting time questioned with the IPAQ-LF-Benin demonstrated invalid results. This was possibly caused by the eight untrained physiotherapists. Thereby, the results of the sitting time were not included for statistical analysis. Considering all these remarks, the results of the IPAQ-LF-Benin and SEPI-13 may be biased. However, the statistical analysis of the data was performed by two independent physiotherapy students. Another strength of this study is that the modalities of PA and the exercise facilitators and barriers are broadly inventoried among Beninese chronic stroke survivors. This inventory can provide the information to adequately set up a stroke rehabilitation program.

5.2. IMPLICATIONS AND RECOMMENDATIONS FOR CLINICAL FIELD AND FUTURE RESEARCH

The results of this study showed the need to increase the PA level among chronic stroke survivors in Benin. There is a need for additional approaches that consider the individual exercise facilitators and barriers to improve the level of PA in people with chronic stroke. Home-based rehabilitation programs already showed positive results on improving the level

of PA in this population (Lim, Lee, & Song, 2021; Marsden et al., 2016). Additionally, PA after stroke can be increased by using mobile health (mHealth) applications (Rintala et al., 2022; Zhou, Du, & Zhou, 2018). Thereby, home-based or mHealth rehabilitation programs are potential additional approaches to stimulate the level of PA in chronic stroke survivors. Moreover, these approaches aiming at PA are easy and at a low cost applicable in low- and middle-income countries (Lear et al., 2017). In this way, considering the exercise facilitators and barriers in these additional rehabilitation programs could be a successful solution to increase PA in chronic stroke survivors.

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MANUSCRIPT PART II:
A TEN-WEEK COMMUNITY-BASED WALKING PROGRAM USING THE WALKWITHME APPLICATION ON WALKING PERFORMANCE IN CHRONIC STROKE SURVIVORS IN BENIN: A FEASIBILITY STUDY

1. ABSTRACT

BACKGROUND: The majority of stroke survivors deal with walking problems and a low physical activity. Physical activity can be increased by using a mobile health application. However, there is a lack of current research about mobile health rehabilitation among stroke survivors in low- and middle-income countries.

OBJECTIVES: The aim of this study was to investigate the feasibility of a ten-week community-based walking program using the WalkWithMe application on walking performance in chronic stroke survivors in Benin.

PARTICIPANTS: Five ambulatory chronic stroke adults were recruited from the University Hospital of Parakou in Benin of which one has been excluded. Four stroke survivors participated in a personalized ten-week walking intervention stimulating their physical activity.

MEASUREMENTS: The outcome measures included the application findings, namely number of activities, total time, total distance, and mean level of fatigue. Also, a logbook was kept by the participants and an individual semi-structured interview was performed after the intervention. Besides, exercise adherence was evaluated.

RESULTS: All participants indicated that the WalkWithMe application stimulated their physical activity in the community. Besides, all the participants experienced the WalkWithMe application positively. However, looking at the application findings, some usability problems were seen due to incorrect understanding and use of the application by the stroke participants.

CONCLUSION: The WalkWithMe application seems feasible among chronic stroke patients in Benin if the participants would receive more support during the intervention. The WalkWithMe application can be an additional approach to stimulate walking activities

among chronic stroke survivors in an easy and low cost way. However, the clinical effect of the WalkWithMe application on chronic stroke survivors is still unclear. Therefore, further interventional research on the WalkWithMe application on a larger sample is needed.

KEYWORDS: stroke, mobile health, application, rehabilitation, physical activity, walking performance

2. INTRODUCTION

The stroke burden is high and still rising in low- and middle-income countries (Owolabi et al., 2015). Regarding the lower middle-income country Benin, a West African country, the age-standardized prevalence of stroke is almost double in comparison to many western European countries (Roth et al., 2020). Concerning the impact of a stroke, physical inactivity is very frequent in stroke survivors (Billinger et al., 2014). Also, the adherence of stroke survivors to physical activity (PA) recommendations decreases after two years post-stroke (Fini, Bernhardt, Churilov, Clark, & Holland, 2021). Additionally, the majority of stroke survivors deal with walking problems (Algurén, Lundgren-Nilsson, & Sunnerhagen, 2010). PA is important to improve health and quality of life in patients with stroke (English, Hillier, & Lynch, 2017). PA helps as well to maintain functional autonomy and reduces the risk of a new stroke (Belfiore, Miele, Gallè, & Liguori, 2018). Therefore, PA recommendations and exercise training should be incorporated into the stroke rehabilitation (Billinger et al.). However, limited physiotherapy services are available in Africa and usually inaccessible for the majority of patients (Urimubenshi, Cadilhac, Kagwiza, Wu, & Langhorne, 2018). Thereby, the available stroke care in Africa usually does not meet the recommended standards, addressing the need for improving the current stroke care (Urimubenshi et al.).

PA after stroke can be increased by using mobile health (mHealth) applications (Rintala et al., 2022). The walking time and number of steps per day of stroke survivors can be significantly improved by applying a mobile, home-based intervention (Grau-Pellicer, Lalanza, Jovell-Fernández, & Capdevila, 2020; Paul et al., 2016). In addition, aiming at PA in rehabilitation is an easy and low-cost method to decrease disability and mortality in low- and middle-income countries (Lear et al., 2017). Moreover, home-based rehabilitation technologies ameliorate stroke patients' physical functioning and the performance of daily activities (Chen et al., 2019). Also, adherence to stroke management can be potentially facilitated by mHealth interventions (Hamine, Gerth-Guyette, Faulx, Green, & Ginsburg, 2015). In this way, a mHealth application can be a successful approach to increase access to health care in low- and middle-income countries (Hurt, Walker, Campbell, & Egede, 2016). However, mobile applications are currently mainly investigated in high-income countries (Rintala et al.). So, there is a lack of current research about mobile rehabilitation among stroke survivors in low- and middle-income countries.

The aim of this study was to investigate the feasibility of a ten-week community-based walking program using the WalkWithMe application on walking performance in chronic stroke survivors in Benin. The WalkWithMe application is a personal community-based mHealth application stimulating PA and walking performance (Geurts, Van Geel, Feys, Coninx, & Assoc Comp, 2019; Van Geel, Geurts, Abasıyanık, Coninx, & Feys, 2020). The WalkWithMe application demonstrated already improvements on walking capacity, walking ability, and PA in patients with multiple sclerosis (Geurts et al.; Van Geel et al.). The feasibility of the WalkWithMe application was successful for persons with multiple sclerosis (Van Geel et al.). Additionally, since there is a lack of literature about mobile applications for stroke rehabilitation in low- and middle-income countries, the feasibility of the WalkWithMe application was investigated in this study for chronic stroke survivors in Benin.

3. METHOD

3.1 PARTICIPANTS

Participants were recruited from the University Hospital of Parakou and were selected based on the eligibility criteria for the study running from the 21st of February to the 22th of May 2022. The inclusion criteria were: (1) stroke survivors in early chronic and chronic stage, at least three months after stroke onset (Cramer, 2018; Rehme, Eickhoff, Rottschy, Fink, & Grefkes, 2012; Wu, Mead, Macleod, & Chalder, 2015), (2) age ≥ 18 years, (3) absence or minimal disability with a modified Rankin Scale (mRS) score ≤ 3 (van Swieten, Koudstaal, Visser, Schouten, & van Gijn, 1988), (4) absence of substantial cognitive impairment and dementia, with a Community Screening Instrument for Dementia (CSI-D) score ≥ 7 (Hall et al., 2000), (5) ability to walk independently or with an assistive device for at least ten minutes, (6) ability of the participant or a family caregiver to use a smartphone application, and (7) availability of an Android smartphone for using the WalkWithMe application. The exclusion criteria were: (1) a contraindication to PA such as asthma and heart failure, and (2) other conditions interfering with walking, such as hip prosthesis or rheumatoid arthritis.

3.2 ETHICAL CONSIDERATIONS

The study received approval from the Ethics Committee of biomedical research of the University of Parakou (0520/CLERB-UP/P/SP/R/SA). Before starting the intervention, the objectives and methodology of the study were explained to the participants and caregivers. Thereafter, the participants signed an informed consent.

3.3 STUDY DESIGN

A mixed method design was used for conducting this feasibility pilot study. The study included both quantitative and qualitative data. After ten weeks an independent interpretation of both data sources was made to evaluate the feasibility of the WalkWithMe application for chronic stroke survivors.

3.4 INTERVENTION

Participants had to walk independently in their own community for ten weeks. At the start of the study, the ten-week walking end-goal was determined. After this, a weekly schedule was established by the WalkWithMe application (see procedure). The participants needed to

walk at least two times a week individually in their own community. Help from a caregiver when using the application was allowed.

3.5 PROCEDURE

Before starting the study, the participants received detailed information about the intervention and about the WalkWithMe application. At the introduction session in the University Hospital of Parakou, the WalkWithMe application was installed on the participants' smartphones. The participants and the physiotherapist practised the application together. Thereafter, the participants could practise the application in their community for a couple of days before the start of the intervention.

At the second session in the University Hospital of Parakou, the participant characteristics and clinical data were collected. Also, the participants and the physiotherapist determined together their individual walking end-goal. Participants were asked about the current number of maximal walking minutes in one walking activity and were asked about their preferred walking end-goal. Based on the individual determined walking end-goal, the WalkWithMe application constructed a weekly walking schedule. The first week of the intervention started with a walking duration of 45 minutes less than the walking end-goal if the walking end-goal was at least 60 minutes. Otherwise, the start duration of the first week was ten minutes. For example, in case of a walking end-goal of 40 minutes, the walking goal of the first week was ten minutes. In case of a walking end-goal of 80 minutes, the walking goal of the first week was 35 minutes. Each week, the walking goal was elevated with five minutes until the walking end-goal was reached. A more detailed example of these two walking schedules can be seen in Table 1. Also, at the second session in the hospital, the step rate of the participants was determined during a walk at a comfortable walking pace for 20 seconds. This step rate was set as a minimal baseline steps per minute for configuring the WalkWithMe application. As well, the participants were asked about possible problems with the application during their practice in their community. Thereafter, participants were instructed to walk in their community using the WalkWithMe application minimal twice a week. A WhatsApp group was created with all the participants and the physiotherapist to contact each other in case of problems during the intervention. Also, weekly written motivation through messages was given by the physiotherapist using the WhatsApp group and the participants stimulated each other by sending screenshots of their walking activities.

Moreover, participants received two weekly notifications from the WalkWithMe application to stimulate adherence to the walking program. Additionally, the participants were weekly invited in the hospital to evaluate their weekly walking progression seen in the weekly overview in the WalkWithMe application.

Table 1

Examples walking schedule

	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
40' walking end-goal (<60')	10'	15'	20'	25'	30'	35'	40'	40'	40'	40'
80' walking end-goal (>60')	35'	40'	45'	50'	55'	60'	65'	70'	75'	80'

Abbreviations: W, week

3.6 WALKWITHME APPLICATION

The WalkWithMe application is a tracking application for walking activities which can be used offline. The application measures distance, duration, step count, average walking speed, level of fatigue before and after an activity, and calories burned of each performed activity. An overview of all these parameters can be seen for each activity. Moreover, a weekly overview of all the performed activities is present in the application. In this way, weekly progression can be seen in the WalkWithMe application providing motivation and feedback about the performed activities. During walking activities, the application provides verbal feedback by a virtual coach to the participants. Also, the participants can share their activities in the community feature of the WalkWithMe application to motivate each other. For more detailed information about the WalkWithMe application, see the report of Geurts et al. (2019). The WalkWithMe application was originally developed in Dutch. For this study, the WalkWithMe application was made available in French since this is the official national language in Benin. Only the community feature of the application was not available in French.

3.7 OUTCOME MEASURES

3.7.1 PARTICIPANT CHARACTERISTICS

Clinical data contained the modified Rankin Scale (mRS), the Community Screening Instrument for Dementia (CSI-D), the Functional Ambulation Category (FAC), the Barthel Index (BI), and the six-minute walk test (6MWT). The mRS, which determined the severity of the handicap (van Swieten et al., 1988) and CSI-D, which screened for dementia (Hall et al., 2000), were both conducted to see if the participants were eligible for inclusion. Besides, the FAC determines the functional ambulation status (Holden, Gill, & Magliozzi, 1986). The BI measures the degree of independence in daily life activities (Kasner, 2006). The 6MWT determines the walking distance evaluating the functional capacity (Macchiavelli, Giffone, Ferrarello, & Paci, 2021). The 6MWT was also performed at the end of the study to evaluate progression.

3.7.2 FEASIBILITY OUTCOME MEASURES

The application findings, including number of activities, total time, total distance, and mean level of fatigue after the activities were described per week to evaluate the use of the WalkWithMe application. Also, participants were asked to keep a logbook during the intervention period. The logbook documented adverse events, physical complaints, experienced difficulties, and contextual factors influencing the walking activities. Additionally, exercise adherence was evaluated by dividing the number of planned sessions of the intervention by the number of performed sessions. An exercise adherence percentage was obtained by multiplying this number by 100. Moreover, application enjoyment, satisfaction, goal setting, and usability were questioned after the intervention in an individual semi-structured interview.

3.8 DATA-ANALYSIS

To evaluate the feasibility outcome measures, a qualitative descriptive evaluation was made by two independent physiotherapy students based on the application findings, logbook, and semi-structured interviews. Furthermore, a quantitative evaluation of the walking performance was made by comparing the results of the 6MWT before and after the ten-week intervention.

4. RESULTS

4.1 PARTICIPANTS

Five participants were included in the study. However, one participant has been excluded after two weeks due to no adherence caused by practical reasons. The four included participants were two men and two women with an age range between 50 and 60 years old. The majority of the participants experienced an ischemic stroke. Two participants had an affected side which was their dominant side, this could cause difficulties with the use of the application. Additionally, the time after stroke ranged from 10 till 34 months. Concerning the FAC, three participants were located in the fourth category, the other patient was located in the fifth category meaning that all the participants could walk independently. The BI ranged from 85 to 100 revealing that the participants had a high degree of functional independency. However, the 6MWT showed a big range from 68.5 to 343.0 metres revealing moderately to rather severely impaired walking endurance (Kubo et al., 2020). Concerning the data of the 6MWT after the intervention, the test administration was not possible to perform due to practical reasons. All participants used the WalkWithMe application independently and did not need help from a caregiver during the intervention. More detailed information can be seen in Table 2.

Table 2

Participants characteristics

Participant	P1	P2	P3	P4
Age (years)	54	50	60	50
Sex	M	F	F	M
Type stroke	Haemorrhagic	Ischemic	Ischemic	Ischemic
Lesion side	Right	Left	Right	Left
Dominant side	Right	Right	Right	Right
Time after stroke (months)	19	34	10	26
Steps/minute	78	108	87	88
mRS	2	1	3	2
CSI-D	9	9	9	9
FAC	4	5	4	4
BI (/100)	90	100	80	85
6MWT (m)	68.5	343.0	170.0	232.0
Caregiver	No	No	No	No

Abbreviations: P, participant; M, man; F, female; mRS, modified Rankin Scale; CSI-D, Community Screening Instrument for Dementia; FAC, Functional Ambulation Category; BI, Barthel Index; 6MWT, six-minute walk test; m, metres

4.2 FEASIBILITY OUTCOME MEASURES

4.2.1 WALKWITHME APPLICATION FINDINGS AND LOGBOOK

P1 performed ten walking activities during the intervention period. In half of the performed activities, he achieved the weekly walking goal. The first, second, and fourth week of the intervention, P1 went for a walk without his smartphone due to difficulties using the application. Hereby, no activities were registered these weeks. From week seven, P1 performed activities where he achieved the weekly walking goal. However, in many performed activities, there is a discrepancy between the registered time and distance. This can possibly be explained by a poor walking performance since P1 completed a 6MWT of 68.5 metres at the start of the intervention. Another possible explanation is an incorrect use of the application by P1. Additionally, P1 did not fill in the fatigue scale before and after a walking activity, this may also indicate an incorrect use of the WalkWithMe application.

P2 completed only the first four weeks of the intervention due to smartphone loss in week five. In total, P2 performed 11 activities of which the weekly walking goal was not achieved for only two activities. The first and third week, she performed well with three to five activities per week and a low level of fatigue after the walking activities. P2 always registered a great distance, except in week two. This week, she complained of low back pain.

P3 performed 13 activities during the intervention period of which the weekly walking goal was achieved for 12 activities. The second week, P3 did not perform activities due to sickness. She completed a maximum of two activities per week. However, in week nine, she complained of fatigue resulting in one performed activity which did not meet the walking goal. Concerning the registered distance, an evolution can be seen during the intervention period. Besides, an increase in her level of fatigue can be seen as the intervention progressed. Additionally, P3 reported that a call on her smartphone disrupted her walking activities several times.

P4 performed 12 activities with a relatively consistent walking time and distance registered for each activity. The first three weeks, he went two or more times walking per week. The following three weeks, he performed only two activities in total. Thereby, he indicated that he experienced pain and fatigue resulting in less activities. However, fatigue was not reported in the WalkWithMe application revealing possible difficulties when using the

application. Also, a decrease in motivation could be a possible cause for the limited performed activities in the last three weeks of available data. Furthermore, P4 had difficulties obtaining his weekly goal-setting. During the intervention period, he did not achieve his weekly walking goal for any activity. However, he found his goal-setting well set but based on the application findings it turned out to be too high. Moreover, in nine of the twelve performed activities, he performed the activity with a pause. This was also an indication that the goal-setting was not achievable for him.

Regarding week ten, data of the performed walking activities was not available due to practical reasons. More detailed information about the activities performed with the WalkWithMe application can be seen in Table 3.

Table 3

Activities with the WalkWithMe application reported for 4 participants for 10 weeks

Participant		P1	P2	P3	P4
Start goal (min)		15	75	15	45
End goal (min)		60	120	60	90
Week 1	Nr. of activities	●	● ● ● ● ●	● ●	●* ●
	Total time		7h50	0h35	1h13
	Total distance (km)		19.4	0.1	2.3
	Fatigue (/10)		1.8	4	0
Week 2	Nr. of activities	●	●	●**	●*● ● ●*
	Total time		0h34		1h14
	Total distance (km)		1.5		2.0
	Fatigue (/10)		4		0
Week 3	Nr. of activities	●	● ● ●	● ●	●*●*●*●*
	Total time	0h15	4h33	0h56	3h16
	Total distance (km)	0.2	9.4	1.4	7.8
	Fatigue (/10)	0	0	0	0
Week 4	Nr. of activities	●	● ●	● ●	●*
	Total time		2h54	1h03	0h38
	Total distance		7.7	3.3	2.1
	Fatigue (/10)		4	3	0
Week 5	Nr. of activities	●	****	●	●***
	Total time	0h14		0h36	
	Total distance (km)	0.1		1.9	
	Fatigue (/10)	0		8	
Week 6	Nr. of activities	● ●	****	● ●	●*
	Total time	1h05		1h23	0h25
	Total distance (km)	0.3		4.3	1.3
	Fatigue (/10)	0		9	0
Week 7	Nr. of activities	●	****	● ●	Data not available
	Total time	1h05		1h33	
	Total distance (km)	0.3		2.8	
	Fatigue (/10)	0		10	
Week 8	Nr. of activities	● ● ●	****	●	Data not available
	Total time	2h19		0h51	
	Total distance (km)	0.5		2.6	
	Fatigue (/10)	0		10	
Week 9	Nr. of activities	● ●	****	●	Data not available
	Total time	2h14		0h52	
	Total distance (km)	0.7		1.9	
	Fatigue (/10)	0		10	
Week 10	Nr. of activities	Data not available	****	Data not available	Data not available
	Total time				
	Total distance (km)				
	Fatigue (/10)				

● Activity performed, ≥ goal duration

● Activity performed, < goal duration

● No activities performed

* Activity with pause

** No activities due to sickness

*** No activities due to pain and/or fatigue

**** Smartphone lost

4.2.2 EXERCISE ADHERENCE

The exercise adherence of the participants is described in Table 4. Only the weeks with available data were counted in the planned activities. P1 scored the least on exercise adherence with a percentage of 55.56. In the first five weeks, he performed only two activities resulting in this low score. The following four weeks, he regularly performed his walking activities with the WalkWithMe application. This can be explained by the fact that the first five weeks, he experienced difficulties using the application. P2 only participated for four weeks. In these four weeks, there were two weeks with more than two walking activities resulting in a high score of 137.50% on exercise adherence. Looking at P3, she performed regular activities during the intervention period. In week two, five, eight, and nine, she did not obtain the two planned activities giving her a score of 72.23% on exercise adherence. Finally, P4 had an exercise adherence of 100.00%. However, three of the six weeks of available data, he performed less than two activities per week. The other three weeks, he performed two to four activities per week resulting in a good exercise adherence.

Table 4

Exercise adherence

	P1	**P2**	**P3**	**P4**
Planned activities (N)	18	8	18	12
Performed activities (N)	10	11	13	12
Adherence percentage (%)	55.56	137.50	72.23	100.00

Abbreviations: P, participant; N, number

4.2.3 SEMI-STRUCTURED INTERVIEW

The semi-structured interview was performed with P4. For P1 and P3, the semi-structured interview could not take place due to practical reasons. Instead, they answered some questions via individual Whatsapp messages. The interview with P2 was not completed due to no cooperation from the participant.

P1 indicated that he needed some time to learn to use the application. In the beginning, he did not understand how to use the application well and performed walking activities without using the application. After two weeks, he started using the application for registering his walking activities. At the end of the study, he found the application much easier to use and enjoyed using it. Thereby, he indicated that the application stimulated him to walk more in

the community than he was used to walk. This motivating factor was important for him because he always walked alone. As well, he found the personal goal-setting achievable and stimulating to perform walking activities. However, based on the application findings, he often not achieved his weekly walking goal. Besides, he experienced pain at the level of the hip after walking activities. This was for him the reason that he did not always performed his weekly planned activities.

P3 found the application really enjoyable and easy to use. She experienced no difficulties on using the application and she performed all walking sessions alone. She really liked having a walking schedule and she indicated that a walking program was very stimulating for her. Fatigue and pain at the level of her legs were factors with a negative impact on her walking performance. Additionally, she indicated that her weekly walking goals were achievable and resulted in more motivation to perform walking activities. However, at the end of the walking program, she experienced some difficulties with achieving her walking goals.

P4 indicated that he enjoyed using the application. Despite that his affected hand was his dominant hand, he did not report difficulties on using the application and he found the app easy to use. The application stimulated him to walk more regularly. However, pain and fatigue resulted in shorter and less performed activities. Additionally, the warm climate in Benin prevented him from walking during the day. As a result, he completed all the activities early in the morning and sometimes in the evening. This was also a major reason that he performed a shorter duration of activities. Thereby, he found his weekly walking goals difficult to achieve. Like the other participants, P4 performed all the walking activities alone.

5. DISCUSSION

This feasibility study reported on the use of a mHealth application in adult cases with chronic stroke who are motivated to increase their walking activity in their community setting. Participants experienced the WalkWithMe application positively. They indicated that the application was enjoyable, easy to use, and stimulating their physical activity. This is consistent with the previous application in persons with multiple sclerosis (Geurts, Van Geel, Feys, Coninx, & Assoc Comp, 2019; Van Geel, Geurts, Abasıyanık, Coninx, & Feys, 2020). However, looking at the performed activities, the application was not always used optimally. One participant did walking activities without registering them with his smartphone. Also, there was sometimes a discrepancy between the registered time and distance, and participants did not share their activities in the community feature of the WalkWithMe application. However, this community feature was in the application only available in Dutch, resulting in no usage of this feature. Additionally, two participants did not fill in the fatigue scale before and after each walking activity, this can possible be explained by incorrect understanding or use of the application. Usability problems among stroke survivors using a mobile rehabilitation application for a first time were also seen in other literature (Grau-Pellicer et al., 2020; Lawson, Tang, & Feng, 2017). During the intervention period, there was one drop-out due to no adherence caused by practical reasons. Besides, activities were sometimes not performed due to sickness, fatigue, or pain, this could indicate that the participants had a need for a more flexible program. The WalkWithMe application sets an individual based walking program at the beginning, but there was no flexibility to change or delay the weekly walking goals during the intervention in the context of this study (Geurts, Van Geel, Feys, Coninx, & Assoc Comp). The individualized goal-setting was verbally determined together with the physiotherapist. The goal-setting for one participant was too high which prevented him from achieving his weekly walking goals. Nevertheless, all participants indicated that their goal-setting was stimulating them to walk longer periods resulting in a positive impact on their walking performance. Furthermore, exercise adherence was not optimal indicating that the participants possibly needed more motivation and support during the intervention. One participant participated well in the Whatsapp group. The other three participants did not actively participate in the Whatsapp group and probably needed more individual guidance. Besides, the test administration of the 6MWT at

the end of the intervention was not achievable due to practical reasons. Thereby, the effect of the WalkWithMe application on the walking performance could not be evaluated.

5.1 STRENGTHS AND LIMITATIONS

The four participants were recruited from the University Hospital of Parakou using a convenience sample. The small sample size in combination with the convenience sample resulted in a sampling bias (Tripepi, Jager, Dekker, & Zoccali, 2010). This sampling bias reduced the external validity and led to a limited generalizability (Tripepi et al.). Furthermore, the procedure of this pilot study was not optimally executed. The introduction sessions were performed by two untrained physiotherapy students who did not master French well enough resulting in a less optimal explanation of the WalkWithMe application. Additionally, the ten-week intervention was also performed with limited guidance of the participants. The follow-up during the intervention happened via Whatsapp instead of weekly visits to the hospital due to practical reasons. Moreover, the semi-structured interview for the feasibility outcomes took only place by one participant. Additionally, this interview was done by two untrained physiotherapy students. By two participants, the semi-structured interview was not possible due to transport difficulties of the participants to the hospital. Hereby, the two participants were questioned via Whatsapp. In this way, the interviews were possibly affected by an interview bias (Salazar, 1990).

The main strength of this study is that it provides a first insight in the feasibility of the WalkWithMe application among chronic stroke survivors in Benin. Besides, this study encourages the use of a mobile application in stroke rehabilitation in Benin and other low- or middle-income countries.

5.2 IMPLICATIONS AND RECOMMENDATIONS FOR CLINICAL FIELD AND FUTURE RESEARCH

This pilot study is the first study in Benin investigating a mobile application for the rehabilitation of stroke survivors. The chronic stroke participants were generally positive about using the WalkWithMe application. The application seems feasible if the participants would receive more support during the intervention. Additionally, it is important to educate people with stroke on how to use the mobile application. Besides, the WalkWithMe application stimulated the participants to walk more regularly resulting in an increased

physical activity. In this way, the WalkWithMe application can be an additional approach to stimulate walking activities among chronic stroke survivors in an easy and low cost way. However, the clinical effect of the WalkWithMe application on chronic stroke survivors is still unclear. Therefore, further interventional research on the WalkWithMe application on a larger sample and in a more controlled way is needed.

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APPENDIX

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. Peter Feys en kadert binnen wetenschappelijke stage/masterproef deel 2. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van neurorevalidatie (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. Peter Feys.

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: Evers Dore

Adres: Kludweg 25, 3520 Zonhoven

Geboortedatum en -plaats : 20/02/1998, Genk

Datum: 17/11/2021

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. Peter Feys en kadert binnen wetenschappelijke stage/masterproef deel 2. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van neurorevalidatie (hierna: "De Onderzoeksresultaten").

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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.

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Gelezen voor akkoord en goedgekeurd,

Naam: Printemps Elyse

Adres: Waterwinningsstraat 2B, 2280 Grobbendonk

Geboortedatum en -plaats : 16/04/1999, Lier

Datum: 17/11/2021

Handtekening: Printemps

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UHASSELT
KNOWLEDGE IN ACTION

INVENTARISATIEFORMULIER WETENSCHAPPELIJKE STAGE DEEL 2

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
19/11/2022	Introductie – overleg protocol	Promotor: Peter Feys Copromotor/Begeleider: Student(e): Student(e):
03/03/2022	Rapportage vooruitgang – overleg methode en dataverwerking	Promotor: Peter Feys Copromotor/Begeleider: Student(e): Student(e):
25/03/2022	Feedback – overleg dataverwerking en resultaten	Promotor: Peter Feys Copromotor/Begeleider: Student(e): Student(e):
23/05/2022	Feedback – overleg resultaten en discussie	Promotor: Peter Feys Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
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		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): Evers Lore & Printemps Elyne
Datum: 31/05/2022

Titel Masterproef:
Physical activity engagement in community dwelling chronic stroke survivors in Benin

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	O
Methodologische uitwerking	O	O	O	O	O	O
Data acquisitie	O	O	O	O	O	O
Data management	O	O	O	O	O	O
Dataverwerking/Statistiek	O	O	O	O	O	O
Rapportage	O	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)
31/05/2022	Peter Feys	31/5/2022
31/05/2022		

Re: Indiening MP2 Benin

PF **Peter FEYS <peter.feys@uhasselt.be>**
29/05/2022 20:51

Aan: Elyne Printemps CC: Lore Evers

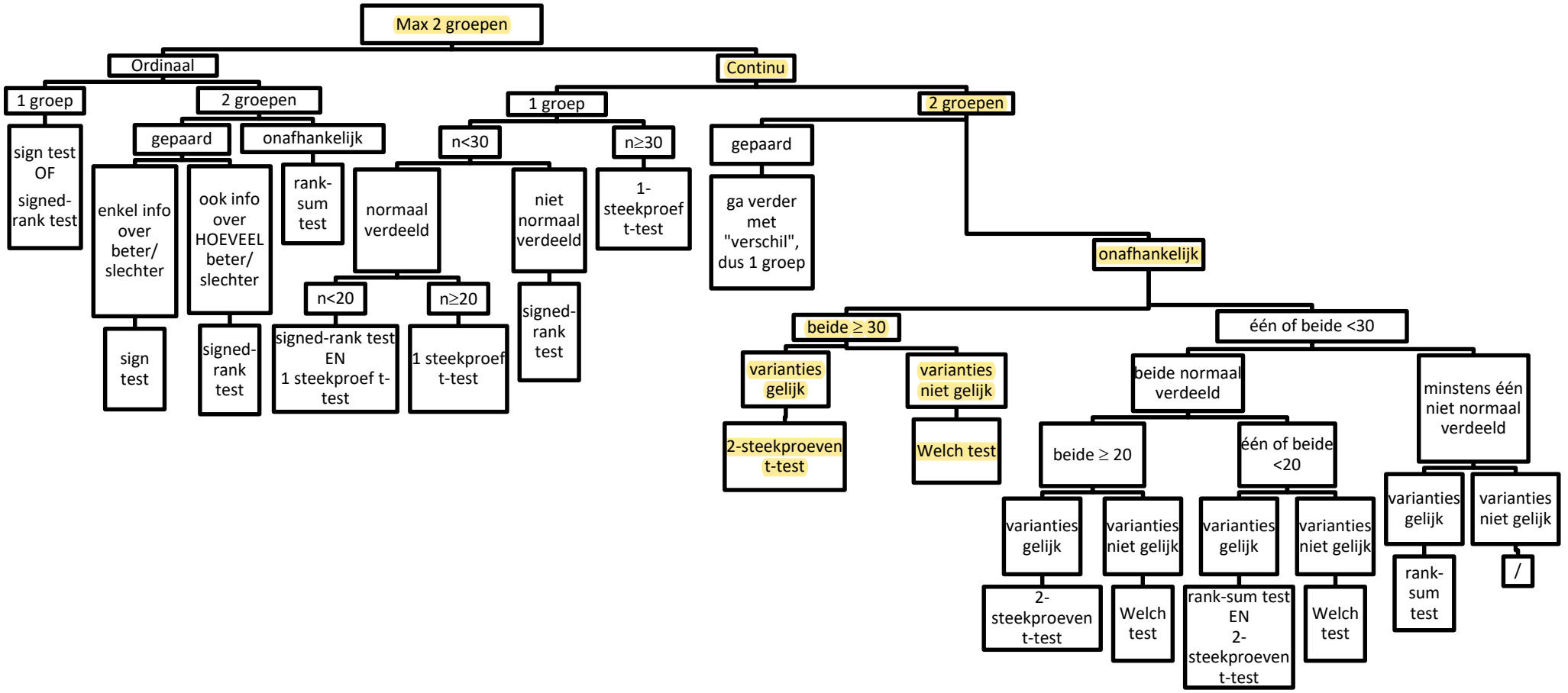
MP2_Inschrijvingsformulier_Lore...
2,64 MB

Dag Elyne en Lore

Met deze mijn toestemming tot verdediging en later indiening. Zie in bijlagen. WELL DONE.
De research context leest vlot. Ik zou nog de data toevoegen van jullie verblijf daar. Dit komt nu niet uit de verf, en is net een grote meerwaarde!

Ik zag nog niet de titelpagina: als ik goed herinner is Oyene Kossi co-promotor en Ines Noukpo begeleider.
Je mag de versies ook naar hen doorsturen ter eventuele feedback in de komende week.

Mvg
Peter Feys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enkel info over beter/ slechter
ook info over HOEVEEL beter/ slechter
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normaal verdeeld
niet normaal verdeeld
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beide ≥ 30
één of beide <30
sign test
signed-rank test
n<20
n≥20
signed-rank test EN 1 steekproef t-test
1 steekproef t-test
signed-rank test
varianties gelijk
varianties niet gelijk
beide normaal verdeeld
minstens één niet normaal verdeeld
2-steekproeven t-test
Welch test
beide ≥ 20
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varianties gelijk
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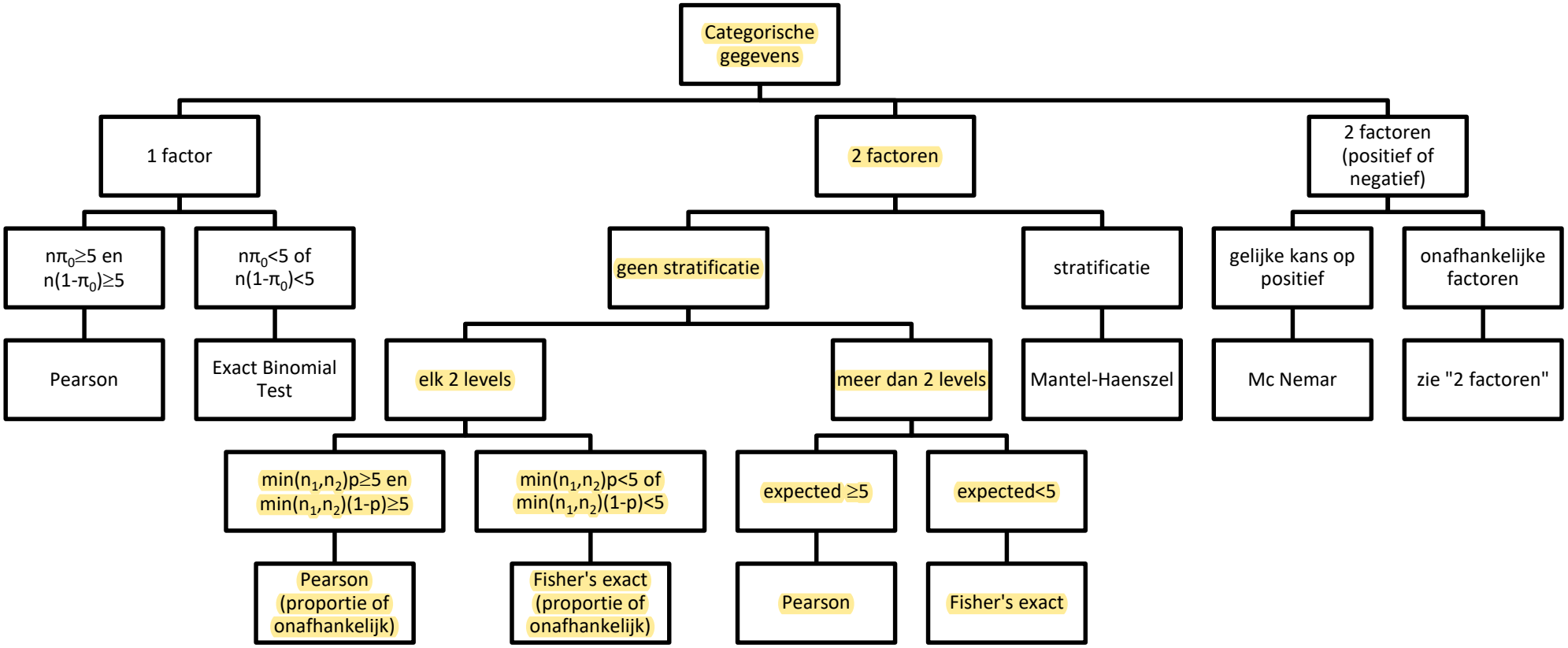
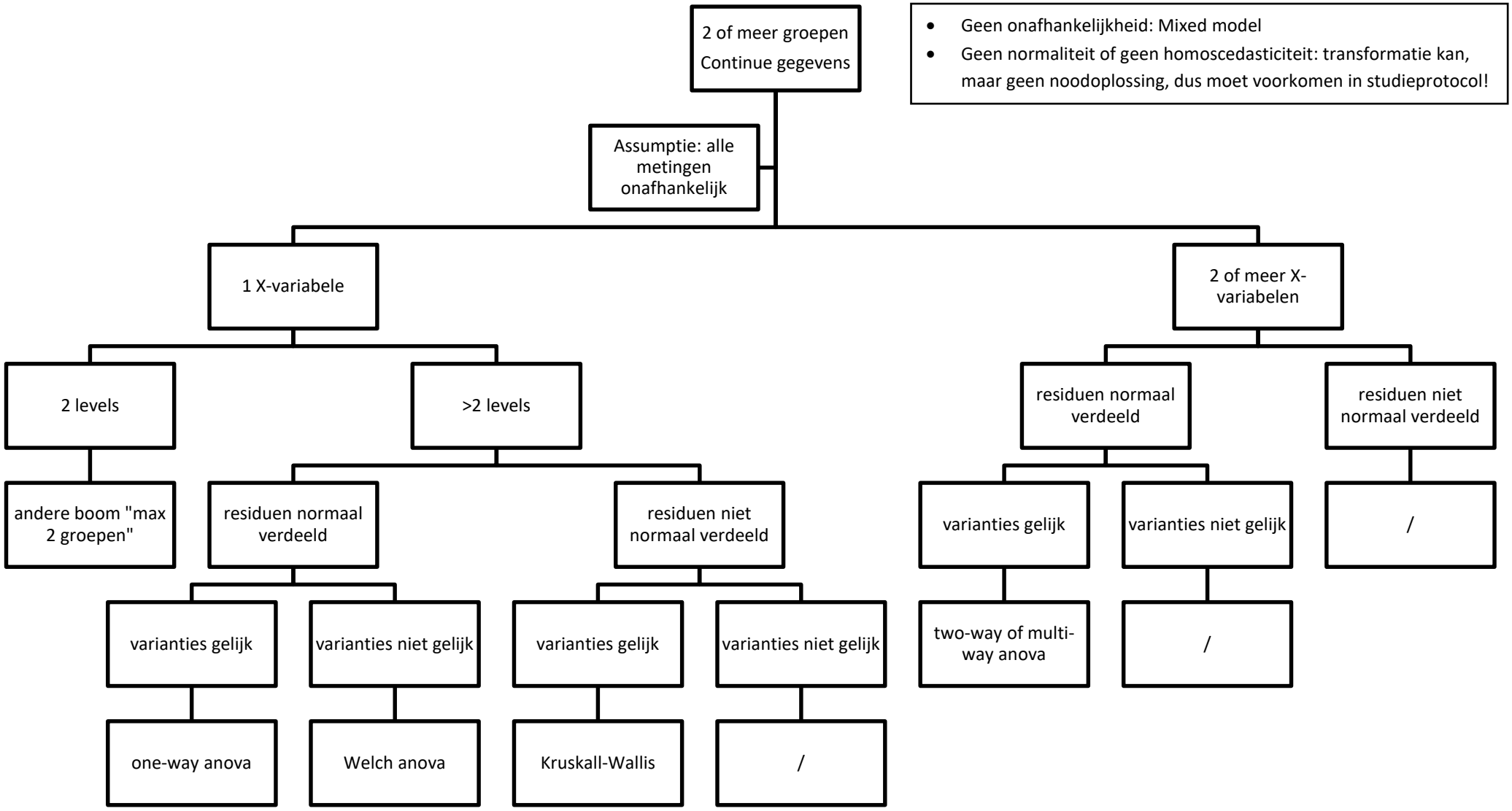
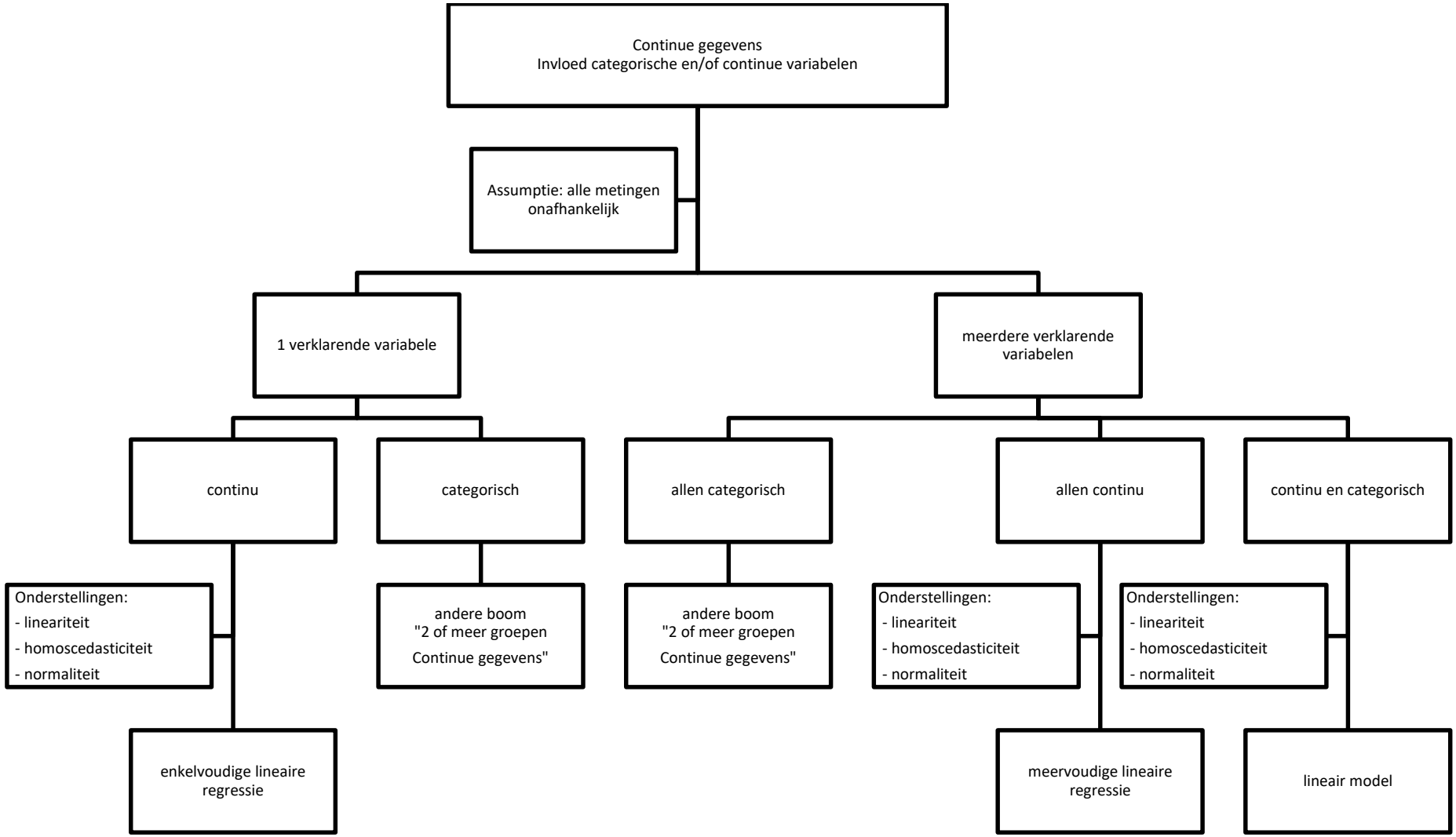

Categorische gegevens
1 factor
2 factoren
2 factoren (positief of negatief)
$n\pi_0 \geq 5$ en $n(1-\pi_0) \geq 5$
$n\pi_0 < 5$ of $n(1-\pi_0) < 5$
geen stratificatie
stratificatie
gelijke kans op positief
onafhankelijke factoren
Pearson
Exact Binomial Test
elk 2 levels
meer dan 2 levels
Mantel-Haenszel
Mc Nemar
zie "2 factoren"
$\min(n_1,n_2)p \geq 5$ en $\min(n_1,n_2)(1-p) \geq 5$
$\min(n_1,n_2)p < 5$ of $\min(n_1,n_2)(1-p) < 5$
expected ≥5
expected<5
Pearson (proportie of onafhankelijk)
Fisher's exact (proportie of onafhankelijk)
Pearson
Fisher's exact


2 of meer groepen
Continue gegevens
Assumptie: alle metingen onafhankelijk
1 X-variabele
2 of meer X-variabelen
2 levels
>2 levels
residuen normaal verdeeld
residuen niet normaal verdeeld
andere boom "max 2 groepen"
residuen normaal verdeeld
residuen niet normaal verdeeld
varianties gelijk
varianties niet gelijk
varianties gelijk
varianties niet gelijk
varianties gelijk
varianties niet gelijk
/
two-way of multi-way anova
/
one-way anova
Welch anova
Kruskall-Wallis
/
Geen onafhankelijkheid: Mixed model
Geen normaliteit of geen homoscedasticiteit: transformatie kan, maar geen noodoplossing, dus moet voorkomen in studieprotocol!


Continue gegevens
Invloed categorische en/of continue variabelen
Assumptie: alle metingen onafhankelijk
1 verklarende variabele
meerdere verklarende variabelen
continu
categorisch
allen categorisch
allen continu
continu en categorisch
Onderstellingen:
- lineariteit
- homoscedasticiteit
- normaliteit
andere boom
"2 of meer groepen
Continue gegevens"
andere boom
"2 of meer groepen
Continue gegevens"
Onderstellingen:
- lineariteit
- homoscedasticiteit
- normaliteit
Onderstellingen:
- lineariteit
- homoscedasticiteit
- normaliteit
enkelvoudige lineaire regressie
meervoudige lineaire regressie
lineair model