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Physical activity behaviour up to 1 year post-rehabilitation among adults with physical disabilities and/or chronic diseases: results of the prospective cohort study ReSpAct

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ABSTRACT

Background Little is known of physical activity behaviour among adults with a disability and/or chronic disease during and up to 1 year post-rehabilitation. We aimed to explore (1) dose characteristics of physical activity behaviour among adults with physical disabilities and/or chronic diseases during that period, and (2) the effects of personal characteristics and diagnosis on the development of physical activity over time.

Methods Adults with physical disabilities and/or chronic diseases (N=1256), enrolled in the Rehabilitation, Sports and Active lifestyle study, were followed with questionnaires: 3–6 weeks before (T0) and 14 (T1), 33 (T2) and 52 (T3) weeks after discharge from rehabilitation. Physical activity was assessed with the adapted version of the Short Questionnaire to ASsess Health enhancing physical activity. Dose characteristics of physical activity were descriptively analysed. Multilevel regression models were performed to assess physical activity over time and the effect of personal and diagnosis characteristics on physical activity over time.

Results Median total physical activity ranged from 1545 (IQR: 853–2453) at T0 to 1710 (IQR: 960–2730) at T3 min/week. Household (495–600 min/week) and light-intensity (900–998 min/week) activities accrued the most minutes. Analyses showed a significant increase in total physical activity moderate-intensity to vigorous-intensity physical activity and work/commuting physical activity for all time points (T1–T3) compared with baseline (T0). Diagnosis, age, sex and body mass index had a significant effect on baseline total physical activity.

Conclusion Physical activity is highly diverse among adults with physical disabilities and/or chronic diseases. Understanding this diversity in physical activity can help improve physical activity promotion activities.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is a large-scale prospective cohort study that gives a detailed overview of the different dose characteristics of physical activity behaviour in adults with physical disabilities and/or chronic diseases.
⇒ We measured physical activity with a self-reported questionnaire specifically designed for adults with disabilities giving detailed information on the different dose characteristics.
⇒ We included a large heterogeneous group of adults with physical disabilities and/or chronic diseases, which makes it more applicable to the general rehabilitation setting and population.
⇒ Potential sample selection bias may be present, since participants could only participate in the Rehabilitation, Sports and Active lifestyle cohort study if they received physical activity counselling support during their rehabilitation treatment.

INTRODUCTION

Regular physical activity (PA) has many benefits on cognitive, mental and physical health, fitness and quality of life, both for the general population as well as for adults with physical disabilities and/or chronic diseases.[1–4] Besides the direct health benefits for adults with physical disabilities/chronic diseases, being more physically active is also considered a secondary (reducing or preventing long-term effects of an established health problem/disease) and tertiary (reduce impact of an established health problem/disease by restoring function and reduce disease-related complications) prevention mechanism.[5 6] Despite these benefits, PA behaviour is suggested to be low among adults with physical disabilities/chronic diseases.[7–9]

The recently updated WHO guidelines for PA recommend that all adults, including those with physical disabilities and/or chronic diseases, should be physically active for at least 150–300 min of moderate intensity or 75–150 min of vigorous intensity per week or an equivalent combination, with

the addition of muscle-strengthening activities of at least moderate intensity twice per week.[10 11] While these recommendations are formulated for adults with physical disabilities/chronic diseases, the development of the guidelines is mainly informed by evidence from studies in the general population.[11] As highlighted by the WHO PA Guidelines Development Group and the accompanying research agenda, there is a clear need for more research on PA among adults with physical disabilities/chronic diseases.[12 13]

Despite various calls for more research on PA in people with disabilities,[14–16] measuring and understanding dose–response relationships of the construct of PA in the context of a heterogeneous population with disabilities are not straightforward. PA is defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure'.[17] It is by definition a multidimensional construct, with setting (eg, PA during leisure time, work), mode (eg, walking, bicycling), frequency (eg, times per week), duration (eg, in hours) and intensity (eg, low, moderate or vigorous) as its crucial constituents.[18 19] These dimensions could also be called the dose characteristics of PA, and are important to understand PA among different subgroups, as well as to study the dose–response relations of PA and health during and after rehabilitation. Furthermore, it could be an important aspect in tailored PA counselling, as more information on dose characteristics can lead to more focused PA recommendations. Only a few studies described details on multiple dose characteristics of PA in adults with physical disabilities/chronic diseases.[20–22] These studies either mainly concern validation of instruments that measure multiple dose characteristics, and not focused on describing the dose characteristics itself[20 22] or are of a cross-sectional nature in small diagnosis-specific populations.[21] Consequently, there is a need for large-scale prospective studies that take this multidimensionality of PA within and among adults with a diversity of disabilities/chronic diseases into account.

An important step to enhance our understanding of PA is to explore the effect of personal characteristics on the multidimensional construct PA behaviour. Adults with physical disabilities/chronic diseases are a heterogeneous group, both in PA behaviour[9] and personal and disease characteristics.[23] Personal characteristics, such as age and sex, are determinants for PA in the general population and specific diagnosis groups,[24–27] yet it is largely unknown how these characteristics influence the development of PA over time during and after a PA-promoting rehabilitation programme. As such, it is important to understand which dimensions of PA behaviour contribute to the dose of PA and how this is perceived in the context of personal characteristics or diagnoses. Such insights will help to understand PA behaviour over time, and will enable to individualise PA stimulation programmes.

The multicentre prospective cohort study 'Rehabilitation, Sports and Active lifestyle' (ReSpAct) offers a great opportunity to start addressing these knowledge gaps.[28 29] This study was built around the implementation of a PA behavioural intervention in Dutch rehabilitation care.[28 29] Uniquely, the ReSpAct Study includes data on self-reported PA behaviour and potential determinants in a large, diverse population of adults with physical disabilities/chronic diseases at four occasions: 3–6 weeks before discharge up to 1 year after discharge of rehabilitation.[28 29]

Using data from the ReSpAct study, the primary aim of this study was to explore the different dose characteristics of PA behaviour (duration, setting, intensity, mode and frequency) among a diverse group of adults with a physical disability and/or chronic disease at discharge from rehabilitation up to 1 year post-rehabilitation. The secondary aims were to explore the development of PA behaviour over time, and to analyse the effects of personal characteristics and diagnosis on PA behaviour and its development over time.

METHODS

Study overview

This study is part of prospective cohort study ReSpAct to evaluate the nationwide implemented Dutch rehabilitation programme Rehabilitation, Sport and Exercise (RSE, Dutch: 'Revalidatie, Sport en Bewegen').[28 29] RSE is an evidence-based PA counselling programme involving multiple counselling sessions based on motivational interviewing during and after rehabilitation to stimulate a physically active lifestyle in adults with physical disabilities/chronic diseases.[28–31] Participants, recruited between May 2013 and August 2015, were followed over time with a set of questionnaires: at baseline (T0: 3–6 weeks before discharge), and at 14 (T1), 33 (T2) and 52 (T3) weeks after discharge from rehabilitation.[28]

Patient and public involvement

Representatives of the Dutch community organisations Knowledge Centre for Sport Netherlands and Stichting Special Heroes (former: Stichting Onbeperkt Sportief) were involved as collaborators and consultants in the design and conduct of the ReSpAct study.[28 29] Rehabilitation professionals (counsellors, project leaders, physicians, managers) from the participating rehabilitation centres and hospitals were involved as consultants in the design and conduct of the ReSpAct study. We did not involve people with disabilities/chronic diseases as consultants/advisors/collaborators in the study. The current paper reports results from the primary outcome measure of the ReSpAct study (PA).

Study population

Inclusion criteria for this study were: (1) aged 18 years or older; (2) having a physical disability and/or chronic disease; (3) receiving inpatient, outpatient or consultancy rehabilitation treatment at one of the participating rehabilitation departments or institutes; (4) participating in the RSE programme; (5) data available on diagnosis; and (6) valid data available of the adapted version of the Short Questionnaire to ASsess Health enhancing physical

activity (Adapted-SQUASH) at baseline and at least one follow-up measurement.

Participants were excluded if they (1) were unable to complete questionnaires, even with help; (2) participated in a PA programme other than RSE.

PA behaviour

Self-reported PA behaviour was measured using the Adapted-SQUASH, a 19-item recall questionnaire to assess PA among adults with disabilities based on an average week of the past month.[32] Participants had to fill out the number of days (frequency), average hours and minutes per day (duration) and the perceived intensity (intensity: light, moderate, vigorous) of different types of activities (mode: for example, walking, cycling, wheeling, gardening) that were prestructured in different settings: activities during commuting, activities at work and school, household activities and leisure time activities. The Adapted-SQUASH has a good reliability (intraclass correlation coefficient (ICC)=0.67 and 0.76, for total activity score and total minutes of activity per week, respectively), and a validity comparable with other PA questionnaires when using accelerometer-derived PA (p=0.40 for total activity score and ICC=0.22 for total minutes of activity per week).[32]

Raw Adapted-SQUASH data were processed with a custom-created syntax (SPSS statistics V.26, IBM). Minutes of activity per week were calculated by multiplying frequency by duration. Intensity of activity was calculated by combining the perceived intensity of each activity with a corresponding metabolic equivalent of task (MET) value based on the Ainsworth compendium of PAs[33] and a compendium of energy costs of the PAs for wheelchair-dependent individuals[34] into light (<4 MET for people 18–65 years old, <3 MET for people older than 65 years), moderate (4–6.5 MET for people 18–65 years old, 3–6 MET for people older than 65 years) or vigorous intensity (>6.5 MET for people 18–65 years old, >6 MET for people older than 65 years).[32 35] Primary outcomes were total minutes of PA per week, minutes of PA per setting, minutes of PA per intensity and the frequency of PA modes.

Adapted-SQUASH data of a measurement occasion were deemed valid when no more than one of the prestructured settings was missing and the total minutes of PA per week was not higher than 6720 min (on average 16 hours/day).

Personal characteristics

Personal characteristics included age, sex, body mass index (BMI), marital status, current smoking habit, current alcohol usage, education level and work status. Current smoking habit was dichotomised into smoker and non-smoker. Current alcohol usage was categorised in no, light (1–3 or 1–2 drinks per week for males and females, respectively), moderate (4–20 or 3–13 drinks per week for males and females, respectively) and excessive (≥21 or ≥14 drinks per week for males and females, respectively).[8] Education level was dichotomised into high (applied university and higher) and low, to make it internationally comparable. Work status was categorised into school, employed, unemployed, retired, unable to work and other (eg, voluntary work). Personal characteristics were self-reported by participants, with the exception of age and sex, which were reported by the RSE counsellor.

Rehabilitation characteristics

Rehabilitation characteristics included diagnosis, rehabilitation context (hospital or rehabilitation centre), rehabilitation form (inpatient, outpatient or consultancy rehabilitation) and number of received counselling sessions from the RSE programme (0 sessions, 1–3 sessions, 4 or more sessions).

Different diagnoses were grouped according to diagnosis groups of the Dutch Diagnose-Treatment Combinations, a structure for the financial aspects of a hospital visit, which has roots in the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) structure: amputation (both upper and lower extremities), brain disease (eg, stroke, congenital brain diseases), chronic pain, musculoskeletal disease (eg, rheumatic conditions, conditions of upper, lower extremities and spine), neurological disease (eg, Parkinson's disease, multiple sclerosis), organ disease (eg, heart disease, chronic obstructive pulmonary disease), spinal cord injury and other (eg, chronic fatigue syndrome, medically unexplained symptoms).[36] Rehabilitation characteristics were reported by the RSE counsellor.

Statistical analysis

Descriptive information of the population and the dose characteristics of PA behaviour are shown in mean±SD or median (IQR) for continuous variables, and percentages for categorical variables. Differences of baseline characteristics between included and excluded participants were tested with independent t-test for continuous variables and Pearson X^2 test for categorical variables.

To evaluate the development of PA behaviour over time, we created six separate multilevel regression models with total minutes of PA per week (model 1), minutes of PA per week per setting (models 2–5) and minutes of moderate to vigorous PA (MVPA) per week (model 6) as dependent variables, and measurement occasions (categorical) as independent variable. Each model consisted of measurement occasion at level 1, participants at level 2 (random intercepts) and rehabilitation institutes as level 3 (random intercepts). Since we expected variation among participants in their PA behaviour over time, we added random slopes for measurement occasion on the level of participants. However, this resulted in non-converging (ie, unreliable) models, and subsequently removed from the models.

To explore the effects of personal characteristics and diagnosis on the development of PA behaviour over time, multilevel regressions models were created with measurement occasion, characteristic and an interaction term

between measurement occasion and characteristic for each of the six dependent variables and for each characteristic separately. Evaluated characteristics were diagnosis (largest diagnosis in our data, that is, brain disease, as reference), age (continuous, in years), sex (male as reference), BMI (continuous, in kg/m^2), smoking (non-smoker as reference), alcohol use (no alcohol use as reference) and education level (low as reference).[24–27] Type III analysis of variance tests were used to assess significance of the overall interaction between measurement occasion and the characteristics. Since multilevel regression analyses are robust against missing data, this was not addressed.[37] All analyses were done with R and RStudio.[38] The lmerTest package was used for multilevel regression analysis.[39] Significance level was set at 0.05.

RESULTS

Study population

Table 1 shows baseline descriptors of included and excluded participants per measurement occasion. Of the 1719 participants in the ReSpAct cohort, 1256 participants were included in this study. The largest diagnosis groups were: brain disease (27.1%, n=341), musculoskeletal disorders (18.6%, n=234), chronic pain (15.8%, n=198) and neurological disease (15.0%, n=188). Excluded participants were younger (p<0.001), more often a smoker (p=0.04) and received less counselling sessions (p<0.001).

PA dose characteristics

Table 2 shows the PA dose characteristics (duration, setting, intensity, mode and frequency) at the four different measurement occasions.

Duration

Total duration of PA (min/week) varied over time and among participants, showing its lowest median value at discharge from rehabilitation (T0: 1545); followed by increased levels of 1770, 1830 and 1710 min/week at, respectively, T1, T2 and T3 (table 2).

Setting

Participants spent most PA time in household tasks (median range T0–T3: 495–600 min/week), followed by leisure time (median range T0–T3: 450–510 min/week). A large proportion of participants reported 0 min/week PA in work (range T0–T3: 52.6%–59.9%; largest IQR 0–1080 min/week) and commuting (range T0–T3: 70.4%–72.5%; largest IQR commuting 0–40 min/week) settings (table 2).

Intensity

Participants spent between T0 and T4 a median of 900–998 min/week in light-intensity PA, 120–180 min/week in moderate-intensity PA and 100–120 min/week in vigorous-intensity PA. In household tasks, most minutes were spent in light intensity (median range T0–T4: 480–540 min/week) and little to none in moderate and vigorous intensity (range T0–T4: 82.0%–87.6% 0 min/week and 100%–100% 0 min/week, respectively). Leisure time activities were predominantly in MVPA (median range T0–T4: 40–60 min/week light; 60–90 min/week moderate; and 90–120 min/week vigorous). Intensity of work activities was of light (range T0–T4: median 0–0, IQR 0–165 to 0–420) or moderate intensity (range T0–T4: median 0–0, IQR 0–0 to 0–60) and not of vigorous intensity (100% 0 min/week at all measurement occasions). Commuting activities were mostly spent in vigorous (range T0–T4: 16.1%–17.0% >0 min/week), followed by light (range T0–T4: 11.2%–12.3% >0 min/week) and moderate intensity (range T0–T4: 4.5%–6.6% >0 min/week) (table 2).

Mode and frequency

Walking is the most frequent mode of leisure time activities at all measurement occasions, with an average frequency ranging from 3.3±2.7 to 3.6±2.7 times/week. Bicycling is the second most frequent mode, with an average frequency ranging from 1.6±2.1 to 1.8±2.2 times/week. Gardening, odd jobs and fitness are frequented around 0.6 times/week (table 2).

PA behaviour over time

Figure 1 and online supplemental appendix 1 show the results of the multilevel regression models for PA behaviour over time. Compared with baseline (T0), there is a significant increase (p<0.001) in total minutes of PA per week over time for each of the three follow-up measurement occasions (increase: 218.6 (95% CI 142.9 to 294.3), 242.2 (95% CI 162.6 to 321.7) and 153.8 (95% CI 70.9 to 236.6) min/week at, respectively, T1, T2 and T3). Time spent in the settings work and commuting significantly increased at follow-up occasions (all p<0.05). With the exception of one occasion, leisure time (T1, p<0.01) and household tasks (T2, p<0.05) remained stable compared with baseline values (T0). Time spent in MVPA significantly increased at each measurement occasion compared with T0 (increase: 105.0 (95% CI 57.6 to 152.2), 138.4 (95% CI 88.7 to 188.1) and 112.9 (95% CI 61.1 to 164.6) min/week at, respectively, T1, T2 and T3, all p<0.001).

Effects of personal characteristics and diagnosis

Figure 2 shows total PA per measurement occasion and distribution of PA in the four settings separated for the different diagnoses. Online supplemental appendix 2 provides a detailed description of PA behaviour per diagnosis.

Figure 3 shows the effect of each personal characteristic on total PA and MVPA. The multilevel regression model analyses showed that at baseline, a significant effect on total PA was found for diagnosis (musculoskeletal disease, β=307.5 (95% CI 92.7 to 522.2), and other diseases, β=392.7 (95% CI 5.0 to 780.3) more active than brain disease), age (higher age less active, β=−12.7 (95% CI −18.0 to −7.4)), sex (females more active than males,

Table 1 Baseline descriptive statistics of included participants at each measurement occasion (T0–T3) and excluded participants at T0

	Included				
	T0	T1	T2	T3	Excluded
N	1256	1114	966	860	463
Age (years)	50.7±13.4	51.1±13.4	51.5±13.0	51.6±13.2	47.5±14.3**
Sex (% male)	47.3	47.9	47.6	49.2	42.1
BMI (kg/m^2)	27.5±8.6	27.5±8.8	27.4±9.1	27.4±9.3	27.0±5.9
Diagnosis					
% Brain disease	27.1	26.8	26.5	27.4	24.4
% Musculoskeletal disease	18.6	18.0	17.6	17.3	18.1
% Chronic pain	15.8	15.8	14.9	14.9	18.1
% Neurological disease	15.0	15.5	16.1	16.9	12.5
% Organ disease	12.1	12.7	12.7	12.4	9.9
% Amputation	4.5	4.7	4.9	4.7	4.3
% Spinal cord injury	3.0	2.7	2.8	2.8	4.3
% Other diseases	3.8	3.8	4.5	3.6	3.2
Smoking					*
% Yes	16.3	16.6	15.4	15.3	13.0
% No	71.3	73.5	74.9	75.2	39.7
Alcohol use					
% No	58.0	57.9	59.0	58.7	34.6
% Light	10.4	10.5	11.0	10.9	5.4
% Moderate	24.0	25.0	24.0	24.1	11.2
% Excessive	2.2	2.4	2.3	2.0	0.6
Marital status					
% Single	26.8	27.7	27.7	27.7	21.4
% Married/living with partner	62.9	63.9	63.9	63.9	39.3
Education level					
% Low	67.0	67.8	68.2	69.5	47.5
% High	22.5	23.7	23.5	22.7	12.7
Work status					
% School	1.8	1.8	1.1	1.7	1.9
% Employed	31.2	32.3	31.9	32.1	20.1
% Unemployed	11.6	11.9	11.4	11.7	9.3
% Retired	15.4	16.4	16.0	16.9	7.6
% Unable to work	21.7	21.8	22.3	21.5	14.9
% Other	7.7	7.5	9.0	8.1	6.3
Rehabilitation context					
% Rehabilitation centre	71.6	71.6	72.3	72.8	75.4
% Hospital	28.4	28.4	27.7	27.2	24.6
Rehabilitation form					
% Inpatient	2.8	2.6	2.3	2.3	3.7
% Outpatient	89.8	90.3	89.8	90.5	90.1
% Consultancy	7.4	7.1	8.0	7.2	6.3
Number of counselling moments					**
% 0	11.4	11.0	10.8	10.0	21.0

Continued

Table 1 Continued

	Included				
	T0	T1	T2	T3	Excluded
% 1–3	56.4	55.8	56.3	57.0	55.3
% 4 or more	32.2	33.1	32.9	33.0	23.8

Data presented as mean±SD or %.
For some participants, information was missing, leading to not all percentages adding up to a 100%. There were more missing data in the excluded group of participants compared with the included group of participants.
* and ** mean significant difference between the included and excluded participants based on independent sample t-tests for continuous variables and based on X^2 tests for categorical variables without unknown category between baseline participants and those excluded. (*p<0.05; **p<0.001).
BMI, body mass index.

β=273.9 (95% CI 130.9 to 417.0)) and BMI (higher BMI less active, β=−8.8 (95% CI −17.6 to −0.03)) (see also online supplemental appendix 3). No interaction effects between these characteristics and measurement occasion were found, that is, the effect of these characteristics on PA remained constant over time. There was one significant interaction effect for education on PA over time, with people with high education increasing their levels of PA more over time than people with low education (p<0.05).

Online supplemental appendix 3 provides a detailed description of the effects of the diagnosis and personal characteristics on baseline levels and the development over time of PA in each setting and MVPA. In short, diagnosis had a significant baseline effect for MVPA and all settings of PA, except for commuting, where we found an interaction effect of diagnosis. People with a higher age were less active in work, household and commuting, but more active in leisure time and MVPA. In the work setting, an older age led to increase in PA over time. Females were more active in household tasks, but less active in MVPA; and in both household and MVPA, females had less increase in PA over time. Smokers had less increase in MVPA over time than non-smokers. Alcohol use had baseline effects on leisure time (moderate alcohol usage more active, excessive alcohol usage less active) and on MVPA (moderate alcohol usage more active) and interaction effect on MVPA (light and excessive alcohol usage had more improvement of MVPA over time).

DISCUSSION

We explored the PA dose characteristics in a broad population of adults with disabilities/chronic diseases from discharge up to 1 year after rehabilitation. We found a significant increase in total minutes per week of PA between baseline and all follow-ups. The largest increase in PA was found between baseline and 14 weeks after rehabilitation, and then more or less stabilised. Almost two-thirds of the total minutes were light-intensity PA. Most minutes of PA were in household setting. Leisure time contributed to the most minutes of MVPA. We found on average an active population, showing a considerable degree of variation in PA among this population and over time, in all dose characteristics and among personal and disease characteristics.

PA dose characteristics

To the best of our knowledge, this is the first prospective cohort study that considers all dose characteristics (duration, setting, intensity, mode and frequency) of PA in a large heterogeneous population of adults with physical disabilities/chronic diseases. Compared with previous studies (self-reported PA in specific disability groups and in heterogeneous disability groups), our participants were more active in total PA, MVPA and leisure time PA.[8 20 22 40–45] Furthermore, the proportion of participants adhering to the aerobic component of the WHO PA guideline (>150 min of moderate PA, >75 min of vigorous PA or combination of both) is higher in our population compared with previous research (68%–74% vs 35%–60%).[8 46–48] This suggests that the ReSpAct cohort is a potential positive selection regarding PA behaviour. A possible explanation of our active population may relate to the fact that all participants voluntarily engaged in the RSE programme, and thus received PA counselling during and after rehabilitation.

Participants completed a large amount of light-intensity PA. There are indications that the curvilinear relationship between PA and health found in able-bodied individuals[3] also applies to adults with physical disabilities/chronic diseases.[49] This means that for inactive people, even a small increase in PA (in any duration, intensity, mode and frequency) can lead to health benefits. Indeed, breaking up sedentary time into light-intensity PA does have positive effects on PA in able-bodied individuals.[50] Also, a study in people with mobility limitations suggested a decrease in all-cause mortality by engaging in light-intensity PA.[51] All this suggests the potential importance of light-intensity PA. However, as light-intensity activities might be harder to recall than MVPA, it is debatable how valid self-reported instruments can measure light intensity. Future research should focus on reliably measuring light intensity and the dose–response relationship between light-intensity PA and health outcomes.

Table 2 Physical activity (PA) behaviour of adults with physical disabilities/chronic diseases per measurement occasion as measured with the Adapted-SQUASH[32]

	T0	T1	T2	T3
Total PA				
N	1256	1114	966	860
Total (min/week)	1545 (853–2453)	1770 (990–2780)	1830 (981–2730)	1710 (960–2730)
Light (min/week)	900 (360–1680)	998 (420–1920)	960 (409–1980)	900 (360–1800)
Moderate (min/week)	120 (0–480)	180 (15–596)	180 (0–690)	150 (0–630)
Vigorous (min/week)	100 (0–246.25)	120 (0–300)	120 (0–300)	120 (0–289)
Adherence to the aerobic WHO PA guidelines (%)	68.3	74.9	71.3	71.2
Leisure time				
N	1252	1098	955	843
Total (min/week)	450 (230–795)	510 (270–853)	480 (240–840)	465 (240–840)
% 0 min/week	3.6	2.4	4.1	4.4
Light (min/week)	60 (0–323)	60 (0–330)	60 (0–300)	40 (0–270)
% 0 min/week	43.6	44.4	44.6	46.9
Moderate (min/week)	75 (0–255)	90 (0–300)	60 (0–300)	70 (0–273)
% 0 min/week	37.6	32.1	36.8	38.0
Vigorous (min/week)	90 (0–213)	120 (0–268)	100 (0–240)	100 (0–240)
% 0 min/week	30.8	27.2	31.0	30.8
Frequency of leisure time activities per week*				
Walking	3.6±2.7	3.5±2.6	3.3±2.6	3.3±2.7
Bicycling	1.8±2.2	1.7±2.1	1.6±2.1	1.7±2.1
Wheelchair riding	0.4±1.5	0.4±1.5	0.4±1.5	0.4±1.5
Handcycling	0.0±0.4	0.1±0.5	0.1±0.5	0.1±0.4
Gardening	0.7±1.2	0.6±1.1	0.5±1	0.5±1.1
Odd jobs	0.7±1.4	0.5±1.2	0.5±1.1	0.5±1.1
Fitness	0.6±1.1	0.7±1.1	0.5±1	0.4±0.9
Swimming	0.3±0.7	0.3±0.6	0.2±0.5	0.2±0.5
Household				
N	1234	1096	953	853
Total (min/week)	540 (180–960)	540 (210–1020)	600 (240–1020)	495 (210–930)
% 0 min/week	13.5	10.4	10.3	11.8
Light (min/week)	510 (180–960)	540 (210–960)	540 (210–960)	480 (185–900)
% 0 min/week	13.9	11.0	11.1	12.3
Moderate (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	87.6	83.4	82.0	82.8
Vigorous (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	100.0	100.0	100.0	100.0
Work				
N	1186	1093	943	844
Total (min/week)	0 (0–600)	0 (0–960)	0 (0–1080)	0 (0–1080)
% 0 min/week	59.9	52.6	52.9	54.5
Light	0 (0–165)	0 (0–420)	0 (0–300)	0 (0–240)
% 0 min/week	72.9	67.9	70.2	71.1
Moderate (min/week)	0 (0–0)	0 (0–60)	0 (0–60)	0 (0–60)
% 0 min/week	80.8	72.9	71.8	73.5

Continued

Table 2 Continued

	T0	T1	T2	T3
Vigorous (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	100.0	100.0	100.0	100.0
Commuting				
N	1246	1108	959	847
Total (min/week)	0 (0–25)	0 (0–30)	0 (0–30)	0 (0–40)
% 0 min/week	72.5	71.3	71.3	70.4
Light (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	88.8	87.7	88.2	88.5
Moderate (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	95.5	93.4	93.8	94.5
Vigorous (min/week)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
% 0 min/week	83.3	83.9	83.6	83.0

*Frequencies of leisure time activities per week are presented in mean±SD. Other data are presented in median (IQR) or percentage.
Adapted-SQUASH, Adapted version of the Short Questionnaire to ASsess Health enhancing physical activity.

PA behaviour over time

In contrast to the common decline in PA after rehabilitation,[52] we found a significant increase in total minutes of PA and in MVPA after rehabilitation. The largest improvement was found between just before discharge (T0) and 14 weeks after (T1) and remained more or less stable until 1 year after rehabilitation. We found a decrease in PA from 33 weeks (T2) to 1 year after rehabilitation (T3), but PA at T3 was still significantly higher compared with PA at T0. The improvement in PA aligns with the period that participants received personalised PA counselling (RSE programme).[28 29 31] As a previous randomised controlled trial (RCT) already showed the effectiveness of counselling after rehabilitation in improving PA behaviour,[31 53] this may explain the increase in PA behaviour between T0 and T1. Since the period just after rehabilitation is a critical window of opportunity for intervening and important to assist people from being a patient to a participant in lifelong PA,[54] a broader implementation of PA counselling not just in the Netherlands[55] but internationally seems a promising approach. However, our data and that of the RCT[31] are limited to 1 year after rehabilitation, and future research should investigate whether these counselling sessions are enough for adherence to lifelong PA.

Effects of personal characteristics and diagnosis

We found a large diversity in individual PA behaviour over time, as seen by the large IQRs for all dose characteristics

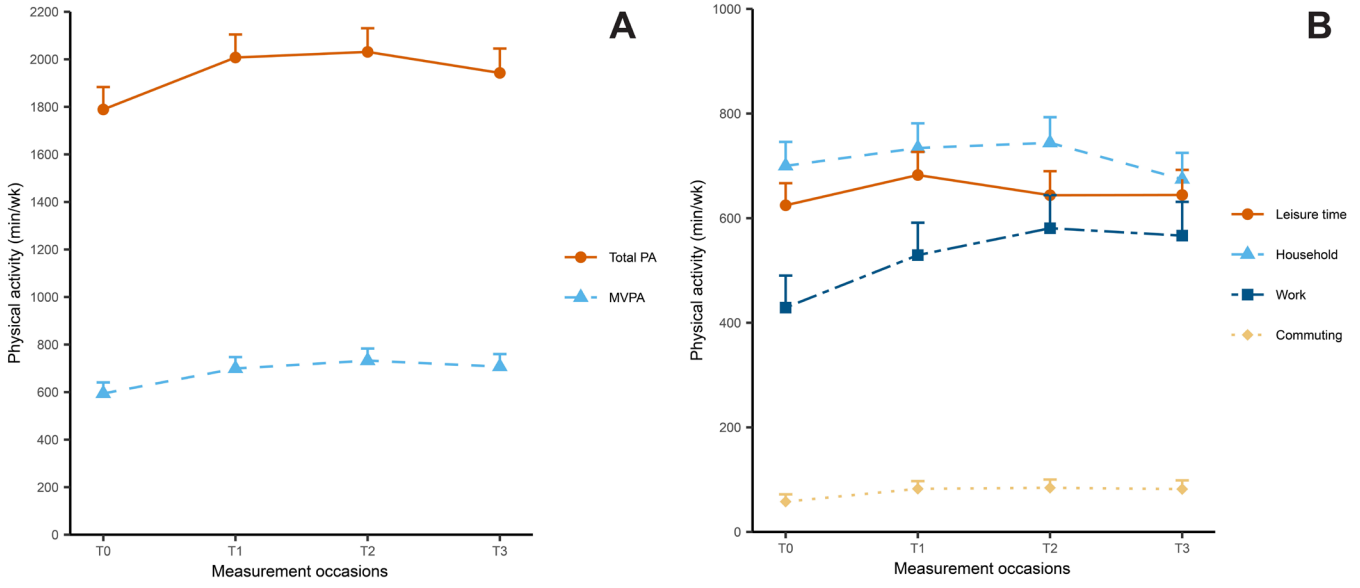

Figure 1 Regression lines of the multilevel regressions models for (A) minutes of total physical activity (PA) per week and minutes of moderate to vigorous physical activity (MVPA) and (B) for minutes of physical activity per week per setting.

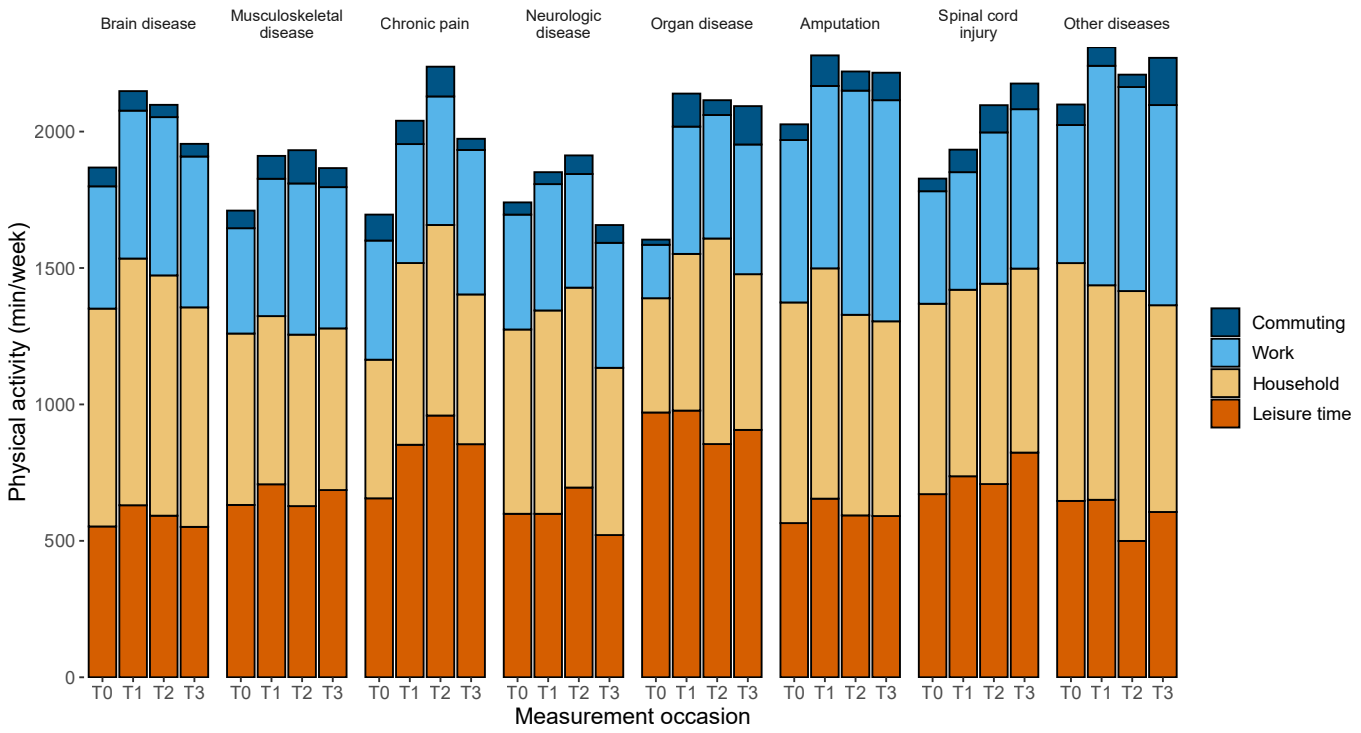

Figure 2 Descriptive data of total physical activity behaviour and the distribution in the four settings per measurement occasion of each diagnosis.

of PA. Part of this diversity in PA can be explained by age, sex, BMI and diagnosis. The effects of age and sex on PA are also found in the general population and in people with disabilities, with older people being less active and males being more active than females.[24 25 46 48] In contrast, we found that females were more active than males, which may be explained by the household PA as these were reported much more by females than males. As household PAs were mostly of light intensity, we also found that males were more active than females in MVPA, which is in line with previous literature.[24 46]

Interestingly, we found that older people were more active in MVPA than younger people. One explanation could be that for people older than 55 years, MVPA is reached with a lower MET value.[56] Because the Adapted-SQUASH has predefined MET values for each activity, it could be that the same activity is categorised as light intensity for people younger than 55 years, but as moderate intensity for people older than 55 years.

Only education had a significant interaction effect on PA over time, with people with higher education increasing their PA behaviour more than people with lower education. Previous research also found that people with higher education were more active, but to the best of our knowledge, the association between education and longitudinal change of PA behaviour was not studied before.[24 57]

Combining the knowledge about dose characteristics of PA behaviour and the influence of personal characteristics on PA behaviour could help health professionals and PA-promoting programmes to give more individually tailored recommendations. This could be beneficial for getting adults with physical disabilities/chronic diseases more active, as it is known from goal setting literature that more specificity is better.[58]

Strengths and limitations

A strength of the current study is that we study people with a broad range of physical disabilities/chronic diseases, who underwent rehabilitation in different rehabilitation centres and hospital departments across the Netherlands. This, together with the pragmatic measurement setting, improves generalisability of the results. However, as the ReSpAct cohort is probably a positive sample regarding PA, results should also be generalised with some caution.

This study used an observational study design, in which all participants received personalised PA counselling as part of the RSE programme. Without a control group, we cannot study the effectiveness of the RSE programme. As such, we do not know whether participating in the RSE programme contributed to the increased levels of PA after rehabilitation. However, the primary aim of this study was to explore the dose characteristics of PA in adults with physical disabilities/chronic diseases up to 1 year after rehabilitation, for which an observational study lends it design. Furthermore, the RSE programme was developed based on the results of an RCT that showed the effectiveness of counselling during and after rehabilitation in increasing overall PA behaviour.[31 53]

PA was measured with a self-reported questionnaire. Questionnaires are prone to recall bias and social desirability, and therefore lead to overestimation of PA.[32 59 60] Intensity outcomes of the Adapted-SQUASH are mostly

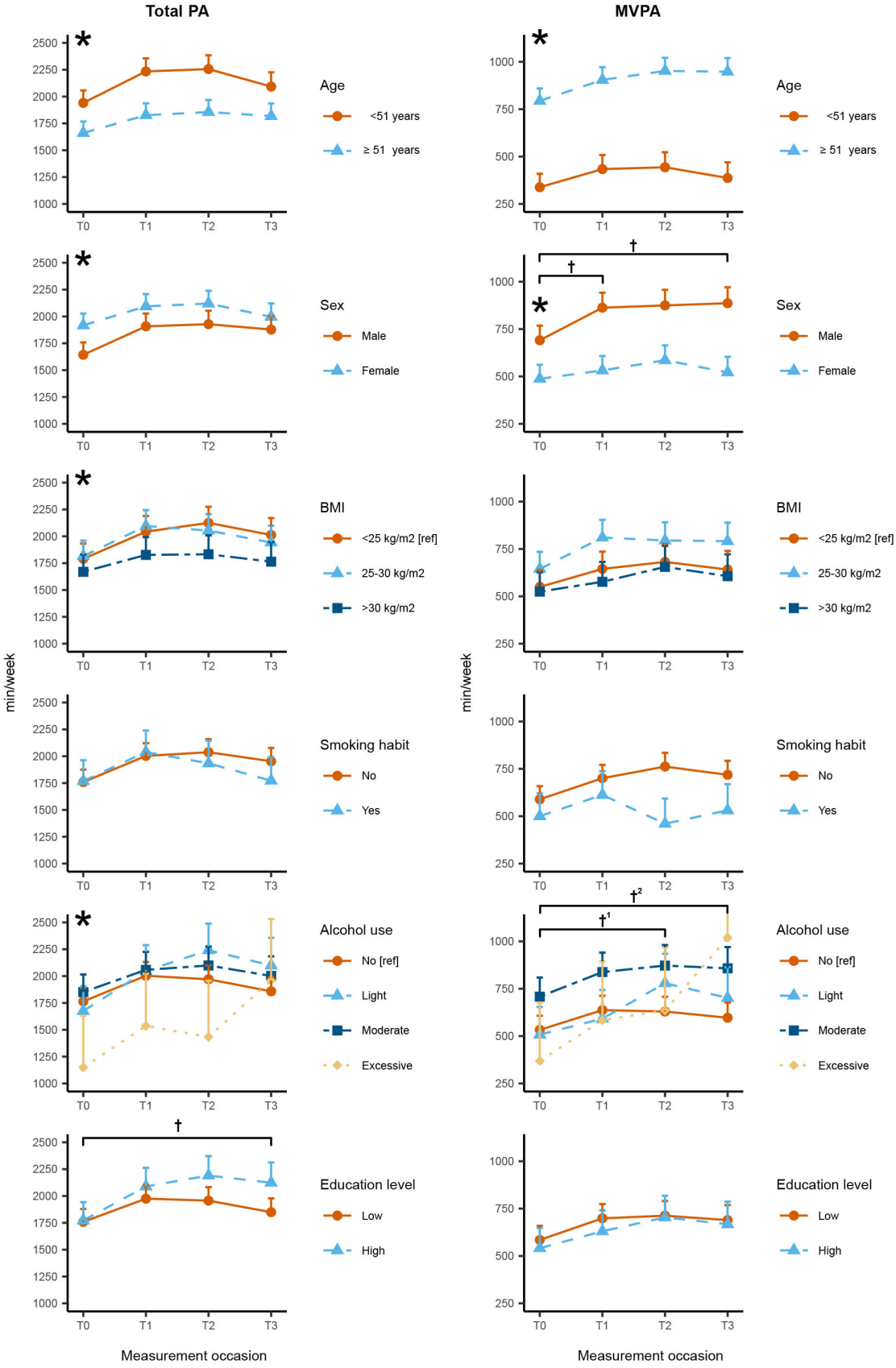

Figure 3 Effects of personal characteristics on baseline levels and development over time of total PA and MVPA, based on the individual multilevel regression models with 95% CI. *Significant difference between groups at baseline (p<0.05). †Significant difference in development over time between groups (1 between light alcohol usages and no alcohol usage, 2 between excessive alcohol usage and no alcohol usage) (p<0.05). BMI, body mass index; MVPA, moderate to vigorous PA; PA, physical activity.

based on MET values from the Ainsworth compendium of PAs, based on a general population,[33] which might not be as valid for people with disabilities. However, as the test–retest reliability was high for the Adapted-SQUASH, the increase of PA behaviour found in this study is fairly robust.

Lastly, possible effects of characteristics (ie, age, sex, BMI, smoking behaviour, alcohol use and education level) and diagnosis on PA were tested univariable and not multivariable. It is possible that effects of characteristics are influenced by other characteristics. Multivariable testing would correct for this. However, because our main aim was to explore the dose characteristics and the studied characteristics were based on previous literature,[24–27] we currently limited the study ambitions to univariate testing.

Future research

This study gives detailed information on the dose characteristics of PA behaviour in adults with physical disabilities/chronic diseases, which is a first step in the dose–response relationship of PA and health. Due to lack of research on this relationship in adults with physical disabilities/chronic diseases, evidence of the current WHO PA guidelines for this population is mostly derived from research in non-disabled populations.[11] This makes it questionable how applicable these guidelines are, and perhaps making disability-specific guidelines more suitable.[15 61] However, the current PA guidelines for people with disabilities do have their merits, as they exposed the lack of systematic research on PA in this population,[62] inspiring new studies, such as the current study, to bridge this gap. Future research should now focus on the dose–response relationships between PA and health.

Closely related to the need for more research on the dose–response relationship of PA and health is the need for more research on PA measurement instruments in adults with physical disabilities/chronic diseases. Both self-reported and device-based instruments have limitations in this population, and future research should find out which types of instruments are most appropriate for dose/dose–response studies.

The effect of personal characteristics and diagnosis on PA behaviour overall and over time found in this study helps to inform readers to points of attention when promoting PA behaviour. Although most characteristics examined in this study cannot be intervened at, theoretical models underlying PA promotion, such as the Physical Activity for people with a Disability model,[63] suggest personal factors (eg, motivation, self-efficacy) and environmental factors (eg, barriers and facilitators, social support) that can be intervened at, also influence PA behaviour. Future research should investigate how these modifiable factors influence the development of PA behaviour during and after rehabilitation. This could help improve PA promotion interventions and gear them more to individualised therapy.

CONCLUSION

Both PA level and change of PA over time are highly variable among adults with physical disabilities/chronic diseases, in terms of different PA dimensions and in the context of personal and diagnosis characteristics. The findings of this study help to understand the construct of PA behaviour among a diverse population of persons with a physical disability and/or chronic disease. In addition, they can potentially be used to improve PA promotion activities among this population during and after rehabilitation.

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Patient consent for publication Not required.

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