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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Can walking capacity and/or fatigability have a relationship with the amount and intensity of physical activity performed by people with Multiple Sclerosis? An exploratory study

Stijn Knapen

Lotte Schoepen

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

BEGELEIDER :

De heer Felipe BALISTIERI SANTINELLI

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2022
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Acknowledgements

In this section, we wish to extend our deepest gratitude to those who contributed to the completion of this master’s thesis.

First and foremost, we would like to thank our supervisor Felipe Balistieri Santinelli for providing us with all the necessary information, invaluable insights, patience and constructive feedback. Also having the opportunity of using the available data has been of great importance. We hope to have been of any help in the process of the realization of his PhD study.

Secondly, we are thankful to our promotor Prof. dr. Peter Feys for guiding and motivating us through the whole, educating yet challenging, process.

Next, we are grateful to all participants who have engaged in this study and dedicated their time and presence to make this all possible. Consequently, we would like to thank the clinical rehabilitation centers, namely National MS centre in Melsbroek and MS centre Noorderhart in Pelt, for providing us with their accommodations and their accessibility.

Lastly, we are truly grateful to our friends and family who always supported and helped us and never lost their faith in us.

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Research context

This master's thesis can be situated within the research domain of neurological rehabilitation, more specifically within the field of people with Multiple Sclerosis (pwMS). The aim of this research is to provide better insight into the amount and intensity of physical activity (PA) performed by pwMS and how this can affect the walking capacity and/or fatigability (WF) in this population.

This master's thesis is part of a bigger research project from the University of Hasselt, called: "*Walking-related fatigability in persons with MS: Psychometric properties of cognitive and coordination fatigability assessment & proof-of-concept of a rehabilitation intervention*", which is founded by the Claire Fouconnier foundation. This master's thesis is executed by two students, Lotte Schoepen (L.S.) and Stijn Knapen (S.K), under the supervision of Prof. dr. Peter Feys (promotor) and Drs. Felipe Balistieri Santinelli (supervisor).

Multiple Sclerosis (MS) is a common disease which has many disabling symptoms. This research aims to elaborate on walking capacity and WF since there has been very little evidence regarding this topic, especially if these two factors can influence, to some extent, to PA.

PA, defined by the World Health Organization as "Any bodily movement produced by skeletal muscles that requires energy expenditure", which could be influenced by many factors like fatigue, depression and disability level. There is already evidence supporting that walking capacity, or the distance a person can walk continuously over an extended duration, has a relationship with PA. However, limited research has examined the relationship between WF, or the decline in walking performance over a sustained period of walking, and PA.

The research design and method were already determined by the research team. Data collection was conducted in the National Multiple Sclerosis Centre in Melsbroek, the MS centre Noorderhart in Pelt and also in the REVAL research centre at the University of Hasselt.

Both students helped to obtain the data through recruitment and testing of the participants. Further, academic writing and statistical analysis was completed thanks to equal effort.

Abstract

Background: Physical activity (PA) in people with MS (pwMS) is often lower compared to the healthy population due to many symptoms like fatigue and motor disability. Also, walking capacity can affect the amount of PA performed by pwMS. However, the role of walking fatigability (WF), which affects prolonged walking ability, on PA remains unclear in this population.

Objectives: The study aims to investigate the relationship of walking capacity and WF on PA and to determine if outcomes from walking tests can predict overall PA in pwMS.

Methods: 74 participants (51 pwMS and 23 healthy controls (HC)) were recruited. The six-Minute Walking Test (6MWT) measured walking capacity through total distance and WF. WF was calculated with the Distance Walking Index (DWI: (Distance of minute 6 - Distance of minute 1) / Distance of minute 1)) x 100). PA levels were assessed with the International Physical Activity Questionnaire (IPAQ).

Results: PwMS are less active than HC. The 6MWT showed significant correlations with following IPAQ domains; total activity (r=0.5752), active transport (r=0.4431), domestic and garden (r=0.4993), total walking (r=0.3955) and total vigorous activities (r=0.5176). The regression analysis revealed that the 6MWT distance could explain between 10-24% of the IPAQ outcomes. The results for the DWI did not reach statistical significance, with the significance level set at $p < 0.05$.

Conclusion: A possible link was found between walking capacity and PA. Suggesting interventions to improve walking capacity could enhance PA in pwMS. In contrast, the absence of significant correlations between WF and PA suggests that WF is not connected with PA.

Keywords: Multiple Sclerosis, walking capacity, walking fatigability, physical activity, IPAQ, 6MWT

Introduction

Multiple Sclerosis (MS) is a chronic autoimmune and neurodegenerative disease in which demyelination and inflammatory processes affect the central nervous system (CNS), causing a wide range of symptoms. Some common symptoms observed are fatigue, depression, lower walking capacity and walking fatigability (WF) (Kuendig et al., 2022, Leone et al., 2016, Severijns et al., 2017). In consequence, it has been reported that the level of PA, defined by the World Health Organization as "Any bodily movement produced by skeletal muscles that requires energy expenditure", could be influenced by several symptoms regarding MS (i.e., depression, fatigue, disability level) as well as the other way around (Marck et al., 2014, Razazian et al., 2020). This complicated interplay between these factors requires deeper exploration to which targeted interventions can be made and to enhance the quality of life (QOL) in people with MS (pwMS). The results of this study may contribute to a better understanding of the factors that influence PA and sedentary behavior in pwMS and may inform the development of interventions to improve the PA level and QOL in pwMS.

PwMS are normally less active when compared with the healthy population, even in the early stages of MS (Gervasoni et al., 2022). PA is often evaluated using sensors like pedometers and accelerometers, which assesses factors such as steps taken, intensity, duration and frequency of PA (Casey et al., 2018). Alternatively, the International Physical Activity Questionnaire (IPAQ) is a widely utilized survey tool. The majority of previous studies preferred the short form of the IPAQ (IPAQ-SF) as it shows consistent and moderate correlations between sitting time scores and sedentary behavior (Motl et al., 2019) as well as favorable outcomes regarding convergent validity when compared to actigraph data (Khalil et al., 2021). However, in this study, the long form of the IPAQ (IPAQ-LF) was used due to a more detailed idea about frequency, duration and intensity of PA performed in pwMS. Research on the IPAQ-LF has been limited, and there have been few studies that used it as a measurement of PA. Wanner et al. (2016) concluded that it offers moderate validation in comparison to the data from accelerometers.

As stated before, pwMS are less physically active than the healthy population (Motl et al., 2005). Additionally, evidence tells us that PA is important for pwMS as it can help improve overall QOL and reduce fatigue and pain (Motl et al., 2009). Limitations in walking speed and walking endurance are often observed in this population (Baird et al., 2019). As mentioned before, there is evidence supporting the relationship between walking capacity and PA. According to Ryan et al. (2019), a decrease of 10 meters on the 6MWT would correspond to a reduction of 130 steps/day in pwMS. Rehabilitation is believed to improve the walking capacity, but not the PA (Kuendig et al., 2022). However, in accordance with our knowledge, poor or no previous studies investigated the contribution of WF on PA in pwMS. This gap in research raised the question of how WF might factor into the complex interplay between walking capacity and PA.

Among the various factors observed in MS, fatigue is one of the most common and disabling symptoms as it affects between 38-83% of this population (Enoka et al., 2021, Kluger et al., 2013, Ramirez et al., 2021). It can be determined by level of tiredness, motivation, energy and the inability to concentrate (Enoka et al., 2021). Fatigability, on the other hand, can be described as the objective or perceived change measured in performance (Kluger et al., 2013) where WF is being recently described. WF is normally evaluated and measured during the 6MWT (Cederberg et al., 2019, Van Geel et al., 2020). It was initially described as a decrease in 15% in distance walked comparing the last minute with the first minute (Distance Walking Index- DWI6-1) during the 6MWT, with a prevalence up to 50% in moderate-to-severe pwMS (Leone et al., 2016). More recently, Van Geel et al. (2021) updated the 15% cut-off to 10% using healthy people to determine whether (ab)normal WF can happen. When pwMS experience WF, it can potentially impact their level of PA by their ability to engage in prolonged, continuous walking (Karpatkin et al., 2022).

Research on MS has shown that reduced PA and increased sedentary behavior are major contributors to the decreased QOL in pwMS. Although walking capacity is considered one of the most critical measures of functional status in pwMS, there are still no clear assumptions about the relationship between the walking capacity and WF of pwMS and the influence on PA.

The aim of this study was to investigate the relationship of walking capacity and WF with PA and whether the outcomes of the walking test can serve as a predictor for the PA levels of pwMS. We hypothesized that better performance on the 6MWT and the DWI, respectively walking capacity and WF, will be associated with increased PA in pwMS. This would mean that a better walking capacity and less WF are associated with higher PA and less sedentary time.

Methods

Participants

A total of 74 participants were gathered. More specifically, there were 51 pwMS and 23 healthy controls (HC). In collaboration with the MS centers in Belgium, most of our participants were recruited from the MS rehabilitation centers Melsbroek (NMSC) and Overpelt (Noorderhart RMSC), as well as the REVAL research centre at the University of Hasselt. Participants were also recruited through information flyers and social media. Common inclusion criteria included age between 30 and 70 years old. Specifically for pwMS, inclusion criteria included the diagnosis with MS following the revisions of the McDonald criteria (Thompson et al., 2017), Expanded Disability status scale (EDSS) between 2.5 and 6.5, no relapses at least 1 month preceding the start of the study and to be able to walk six minutes without rest. Walking aids were allowed. Common exclusion criteria included cognitive impairment, the presence of musculoskeletal disorders in the lower limbs which were not related to MS and pregnancy.

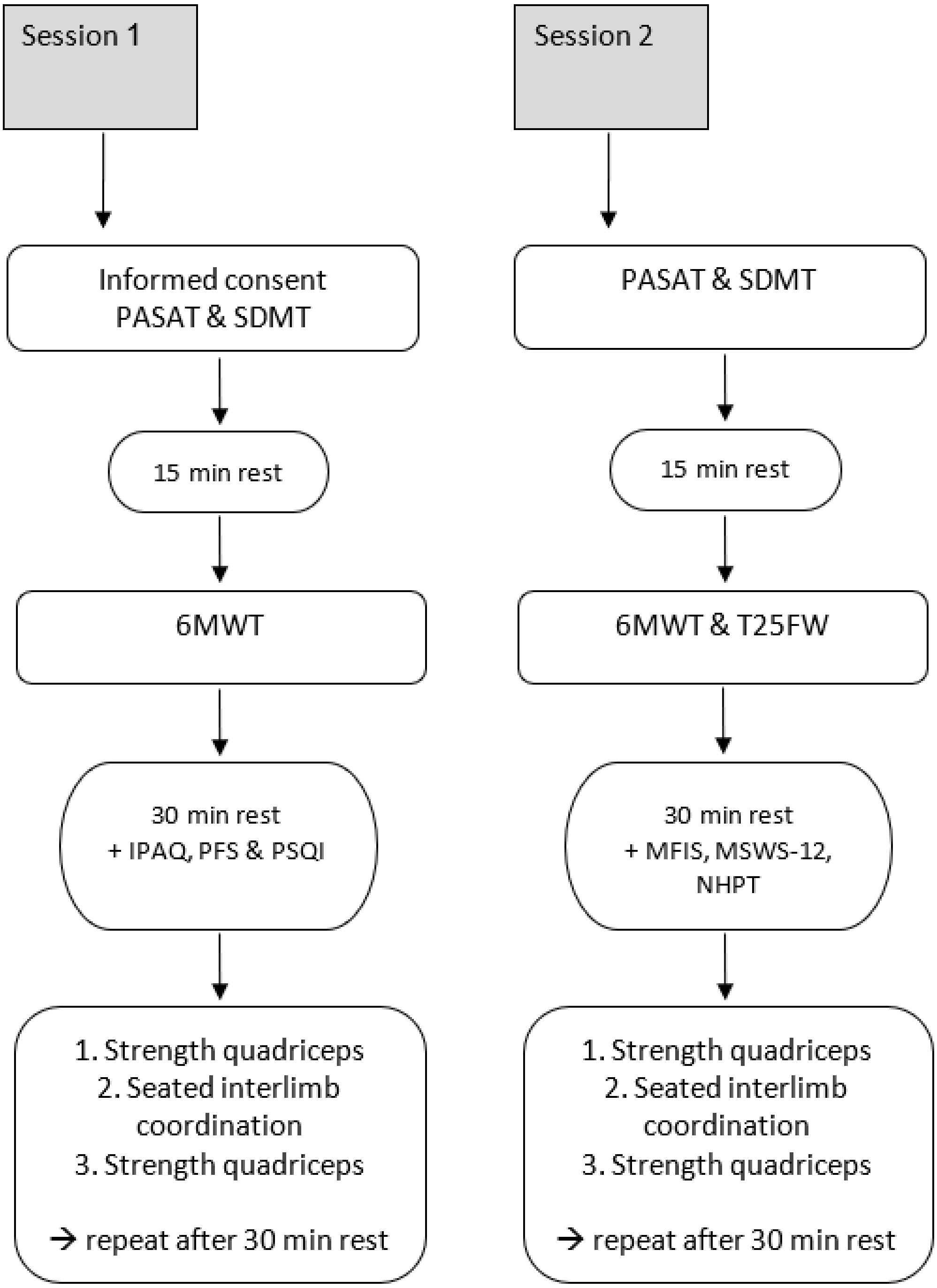
Protocol

Our master thesis is part of a larger study from the University of Hasselt. The latter study aims to examine psychometric properties of a new measurement and to inspect the relationship between coordination and cognitive fatigability with WF. To do this, the study consists of two test sessions which were separated by 5 to 7 days. For most of this master thesis, the assessments of the first session were implemented. The Timed 25 Foot Walk (T25FW), the twelve item MS Walking Scale (MSWS-12) and the Modified Fatigue Impact Scale (MFIS) were used from the second session.

Testing of the participants started with the SDMT and the PASAT. After the cognitive measurements, there was a period of rest for 15 minutes. The next assessment was the 6MWT. While the participants were resting after the 6MWT for 30 minutes, they filled in the questionnaires; namely the IPAQ and PFS and Pittsburgh Sleep Quality Index (PSQI). Also, they got information about the use of the Actigraph. For the second session, the structure was the same. The T25FW was added just before the beginning of the 6MWT. Also, instead of filling in the former questionnaires after the 6MWT, the participants were asked to fill in the MFIS and the MSWS-12 (only for the pwMS) and to perform the Nine Hole Peg Test (NHPT) and the T25FW. Test results of session 1 were used: 6MWT, SDMT, PASAT, IPAQ, PFS and PSQI. For the second session, only the MFIS, MSWS-12 and T25FW were used. The sessions are shown in figure 1.

Figure 1

Protocol of both testing days



Clinical evaluations

Six-Minute Walking Test - 6MWT and Distance Walking Index - DWI

The 6MWT was used to measure the walking capacity (total distance) and WF (DWI). The 6MWT is a submaximal test that measures the maximal/farthest distance an individual can walk in 6 minutes. This was taken in a 25-30 meter hallway by 2 researchers and after every minute the participants were asked about their rate of perceived exertion on the Borg scale (0-10) (Morishita et al., 2018). When using the 6MWT, the walked distance in each minute was obtained. With this information, the DWI can be calculated with the following formula: ((Distance walked at minute n - Distance walked at minute 1) / Distance walked at minute 1)) x 100. This score can provide insight into whether the individual is maintaining a steady pace or whether they are slowing down over time. If the score is negative, it means that the participant is slowing down. If the score is positive, it means acceleration is present. A score of zero means that they had the exact same pace. In addition to providing insight into the pace, it also gives information about the experienced WF and to what extent it is impacting their functional exercise capacity. If the score of the DWI, between minute six and minute one, is less than -10%, the participant has WF (Van Geel et al., 2020).

International Physical Activity Questionnaire- IPAQ

The IPAQ is a standardized tool used to assess overall PA levels. It is a self-administered questionnaire that asks individuals to report on their amount and intensity of PA over a common week. With this test, the metabolic equivalents (METs) can be estimated. This means that the IPAQ can be used to assess PA levels in pwMS to monitor changes in PA over time (Krüger et al., 2017). The long form, IPAQ-LF, was used in this study. Following domains are evaluated: work, transportation, leisure time and domestic/garden. Regarding this thesis, other variables were also subtracted from this questionnaire: total walking time, total amount of moderate activities and total time of vigorous activities. Lastly, time sitting was also obtained. All above-mentioned variables of the IPAQ-LF are portrayed as domains. A structured overview of the IPAQ domains evaluated can be found in table 1.

Table 1

Overview IPAQ domains

Total time	M	V	W	C
Part 1: Job-related physical activity (METs/week)	X	X	X	
Part 2: Transportation physical activity (METs/week)			X	X
Part 3: Housework, house maintenance and caring for family (METs/week)	X	X		
Part 4: Recreation, sport and leisure-time physical activity (METs/week)	X	X	X	
Part 5: Time spent sitting (min/week)				

Note. M = Moderate activity, V = Vigorous activity, W = Walking, C = Cycling, METs: Metabolic Equivalent of Task, min: minutes

Symbol Digit Modality Test - SDMT

The SDMT is a widely used test in MS that assesses attention and cognitive processing speed by requiring participants to match a series of symbols to corresponding numbers within a limited time frame (Drake et al., 2010).

Paced Auditory Serial Addition Test - PASAT

To assess attention, processing speed and working memory, the PASAT was used, which requires participants to add up pairs of digits presented auditorily at a rapid pace (Drake et al., 2010).

Modified Fatigue Impact Scale - MFIS

The MFIS (Mills et al., 2010) is a questionnaire that assesses perceived levels of fatigue. It measures subjective fatigue across three categories: physical fatigue, cognitive fatigue and psychosocial fatigue.

Pittsburgh Fatigability Scale - PFS

The PFS is a 10- item questionnaire that assesses fatigability. It measures physical and mental tiredness on a scale from 0 (no fatigue) to 5 (extreme fatigue) (Glynn et al., 2014).

Multiple Sclerosis Walking Scale (12 items) - MSWS-12

The MSWS-12 questionnaire was used to evaluate the impact of MS on walking ability and perceived limitations on daily life (Mokkink et al., 2016, Motl et al., 2008).

Timed 25 Foot Walk - T25FW

Additionally, the T25FW was conducted to evaluate walking speed (Kalinowski et al., 2022).

Statistical analysis

Data were analyzed using JMP Pro 16 and significance was set on $p < 0.05$. Normality was checked using distribution of each variable by performing the Shapiro-Wilk test.

First, the participant and parameter characteristics were analysed. This was done using a one way analysis of the Y variable with the MS or HC category in the 'by' section. Group comparisons were made with Fit Y by X, with MS or HC category as x variable and the characteristics. The t-test was observed for the normally distributed data while the non - parametric wilcoxon test was observed for the non-normally distributed data.

The relationship between the independent variables (6MWT and DWI) and the normally distributed dependent variables (some domains of the IPAQ) were then examined by a Pearson (r) test and non-normally distributed variables were tested using a Spearman's (ρ) test.

The impact of the variables that demonstrated significant p - values was further examined using multiple linear regression analysis. The independent variables were alternatively put in the X group, while the associated significant variables were put in the Y group.

To check for the possible influence of factors such as cognition (PASAT and SDMT), fatigue (PFS and MFIS) and walking aspects (T25FW and MSWS-12) on PA, correlations were analysed using the Spearman's (ρ) test. Correlations were interpreted using the magnitude of Schober et al., 2018.

Results

Firstly, not every participant of the MS group was included in the data set. Three participants filled in their questionnaires incompletely so their data was excluded from the analysis. Also, there were two drop outs during testing. Next to that, there were missing questionnaires from three participants and so our total sample size ended at 43 participants in the MS group. Secondly, in the HC group were three participants who did not correctly fill in the IPAQ. They filled in more minutes in a day than possible, so they were excluded as well, leaving a total of 20 HC's.

The participant characteristics from both groups, using group means and standard deviations, can be found in table 2. Only for EDSS, median was used as a consequence of not normal distribution. In addition, EDSS and assistive devices were only registered for the MS group. There were 62.79% female participants in the MS group and 82.61% in the HC group.

Table 2

Participant characteristics

Variable	**MS**	**HC**	**p-value**
Age (years)	54.659 ± 8.499	50.609 ± 6.177	0.0678
Height (cm)	170.463 ± 8.964	169.217 ± 7.039	0.8899
Body mass (kg)	77.517 ± 19.148	73.196 ± 17.015	0.6337
Female (n%)	27 (62.79%) total 43	19 (82.61%) total 23	
EDSS (median range)	4.786 (4 - 6)		
Assistive device (n%)	14 (32.56%)		

Note. MS: Multiple Sclerosis, HC: Healthy Controls, EDSS: Expanded Disability Status Scale

*Significance at the p<0.5 level

Further, the parameter characteristics for each domain of the IPAQ were analysed and are shown in table 3. There were significant differences between HC and pwMS in three domains; IPAQ work (p = 0.0332), IPAQ domestic and garden (p = 0.0010) and IPAQ total time vigorous (p = 0.0482).

Table 3

Parameter characteristics

Variable	**MS**	**HC**	**p-value**
IPAQ active	3453.09 ± 3796.31	8351.46 ± 10806.49	*0.1478*
IPAQ sedentary	2900.93 ± 1410.22	2312.61 ± 1267.48	*0.2315*
IPAQ work	1016.30 ± 2392.22	3475.7 ± 5947.89	*0.0010**
IPAQ transport	594.81 ± 939.33	874.89 ± 1172.61	*0.3768*
IPAQ domestic and garden	821.98 ± 1205.06	2950.22 ± 5183.21	*0.0332**
IPAQ leisure	1020 ± 1430.38	1050.65 ± 1437.05	*0.9643*
IPAQ total walking	994.84 ± 1264.86	1188.717 ± 1697.03	*0.9291*
IPAQ moderate	1743.84 ± 1733.53	5537.7 ± 7910.76	*0.0697*
IPAQ vigorous	714.42 ± 1779.49	1625.04 ± 4930.87	*0.0482**
6MWT (m)	345.19 ± 130.98	592.91 ± 67.17	<.0001
DWI (%)	-8.6 ± 8.71	-0.83 ± 7.6	*0.0011**
PASAT (n)	42.66 ± 11.57	47.91 ± 7.74	*0.1163*
SDMT 1.1 (n)	50.419 ± 11.626	57.304 ± 15.683	*0.0166**
T25FW (sec)	7.854 ± 6.967	3.960 ± 0.672	*<.0001**
MFIS (n)	40.884 ± 14.902	21.6 ± 14.010	*0.0001**
PFS physical (n)	31.186 ± 8.729	16.522 ± 8.174	*<.0001**

PFS mental (n)	23.093 ± 10.876	10.652 ± 6.110	*<.0001**
MSWS - 12 (n)	68.140 ± 19.606		

Note. IPAQ: International Physical Activity Questionnaire, 6MWT: Six - Minute Walking Test, DWI: Distance Walking Index, PASAT: Paced Auditory Serial Addition Test, SDMT: Symbol Digit Modalities Test, T25FW: Timed 25 Foot Walk, MFIS: Modified Fatigue Impact Scale, PFS: Pittsburgh Fatigue Scale, MSWS-12: Twelve Item Multiple Sclerosis Walking Scale, MS: Multiple Sclerosis, HC: Healthy Controls, m: meters, %: procent, n: amount, sec: seconds
Note. IPAQ variable units are in METs/week, IPAQ sedentary in minutes/week
*Significant at p<0.05 level
Italic: Wilcoxon signed rank test due to not normal distributed data

The correlations between the 6MWT and PA levels measured by the IPAQ were then examined. The correlation coefficient (r) and the p - value for each correlation are presented in table 4. Presented for pwMS and HC.

The correlations between DWI and dependent variables were also examined. The correlation coefficient (r) and the p - value for each correlation are provided in table 4 as well.

6MWT has multiple moderate strong correlations with some domains of the IPAQ. The two that stand out most are IPAQ total active in METs/week and IPAQ total moderate in METs/week, both with a moderate correlation. IPAQ domains that measure a total amount of activity all had positive correlations. The only domain that had a negative correlation was the IPAQ sedentary domain. This is also the only domain that measures the opposite of PA.

Correlations with the other variables were also observed. 6MWT had a very strong negative correlation with the T25FW. Also the MSWS-12 has a moderately strong negative correlation. The cognitive tests, SDMT and PASAT both revealed positive correlations with the 6MWT.

For the DWI correlations with the IPAQ domains, there were no strong or moderate strong correlations found nor were there significant p - values which indicates that there is no possibility to further examine the relationship with a regression model.

MSWS-12 and T25FW both had a weak negative correlation with DWI and had significant p - values.

For the HC group, both the 6MWT and the DWI had no significant p - values with the IPAQ variables after the statistical analysis. Therefore, there were no strong correlations found between any of the variables.

Table 4

Correlations 6MWT & DWI in MS and HC group

6MWT	Correlation	p-value	Correlation	p-value
	MS		HC	
IPAQ total active	0.5752	<.0001*	0.0801	0.7162
IPAQ sedentary	-0.2166	0.1630	0.0649	0.7686
IPAQ work	0.2186	0.1590	0.0298	0.8925
IPAQ active transport	0.4431	0.0029*	-0.1802	0.4105
IPAQ domestic and garden	0.4993	0.0007*	0.0369	0.8673
IPAQ leisure time	0.2577	0.0953	0.0163	0.9410
IPAQ total walking	0.3955	0.0087*	-0.1010	0.6466
IPAQ total moderate	0.5176	0.0004*	0.0905	0.6812
IPAQ total vigorous	0.2340	0.1310	-0.2042	0.3500
DWI	**Correlation**	**p-value**	**Correlation**	**p-value**

	MS		HC	
IPAQ total active	0.2366	0.1266	0.0163	0.9411
IPAQ sedentary	-0.1176	0.4528	-0.2935	0.1741
IPAQ work	0.0069	0.9650	-0.0968	0.6602
IPAQ active transport	0.0330	0.8334	-0.0111	0.9598
IPAQ domestic and garden	0.1352	0.3873	0.0381	0.8631
IPAQ leisure time	0.1630	0.2964	0.0520	0.8139
IPAQ total walking	0.2842	0.0648	-0.2667	0.2186
IPAQ total moderate	0.1604	0.3042	-0.0549	0.8036
IPAQ total vigorous	0.0898	0.5669	0.1700	0.4382

Note. IPAQ: International Physical Activity Questionnaire, 6MWT: Six - Minute Walking Test, DWI: Distance Walking Index, MS: Multiple Sclerosis, HC: Healthy Controls

Note. Correlation coefficient interpretation = 0.00-0.10: negligible correlation, 0.10-0.39: weak correlation, 0.40-0.69: moderate correlation, 0.70-0.89: strong correlation, 0.90-1.00: very strong correlation (Schober et al., 2018)

*Significant at $p<0.05$ level

The correlation analysis revealed that for pwMS the 6MWT was significantly correlated with five domains of the IPAQ. These variables were used in the regression analysis. The results are shown in table 5.

On the other hand, no significant p - values were found for the DWI with the domains of the IPAQ, so no further analysis was performed.

Besides, no significant p - values were observed for the HC, for both 6MWT and DWI with the IPAQ domains, so no further analysis was performed.

In the linear regression model, the analysis focused on the R square value for every significant variable as well as on the observed line of fit. The R square value for every variable was lower than 0.3, indicating a weak relationship. A structured overview can be found in figure 4. The line of fit can be observed in figure 5-9.

Table 5

Regression analysis

	R square	p-value
	MS	
6MWT - IPAQ total active	0.144521	0.0021*
6MWT - IPAQ active transport	0.04518	0.0944
6MWT - IPAQ domestic and garden	0.128538	0.0039*
6MWT - IPAQ total walking	0.020784	0.2596
6MWT - IPAQ total moderate	0.194994	0.0003*

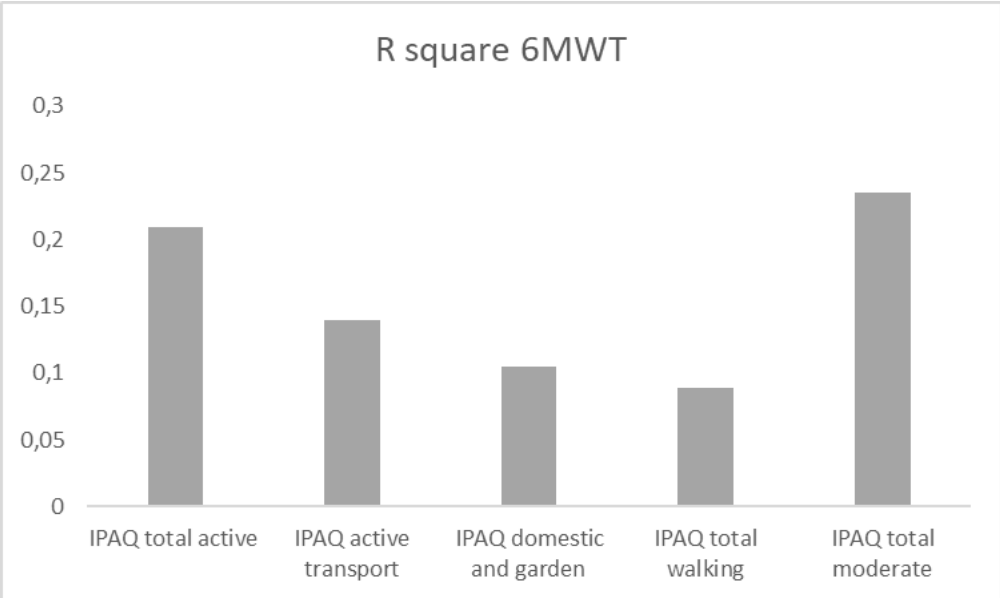
Note. IPAQ: International Physical Activity Questionnaire, 6MWT: Six - Minute Walking Test, MS: Multiple Sclerosis

Note. The 6MWT is the explanatory variable

*Significance at the p<0.5 level

Figure 4

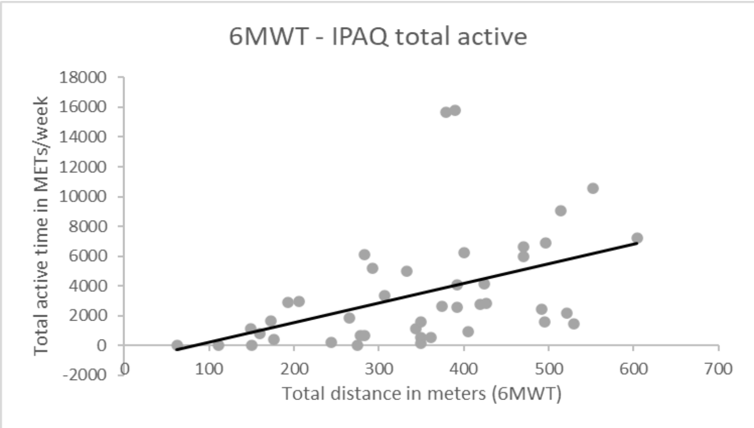
Regression analysis



Note. 6MWT: Six-Minute Walking Test, IPAQ: International Physical Activity Questionnaire
Note.

Figure 5

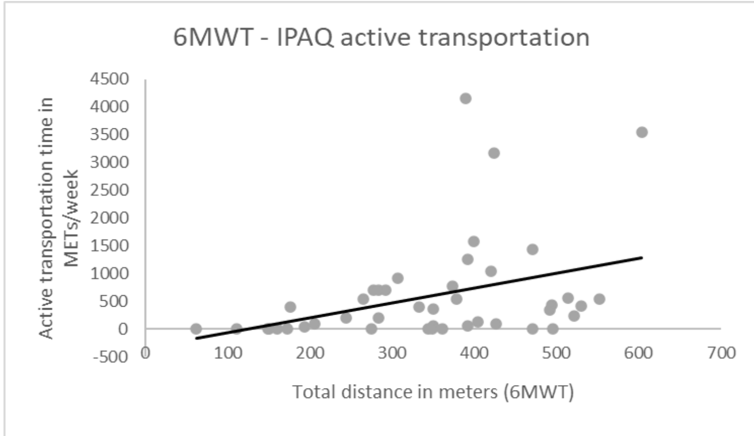
Scatter plot IPAQ total active



Note. 6MWT: Six-Minute Walking Test,
IPAQ: International Physical Activity Questionnaire
Note. Fit line: 1128,239 + 13,272059*6MWT

Figure 6

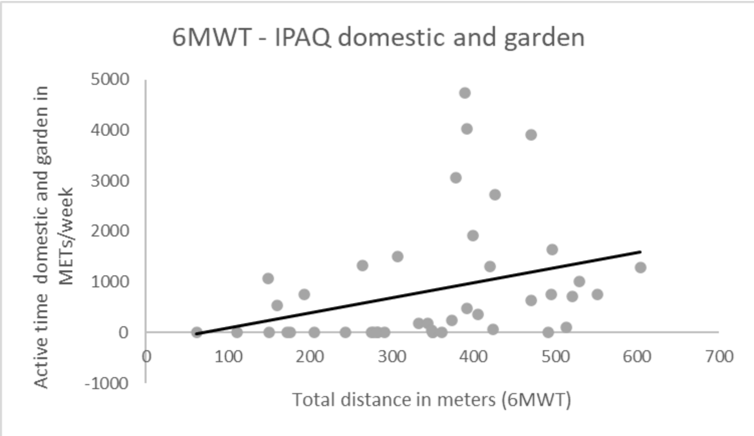
Scatter plot IPAQ active transportation



Note. 6MWT: Six-Minute Walking Test,
IPAQ: International Physical Activity Questionnaire
Note. Fit line: -329,1685 + 2,6767531*6MWT

Figure 7

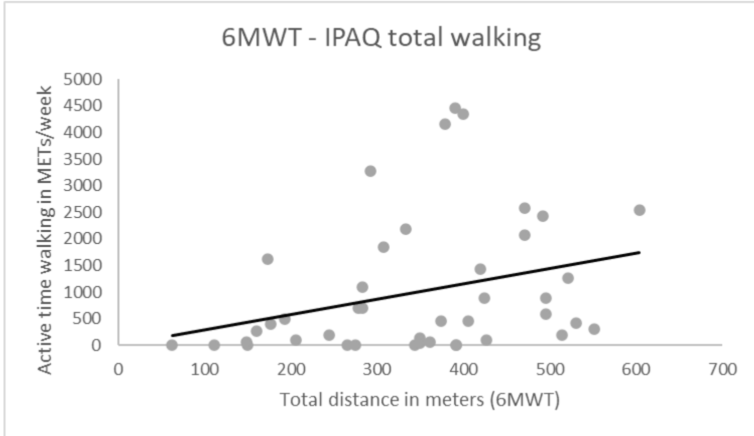
Scatter plot IPAQ domestic and garden



Note. 6MWT: Six-Minute Walking Test,
IPAQ: International Physical Activity Questionnaire
Note. Fit line: -208,2105 + 2,9844406*6MWT

Figure 8

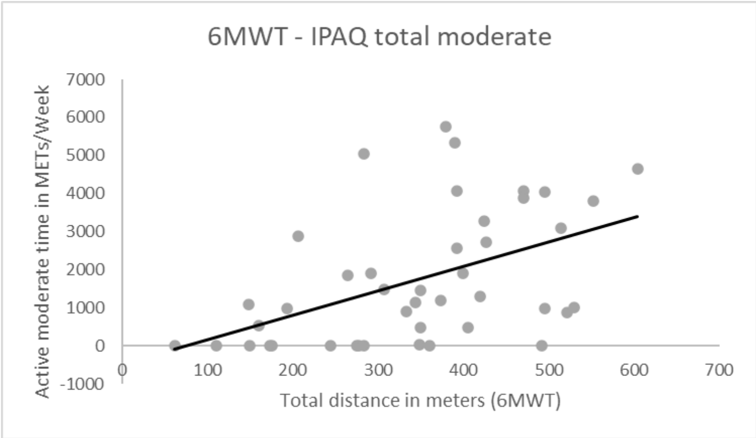
Scatter plot IPAQ total walking



Note. 6MWT: Six-Minute Walking Test,
IPAQ: International Physical Activity Questionnaire
Note. Fit line: -0,747657 + 2,8841912*6MWT

Figure 9

Scatter plot IPAQ total moderate



Note. 6MWT: Six-Minute Walking Test,

IPAQ: International Physical Activity Questionnaire

Note. Fit line: -472,4253 + 6,420487*6MWT

Additional to the research question, correlation values between cognition (PASAT and SDMT), fatigue (PFS and MFIS) and walking aspects (T25FW and MSWS-12) with PA (IPAQ total active) are demonstrated in table 6.

The IPAQ total active shows two positive correlations, namely with the PFS mental (moderate correlation) and the SDMT (weak correlation). All others had negative correlations with the IPAQ total active. MSWS-12 and T25FW showed moderately strong negative correlations whereas the PFS physical and MFIS had weak negative correlations. The PASAT had a negligible correlation with the IPAQ total active. Both parts of the PFS had a significant p-value, as well as the T25FW and the MSWS-12.

Table 6

Correlations PFS, MFIS, T25FW, SDMT, PASAT, MSWS-12 - IPAQ total active

		PFS physical	**PFS mental**	**MFIS**	**T25FW**	**SDMT 1.1**	**PASAT**	**MSWS-12**
IPAQ total active (METs/week)	Correlation value	-0.3725	0.5819	-0.28	-0.5057	0.1681	-0.0074	-0.5231
	p-value	0.0139*	<.0001*	0.0690	0.0005*	0.2813	0.9633	0.0003*

Note. IPAQ: International Physical Activity Questionnaire, PFS: Pittsburgh Fatigability Scale, MFIS: Modified Fatigue Impact Scale, T25FW: Timed 25 Foot

Walk, SDMT: Symbol Digit Modalities Test, PASAT: Paced Auditory Serial Addition Test, MSWS-12: twelve item Multiple Sclerosis Walking Scale

Note. Correlation coefficient interpretation = 0.00-0.10: negligible correlation, 0.10-0.39: weak correlation, 0.40-0.69: moderate correlation, 0.70-0.89: strong correlation, 0.90-1.00: very strong correlation (Schober et al., 2018)

*Significant at p<0.05 level

Discussion

The aim of this thesis was to examine the possible relationship of walking capacity and/or WF on PA performed in pwMS. The results showed several correlations between the 6MWT and various aspects of PA for pwMS, providing insights into the effect of walking capacity and the involvement of various domains of PA. However, regarding WF, there were no significant correlations found with PA.

Group comparison

Previous research has shown that there is a clear difference in the amount of PA between HC and pwMS (Motl et al., 2005). This was also observed in the parameter characteristics. HC were significantly more active on three domains of the IPAQ; specifically IPAQ work, IPAQ domestic and garden and IPAQ total vigorous time.

Correlations with HC were different from those observed for pwMS. Some correlations values of the HC were negative whereas the correlation values of the pwMS were moderately positive. This could suggest that walking capacity does not have the same effect on PA in HC as in pwMS. However the significance of this needs to be proven as there were no comparisons made of the correlation values. It is necessary to keep in mind that there are always some factors that influence PA other than having a chronic disease like MS. These factors could be categorized in internal and external factors. Chan et al. (2023) describes poor weather, perceived safety, travel time, cost and accessibility problems as external factors. Some internal factors are motivation, beliefs, knowledge specifically about MS and positive experiences. All these factors could either be a barrier to PA, or a facilitator. In general, thus not only applied for pwMS, there are invariable factors (such as gender and age) and variable factors (such as behavioral characteristics and community settings) that can have an effect on PA (Seefeldt et al., 2002).

Walking capacity in pwMS

First, for the pwMS, the correlation analysis revealed a moderate correlation between the 6MWT and four domains of the IPAQ, specifically: total amount of activity, total moderate amount of activity, total time active in garden and domestic activities and lastly the total time of active transport, all in METs/week. This indicates that individuals with better walking capacity tend to have higher levels of PA, as measured by the IPAQ. This supports the hypothesis that PA is influenced by walking capacity. Therefore, patients with better walking capacity are likely to have a more active lifestyle, which is in line with previous research (Casey et al., 2018). Considering this approach during practical sessions could thereby be of noteworthy importance, as it can help stimulate the patients to achieve a more active lifestyle, accompanied by numerous health benefits (Ruegsegger et al., 2018, Warburton et al., 2006). Notably, Mate et al. (2020) conducted a study observing that pwMS had less community walking performance in comparison to their measured walking capacity. Consequently, it becomes important to minimize this gap through the implementation of effective practical sessions.

In addition to the moderate positive correlation, there were also a few weak positive correlations with the 6MWT. These results indicate that pwMS who benefit from higher walking capacity, could also be more active at work, have more active leisure time, total walking and vigorous intensity activities. A possible hypothesis for these weaker correlations could come from the characteristics of our target group, as they are less likely to engage in, for example, active employment (Busche et al., 2003) and vigorous intensity activities (Pau et al., 2020). It seems that walking capacity has a relationship with both moderate, moderate correlated, and vigorous, weak correlated, intensity activities. Persons who have higher scores on the 6MWT, and thereby a higher level of walking capacity, are more likely to have moderate and vigorous physical activity.

Unlike the above domains, the sedentary domain had a weak negative correlation with the 6MWT. This could suggest that better walking capacity has little influence on sedentary behavior. To be specific, if pwMS have lower walking capacity, they tend to have more sedentary time. In their study, Van Zanten et al. (2016) concluded that various symptoms, such as mobility, disability and fatigue could potentially account for the increased amount of sedentary time. More sitting time has shown to be associated with higher risk of comorbidities (Magyari et al., 2020). A study of Hubbert et al. (2015) already showed that interventions that target less sitting time and more movement have changed PA behavior in pwMS. Thereby, the study showed that sedentary time was linked with disability, endurance walking performance and walking speed and this specifically in the people with the most severe impairments. These findings seem to be in line with the hypothesis of this study that pwMS who have higher walking capacity show signs to have more PA in daily life. Thereby, they appear to spend less time sitting.

In spite of everything said thus far, a weak linear regression model is found. By consulting the R square (Hamilton et al., 2015), it appears that walking capacity cannot fully explain PA. One study found similar results when looking at activity capacity, capability and performance. It was found that those were all related but activity was a poor predictor of the amount of participation (Ryan et al., 2019).

Walking fatigability in pwMS

There were no significant correlations found between the DWI and the IPAQ domains. In addition, correlations between WF and the intensity of PA were none to weak. Thereby, none of the correlation values seemed moderate or strong. This might suggest that WF has little impact on the amount and intensity of PA in pwMS. This could imply that rehabilitation programs for pwMS targeting WF may not result in additional PA beyond the rehabilitation itself. One possibility could be that individuals who suffer from WF might engage more in intermittent PA rather than in prolonged activities. Exploring this hypothesis revealed that pwMS demonstrated greater volume of walking when they participated in intermittent walking (Karpatkin et al., 2022). A second possible explanation could be that there are several factors that contribute more to the amount of PA a person has than WF. Reider et al. (2017) found that the level of education, income, relationship status, level of depression, fatigue, spasticity and normal hand and bladder function were all associated with PA. An additional possibility for these findings could be that there was no distinction made between pwMS who experience WF (n = 23) and pwMS (n = 22) who do not experience WF. As a result, the ones without fatigability could have possibly influenced the researched correlations. Sadly, since there has been no significant research regarding the relationship between WF and PA, limited hypotheses can be made.

Additional findings

Firstly, the correlation between the PFS physical and IPAQ total active was significantly moderately negative. This means that people who showed higher scores on the PFS physical had lower scores on the IPAQ total active. Moreover, the MFIS showed similar results. This suggests that pwMS who experience more (physical) fatigue, tend to have lower PA levels. This goes in line with the findings of Fjeldstad et al. (2010), who observed that a higher score of fatigue was correlated with lower participation in PA. Yet, the PFS mental showed a significantly strong positive correlation with the IPAQ total active, suggesting that pwMS who experience more mental fatigue also tend to have higher levels of PA. This is not in line with previous findings…

Secondly, both T25FW and MSWS-12 showed significantly moderately negative correlations with the IPAQ total active. This means that pwMS who score higher on these walking evaluations (higher score equals worse outcomes), tend to have lower PA levels. This is in line with the findings of the research question, as Ramari et al. (2021) concluded that the T25FW is an acceptable predictor of the 6MWT in pwMS.

Thirdly, both the PASAT and SDMT had negligible to weak correlations with the IPAQ total active. This may suggest that cognitive impairments do not have an impact on the PA levels in pwMS. There is little evidence to either support these findings or reject them.

Strengths and weaknesses

First, since the relationship between WF and PA is still a very unknown research ground, this study could open up the possibility for further investigation. Next to that, a comparison was made between the HCs and pwMS. The control group makes it possible, with some confidence, to determine whether the outcomes are due to the investigated topic rather than other variables. It contributes to the internal validity and restricts the chances of biases. Another strength of this study is the well described experimental protocol. This enhances the reproducibility. Lastly, this study brought the risk of selection bias to a minimum by recruiting participants via several ways.

However, there are some limitations found as well. Firstly, the IPAQ is a self reported measurement of PA, which could make the data questionable because of risk for recall and/or information bias. Secondly, most parts of the data were not normally distributed which could have multiple consequences, such as limited power and validity. Thirdly, there were multiple researchers who participated in data collection. For this reason, the risk of researcher performance bias for the walking tests could not be brought to a minimum. Fourthly, this study did not specifically check for confounding factors such as EDSS score, use of assistive devices, relapse rate, onset and the kind of MS. Finally, the sample size of this study, particularly for the HCs, is relatively small. This limited sample size causes challenges in interpreting non-significant outcomes of the results.

Future research

Future research is essential to delve deeper into the relationship of walking capacity and WF with PA in pwMS. To enhance the power of findings, future investigations should employ newly objective measurements, like the pedometers or accelerometers, of PA rather than a self reported questionnaire. Furthermore, investigating the sedentary behavior among pwMS could have important information about the daily live activity and could be targeted for intervention. Further research on WF would contribute to a more comprehensive understanding of the factors affecting PA in this population and could inform the development of targeted interventions. Moreover, examining the potential interactions between WF, PA, and various factors like depression, cognition and cognitive fatigability could open up a possible, and intriguing, research ground. In addition, it could be useful to explore the impact of WF on the QOL in pwMS.

Conclusion

This study aimed to investigate the influence of walking capacity and/or WF on the amount and intensity of PA in pwMS. The results revealed a significant correlation between walking capacity and various aspects of PA in pwMS as assessed by the IPAQ. This could be indicating that better performance on the 6MWT was associated with increased PA. Although, 6MWT can only explain a small part of the amount of PA in pwMS.

Furthermore, no significant correlation was found between WF and PA levels. Further research should explain the complex relationship between walking capacity, WF and PA in pwMS and develop implications for interventions to improve QOL in this population.

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Appendix

Verklaring op Eer

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

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en kinesitherapie, waarbij ik de kans krijg om in het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen en kinesitherapie aan de UHasselt. Dit onderzoek wordt beleid door Nele Vanbilsen en kadert binnen het opleidingsonderdeel Algemene wetenschappelijke stage en masterproef. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van Auditory-motor coupling (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 Nele Vanbilsen

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

Gelezen voor akkoord en goedgekeurd,

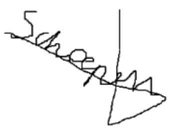
Naam: Lotte Schoepen

Adres: Luikersteenweg 57, 3500 Hasselt

Geboortedatum en –plaats : 17 mei 1999, 3500 Hasselt

Datum: 29/11/2021

Handtekening:



Verklaring op Eer

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

1. Ik ben ingeschreven als student aan de UHasselt in de opleiding Revalidatiewetenschappen en kinesitherapie, waarbij ik de kans krijg om in het kader van mijn opleiding mee te werken aan onderzoek van de faculteit Revalidatiewetenschappen en kinesitherapie aan de UHasselt. Dit onderzoek wordt beleid door Nele Vanbilsen en kadert binnen het opleidingsonderdeel Algemene wetenschappelijke stage en masterproef. Ik zal in het kader van dit onderzoek creaties, schetsen, ontwerpen, prototypes en/of onderzoeksresultaten tot stand brengen in het domein van Auditory-motor coupling (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:
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[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;
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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 Nele Vanbilsen

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,

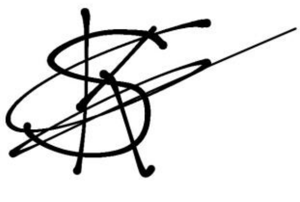
Naam: Stijn Knapen

Adres: Stationsstraat 30, 3722 Kortessem

Geboortedatum en –plaats : 30 augustus 2000, Tongeren

Datum: 29/11/2021

Handtekening:



Inschrijvingsformulier verdediging masterproef academiejaar 2022-2023,
Registration form jury Master's thesis academic year 2022-2023,

GEGEVENS STUDENT - *INFORMATION STUDENT*

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

Stamnummer + naam: **1849368 Knapen Stijn**
Student number + name

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

INSTRUCTIES - *INSTRUCTIONS*

Neem onderstaande informatie grondig door.

Print dit document en vul het aan met DRUKLETTERS.

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

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

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

Titel van Masterproef/*Title of Master's thesis: Can walking capacity and/or fatigability influence the amount and intensity of physical activity performed by people with Multiple Sclerosis? An exploratory study*

O behouden - *keep*
O wijzigen - *change to*:

/:

O behouden - *keep*
O wijzigen - *change to*:

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

O behouden - *keep*
O wijzigen - *change to:*

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

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

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

Scriptie/*Thesis:*

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

Juryverdediging/*Jury Defense:*

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

O te verdedigen/*to defend the aforementioned Master's thesis within the aforementioned period of time*
O de verdediging is openbaar/*in public*
O de verdediging is niet openbaar/*not in public*
O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

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

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

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

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

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

16/08/2023

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

17/08/2023

Inschrijvingsformulier verdediging masterproef academiejaar 2022-2023,
Registration form jury Master's thesis academic year 2022-2023,

GEGEVENS STUDENT - *INFORMATION STUDENT*

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

Stamnummer + naam: **1745935 Schoepen Lotte**
Student number + name

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

INSTRUCTIES - *INSTRUCTIONS*

Neem onderstaande informatie grondig door.

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

Vul luik A aan. Bezorg het formulier aan je promotoren voor de aanvullingen in luik B. Zorg dat het formulier ondertekend en gedateerd wordt door jezelf en je promotoren in luik D en dien het in bij de juiste dienst volgens de afspraken in jouw opleiding.
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Without this registration form, you will not have access to the upload/defense of your master's thesis.

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

Titel van Masterproef/*Title of Master's thesis:* **"Can walking capacity and/or fatigability influence the amount and intensity of physical activity performed by people with Multiple Sclerosis? An exploratory study"**

O behouden - *keep*

O wijzigen - *change to*:

/:

O behouden - *keep*

O wijzigen - *change to*:

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

O behouden - *keep*

O wijzigen - *change to:*

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

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

O goedgekeurd - *approved*

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

Scriptie/*Thesis:*

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

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

Juryverdediging/*Jury Defense:*

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

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

O de verdediging is openbaar/*in public*

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

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

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

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

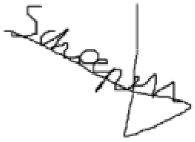
O niet te verdedigen/*not to defend the aforementioned Master's thesis within the aforementioned period of time*

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

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

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

16/08/2023



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

17/08/2023