UHASSELT

KNOWLEDGE IN ACTION

Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Compensatory behavior in MS

Kristoff Liekens

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

PROMOTOR :
Prof. dr. Bert OP 'T EIJNDE

COPROMOTOR :
Mevrouw Ine NIESTE

UHASSELT
KNOWLEDGE IN ACTION

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

2019
2020

UHASSELT

KNOWLEDGE IN ACTION

Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Compensatory behavior in MS

Kristoff Liekens

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

PROMOTOR :
Prof. dr. Bert OP 'T EIJNDE

COPROMOTOR :
Mevrouw Ine NIESTE

Acknowledgements

I wish to express my deepest gratitude to my co-promotor Drs. Ine Nieste. Going the extra mile with continuous feedback, important tips and noticing every flaw, I could not wish for somebody else to guide me.

Furthermore, I would like to thank my promotor Prof. Dr. Bert Op ‘t Eijnde and his whole research team for their feedback. I had the opportunity to experience a small part of scientific research in an environment that every student, among whom future researchers, would gladly take my place.

Last but not least, I would like to thank all the participants who participated in the original study for their effort and Dr. Charly Keytsman for providing me all the data.

Beerse (Belgium), 27/05/2020 K.L

Context of the master thesis

This master thesis focusses on the research domain rehabilitation of cardiorespiratory and internal disorders in a neurological population. In particular, on the rehabilitation in persons with Multiple Sclerosis (PwMS).

Multiple sclerosis is a chronic inflammatory and demyelinating disease affecting the central nervous system (CNS) (Kaminska, Koper et al. 2017). Neurological symptoms include weakness, spasticity, fatigue, changes in sensation, coordination, vision, cognition and bladder function (Cameron and Nilsagard 2018). Moreover, PwMS have an elevated cardiovascular risk (CVD) (Wens, Dalgas et al. 2013).

Low-to-moderate intensity exercise therapy is often used in the rehabilitation programs of MS (Motl and Gosney 2008). Since higher levels of physical activity are associated with a reduced cardiovascular risk (Kubota, Evenson et al. 2017), it would be assumed that these exercise programs in MS would also lead to a reduced cardiovascular risk. However, a periodized home-based training consisting of endurance training and high intensity interval training (HIIT) did not reduce the cardiovascular risk in PwMS (Keytsman, Hansen et al. 2019).

Because it has been shown that PwMS have a more sedentary lifestyle (Ng and Kent-Braun 1997), defined by waking activities that involve an energy expenditure between 1.0 - 1.5 metabolic equivalent units (METs) (Pate, O'Neill et al. 2008), and more time spent sedentary is correlated with CVD related mortality (Warren, Barry et al. 2010), it is possible that the increased CVD risk in PwMS (Keytsman, Eijnde et al. 2017) is due to a more sedentary lifestyle (Ng and Kent-Braun 1997). Furthermore, PwMS might even increase their already sedentary lifestyle on training days as compensatory behavior.

In other populations, it is already shown that individuals compensate increased exercise with metabolic and behavioral responses, throughout the rest of the day (King, Caudwell et al. 2007).

Hence, the aim of this retrospective data analysis of the previous mentioned study (Keytsman, Van Noten et al. 2019) is to investigate compensatory responses of PwMS in response of structured training. This results in the following research question: “Do persons with Multiple Sclerosis (PwMS) compensate increased exercise with more sedentary time post-exercise?”

This study was executed using conducted data from an earlier published study from dr. Charly Keytsman at the Rehabilitation Research Centre (REVAL) (Diepenbeek, Belgium).

This retrospective study is part of a Doctor of Philosophy (PhD) project of Drs. Ine Nieste and was supervised by Prof. Dr. Bert Op ‘t Eijnde. This study was executed by Kristoff Liekens as part of his master’s thesis project during the second master year at Uhasselt (Diepenbeek, Belgium).

References

Cameron, M. H. and Y. Nilsagard (2018). "Balance, gait, and falls in multiple sclerosis." Handb Clin Neurol **159**: 237-250.

Kaminska, J., O. M. Koper, K. Piechal and H. Kemona (2017). "Multiple sclerosis - etiology and diagnostic potential." Postepy Hig Med Dosw (Online) **71**(0): 551-563.

Keytsman, C., D. Hansen, I. Wens and O. E. B (2019). "Impact of high-intensity concurrent training on cardiovascular risk factors in persons with multiple sclerosis - pilot study." Disabil Rehabil **41**(4): 430-435.

Keytsman, C., B. O. Eijnde, D. Hansen, K. Verboven and I. Wens (2017). "Elevated cardiovascular risk factors in multiple sclerosis." Mult Scler Relat Disord **17**: 220-223.

King, N. A., P. Caudwell, M. Hopkins, N. M. Byrne, R. Colley, A. P. Hills, J. R. Stubbs and J. E. Blundell (2007). "Metabolic and behavioral compensatory responses to exercise interventions: barriers to weight loss." Obesity (Silver Spring) **15**(6): 1373-1383.

Kubota, Y., K. R. Evenson, R. F. Maclehose, N. S. Roetker, C. E. Joshu and A. R. Folsom (2017). "Physical Activity and Lifetime Risk of Cardiovascular Disease and Cancer." Med Sci Sports Exerc **49**(8): 1599-1605.

Motl, R. W. and J. L. Gosney (2008). "Effect of exercise training on quality of life in multiple sclerosis: a meta-analysis." Mult Scler **14**(1): 129-135.

Ng, A. V. and J. A. Kent-Braun (1997). "Quantitation of lower physical activity in persons with multiple sclerosis." Med Sci Sports Exerc **29**(4): 517-523.

Pate, R. R., J. R. O'Neill and F. Lobelo (2008). "The evolving definition of "sedentary"." Exerc Sport Sci Rev **36**(4): 173-178.

Warren, T. Y., V. Barry, S. P. Hooker, X. Sui, T. S. Church and S. N. Blair (2010). "Sedentary behaviors increase risk of cardiovascular disease mortality in men." Med Sci Sports Exerc **42**(5): 879-885.

Wens, I., D. Hansen, K. Verboven, N. Deckx, L. Kosten, A. L. Stevens, N. Cools and B. O. Eijnde (2015). "Impact of 24 Weeks of Resistance and Endurance Exercise on Glucose Tolerance in Persons with Multiple Sclerosis." Am J Phys Med Rehabil **94**(10 Suppl 1): 838-847.

Content

1 Abstract

Background: Multiple sclerosis (MS) is a chronic inflammatory disease causing demyelination and neurodegeneration. Next to primary neurological symptoms, persons with MS (PwMS) also have an elevated cardiovascular risk. Exercise programs are often prescribed and have functional benefits, yet fail to improve these cardiovascular risk factors.

Aim of the study: Retrospectively analyze possible compensatory changes in inactive time, step count, standing time, sedentary time and sleep time due to participation in a structured exercise program, consisting of both endurance training and high intensity interval training (HIIT), in persons with Multiple Sclerosis (PwMS) and healthy controls (HC).

Methods: Data from 12 participants was retrospectively analyzed for differences in inactive time, step count, standing time, sedentary time and sleep time in MS and healthy controls at the beginning (first 3 months) and ending (last 3 months) of the exercise intervention on resting days, days of endurance training and HIIT days.

Results: Although there are no significant differences, PwMS spent 3 ±36 min more inactive per day and take 3124 ±4845 steps less than HC at the end of the intervention (post) on HIIT days. In the other remaining conditions PwMS take more steps and spent less time inactive. However, the time spent sedentary is higher in PwMS in every condition, except for pre HIIT days (36.6 ±234 min) and post endurance training days (24 ±282 min). PwMS show a non-significant increase in time spent inactive per day (+15.6 ± 82.2 min), a decrease in step count (-144 ±8169 steps) and an increase in time spent sedentary (+43.8 ±85.8 min) following HIIT.

Conclusion: An increase in inactive time, reduced steps and increased sedentary behavior shows the possibility that compensatory behavior can be one of the reasons why a periodized training program does not improve cardiovascular risk in PwMS.

2 Introduction

Multiple sclerosis (MS) is a chronic inflammatory disease causing demyelination and neurodegeneration (Correale, Gaitan et al. 2017) and is characterized by fatigue, pain, depression, and anxiety (Nicholas and Rashid 2013). Beside these primary neurologic symptoms, persons with MS (PwMS) also have an elevated cardiovascular risk (CVD), apparent in an abnormal: fat mass, fat percentage, systolic and diastolic blood pressure, resting heart rate, blood triglycerides, fasting insulin, 2 h insulin, 2 h glucose and HOMA index (Keytsman, Eijnde et al. 2017). Since it has been shown that in a healthy population the time spent sedentary, defined by activities that involve an energy expenditure between 1.0 - 1.5 metabolic equivalent units (METs) (Pate, O'Neill et al. 2008), is positively correlated with mortality and health risks (Matthews, George et al. 2012) and the higher reported sedentary time in PwMS (Ng and Kent-Braun 1997), it is possible that sedentary time (at least partly) accounts for the increased cardiovascular risk. However, this has not been investigated yet. Other possible causes of the elevated cardiovascular include drugs use, weight gain, smoking and sleep deprivation (Wens, Dalgas et al. 2013) or disease specific factors such as a reduced possibility to reach the required exercise intensities to affect cardiovascular parameters (Keytsman, Hansen et al. 2019) or the abnormal muscular energy metabolism shown in MS (Kent-Braun, Ng et al. 1997).

Therefore, current research and rehabilitation programs -focus on increasing physical activity by means of -different kind of exercise programs, such as high intensity interval training (HIIT), strength training or endurance training. Although these interventions show positive functional improvements, such as muscle strength and exercise tolerance (Wens, Hansen et al. 2015) effects on the cardiovascular risks in PwMS remain limited (Keytsman, Hansen et al. 2019).

Possibly, PwMS blunt health effects from structured exercise by increasing post-exercise sedentary time and/or energy intake (King, Caudwell et al. 2007) and thus undermine the effectivity of exercise on body composition and health (King, Horner et al. 2012). When these compensatory responses are already apparent in healthy persons, this might also be the case in PwMS where fatigue is already a commonly reported symptom (Braley and Chervin 2010).

The aim of the present study is to investigate whether the time spent sedentary changes in PwMS after an exercise program, indicating the presence or absence of compensatory behavior. This will be achieved be retrospectively analyzing data from a wrist worn activity tracker acquired during a 6-month periodized training program, combining both endurance and HIIIT training. Data from resting days, days of endurance training and HIIT days will be compared within group (pre-post) and between groups (HC vs PwMS).

3 Materials & Methods

3.1 Study design

Data was obtained from the study 'Periodized home-based training: A new strategy to improve high intensity exercise therapy adherence in mildly affected patients with Multiple Sclerosis'. A home-based 24-week training program, divided into 8 training cycles of 3 weeks, was given. Each first week contains 3 longer training sessions (1-3 hours), the second week contains 3 High intensity interval training (HIIT) sessions (3x 60-90 sec) and in the last week one single HIIT training had to be performed, accompanied by either an endurance group session or an optional endurance training (Figure.1).

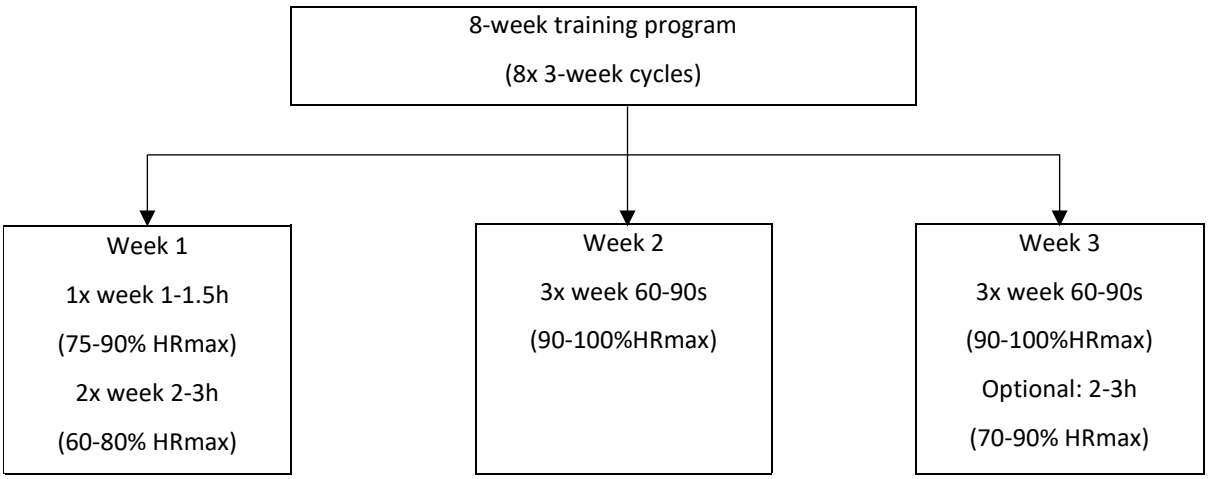

Figure 1. Representation of the training schedule

The authors concluded that six months of periodized and home-based HIT oriented training led to improvements in body weight, body mass index (BMI), total mass, VO_{2max}, workload, time until exhaustion, recovery heart rate, lactate peak and RER in PwMS. However, as the authors note, there was no improvement in health-related parameters such as fat mass, fat percentage and fat free mass (Keytsman, Van Noten et al. 2019).

During the six months (March 2017 - September 2017) of this research, participants wore a polar M200 (Polar Electro Oy, Kempele, Finland). No published data about the validity of this activity tracker was available. However, preliminary data from own earlier research, consisting of both healthy controls and PwMS, shows an inter class correlation (ICC) = 0.559 for measuring inactive time and an ICC = 0.946 for the step count, compared with the Activpal3 (PAL technologies, Glasgow, United Kingdom), which is already shown to be a valid tool in healthy controls and PwMS (Grant, Ryan et al. 2006, Coulter, Miller et al. 2017). The preliminary measured ICC shows the polar watch to have moderate reliability considering inactive time and excellent reliability for measuring step count (Koo and Li 2016).

All the data measured by the wrist worn polar watch, was available through the polar coach (Polar Electro Oy, Kempele, Finland) platform. The available data was screened for inclusion of participants. Participants were included if they had three valid days (days with a wear time ≥ 23 hours) in both the first three months (pre intervention) and the last three months (post intervention), for non-training days and endurance training days and/or HIIT training days (Keytsman, Hansen et al. 2019).

The following questions will be researched:

- Does the inactive time, steps count, sedentary time and sleep time within groups (PwMS and HC) change over the course of the exercise program on non-training days, endurance days and HIIT days?

- Is there a significant difference between the baseline, post-intervention and change in inactive time, steps count, sedentary time and sleep time between PwMS and HC on non-training days, days of endurance training and HIIT days for both PwMS and HC?

3.2 Subjects

Data from 35 participants was available for screening. After screening, data from 12 participants was included (figure 2.). Both groups (n: 6 per group, equal gender distribution) were checked for baseline comparability.

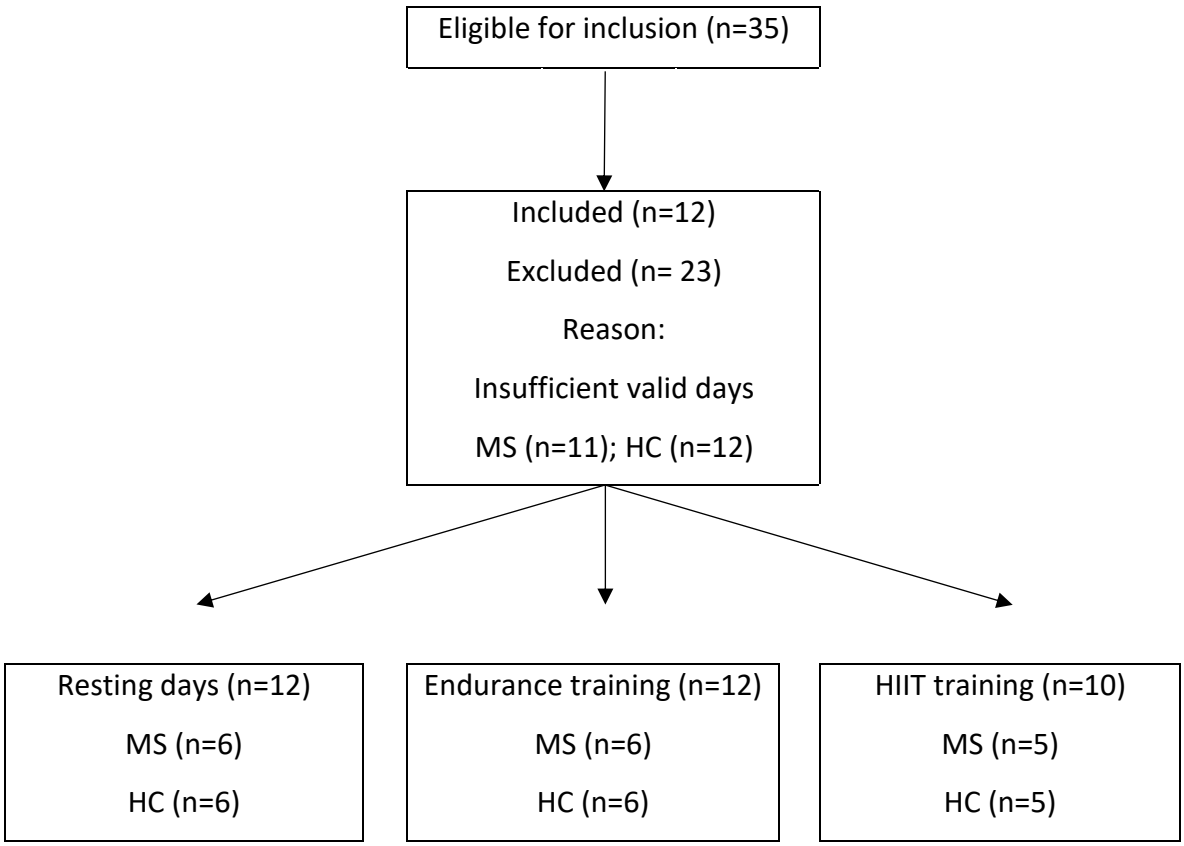

Figure 2. Flowchart of the inclusion process

3.3 Outcome measures

3.3.1 Primary outcome measure

The total inactive time per day, step count per day and non-wear time are considered as primary outcome measures.

All measurements were obtained by the polar M200 and accessed through the online polar coach platform.

For each outcome, both primary and secondary, 6 valid days were searched, three at the beginning of the intervention (during the first three months) and three at the end of the intervention (during the last three months), for each of the three conditions (resting day, endurance training and HIIT). A day was considered valid when the wear time of the activity tracker was <23 hours.

3.3.1.1 Inactive time per day (IT)

Sitting time and time spent lying were obtained through the polar coach platform. Both were added up and converted to decimal numbers, rounded to two digits. The total time spent sitting and lying for each 3 days per condition were added up and divided by three to obtain the average time spent sitting and lying per 24 hours.

Since sedentary behavior is defined by activities that involve energy expenditure between 1.0 1.5 metabolic equivalent units (METs) (Pate, O'Neill et al. 2008) and the time spent lying measured by the polar also includes sleeping, this outcome measure is described as ‘inactive time’.

3.3.1.2 Step count per day (SC)

From each valid day, the number of steps taken during the three days were added up per condition and divided by three to calculate the average number of steps taken per 24 hours.

3.3.1.3 Non-wear time

The non-wear time was calculated by adding up the time spent per day doing each of the 5 activities which the activity tracker measures. This total measurement time was subtracted from 24. Consequently, the non-wear time from each three days per condition was added up and divided by three to calculate the average non- wear time per 24 hours.

The % inactive time, standing time per day, % standing time, sedentary time per day, % sedentary time and sleep time are reported as secondary measures.

3.3.2 Secondary outcome measure

3.3.2.1 % inactive time (%IT)

The total inactive time spent per day was divided by the wear time to obtain the percentage of time spent sitting or lying corrected for the non-wear time.

3.3.2.2 standing time per day

The time spent standing during the three days was added up per condition and divided by three to calculate the average standing time per day.

3.3.2.3 % standing time (%ST)

The time spent standing during the three days was divided by the wear time to obtain the percentage of time spent standing corrected for the non-wear time.

3.3.2.4 Sedentary time per day

As mentioned earlier, it was not possible to directly measure sedentary behavior. However, because the polar watch also tracks sleeping time, it is possible to indirectly measure sedentary behavior by subtracting the total sleeping time per condition from the total time spent sitting and lying per condition. This was than divided by 3 to get the average sedentary time per day.

3.3.2.5 % sedentary time (%SET)

The total time spent sedentary per condition was divided by the wear time to obtain the percentage of time spent sedentary corrected for the non-wear time.

3.3.2.6 Sleep time (SLT)

Sleeping time was added up per condition and divided by three to obtain the average sleeping time per day.

3.4 Statistical analysis

Statistical analysis was performed using IBM SPSS statistics v. 25 (IBM, Armonk, NY). Differences in both primary and secondary outcome measures between-groups were tested using the t-test and the Mann–Whitney U test when the data from both groups was normally distributed and the variances were equal. In case of not normally distributed data and equal variances between-groups, only the Mann–Whitney U test was used. Within-group measures (pre-post) were tested using a paired t-test and the Wilcoxon signed-rank test when the data was normally distributed and with only the Wilcoxon signed-rank test when data was not normally distributed. P-values <0.05 were considered to be significant.

4 Results

4.1 Subject characteristics

No differences in characteristics were found between both groups: age (p= 0.093), gender (p= 1), height (p= 0.589), weight (p= 0.699), BMI (p= 0.818), fat mass (p= 0.485) and fat percentage (p= 0.818). The characteristics of the included participants are shown in table 1.

Table 1

Baseline subject characteristics

	MS	HC
EDSS	2.58 ± 2.29	/
Age (years)	43.44 ± 3.12	52.84 ± 10.29
Gender (f/M)	3/3	3/3
Height (m)	1.73 ± 0.09	1.75 ± 0.08
Weight (Kg)	73.88 ± 9.96	78.63 ± 12.02
BMI (kg/cm^2)	24.72 ± 2.07	25.57 ± 2.05
Fat mass (KG)	15.73 ± 3	18.15 ± 5.31
Fat (%)	23.68 ± 6.44	26.08 ± 8.58

Data are expressed as means ±SD and represent baseline characteristics. No significant between-groups differences were found. Abbreviations: BMI, Body Mass Index; cm, centimeter: EDSS, Expanded Disability Status Scale; f, female; Kg, kilogram; M, male; m, meter.

4.2 Outcome measures

4.2.1 Within group

Primary and secondary outcome measures for both groups at baseline (pre) and after 24 weeks (post) are presented in table 2-3 and graphically illustrated figure 3.

4.2.1.1 Inactive time

No statistically significant differences were found over time within groups. However, a non-significant increase in total inactive time per day is observed on the MS HIIT days (+15.6 ±82.8 min). A decrease is observed on MS resting (-25.8 ±108 min), MS endurance training (-2.4 ±56.4 min), HC resting (-48 ±111 min), HC endurance (-35.4 ±125.4 min), and HC HIIT days (-22.2 ± 105.6 min).

The % inactive time shows a stagnation in the MS endurance group of 0 ±4% and a 1 ±4% increase in the MS HIIT group. The MS rest (-2 ±8%), HC rest (-4 ±8%), HC endurance (-3 ± 8%) and HC HIIT (-2 ±8%) group show a decrease.

4.2.1.2 Step count

No significant differences were found in the total number of steps taken per day. The total number of steps taken per day increased at the end of the intervention compared to the beginning in all groups, except for the MS HIIT group with a decrease of 144 ±8169 steps. On the resting days in the MS group an increase of 355 ±5087 steps is notable and on endurance training days in MS an increase of 1998 ±4427 steps is observed. In all three of the HC conditions an increase in steps taken per day is observed, with an increase of 1569 ±8324 steps on the resting days, 3952 ±7661 steps on the endurance training days and 3736 ±5843 steps on the HIIT training days.

4.2.1.3 Non-wear time

Both groups show a non-significant decrease in non-wear time for both the resting days and HIIT days. In the HC group a decrease of 1.2 ±1.8 min is observed on resting days and a decrease of 1.8 ±12 min on HIIT days. In the MS group a decrease of 0.24 ±1.2 min is observed on resting days and a decrease of 2.4 ±19.8 min on HIIT days. Both the HC and MS group show a non-significant decrease in non-wear time on endurance training days of, respectively 1.8 ±20.4 min and 9 ±9.6 min.

4.2.1.4 Standing time

An increase in standing time is observed in the MS resting group, HC resting group, MS endurance training group and HC HIIT group, with respectively a 22.8 ±75.6, 28.2 ±93, 1.8 ±83.4 and 9.6 ±103.8 min increase. In the two MS exercise conditions a decrease in standing time is observed. There is a decrease of 30.6 ±41.4 minutes in the MS endurance group and a 11.4 ±44.4 minutes decrease in the MS HIIT group. However, none of these differences are significant.

In the MS resting group, HC resting group and HC HIIT group, an increase in %standing time is observed, with respectively a 1 ±5, 2 ±6 and 1 ±7 % increase. In the MS endurance group a 2 ±3% decrease is noticeable and in the MS HIIT group a 1±3% decrease. None of these differences are significant.

4.2.1.5 Sedentary time

A decrease in time spent sedentary is noticeable in both the MS resting group (-28.8 min ±87.6) and HC resting group (-65.4 ± 103.8 min). While on the endurance training days in the MS group there is a decrease (-25.2 ± 75.6 min) in sedentary time, there is an increase (+54.6 ±185.4 min) in the corresponding HC group. The opposite pattern is apparent concerning the HIIT days where there is an increase of 43.8 ±85.8 min in the MS group and a decrease of 49.2 ± 126 min in the HC group. However, none of these differences are significant.

Concerning the % sedentary time, the same tendency is observed. There is a decrease in the MS resting group (-2 ±6%), HC resting group (-5 ±7%), MS endurance group (-2 ±5%) and the HC HIIT group (-3 ±9%). In the HC endurance group there is an increase of +4 ±13 in %sedentary time and in the MS HIIT a 3 ±5% increase is observed. However, none of these differences are significant.

4.2.1.6 Sleeping time

On the resting days there is an increase in sleeping time for both the MS and HC group with an increase of, respectively 1.2 ±130.8 min and 1.2 ±39 min. In the MS endurance group an increase of 3 ±63.6 min was observed, while in the HC endurance group there was a decrease of 90 ±126 min sleeping time. On the HIIT days there is a decrease of 18 ±19.8 min in the MS group and a 18.6 ±31.2 min increase in the HC group. However no differences were found to be significant.

4.2.2 Between group

Primary and secondary outcome measures between both groups at baseline (pre) and after 24 weeks (post) are presented in table 2-3 and graphically illustrated figure 3.

4.2.2.1 Inactive time

The HC group spends both in the beginning of the intervention (pre) and the end of the intervention (post) more time inactive per day, respectively 27 ±222 min and 4.8 ±138 min. Concerning the % inactive time, there is a difference of 2 ±16% between MS and HC pre intervention and a 0 ±10% difference post intervention,

The MS group spends less time siting on endurance training days, both pre and post, and at the beginning at HIIT days. The MS group spends 48.6 ±180 min less inactive per day and 5±12% per % wear time in the beginning of the endurance training and 15.6 ±138 min less inactive per day and 1 ±11% per wear time at the end of the endurance training. On HIIT days the MS group spends 34.8 ±156 min less inactive per day and 2 ±11% less inactive per wear time.

At the end of the HIIT intervention the MS group spends more time inactive, with a 3 ±36 min difference in terms of total time per day and a 1 ±3% difference in terms of inactive time per wear time. However, none of these differences were found to be significant.

4.2.2.2 Step count

On the pre rest, pre endurance, pre HIIT, post rest and post endurance days, respectively 3341 ±12123, 5853 ±8994, 756 ±8511, 2127 ±6015 and 3899 ±8299 more steps are taken per day in the MS group.

At the end of the HIIT days less steps per day are taken in the MS group compared to the HC group (3124 ±4845 steps). None of the mentioned differences were significant.

4.2.2.3 Non-wear time

No significant differences were found comparing non-wear time. The non-wear time was higher in the HC group in the beginning of the intervention for resting days (0.6 ±2.4 min) and endurance training days (6.6 ±13.2 min). On pre HIIT days, post resting days, post endurance training days and post HIIT days, the non-wear time was higher in the MS group with a, respectively 7.2 ±4.8 min, 0.6 ±0.6 min, 0.6 ±16.8 min, 6.6 ±18 min difference.

4.2.2.4 Standing time

No significant differences were found between standing time. For every condition, except for Post resting days (4.2 ±282 min difference), the MS group spends more time standing than the HC group with a 1.2 ±216 min difference on pre resting days, a 43.2 ±186 min difference on pre endurance training days, a 27.6 ±78 difference on pre HIIT days, a 10.8 ±264 min difference on pos endurance training days and a 6.6 ±318minutes difference on post HIIT days.

For every condition, except for pre (0 ±10%) and post resting days (1 ±11% difference), the MS group spends more %standing time than the HC group with a 3 ±7% difference on pre endurance days, a 3 ±7 difference on pre HIIT days, a 1 ±6% difference on post endurance training days and a 1 ±3% difference on post HIIT days.

4.2.2.5 Sedentary time

On both pre and post resting days the time spent sedentary was higher in the MS group compared with the HC group, with a difference of respectively 14.4 ±264 min and 51.6 ±186 min. The sedentary time was lower in MS when comparing the pre HIIT (36.6 ±234 min) and the post endurance training days (24 ±282 min). The opposite pattern is present comparing pre endurance training and post HIIT days, with respectively 55.8 ±204 min and 56.4 ±228 min spent more sedentary in the MS group.

On both pre and post resting days the % sedentary time was higher in the MS group compared with the HC group, with a difference of respectively 1 ±27% and 4 ±20%. The sedentary time was lower in MS when comparing the pre HIIT (2 ±21%) and the post endurance training days (2 ±18%). The opposite pattern is present comparing pre endurance training and post HIIT days, with respectively 4 ±13% and 4 ±22% more % sedentary time in the MS group.

4.2.2.6 Sleeping time

Except for post endurance, where MS spends 1.8 ±78 min more sleeping, less time is spend sleeping in MC compared with HC. Pre endurance there is a 90.6 ±102 min difference favoring the sleeping time in HC. On the pre and post resting days there is, respectively 43.8 ±138 min and 43.2 ±162 min less sleeping time in MS. The differences comparing the HIIT days shows that the MS group had 17.4 ±96 min less sleep time comparing the pre HIIT days and 54 ±48 min less sleep comparing the post HIIT days.

Table 2

Primary outcome measures for both groups at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

	MS								
	Rest			Endurance			HIIT		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
	(n=6/6/6)	(n=6/6/6)		(n=6/6/6)	(n=6/6/6)		(n=5/5/5)	(n=5/5/5)	
IT (h)	16.23 ±2.66	15.80 ±1.67	-25.8 ±108	15.51 ±1.75	15.47 ±1.48	-2.4 ±56.4	16.34 ±2.07	16.61 ±1.68	+15.6 ±82.2
SC (N)	17673 ±8704	18028 ±5113	+355 ±5087	28951 ±7515	30949 ±4858	+1998 ±4427	16558 ±6588	16414 ±5761	-144 ±8169
NW-time (h)	0.03 ±0.02	0.02 ±0.01	-0.24 ±1.2	0.10 ±0.10	0.25 ±0.19	+9 ±9.6	0.30 ±0.16	0.27 ±0.20	-2.4 ±19.8
	HC								
	Rest			Endurance			HIIT		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
	(n=6/6/6)	(n=6/6/6)		(n=6/6/6)	(n=6/6/6)		(n=5/5/5)	(n=5/5/5)	
IT (h)	16.68 ±2.25	15.88 ±1.78	-48 ±111	16.32 ±1.46	15.73 ±1.26	-35.4 ±125.4	16.93 ±1.04	16.56 ±1.33	-22.2 ±105.6
SC (N)	14332 ±7470	15901 ±4296	+1569 ±8324	23098 ±5714	27050 ±4568	+3952 ±7661	15802 ±4344	19538 ±4607	+3736 ±5843
NW-time (h)	0.04 ±0.03	0.02 ±0.00	-1.2 ±1.8	0.21 ±0.24	0.24 ±0.22	+1.8 ±20.4	0.18 ±0.14	0.16 ±0.14	-1.8 ±12

Data are expressed as means ±SD and show primary outcome measures pre- and post-intervention. No significant within-group differences were found. Abbreviations: Diff, Difference; HC, Healthy Controls; HIIT, High Intensity Interval training; IT, Inactive Time per day; MS, Multiple Sclerosis; NW-time, Non-Wear time; SC, Step Count. Differences in time are expressed in minutes.

Table 3

Secondary outcome measures for both groups at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

	MS								
	Rest			Endurance			HIIT		
	Pre (n=6/6/3/3/3/3)	Post (n=6/6/3/3/3/3)	Diff	Pre (n=6/6/4/4/4/4)	Post (n=6/6/4/4/4/4)	Diff	Pre (n=5/5/3/3/3/3)	Post (n=5/5/3/3/3/3)	Diff
%IT	68 ±11	66 ±7	-2 ±8	65 ±7	65 ±6	0 ±4	69 ±9	70 ±7	+1 ±6
ST (h)	5.95 ±1.69	6.33 ±1.44	+22.8 ± 75.6	5.40 ±0.86	4.89 ±0.94	-30.6 ±41.4	5.34 ±1.22	5.15 ±1.06	-11.4 ±44.4
%ST	25 ±7	26 ±6	+1 ±5	23 ±4	21 ±4	-2 ±3	23 ±5	22 ±5	-1 ±3
SET (h)	9.09 ±3.14	8.62 ±2.08	-28.8 ±87.6	8.59 ±2.22	8.17 ±1.81	-25.2 ±75.6	8.76 ±2.32	9.49 ±2.44	+43.8 ±85.8
%SET	38 ±13	36 ±9	-2 ±6	36 ±9	34 ±7	-2 ±5	37 ±10	40 ±10	+3 ±5
SLT (h)	6.85 ±2.04	6.88 ±1.55	+1.2 ±130.8	6.99 ±1.35	7.04 ±1.66	+3.00 ±63.6	7.16 ±0.23	6.86 ±0.19	-18 ± 19.8
	HC								
	Rest			Endurance			HIIT		
	Pre (n=6/6/5/5/5/5)	Post (n=6/6/5/5/5/5)	Diff	Pre (n=6/6/6/6/6/6)	Post (n=6/6/6/6/6/6)	Diff	Pre (n=5/5/5/5/5/5)	Post (n=5/5/5/5/5/5)	Diff
%IT	70 ±9	66 ±7	-4 ±8	69 ±5	66 ±5	-3 ±8	71 ±4	69 ±6	-2 ±8
ST (h)	5.93 ±168	6.40 ±1.44	+28.2 ±93	4.68 ±1.22	4.71 ±0.79	+1.8 ±83.4	4.88 ±1.22	5.04 ±1.13	+9.6 ±103.8
%ST	25 ±7	27 ±6	+2 ±6	20 ±5	20 ±3	0 ±6	20 ±5	21 ±5	+1 ±7
SET (h)	8.85 ±2.32	7.76 ±0.84	-65.4 ±103.8	7.66 ±1.66	8.56 ±3.00	+54.6 ±185.4	9.38 ±1.79	8.56 ±2.38	-49.2 ±126
%SET	37 ±10	32 ±4	-5 ±7	32 ±7	36 ±12	+4 ±13	39 ±8	36 ±10	-3 ±9
SLT (h)	7.58 ±0.90	7.59 ±1.14	+1.2 ±39	8.50 ±0.53	7.00 ±2.11	-90 ±126	7.45 ±0.81	7.76 ±1.31	+18.6 ±31.2

Data are expressed as means ±SD and show secondary outcome measures pre- and post-intervention. No significant within-group differences were found. Abbreviations: %IT, % Inactive Time; %SET, % Sedentary Time; %ST, % Standing Time; Diff, Difference; HC, Healthy Controls; HIIT, High Intensity Interval training; MS, Multiple Sclerosis; SET, Sedentary Time; SLT, Sleep Time; ST, Standing Time. Differences in time are expressed in minutes.

Table 4

Primary outcome measures comparing both groups at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

				pre					
	Rest			Endurance			HIIT		
	MS	HC	Diff	MS	HC	Diff	MS	HC	Diff
	(n=6/6/6)	(n=6/6/6)		(n=6/6/6)	(n=6/6/6)		(n=5/5/5)	(n=5/5/5)	
IT (h)	16.23 ±2.66	16.68 ±2.25	27 ±222	15.51 ±1.75	16.32 ±1.46	48.6 ±180	16.34 ±0.09	16.93 ±1.04	34.8 ±156
SC (N)	17673 ±8704	14332 ±7470	3341 ±12123	28951 ±7515	23098 ±5714	5853 ±8994	16558 ±276	15802 ±4344	756 ±8511
NW-time (h)	0.03 ±0.02	0.04 ±0.03	0.6 ±2.4	0.10 ±0.10	0.21 ±0.24	6.6 ±13.2	8.76 ±2.32	0.18 ±0.14	7.2 ±4.8
				Post					
	Rest			Endurance			HIIT		
	MS	HC	Diff	MS	HC	Diff	MS	HC	Diff
	(n=6/6/6)	(n=6/6/6)		(n=6/6/6)	(n=6/6/6)		(n=5/5/5)	(n=5/5/5)	
IT (h)	15.80 ±1.67	15.88 ±1.78	4.8 ±138	15.47 ±1.48	15.73 ±1.26	15.6 ±138	16.61 ±0.07	16.56 ±1.33	3 ±36
SC (N)	18028 ±5113	15901 ±4296	2127 ±6015	30949 ±4858	27050 ±4568	3899 ±8229	16414 ±246	19538 ±4607	3124 ±4845
NW-time (h)	0.02 ±0.01	0.02 ±0.00	0.6 ±0.6	0.25 ±0.19	0.24 ±0.22	0.6 ±16.8	9.49 ±2.44	0.16 ±0.14	6.6 ±18

Data are expressed as means ±SD and show primary outcome measures pre- and post-intervention. No significant between group differences were found. Abbreviations: Diff, Difference; HC, Healthy Controls; HIIT, High Intensity Interval training; IT, Inactive Time per day; MS, Multiple Sclerosis; NW-time, Non-Wear time; SC, Step Count. Differences in time are expressed in minutes.

Table 5

Secondary outcome measures comparing both groups at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

	MS								
	Rest			Endurance			HIIT		
	Pre (n=6/6/3/3/3/3)	Post (n=6/6/5/5/5/5)	Diff	Pre (n=6/6/4/4/4/4)	Post (n=6/6/6/6/6/6)	Diff	Pre (n=5/5/3/3/3/3)	Post (n=5/5/5/5/5/5)	Diff
%IT	68 ±11	70 ±9	2 ±16	65 ±7	70 ±6	5 ±12	69 ±9	71 ±4	2 ±11
ST (h)	5.95 ±1.69	5.93 ±1.68	1.2 ±216	5.40 ±0.86	4.68 ±1.22	43.2 ±186	5.34 ±1.22	4.88 ±1.22	27.6 ±78
%ST	25 ±7	25 ±7	0 ±10	23 ±4	20 ±5	3 ±7	23 ±5	20 ±5	3 ±7
SET (h)	9.09 ±3.14	8.85 ±2.32	14.4 ±264	8.59 ±2.22	7.66 ±1.66	55.8 ±204	8.76 ±2.32	9.38 ±1.79	36.6 ±234
%SET	38 ±13	37 ±10	1 ±27	36 ±9	32 ±7	4 ±13	37 ±10	39 ±8	2 ±21
SLT (h)	6.85 ±2.04	7.58 ±0.90	43.8 ±138	6.99 ±1.35	8.50 ±0.53	90.6 ±102	7.16 ±0.23	7.45 ±0.81	17.4 ±96
	HC								
	Rest			Endurance			HIIT		
	Pre (n=6/6/3/3/3/3)	Post (n=6/6/5/5/5/5)	Diff	Pre (n=6/6/4/4/4/4)	Post (n=6/6/6/6/6/6)	Diff	Pre (n=5/5/3/3/3/3)	Post (n=5/5/5/5/5/5)	Diff
%IT	66 ±7	66 ±7	0 ±10	65 ±6	66 ±5	1 ±11	70 ±7	69 ±6	1 ±3
ST (h)	6.33 ±1.44	6.40 ±1.44	4.2 ±282	4.89 ±0.94	4.71 ±0.79	10.8 ±264	5.15 ±1.06	5.04 ±1.13	6.6 ±318
%ST	26 ±6	27 ±6	1 ±11	21 ±4	20 ±3	1 ±6	22 ±5	21 ±5	1 ±3
SET (h)	8.62 ±2.08	7.76 ±0.84	51.6 ±186	8.17 ±1.81	8.56 ±3.00	24.0 ±282	9.49 ±2.44	8.56 ±2.38	56.4 ±228
%SET	36 ±9	32 ±4	4 ±20	34 ±7	36 ±12	2 ±18	40 ±10	36 ±10	4 ±22
SLT (h)	6.88 ±1.55	7.59 ±1.14	43.2 ±162	7.04 ±1.66	7.00 ±2.11	1.8 ±78	6.86 ±0.19	7.76 ±1.31	54 ±48

Data are expressed as means ±SD and show secondary outcome measures pre- and post-intervention. No significant between group differences were found. Abbreviations: %IT, % Inactive Time; %SET, % Sedentary Time; %ST, % Standing Time; Diff, Difference; HC, Healthy Controls; HIIT, High Intensity Interval training; MS, Multiple Sclerosis; SET, Sedentary Time; SLT, Sleep Time; ST, Standing Time. Differences in time are expressed in minutes.

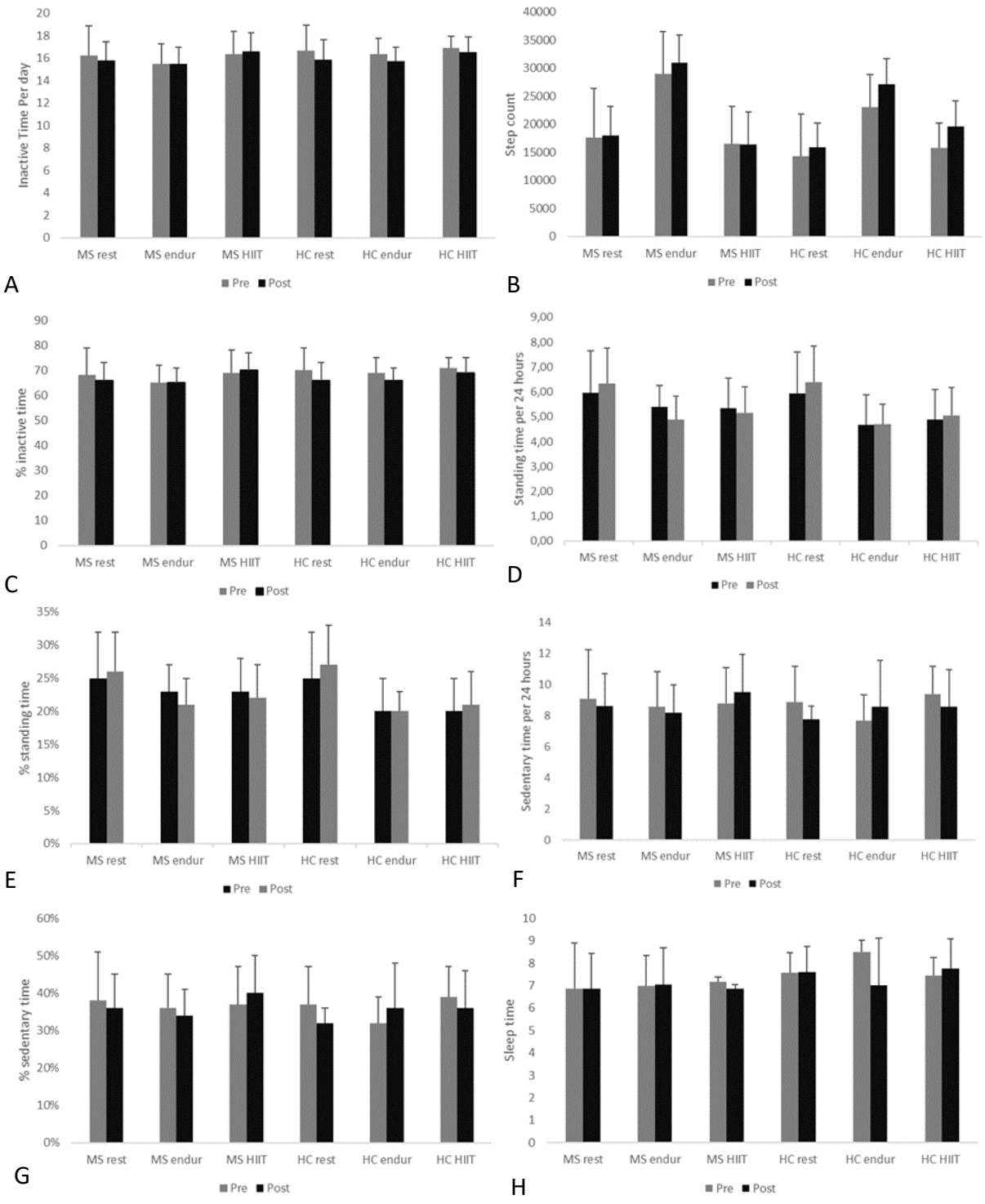

Figure 3. Graphic illustration of the outcome measures (A) Inactive Time Per Day (B) Step Count Per Day (C) % Inactive Time (D) Standing Time per day (E) % Standing Time (F) Sedentary time per day (G) % Sedentary time and (H) Sleep time for both groups (HC and MS), at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

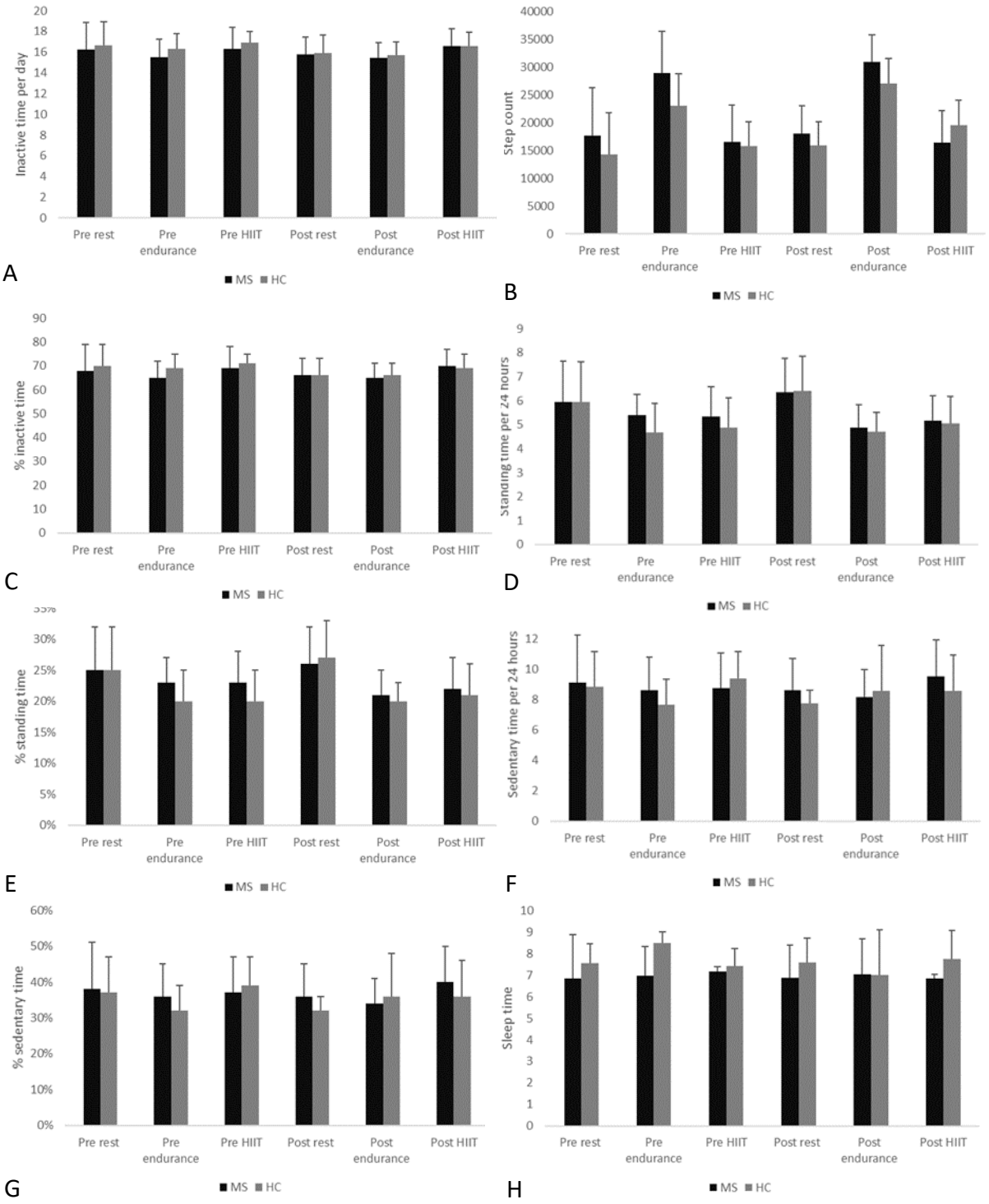

Figure 4. Graphic illustration of the outcome measures comparing both groups (A) Inactive Time Per Day (B) Step Count Per Day (C) % Inactive Time (D) Standing Time per day (E) % Standing Time (F) Sedentary time per day (G) % Sedentary time and (H) Sleep time between both groups (HC and MS), at baseline (pre-intervention) and after 24 weeks periodized home training (post-intervention).

Table 6

Analysis of endurance training duration for PwMS and HC at the beginning (pre) and ending (post).

					MS				
	Day 1 pre	Day 2 pre	Day 3 pre	Day 1 post	Day 2 post	Day 3 post	Mean pre	Mean post	Diff pre-post
1.10	1.34	2.39	2.65	1	2.3	2.86	2.13	2.05	-0.07
1.12	1.33	2.33	1.84	2.29	3.5	1.75	1.83	2.51	0.68
1.11	1.76	2.05	1.42	3.26	1.39	3.37	1.74	2.67	0.93
1.4	1.35	1.85	2.64	3.37	1.83	2.63	1.95	2.61	0.66
1.3	1.44	2.67	2.07	2.58	1.9	2.57	2.06	2.35	0.29
1.19	3.47	1.73	2.23	2.54	1.31	2.78	2.48	2.21	-0.27
Mean							2.03 ±0.26	2.40 ±0.24	0,37 ±0.47
					HC				
	Day 1 pre	Day 2 pre	Day 3 pre	Day 1 post	Day 2 post	Day 3 post	Mean pre	Mean post	Diff pre-post
2.14	1.85	2.39	1.73	2.19	2	2.99	1.99	2.39	0.40
2.17	1.46	1.81	1.41	2.08	2.19	2.33	1.56	2.20	0.64
2.11	1.07	2.64	2.27	3.33	2.75	1.44	1.99	2.51	0.51
2.10	1.31	2.62	1.87	1.41	1.53	2.24	1.93	1.73	-0.21
2.12	2.44	2.62	2.18	3.06	1.5	2.47	2.41	2.34	-0.07
2.1	2.05	2.21	2.06	1.93	2.17	2.77	2.11	2.29	0.18
Mean							2.00 ±0.28	2.24 ±0.27	0.24 ±0.33

Data are expressed as means and means ±SD and show endurance training duration. Abbreviations: Diff, Difference; HC, Healthy Controls; MS, Multiple Sclerosis. Time and differences in time are expressed in hours.

5 Discussion

The aim of the study was to analyze whether compensatory behavior is present in PwMS when performing a periodized training program, to explore why HIIT in PwMS is not so efficient to reduce cardiovascular risk factors as it is in healthy persons (Viana, Naves et al. 2019). Although no significant differences were found, it might be clinically relevant that the change in primary and secondary parameters in PwMS on the days performing HIIT training are smaller, compared with the improvements made on either resting days or endurance training days or any of these three conditions in healthy controls.

The total inactive time, consisting of sitting, lying and sleeping, decreases in every group, excepted for MS HIIT (+15.6 min) when comparing within measurements from the first weeks of the 6-month training program, compared with the last weeks. The same tendency is noticeable comparing % inactive time of the wear time, showing an increase (+0.6 min) of inactive time in MS HIIT and a stagnation in the MS endurance group. It needs to be noted that the endurance training duration progressively increased each training cycle. Analysis from the training data (table 6) from the MS endurance trainings reveals an average training duration of 2.03 hours pre training and 2.40 hours post training. This average increase in training duration of 22.2 minutes would be expected to cause an elevation in time spent active over time and as such, decrease time spent inactive. Yet there is only a small decrease (2.4 min) in time spent inactive per day and even a stagnation in % inactive time per wear time. Keeping this in mind, there is a considerable chance that this small increase in the MS endurance group is only caused by the progression of the training and possibly a similar study with a continuous training duration would find an increase in inactive time. However, because participant need to start and stop their training registration manually, it is possible that this info is not accurate, since it is possible that they forget any of the two actions immediately after starting or stopping the training session.

When breaking down inactive time in sleeping time and % sedentary time, a decrease in % sedentary time is observed in every group, except for MS HIIT (+ 3%) and HC endurance (+4 %) and an increase in sleeping time is observed in every group, again except for the MS HIIT (-18 min) and HC endurance group (-90 min).

The number of steps taken per day decreased in PwMS performing HIIT (-144 steps), while in the other five groups there was an increase in the number of steps. However, none of the above findings were significant.

Although it has been proven that PwMS spent more time sedentary than HC (Veldhuijzen van Zanten, Pilutti et al. 2016), the PwMS in this analysis spent less time sedentary in two of six groups, pre HIIT (-2%) and post endurance (-2%). Furthermore, the PwMS spent less time inactive compare to the HC, both per day and per % wear time, and take more steps per day in every condition, except for post HIIT. This indicates that the MS group was remarkably active and the presence of a possible sampling bias. Since the goal was to climb the Mont Ventoux, possibly more active PwMS might have been attracted. This can also explain the low mean EDSS in the MS group, indicating little impact on physical performance. Due to the fact that the sedentary time is higher in PwMS in four of six conditions, supporting the earlier mentioned finding (Veldhuijzen van Zanten, Pilutti et al. 2016), PwMS can possibly benefit from interventions focused on the reduction of sedentary time, additional to exercise programs, especially performing HIIT. A possible explanation for the increased sedentary time in MS could possibly be that the already apparent fatigue in MS (Braley and Chervin 2010), enlarges as reaction to training.

Although the MS group performs better compared with HC on multiple parameters, the within changes through the intervention are not as great as in the HC group. For instance, the MS group takes 354 mores steps on resting days and 1998 more steps on endurance training days at the end compared with the beginning. However, in the corresponding HC groups the changes are bigger with, respectively 1570 and 3952 steps. This same tendency of decreased effectivity in PwMS is also apparent concerning inactive time, when compared with the HC.

On resting days and endurance training days improvements are not as great in PwMS than in HC. However, performing HIIT in MS there are no improvements for inactive time and step count, in contrary a relapse is seen in both of these outcomes, with a decrease of 144 steps and 15.6 minutes spent more inactive. This indicates the possibility of compensatory behavior in PwMS performing HIIT, indicating why HIIT is not so effective in PwMS to improve CVD risk as it is in healthy persons. However, if compensatory behavior is apparent in PwMS, it is probably not the only reason for the lacking effect of training programs on CVD risk.

An abnormal muscular energy metabolism and the possibility that PwMS are not able to reach the required maximal exercise intensities to affect these outcomes, have already been suggested as possible hypothesis for the limited effect on CVD risk factors (Keytsman, Hansen et al. 2019).

Consequently, PwMS might benefit more from an alternative, more feasible physical activity approach, such as replacing sedentary time with low-intensity physical activity.

Despite the fact that HIIT has already been proven to improve CVD risk in a healthy population, such as fat mass (Viana, Naves et al. 2019), no improvement in fat mass was found in the HC group of the original study from which the data for this study was extracted. Possible explanations for this lacking effect could be that the implemented combination of training duration and intensity are not sufficient to reduce fat mass, a rather small sample size or participants not meeting the prescribed training intensities and durations.

Since this was a retrospective study, a few disadvantages are present. A first drawback in this research is the fact that the data used was measured by a wrist worn consumer-grade activity monitor (polar M200). There is no information available about the validity of this measuring device and in particular for the group of PwMS the evidence about the validation of consumer-grade activity monitors is scarce. However, one study was found investigating the validity of a comparable consumer-grade activity monitor, the polar M430 (Polar Electro Oy, Kempele, Finland) in HC (Henriksen, Grimsgaard et al. 2019).

Henriksen et al. noted that the M430 overreports step counting, yet shows a very strong correlation. Furthermore, preliminary data, comparing the validity of the polar M200 compared with the Activpal3 (PAL technologies, Glasgow, United Kingdom), shows moderate reliability considering inactive time and excellent reliability for measuring step count, in a population of PwMS and HC.

Taking this into account, the numbers of steps measured and the time spent sitting and lying should be considered useful. However, sedentary behavior is also an important factor concerning cardiovascular risk factors. The polar M200 does not measure sedentary behavior, but time spent sitting and lying, which includes sleeping. Therefore, this cannot be defined as sedentary behavior, since sedentary behavior is characterized by waking activities (Pate, O'Neill et al. 2008).

Due to the fact that the polar does measure sleeping time, the sedentary time can be calculated by extracting the sleeping time from the time spent sitting and lying. The downside to this method is that it relies on both valid information of time spent inactive and about the sleeping registration from the polar, which is not available yet. Also, depending on the condition, sleeping data from only 3-6 participant was available and thus only info about sedentary time of 3-6 participants is available.

A shortcoming in the outcome variable time spent sedentary, is that it reveals how much time was spent sedentary, but no in which manner sedentary time was accumulated. For example, it has already been proven in HC that interrupting sitting time has a positive effect on postprandial glucose, compared with continuous sitting (Brocklebank, Andrews et al. 2017).

Data was available from 35 participants, but only data from 12 participants was included for both the rest days and the endurance training. The HIIT group consisted of only 10 participants, leading to a small sample size. Because days, in any of the three conditions, were only considered valid if there was a non-wear time ≤ 1 hour and these were scarce, only three days per condition were included leading to a limited data sample.

Due to the fact that there were in the original study no guidelines about a minimal resting period between two trainings, it happened that participants performed two trainings on two consecutive days. It is plausible that the time spent inactive increases the days after executing two trainings on two consecutive days compared to only executing one training followed by one or two resting days.

Since the dates were chronologically screened for validity, both weekdays and weekend days can be included, causing week- and weekend days to be randomly compared. However, during the week most of the subjects are occupied with their work and are not in the weekend, causing the organization of time to be totally different, making it not ideal to compare these with each other. Consequently, it is recommended to break these down into two different analyses in future research.

During screening it was notable that the wear time of the polar was less on days of either endurance training or HIIT compared to resting days during the 6-month period. A possible hypothesis explaining this phenomenon could be removing the device before showering for convenience and forgetting to wear it again.

Another explanation could be that after training participants compensate by a prolonged period of sitting, causing an inactivity alert on their watch after 55 minutes of sitting behavior. This message goes away with movement or when the button is pressed. However, in the last case of pressing the button, where one keeps on sitting, after 5 minutes of sitting an inactivity stamp is placed. This can be observed by the researchers, through the online platform, indicating how many stamps are collected per day. It is possible that this influenced participants' behaviour and that they did not wear the polar to avoid the researchers to see this. Since the participants were aware they were being monitored, it is also possible this influenced their behavior, also know as the Hawthorne-effect, where participants show deviant behavior due to the fact that they know they are being observed (Schwartz, Fischhoff et al. 2013).

The less wear time on training days causes a discrepancy between both individuals as well as the three conditions (rest, endurance training or HIIT). Because of the higher prevalence of resting days, measurements were for most participants at the beginning and ending of the 12 weeks, half of march and respectively the end of august, causing a mean difference between pre-and post-measurement of 21 weeks. However for two training conditions the included pre and post days are closer to each other, on average, only 15 weeks apart for the HIIT and 11 weeks apart from each other for the endurance training. However, similar periods between measurements were observed in the healthy controls.

Although more resting days with a sufficient wear time were available, it occurred that both one or two days after an endurance training were considered as resting day for some participants but for others the resting days were one or two days after HIIT. There has not been any research investigating the compensatory response to endurance training compared with the compensatory response to HIIT, but it could be possible that this differs, however in this present study both resting days after HIIT and endurance training were added together. Future research with this as primary research question is warranted.

Participants were required to register every training through their polar, manually starting and stopping the registration at respectively the beginning and ending of their training. It is possible that participants did not registered all their training sessions, whereby days that were included as resting days, might not have been actual resting days. There were also participants who also did additional sport activities, such as hockey or cycling.

This not only indicates possible different levels of activity between participants, but in case of cycling it is possible that a day where a participant registered a recreational bicycle ride, this can be included as a training day. Furthermore, due the fact that the polar was worn around the wrist and no information about validity is available, it is possible that in sports requiring excessive arm movements, these arm movements affect the measurements from the polar.

This study focused on the compensatory behavior as response to training by compensating with less activity during the rest of the day(s), which is a behavioral compensatory response. Another type of behavioral compensatory response that can be important in body and health is change in diet. It is possible that subjects in response to exercise eat more calories or eat unhealthier (King, Caudwell et al. 2007). The timing of food intake is also important. It has been shown that a snack of fructose or glucose before exercise significantly lowers fat oxidation (Horowitz, Mora-Rodriguez et al. 1997). Because no information was available about the diet of the participants, it was not possible to investigate this.

Another important element in the outcome of an exercise program is sleep, since a correlation between reduced sleep and a higher BMI has been shown (Gangwisch, Malaspina et al. 2005). This is due to the fact that reduced sleeping time leads to lower leptin and elevated ghrelin levels and therefore likely to increase appetite (Spiegel, Tasali et al. 2004). One study showing that three hours less sleep, 5.5 hours versus 8.5 h, leads to 55% less fat mass and 60% more lean body mass loss (Nedeltcheva, Kilkus et al. 2010), indicating the importance of sleep quality. Compared to the HC the PwMS in this study show a reduced sleeping time, but since there is no information available about the validity of the used activity tracker and no sleep diary was used in the original study, it was not possible to measure a possible influence from training on sleep pattern in PwMS.

6 Recommendations for future research

Important in future research is the use of a validated activity monitor, preferably one that is validated in the population of PwMS. A bigger sample size with more valid registered days is also recommended. Ideally a valid day should be considered a full day (24 hours wear time) instead of the ≥ 23 hours wears time. Additionally it is possible to ask participants to note sleeping time to distinguish between time spent sitting or lying and time spent sedentary, since sedentary behavior does not include sleeping. This also makes it possible to investigate the effect of exercise on sleep in PwMS. Considering the effect of compensatory behavior and the possibility that more or less compensation depends on the type of exercise, it is warranted that future research about compensatory behavior only focuses on only one exercise modality, such as either endurance training or either HIT instead of the effect of both. It is also important to define in advance from which days data is going to be extracted, for example each first day after the intervention for resting days. Furthermore, it is important to distinguish between weekdays and weekend days. Due to the fact that compensatory behavior can manifest as well by a decrease in energy expenditure, but also by an increase in food intake, the use of a food dairy in future research is also recommended, whereby also the timing of intake can be noted since this can also affect the outcome. The inclusion of PwMS with higher EDSS score is also suggested, because of the possible proportional relationship between EDSS and compensatory behavior.

7 Conclusion

A 24-week periodized home-based training consisting of both endurance training and high intensity interval training has no significant influence on the time spent inactive, step count, sedentary time or sleep time in persons with multiple sclerosis. However, current results might be clinically relevant. PwMS seem to perform better than HC, but the magnitude of improvement from pre- to post intervention is smaller in MS than in HC. The increase of inactive and sedentary time together with the decreased number of steps can might show the presence of compensatory behavior and such, explain why a periodized training program, and in particular HIIT, does not improve cardiovascular risk in PwMS like it does in a healthy population. However, since this research consists of preliminary data with a limited sample size, further research is warranted.

8 Abbreviations

%IT: % Inactive time

%SET: % Sedentary time

%ST: % Standing time

BMI: Body mass index

CNS: Central nervous system

CVD: Cardiovascular risk

HC: Healthy controls

HIIT: High intensity interval training

ICC: Inter Class Correlation

IT: Inactive time per day

MET: Metabolic equivalent units

Min: Minutes

MS: Multiple sclerosis

NW-time: Non-wear time

PhD: Doctor of Philosophy

PwMS: Persons with multiple sclerosis

SC: Step count

SET: Sedentary time

SLT: Sleep time

ST: Standing time

9 References

Braley, T. J. and R. D. Chervin (2010). "Fatigue in multiple sclerosis: mechanisms, evaluation, and treatment." Sleep **33**(8): 1061-1067.

Brocklebank, L. A., R. C. Andrews, A. Page, C. L. Falconer, S. Leary and A. Cooper (2017). "The Acute Effects of Breaking Up Seated Office Work With Standing or Light-Intensity Walking on Interstitial Glucose Concentration: A Randomized Crossover Trial." J Phys Act Health **14**(8): 617-625.

Cameron, M. H. and Y. Nilsagard (2018). "Balance, gait, and falls in multiple sclerosis." Handb Clin Neurol **159**: 237-250.

Correale, J., M. I. Gaitan, M. C. Ysrraelit and M. P. Fiol (2017). "Progressive multiple sclerosis: from pathogenic mechanisms to treatment." Brain **140**(3): 527-546.

Coulter, E. H., L. Miller, S. McCorkell, C. McGuire, K. Algie, J. Freeman, B. Weller, P. G. Mattison, A. McConnachie, O. Wu and L. Paul (2017). "Validity of the activPAL3 activity monitor in people moderately affected by Multiple Sclerosis." Med Eng Phys **45**: 78-82.

Gangwisch, J. E., D. Malaspina, B. Boden-Albala and S. B. Heymsfield (2005). "Inadequate sleep as a risk factor for obesity: analyses of the NHANES I." Sleep **28**(10): 1289-1296.

Grant, P. M., C. G. Ryan, W. W. Tigbe and M. H. Granat (2006). "The validation of a novel activity monitor in the measurement of posture and motion during everyday activities." Br J Sports Med **40**(12): 992-997.

Horowitz, J. F., R. Mora-Rodriguez, L. O. Byerley and E. F. Coyle (1997). "Lipolytic suppression following carbohydrate ingestion limits fat oxidation during exercise." Am J Physiol **273**(4): E768-775.

Kaminska, J., O. M. Koper, K. Piechal and H. Kemona (2017). "Multiple sclerosis - etiology and diagnostic potential." Postepy Hig Med Dosw (Online) **71**(0): 551-563.

Kent-Braun, J. A., A. V. Ng, M. Castro, M. W. Weiner, D. Gelinas, G. A. Dudley and R. G. Miller (1997). "Strength, skeletal muscle composition, and enzyme activity in multiple sclerosis." J Appl Physiol (1985) **83**(6): 1998-2004.

Keytsman, C., B. O. Eijnde, D. Hansen, K. Verboven and I. Wens (2017). "Elevated cardiovascular risk factors in multiple sclerosis." Mult Scler Relat Disord **17**: 220-223.

Keytsman, C., D. Hansen, I. Wens and O. E. B (2019). "Impact of high-intensity concurrent training on cardiovascular risk factors in persons with multiple sclerosis - pilot study." Disabil Rehabil **41**(4): 430-435.

Keytsman, C., P. Van Noten, J. Spaas, I. Nieste, P. Van Asch and B. O. Eijnde (2019). "Periodized home-based training: A new strategy to improve high intensity exercise therapy adherence in mildly affected patients with Multiple Sclerosis." Mult Scler Relat Disord **28**: 91-97.

King, N. A., P. Caudwell, M. Hopkins, N. M. Byrne, R. Colley, A. P. Hills, J. R. Stubbs and J. E. Blundell (2007). "Metabolic and behavioral compensatory responses to exercise interventions: barriers to weight loss." Obesity (Silver Spring) **15**(6): 1373-1383.

King, N. A., K. Horner, A. P. Hills, N. M. Byrne, R. E. Wood, E. Bryant, P. Caudwell, G. Finlayson, C. Gibbons, M. Hopkins, C. Martins and J. E. Blundell (2012). "Exercise, appetite and weight management: understanding the compensatory responses in eating behaviour and how they contribute to variability in exercise-induced weight loss." Br J Sports Med **46**(5): 315-322.

Koo, T. K. and M. Y. Li (2016). "A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research." J Chiropr Med **15**(2): 155-163.

Kubota, Y., K. R. Evenson, R. F. Maclehose, N. S. Roetker, C. E. Joshu and A. R. Folsom (2017). "Physical Activity and Lifetime Risk of Cardiovascular Disease and Cancer." Med Sci Sports Exerc **49**(8): 1599-1605.

Matthews, C. E., S. M. George, S. C. Moore, H. R. Bowles, A. Blair, Y. Park, R. P. Troiano, A. Hollenbeck and A. Schatzkin (2012). "Amount of time spent in sedentary behaviors and cause-specific mortality in US adults." Am J Clin Nutr **95**(2): 437-445.

Motl, R. W. and J. L. Gosney (2008). "Effect of exercise training on quality of life in multiple sclerosis: a meta-analysis." Mult Scler **14**(1): 129-135.

Nedeltcheva, A. V., J. M. Kilkus, J. Imperial, D. A. Schoeller and P. D. Penev (2010). "Insufficient sleep undermines dietary efforts to reduce adiposity." Ann Intern Med **153**(7): 435-441.

Ng, A. V. and J. A. Kent-Braun (1997). "Quantitation of lower physical activity in persons with multiple sclerosis." Med Sci Sports Exerc **29**(4): 517-523.

Nicholas, R. and W. Rashid (2013). "Multiple sclerosis." Am Fam Physician **87**(10): 712-714.
Pate, R. R., J. R. O'Neill and F. Lobelo (2008). "The evolving definition of "sedentary"." Exerc Sport Sci Rev **36**(4): 173-178.

Schwartz, D., B. Fischhoff, T. Krishnamurti and F. Sowell (2013). "The Hawthorne effect and energy awareness." Proc Natl Acad Sci U S A **110**(38): 15242-15246.

Spiegel, K., E. Tasali, P. Penev and E. Van Cauter (2004). "Brief communication: Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite." Ann Intern Med **141**(11): 846-850.

Veldhuijzen van Zanten, J. J., L. A. Pilutti, J. L. Duda and R. W. Motl (2016). "Sedentary behaviour in people with multiple sclerosis: Is it time to stand up against MS?" Mult Scler **22**(10): 1250-1256.

Viana, R. B., J. P. A. Naves, V. S. Coswig, C. A. B. de Lira, J. Steele, J. P. Fisher and P. Gentil (2019). "Is interval training the magic bullet for fat loss? A systematic review and meta-analysis comparing moderate-intensity continuous training with high-intensity interval training (HIIT)." Br J Sports Med **53**(10): 655-664.

Warren, T. Y., V. Barry, S. P. Hooker, X. Sui, T. S. Church and S. N. Blair (2010). "Sedentary behaviors increase risk of cardiovascular disease mortality in men." Med Sci Sports Exerc **42**(5): 879-885.

Wens, I., U. Dalgas, E. Stenager and B. O. Eijnde (2013). "Risk factors related to cardiovascular diseases and the metabolic syndrome in multiple sclerosis - a systematic review." Mult Scler **19**(12): 1556-1564.

Wens, I., D. Hansen, K. Verboven, N. Deckx, L. Kosten, A. L. Stevens, N. Cools and B. O. Eijnde (2015). "Impact of 24 Weeks of Resistance and Endurance Exercise on Glucose Tolerance in Persons with Multiple Sclerosis." Am J Phys Med Rehabil **94**(10 Suppl 1): 838-847.

Appendix

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

UHASSELT
KNOWLEDGE IN ACTION

INVENTARISATIEFORMULIER WETENSCHAPPELIJKE STAGE DEEL 2

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
01-10-2019	Overlopen onderwerp MP2	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
15-10-2019	Bespreken van de onderzoeksvragen	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
12-11-2019	Overlopen gevonden data + inclusiecriteria	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
09-12-2019	Te gebruiken statistiek overlopen	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
15-05-2020	Presentatie oefenen	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
20-05-2020	Feedback voorlopige versie MP + feedback presentatie	Promotor: Copromotor/Begeleider: Student(e): K. Hiebens Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):

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

Naam Student(e): …… Datum:……..

Titel Masterproef: ……

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) <u>Niet-bindend advies:</u> 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)

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. Bert Op 't Eijnde en Drs. Ine Nieste] en kadert binnen het opleidingsonderdeel [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 [neurologische revalidatie] (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. Bert Op 't Eijnde en Drs. Ine Nieste].

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: Kristoff Liekens

Adres: Larenstraat 6, 2340 Beerse

Geboortedatum en -plaats : 22/04/1996, Turnhout

Datum:22/05/2020

Handtekening: 

AFSPRAKENNOTA

1. Organisatie

Naam	Universiteit Hasselt/transnationale Universiteit Limburg (Hierna: UHasselt/tUL)
Adres	Martelarenlaan 42 3500 Hasselt
Sociale doelstelling	De UHasselt/tUL is een dynamisch kenniscentrum van onderwijs, onderzoek en dienstverlening.
Werking van de organisatie	**Faculteiten** De UHasselt telt zes faculteiten die het onderwijs en onderzoek aansturen: o faculteit Architectuur en kunst o faculteit Bedrijfseconomische wetenschappen o faculteit Geneeskunde en levenswetenschappen o faculteit Industriële ingenieurswetenschappen o faculteit Rechten o faculteit Wetenschappen Elke faculteit stelt per opleiding een onderwijsmanagementteam (OMT) en een examencommissie samen. **Vakgroepen** Binnen de faculteiten opereren diverse vakgroepen. Zij groeperen alle personeelsleden die onderzoek en onderwijs verrichten binnen eenzelfde discipline. Elke vakgroep bestaat vervolgens uit een of meerdere onderzoeksgroepen. Zij staan in voor de organisatie van het gespecialiseerd onderzoek. Deze klassieke boomstructuur van faculteiten, onderzoeksgroepen en vakgroepen wordt doorkruist door de onderzoeksinstituten. De instituten groeperen onderzoekers uit verschillende onderzoeksgroepen die in bepaalde speerpuntdomeinen onderzoek uitvoeren. Daarbij wordt het volledige onderzoekspectrum afgedekt, van fundamenteel over toegepast onderzoek tot concrete valorisatietoepassingen.
Juridisch statuut	Autonome openbare instelling

Verantwoordelijke van de organisatie, die moet verwittigd worden bij ongevallen.

Naam	
Functie	
Tel. - GSM	

2. De vrijwilliger: student-onderzoeker

Naam	Kristoff Liekens
Correspondentieadres	Larenstraat 6, 2340 Beerse
Tel. - GSM	0493020063

3. Verzekeringen

Waarborgen	De burgerlijke aansprakelijkheid van de organisatie.
Maatschappij	Ethias
Polisnummer	45009018

Waarborgen	Lichamelijke schade die geleden is door vrijwilligers bij ongevallen tijdens de uitvoering van het vrijwilligerswerk of op weg naar- en van de activiteiten.
Maatschappij	Ethias
Polisnummer	45055074

4. Vergoedingen

De organisatie betaalt geen vergoeding aan de vrijwilliger.

5. Aansprakelijkheid

De organisatie is burgerrechtelijk aansprakelijk voor de schade die de vrijwilliger aan derden veroorzaakt bij het verrichten van vrijwilligerswerk.

Ingeval de vrijwilliger bij het verrichten van het vrijwilligerswerk de organisatie of derden schade berokkent, is hij enkel aansprakelijk voor zijn bedrog en zijn zware schuld.

Voor lichte schuld is hij enkel aansprakelijk als die bij hem eerder gewoonlijk dan toevallig voorkomt.

Opgelet: voor het materiaal dat de vrijwilliger zelf meebrengt, is hij/zij zelf verantwoordelijk.

6. Geheimhoudingsplicht – verwerking persoonsgegevens

De vrijwilliger verleent de UHasselt toestemming om de gegevens die in het kader van zijn/haar inschrijving aan UHasselt werden verzameld, ook te gebruiken voor de uitvoering van deze afsprakennota (de evaluatie van de vrijwilliger alsook het aanmaken van een certificaat). UHasselt zal deze informatie vertrouwelijk behandelen en zal deze vertrouwelijkheid ook bewaken na de beëindiging van het statuut student-onderzoeker. De UHasselt neemt hiertoe alle passende maatregelen en waarborgen om de persoonsgegevens van de vrijwilliger conform de Algemene Verordening Gegevensbescherming (EU 2016/679) te verwerken.

De vrijwilliger verbindt zich ertoe om alle gegevens, documenten, kennis en materiaal, zowel schriftelijk als mondeling ontvangen in de hoedanigheid van student-onderzoeker aan de UHasselt als strikt vertrouwelijk te behandelen, ook indien deze niet als strikt vertrouwelijk werd geïdentificeerd. Indien de vertrouwelijke gegevens van de UHasselt ook persoonsgegevens bevatten dient de stagiair hiertoe steeds de Algemene Verordening Gegevensbescherming (EU 2016/679) na te leven en bij elke verwerking het advies van het intern privacycollege van de UHasselt in te winnen. Hij/zij verbindt zich ertoe om in geen geval deze vertrouwelijke informatie mee te delen aan derden of anderszins openbaar te maken, ook niet na de beëindiging van het statuut student-onderzoeker.

7. Concrete afspraken

Functie van de vrijwilliger

De vrijwilliger zal volgende taak vervullen: Het maken van een masterproef
Deze taak omvat volgende activiteiten: Data-analyse
De vrijwilliger voert zijn taak uit onder verantwoordelijkheid van de faculteit Revalidatiewetenschappen
De vrijwilliger wordt binnen de faculteit begeleid door Prof. Dr. Bert Op't Eijnde
Zijn vaste werkplek voor het uitvoeren van de taak is

De vrijwilliger zal deze taak op volgende tijdstippen uitvoeren:

- op de volgende dag(en):
    - maandag
    - dinsdag
    - woensdag
    - donderdag
    - vrijdag
    - zaterdag
    - zondag
- het engagement wordt aangegaan voor de periode van 01/09/2019 tot 30/06/2020 (deze periode kan maximaal 1 kalenderjaar zijn en moet liggen tussen 1 januari en 31 december).

Begeleiding

De organisatie engageert zich ertoe de vrijwilliger tijdens deze proefperiode degelijk te begeleiden en te ondersteunen en hem/haar van alle informatie te voorzien opdat de activiteit naar best vermogen kan worden uitgevoerd.
De vrijwilliger voert de taken en activiteiten uit volgens de voorschriften vastgelegd door de faculteit. Hij/zij neemt voldoende voorzorgsmaatregelen in acht, en kan voor bijkomende informatie over de uit te voeren activiteit steeds terecht bij volgende contactpersoon: …

De vrijwilliger krijgt waar nodig vooraf een vorming. Het volgen van de vorming indien aangeboden door de organisatie, is verplicht voor de vrijwilliger.

De vrijwilliger heeft kennis genomen van het 'reglement statuut student-onderzoeker' dat als bijlage aan deze afsprakennota wordt toegevoegd en integraal van toepassing is op de vrijwilliger.

Certificaat

Indien de vrijwilliger zijn opdracht succesvol afrondt, ontvangt hij/zij een certificaat van de UHasselt ondertekend door de decaan van de faculteit waaraan de vrijwilliger zijn opdracht voltooide.

8. Einde van het vrijwilligerswerk.

Zowel de organisatie als de vrijwilliger kunnen afzien van een verdere samenwerking. Dat kan gebeuren:

- bij onderlinge overeenstemming;
- op vraag van de vrijwilliger zelf;
- op verzoek van de organisatie.

Indien de samenwerking op initiatief van de vrijwilliger of de organisatie wordt beëindigd, gebeurt dit bij voorkeur minstens 2 weken op voorhand. Bij ernstige tekortkomingen kan de samenwerking, door de organisatie, onmiddellijk worden beëindigd.

Datum: 28/05/2020

Naam en Handtekening decaan

Naam en Handtekening vrijwilliger

K. Lintens

Opgemaakt in 2 exemplaren waarvan 1 voor de faculteit en 1 voor de vrijwilliger.

Bijlage 1

Reglement betreffende het statuut van student-onderzoeker[1]

Artikel 1. Definities

Voor de toepassing van dit reglement wordt verstaan onder:
student-onderzoeker: een regelmatig ingeschreven bachelor- of masterstudent van de UHasselt/tUL die als vrijwilliger wordt ingeschakeld in onderzoeksprojecten. De opdrachten uitgevoerd als student-onderzoeker kunnen op geen enkele wijze deel uitmaken van het studietraject van de student. De opdrachten kunnen geen ECTS-credits opleveren en zij kunnen geen deel uitmaken van een evaluatie van de student in ket kader van een opleidingsonderdeel. De onderzoeksopdrachten kunnen wel in het verlengde liggen van een opleidingsonderdeel, de bachelor- of masterproef.

Artikel 2. Toepassingsgebied

Enkel bachelor- en masterstudenten van de UHasselt/tUL die voor minstens 90 studiepunten credits hebben behaald in een academische bacheloropleiding komen in aanmerking voor het statuut van student-onderzoeker.

Artikel 3. Selectie en administratieve opvolging

§1 De faculteiten staan in voor de selectie van de student-onderzoekers en schrijven hiervoor een transparante selectieprocedure uit die vooraf aan de studenten kenbaar wordt gemaakt.
§2 De administratieve opvolging van de dossiers gebeurt door de faculteiten.

Artikel 4. Preventieve maatregelen en verzekeringen

§1 De faculteiten voorzien waar nodig in de noodzakelijke voorafgaande vorming van student-onderzoekers. De student is verplicht deze vorming te volgen vooraleer hij/zij kan starten als student-onderzoeker.
§2 Er moet voor de betrokken opdrachten een risicopostenanalyse opgemaakt worden door de faculteiten, analoog aan de risicopostenanalyse voor een stagiair van de UHasselt/tUL. De faculteiten zien er op toe dat de nodige veiligheidsmaatregelen getroffen worden voor aanvang van de opdracht.
§3 De student-onderzoekers worden door de UHasselt verzekerd tegen:
- Burgerlijke aansprakelijkheid
- Lichamelijke ongevallen

en dit ongeacht de plaats waar zij hun opdrachten in het kader van het statuut uitoefenen.

Artikel 5. Vergoeding van geleverde prestaties

§1 De student-onderzoeker kan maximaal 40 kalenderdagen, gerekend binnen één kalenderjaar, worden ingeschakeld binnen dit statuut. De dagen waarop de student-onderzoeker een vorming moet volgen, worden niet meegerekend als gepresteerde dagen.

§2 De student-onderzoeker ontvangt geen vrijwilligersvergoeding voor zijn prestaties. De student kan wel een vergoeding krijgen van de faculteit voor bewezen onkosten. De faculteit en de student maken hier aangaande schriftelijke afspraken.

Artikel 6. Dienstverplaatsingen

De student-onderzoeker mag dienstverplaatsingen maken. De faculteit en de student maken schriftelijke afspraken over deal dan niet vergoeding voor dienstverplaatsingen. De student wordt tijdens de dienstverplaatsingen en op weg van en naar de stageplaats uitsluitend verzekerd door de UHasselt voor lichamelijke ongevallen.

[1] Zoals goedgekeurd door de Raad van Bestuur van de Universiteit Hasselt op 15 juni 2017.

Artikel 7. Afsprakennota

§1 Er wordt een afsprakennota opgesteld die vooraf wordt ondertekend door de decaan en de student-onderzoeker. Hierin worden de taken van de student-onderzoeker alsook de momenten waarop hij/zij de taken moet uitvoeren zo nauwkeurig mogelijk omschreven.
§2 Aan de afsprakennota wordt een kopie van dit reglement toegevoegd als bijlage.

Artikel 8. Certificaat

Na succesvolle beëindiging van de opdracht van de student-onderzoeker, te beoordelen door de decaan, ontvangt hij een certificaat van de studentenadministratie. De faculteit bezorgt de nodige gegevens aan de studentenadministratie. Het certificaat wordt ondertekend door de decaan van de faculteit waaraan de student-onderzoeker zijn opdracht voltooide.

Artikel 9. Geheimhoudingsplicht

De student-onderzoeker verbindt zich ertoe om alle gegevens, documenten, kennis en materiaal, zowel schriftelijk (inbegrepen elektronisch) als mondeling ontvangen in de hoedanigheid van student-onderzoeker aan de UHasselt, als strikt vertrouwelijk te behandelen, ook indien deze niet als strikt vertrouwelijk werd geïdentificeerd. Hij/zij verbindt zich ertoe om in geen geval deze vertrouwelijke informatie mee te delen aan derden of anderszins openbaar te maken, ook niet na de beëindiging van zijn/haar opdracht binnen dit statuut.

Artikel 10. Intellectuele eigendomsrechten

Indien de student-onderzoeker tijdens de uitvoering van zijn/haar opdrachten creaties tot stand brengt die (kunnen) worden beschermd door intellectuele rechten, deelt hij/zij dit onmiddellijk mee aan de faculteit. Deze intellectuele rechten, met uitzondering van auteursrechten, komen steeds toe aan de UHasselt.

Artikel 11. Geschillenregeling

Indien zich een geschil voordoet tussen de faculteit en de student-onderzoeker met betrekking tot de interpretatie van dit reglement of de uitoefening van de taken, dan kan de ombudspersoon van de opleiding waarbinnen de student-onderzoeker zijn taken uitoefent, bemiddelen. Indien noodzakelijk, beslecht de vicerector Onderwijs het geschil.

Artikel 12. Inwerkingtreding

Dit reglement treedt in werking met ingang van het academiejaar 2017-2018.

COVID-19 Addendum - Masterproef 2

Gelieve dit document in te laten vullen door de promotor en ingevuld toe te voegen aan je masterproef.

Naam promotor(en): Bert Op't Eijnde, co-promotor: Ine Nieste

Naam studenten: Kristoff Liekens

1) Duid aan welk type scenario is gekozen voor deze masterproef:

☐ scenario 1: masterproef bestaat uit een meta-analyse - masterproef liep door zoals voorzien
☒ scenario 2: masterproef bestaat uit een experiment - masterproef liep door zoals voorzien
☐ scenario 3: masterproef bestaat uit een experiment - maar een deel van de voorziene data is verzameld
    ☐ 3A: er is voldoende data, maar met aangepaste statische procedures verder gewerkt
    ☐ 3B: er is onvoldoende data, dus gewerkt met een descriptieve analyse van de aanwezige data
☐ scenario 4: masterproef bestaat uit een experiment - maar er kon geen data verzameld worden
    ☐ 4A: er is gewerkt met reeds beschikbare data
    ☐ 4B: er is gewerkt met fictieve data

2) 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	☐	☐	☐	☒	☐	☐
Methodologische uitwerking	☐	☐	☐	☐	☐	☒
Data acquisitie	☒	☐	☐	☐	☐	☐
Data management	☐	☐	☐	☐	☒	☐
Dataverwerking/Statistiek	☐	☐	☐	☐	☒	☐
Rapportage	☐	☐	☐	☒	☐	☐

Datum: 20/05/2020

UHASSELT

Kristoff Liekens <kristoff.liekens@student.uhasselt.be>

Documenten MP

3 berichten

Kristoff Liekens <kristoff.liekens@student.uhasselt.be> 22 mei 2020 om 11:05
Aan: Bert OP 'T EIJNDE <bert.opteijnde@uhasselt.be>

Geachte prof. Op ’t Eijnde,

Bij deze de nodige documenten (inventarisatieformulier, verklaring op eer en het inschrijvingsformulier) en de masterproef.

Met vriendelijke groeten,
kristoff Liekens

4 bijlagen

inschrijfformulier.pdf
309K

verklaring op eer.pdf
726K

inventarisatie.pdf
502K

MP 2 4.docx
327K

Bert OP 'T EIJNDE <bert.opteijnde@uhasselt.be> 25 mei 2020 om 11:26
Aan: Kristoff Liekens <kristoff.liekens@student.uhasselt.be>
Cc: Ine NIESTE <ine.nieste@uhasselt.be>

Dag Kristoff,

Inmiddels hebben Wouter en ik je werk en diverse documenten kunnen doornemen en geven wij je een gunstig advies voor het afleggen van je masterproef tijdens de eerste examenperiode 2019-2020.

Met vriendelijke groeten,

Ine Nieste en Bert Op ’t Eijnde

Prof. Dr. Bert Op ’t Eijnde | EIM - Exercise is Medicine
Exercise physiology, sports medicine & sport/rehabilitation sciences

ADLON Sports Medical Center | BIOMED - Biomedical Research Institute | Faculty of Medicine & Life Sciences | Hasselt University | Agoralaan, Gebouw A | B-3590 Diepenbeek | België/Belgium

+32(0)11269201 (secr.) | bert.opteijnde@uhasselt.be | www.uhasselt.be/glw | www.adlon.be | @bertopteijnde

[Tekst uit oorspronkelijke bericht is verborgen]
[Tekst uit oorspronkelijke bericht is verborgen]
<inschrijfformulier.pdf><verklaring op eer.pdf><inventarisatie.pdf><MP 2 4.docx>

Kristoff Liekens <kristoff.liekens@student.uhasselt.be> 25 mei 2020 om 12:19
Aan: Vicky VANHILLE <vicky.vanhille@uhasselt.be>
Cc: Bert OP 'T EIJNDE <bert.opteijnde@uhasselt.be>, Ine NIESTE <ine.nieste@uhasselt.be>

Geachte mevrouw Vanhille,

Hierbij de nodige documenten (inventarisatieformulier, verklaring op eer en het inschrijvingsformulier) en de goedkeuring voor het verdedigen van mijn masterproef.

Met vriendelijke groeten,
kristoff Liekens
2e master Reki
1437176
[Tekst uit oorspronkelijke bericht is verborgen]

---

3 bijlagen

verklaring op eer.pdf
726K

inschrijfformulier.pdf
384K

inventarisatie.pdf
502K