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

Brief running head: PA in adults with physical disabilities/chronic diseases

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Background: Little is known of physical activity behavior among adults with a disability and/or chronic disease during and up to one year post rehabilitation. We aimed to explore 1) dose characteristics of physical activity behavior 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 (ReSpAct) 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-SQUASH. Dose characteristics of physical activity were descriptively analyzed. Multilevel regression models were performed to assess physical activity over time and the effect of personal and diagnosis characteristics on PA over time.

Results: Median total physical activity ranged from 1545 (IQR: 853 – 2453) at T0 to 1710 (IQR: 960 – 2730) at T3 min/wk. Household (495 to 600 min/wk) and light-intensity (900 to 998 min/wk) activities accrued the most minutes. Analyses showed a significant increase in total physical activity moderate- to vigorous-intensity physical activity and work/commuting physical activity for all time points (T1-T3) compared to 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 improving physical activity promotion activities.

Keywords: Epidemiology, Rehabilitation medicine, Sports medicine, Public health

Strengths and limitations of this study

- This is a largescale prospective cohort study that gives a detailed overview of the different dose characteristics of physical activity behavior 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 ReSpAct 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, for both 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 behavior is suggested to be low among adults with physical disabilities/chronic diseases.[7-9]

The recently updated World Health Organization (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 minutes of moderate-intensity or 75-150 minutes 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 is 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 (e.g. PA during leisure time, work), mode (e.g. walking, bicycling), frequency (e.g. times per week), duration (e.g. in hours) and intensity (e.g. low, moderate or vigorous) as its crucial constituants.[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 counseling, 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 largescale 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 behavior. Adults with physical disabilities/chronic diseases are a heterogeneous group, both in PA behavior[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 program. As such, it is important to understand which dimensions of PA behavior 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 behavior over time, and will enable to individualize PA stimulation programs.

The multicenter 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 behavioral intervention in Dutch rehabilitation care.[28, 29] Uniquely, the ReSpAct study includes data on self-reported PA behavior 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 behavior (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 one year post rehabilitation. The secondary aims were to explore the development of PA behavior over time, and to analyze the effects of personal characteristics and diagnosis on PA behavior and its development over time.

Methods

Study overview

This study is part of prospective cohort study ReSpAct to evaluate the nationwide implemented Dutch rehabilitation program Rehabilitation, Sport and Exercise (RSE, Dutch: "Revalidatie, Sport en Bewegen").[28, 29] RSE is an evidence-based PA counseling program involving multiple counseling 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] The study was approved by the Ethical Committee of the Center for Human Movement Sciences of the University Medical Center Groningen (reference: ECB/2013.02.28_1). All participants voluntarily participated after signing an informed consent.

Patient and public involvement

Representatives of the Dutch community organizations 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 (physical activity).

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 program; 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 program other than RSE.

PA behavior

Self-reported PA behavior 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: e.g. walking, cycling, wheeling, gardening) that were pre-structured in different settings: activities during commuting, activities at work and school, household activities and leisure time activities. The Adapted-SQUASH has a good reliability (ICC = .67 and .76, for total activity score and total minutes of activity per week respectively), and a validity comparable to other PA questionnaires when using accelerometer derived PA (ρ = .40 for total activity score and ICC = .22 for total minutes of activity per week).[32]

Raw Adapted-SQUASH data were processed with a custom created syntax (SPSS statistics 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 physical activities[33] and a compendium of energy costs of the physical activities for wheelchair dependent individuals[34] into light (<4 MET for people 18-65 years old, <3 for people older than 65), moderate (4-6.5 for people 18-65 years old, MET 3-6 MET for people older than 65) or vigorous intensity (>6.5 for people 18-65 years old, >6 MET for people older than 65).[32, 35] Primary outcomes were total minutes PA per week, minutes PA per setting, minutes PA per intensity, and the frequency of PA modes.

Adapted-SQUASH data of a measurement occasion was deemed valid when no more than one of the pre-structured settings was missing and the total minutes PA per week was not higher than 6720 minutes (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 dichotomized into smoker and non-smoker. Current alcohol usage was categorized 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 dichotomized into high

(applied university and higher) and low, to make it internationally comparable. Work status was categorized into school, employed, unemployed, retired, unable to work and other (e.g. voluntary work). Personal characteristics were self-reported by participants, with the exception of age and sex, which were reported by the RSE counselor.

Rehabilitation characteristics

Rehabilitation characteristics included diagnosis, rehabilitation context (hospital or rehabilitation center), rehabilitation form (inpatient-, outpatient, or consultancy rehabilitation) and number of received counseling sessions from the RSE program (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 ICD-10 structure: amputation (both upper and lower extremities), brain disease (e.g. stroke, congenital brain diseases), chronic pain, musculoskeletal disease (e.g. rheumatic conditions, conditions of upper-, lower extremities and spine), neurologic disease (e.g. Parkinson's disease, multiple sclerosis), organ disease (e.g. heart disease, chronic obstructive pulmonary disease), spinal cord injury (SCI) and other (e.g. chronic fatigue syndrome, medically unexplained symptoms).[36] Rehabilitation characteristics were reported by the RSE counselor.

Statistical analysis

Descriptive information of the population and the dose characteristics of PA behavior 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 chi^2-test for categorical variables.

To evaluate the development of PA behavior 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 behavior over time, we added random slopes for measurement occasion on the level of participants. However, this resulted in non-converging (i.e. unreliable) models, and subsequently removed from the models.

To explore the effects of personal characteristics and diagnosis on the development of PA behavior 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, i.e. 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 ANOVA 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 regressions analysis.[39] Significance level was set at 0.05.

Results

Study population

Table 1 shows 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 neurologic disease (15.0%, n=188). Excluded participants were younger (p<.001), more often a smoker (p=.04), and received less counseling sessions (p<.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/wk) 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/wk at respectively T1, T2 and T3 (table 2).

Setting

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

Intensity

Participants spent between T0 and T4 a median of 900 – 997.5 min/wk in light-intensity PA, 120 – 150 min/wk in moderate-intensity and 100 – 120 min/wk in vigorous-intensity. In household tasks, most minutes were spent in light intensity (median range T0-T4: 480-540 min/wk) and little to none in moderate and vigorous-intensity (range T0-T4: 82-87.6% 0 min/wk and 100-100% 0 min/wk, respectively). Leisure time activities were predominantly in MVPA (median range T0-T4: 40-60 min/wk light; 60-90 min/wk moderate; and 90-120 min/wk vigorous). Intensity of work activities were 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/wk at all measurement occasions). Commuting activities were mostly spent in vigorous (range T0-T4: 16-17% >0 min/wk), followed by light (range T0-T4: 11-12% >0 min/wk) and moderate-intensity (range T0-T4: 5-7% >0 min/wk).

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/wk. Bicycling is the second most frequent mode, with an average frequency ranging from 1.6 ± 2.1 to 1.8 ± 2.2 times/wk. Gardening, odd jobs and fitness are frequented around 0.6 times/wk (Table 2).

PA behavior over time

Figure 1 and appendix 1 show the results of the multilevel regression models for PA behavior over time. Compared to baseline (T0), there is a significant increase ($p<.001$) in total minutes of PA per week over time for each of the three follow-up measurement occasions (increase: 218.6 [CI 142.9 – 294.3], 242.2 [CI 162.6 – 321.7] and 153.8 [CI 70.9 – 236.6] min/wk at respectively T1, T2 and T3). Time spent in the settings work and commuting significantly increased at follow-up occasions (all $p<.05$). With the exception of one occasion, leisure time (T1, $p<.01$) and household tasks (T2, $p<.05$) remained stable compared to baseline values (T0).

Time spent in MVPA significantly increased at each measurement occasion compared to T0 (increase: 105.0 [CI 57.6 – 152.2], 138.4 [CI 88.7 – 188.1] and 112.9 [CI 61.1 – 164.6] min/wk at respectively T1, T2 and T3, all p<.001).

Effects of personal characteristics and diagnosis

Figure 2 shows total PA per measurement occasion and distribution of PA in the 4 settings separated for the different diagnoses. Appendix 2 provides a detailed description of PA behavior 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 [CI 92.7 – 522.2], and other diseases, β = 392.7 [CI 5.0 – 780.3] more active than brain disease), age (higher age less active, β = -12.7 [CI -18.0 – -7.4]), sex (females more active than males, β = 273.9 [CI 130.9 – 417.0]) and BMI (higher BMI less active, β = -8.8 [CI -17.6 – -0.03]) (see also appendix 3). No interaction effects between these characteristics and measurement occasion were found, i.e. 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<.05).

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 one 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 stabilized. Almost two thirds of the total minutes was light intensity PA. Most PA were in household setting. Leisure time contributed to the most minutes of MVPA. We found an on average 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 to previous studies (self-reported PA in specific disability groups and in a 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 to previous research (68-74% versus 35-60%).[8, 46-48] This suggests that the ReSpAct cohort is a potential positive selection regarding PA behavior. A possible explanation of our active population may relate to the fact that all participants voluntary engaged in the RSE program, 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 apply 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.

PA behavior 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 till one year after rehabilitation. We found a decrease in PA from 33 weeks (T2) to one year after rehabilitation (T3), but PA at T3 was still significantly higher compared to PA at T0. The improvement in PA aligns with the period that participants received personalized PA counseling (RSE program).[28, 29, 31] As a previous RCT already showed the effectiveness of counseling after rehabilitation in improving PA behavior[31, 53], this may explain the increase in PA behavior 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 counseling not just in the Netherlands[55] but internationally seems a promising approach. However, our data and that of the RCT[31] is limited to one year after rehabilitation, and future research should investigate whether these counseling sessions are enough for adherence to lifelong PA.

Effects of personal characteristics and diagnosis

We found a large diversity in individual PA behavior over time, as seen by the large interquartile ranges for all dose characteristics 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 PA 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 categorized 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 a higher education increasing their PA behavior more than people with a 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 behavior was not studied before.[24, 57]

Combining the knowledge about dose characteristics of PA behavior and the influence of personal characteristics on PA behavior could help health professionals and PA promoting programs 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 centers and hospitals departments across the Netherlands. This, together with the pragmatic measurement setting, improves generalizability of the results. However, as the ReSpAct cohort is probably a positive sample regarding PA, results should also be generalized with some caution.

This study used an observational study design, in which all participants received personalized PA counseling as part of the RSE program. Without a control group, we cannot study the effectiveness of the RSE program. As such, we do not know whether participating in the RSE program 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 one year after rehabilitation, for which an observational study lends it design. Furthermore, the RSE program was developed based on the results of an RCT that showed the effectiveness of counseling during and after rehabilitation in increasing overall PA behavior.[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 based on MET-values from the Ainsworth compendium of physical activities, 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 behavior found in this study is fairly robust.

Lastly, possible effects of characteristics (i.e., age, sex, BMI, smoking behavior, 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 behavior 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 does have its merits, as it 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 behavior overall and over time found in this study, helps to inform readers to points of attention when promoting PA behavior. 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 (PAD) model[63], suggest personal factors (e.g. motivation, self-efficacy) and

environmental factors (e.g. barriers and facilitators, social support) that can be intervened at, also influence PA behavior. Future research should investigate how these modifiable factors influence the development of PA behavior during and after rehabilitation. This could help improve PA promotion interventions and gear them more to individualized 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 behavior among a diverse population of persons with a physical disability and/or chronic disease what potentially can be used to improve PA promotion activities among this population during and after rehabilitation.

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Author contribution:

PB conceptualized the current study, analyzed the data, interpreted the data and drafted the manuscript. FH, LAK, LHVVDW and RD aiding in the conceptualization, interpretation and drafting of the manuscript. FH and BLS collected the data. LHVVDW, RD and FJH designed the overarching ReSpAct study. TH and LAK helped with statistical analysis. All authors provided critical feedback. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests:

The authors declare that they have no competing interests

Reference list:

1. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: Updated recommendation for adults from the american college of sports medicine and the american heart association. *Med Sci Sports Exerc* 2007;**39**:1423-34.
2. Martin JJ. Benefits and barriers to physical activity for individuals with disabilities: A social-relational model of disability perspective. *Disabil Rehabil* 2013;**35**:2030-7.
3. Warburton DER, Bredin SSD. Health benefits of physical activity: A systematic review of current systematic reviews. *Curr Opin Cardiol* 2017;**32**:541-56.
4. WHO. Global action plan for the prevention and control of ncds. 2013.
5. Ng R, Sutradhar R, Wodchis WP, Rosella LC. Chronic disease population risk tool (cdport): A study protocol for a prediction model that assesses population-based chronic disease incidence. *Diagn Progn Res* 2018;**2**:19.

6. World Health O, World B. World report on disability 2011. Geneva: World Health Organization; 2011.
7. Carroll DD, Courtney-Long EA, Stevens AC, et al. Vital signs: Disability and physical activity--united states, 2009-2012. *MMWR Morb Mortal Wkly Rep* 2014;**63**:407-13.
8. de Hollander EL, Proper KI. Physical activity levels of adults with various physical disabilities. *Prev Med Rep* 2018;**10**:370-6.
9. van den Berg-Emons RJ, Bussmann JB, Stam HJ. Accelerometry-based activity spectrum in persons with chronic physical conditions. *Arch Phys Med Rehabil* 2010;**91**:1856-61.
10. Bull FC, Al-Ansari SS, Biddle S, et al. World health organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med* 2020;**54**:1451-62.
11. Carty C, van der Ploeg HP, Biddle SJH, et al. The first global physical activity and sedentary behavior guidelines for people living with disability. *J Phys Act Health* 2021;**18**:86-93.
12. van der Ploeg HP, Bull FC. Invest in physical activity to protect and promote health: The 2020 who guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act* 2020;**17**:145.
13. DiPietro L, Al-Ansari SS, Biddle SJH, et al. Advancing the global physical activity agenda: Recommendations for future research by the 2020 who physical activity and sedentary behavior guidelines development group. *Int J Behav Nutr Phys Act* 2020;**17**:143.
14. Cooper RA, Quatrano LA, Axelson PW, et al. Research on physical activity and health among people with disabilities: A consensus statement. *J Rehabil Res Dev* 1999;**36**:142-54.

15. Martin Ginis KA, Latimer-Cheung AE, West CR. Commentary on "the first global physical activity and sedentary behavior guidelines for people living with disability". *J Phys Act Health* 2021;**18**:348-9.

16. Rosenberg DE, Bombardier CH, Hoffman JM, Belza B. Physical activity among persons aging with mobility disabilities: Shaping a research agenda. *J Aging Res* 2011;**2011**:708510.

17. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Rep* 1985;**100**:126-31.

18. Strath SJ, Kaminsky LA, Ainsworth BE, et al. Guide to the assessment of physical activity: Clinical and research applications: A scientific statement from the american heart association. *Circulation* 2013;**128**:2259-79.

19. Mahar M, Rowe D. Construct validity in physical activity research. In: Welk G, editor *Physical activity assessments for health-related research*. Human Kinetics; 2002, p. 51-72.

20. Arends S, Hofman M, Kamsma YP, et al. Daily physical activity in ankylosing spondylitis: Validity and reliability of the ipaq and squash and the relation with clinical assessments. *Arthritis Res Ther* 2013;**15**:R99.

21. Sliepen M, Mauricio E, Lipperts M, Grimm B, Rosenbaum D. Objective assessment of physical activity and sedentary behaviour in knee osteoarthritis patients - beyond daily steps and total sedentary time. *BMC Musculoskelet Disord* 2018;**19**:64.

22. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, et al. Reliability and validity of the short questionnaire to assess health-enhancing physical activity (squash) in patients after total hip arthroplasty. *BMC Musculoskelet Disord* 2008;**9**:141.

554 23. Kaptein SA, Badley EM. Sex differences, age, arthritis, and chronic disease: Influence
555 on physical activity behaviors. *J Phys Act Health* 2012;**9**:540-8.
556 24. Bauman AE, Sallis JF, Dzewaltowski DA, Owen N. Toward a better understanding of
557 the influences on physical activity: The role of determinants, correlates, causal
558 variables, mediators, moderators, and confounders. *Am J Prev Med* 2002;**23**:5-14.
559 25. Fekete C, Rauch A. Correlates and determinants of physical activity in persons with
560 spinal cord injury: A review using the international classification of functioning,
561 disability and health as reference framework. *Disabil Health J* 2012;**5**:140-50.
562 26. Streber R, Peters S, Pfeifer K. Systematic review of correlates and determinants of
563 physical activity in persons with multiple sclerosis. *Arch Phys Med Rehabil*
564 2016;**97**:633-45 e29.
565 27. Postma K, Bussmann JBJ, van Diemen T, et al. Physical activity and sedentary
566 behavior from discharge to 1 year after inpatient rehabilitation in ambulatory people
567 with spinal cord injury: A longitudinal cohort study. *Arch Phys Med Rehabil*
568 2020;**101**:2061-70.
569 28. Alingh RA, Hoekstra F, van der Schans CP, Hettinga FJ, Dekker R, van der Woude LH.
570 Protocol of a longitudinal cohort study on physical activity behaviour in physically
571 disabled patients participating in a rehabilitation counselling programme: Respact.
572 *BMJ Open* 2015;**5**:e007591.
573 29. Hoekstra F, Alingh RA, van der Schans CP, et al. Design of a process evaluation of the
574 implementation of a physical activity and sports stimulation programme in dutch
575 rehabilitation setting: Respact. *Implement Sci* 2014;**9**:127.
576 30. Miller WR, Rose GS. Toward a theory of motivational interviewing. *Am Psychol*
577 2009;**64**:527-37.

31. van der Ploeg HP, Streppel KR, van der Beek AJ, et al. Successfully improving physical activity behavior after rehabilitation. *Am J Health Promot* 2007;**21**:153-9.

32. Seves BL, Hoekstra F, Schoenmakers JWA, et al. Test-retest reliability and concurrent validity of the adapted short questionnaire to assess health-enhancing physical activity (adapted-squash) in adults with disabilities. *J Sports Sci* 2020:1-12.

33. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 compendium of physical activities: A second update of codes and met values. *Med Sci Sports Exerc* 2011;**43**:1575-81.

34. Conger SA, Bassett DR. A compendium of energy costs of physical activities for individuals who use manual wheelchairs. *Adapt Phys Activ Q* 2011;**28**:310-25.

35. Wendel-Vos G. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *J Clin Epidemiol* 2003;**56**:1163-9.

36. Organization WH. *Icd-10 : International statistical classification of diseases and related health problems / world health organization.* Geneva: World Health Organization; 2004.

37. Twisk J, de Boer M, de Vente W, Heymans M. Multiple imputation of missing values was not necessary before performing a longitudinal mixed-model analysis. *J Clin Epidemiol* 2013;**66**:1022-8.

38. Team R. Rstudio: Integrated development encironment for r. 2020.

39. Kuznetsova A, Brockhoff PB, Christensen RHB. Lmertest package: Tests in linear mixed effects models. *2017* 2017;**82**:26 %J Journal of Statistical Software.

40. Ginis KA, Latimer AE, Arbour-Nicitopoulos KP, et al. Leisure time physical activity in a population-based sample of people with spinal cord injury part i: Demographic and injury-related correlates. *Arch Phys Med Rehabil* 2010;**91**:722-8.

41. Krops LA, Geertzen JHB, Horemans HLD, Bussmann JBJ, Dijkstra PU, Dekker R. Feasibility and short-term effects of activity coach+: A physical activity intervention in hard-to-reach people with a physical disability. *Disabil Rehabil* 2020:1-10.

42. Pans M, Ubeda-Colomer J, Monforte J, Devis-Devis J. Physical activity and accomplishment of recommendations in university students with disabilities: A longitudinal study. *Int J Environ Res Public Health* 2021;**18**.

43. Rosenberg DE, Bombardier CH, Artherholt S, Jensen MP, Motl RW. Self-reported depression and physical activity in adults with mobility impairments. *Arch Phys Med Rehabil* 2013;**94**:731-6.

44. Stewart RAH, Held C, Hadziosmanovic N, et al. Physical activity and mortality in patients with stable coronary heart disease. *J Am Coll Cardiol* 2017;**70**:1689-700.

45. Vanroy C, Vissers D, Vanlandewijck Y, et al. Physical activity in chronic home-living and sub-acute hospitalized stroke patients using objective and self-reported measures. *Top Stroke Rehabil* 2016;**23**:98-105.

46. Groen J-W, Stevens M, Kersten RFMR, Reininga IHF, van den Akker-Scheek I. After total knee arthroplasty, many people are not active enough to maintain their health and fitness: An observational study. *J Physiother* 2012;**58**:113-6.

47. Hassett L, Shields N, Cole J, Owen K, Sherrington C. Comparisons of leisure-time physical activity participation by adults with and without a disability: Results of an australian cross-sectional national survey. *BMJ Open Sport Exerc Med* 2021;**7**:e000991.

48. Murphy LB, Hootman JM, Boring MA, et al. Leisure time physical activity among u.S. Adults with arthritis, 2008-2015. *Am J Prev Med* 2017;**53**:345-54.

49. Geidl W, Schlesinger S, Mino E, Miranda L, Pfeifer K. Dose-response relationship between physical activity and mortality in adults with noncommunicable diseases: A systematic review and meta-analysis of prospective observational studies. *Int J Behav Nutr Phys Act* 2020;**17**:109.

50. del Pozo-Cruz J, García-Hermoso A, Alfonso-Rosa RM, et al. Replacing sedentary time: Meta-analysis of objective-assessment studies. *American Journal of Preventive Medicine* 2018;**55**:395-402.

51. Frith E, Loprinzi PD. Accelerometer-assessed light-intensity physical activity and mortality among those with mobility limitations. *Disabil Health J* 2018;**11**:298-300.

52. Rimmer JH. Getting beyond the plateau: Bridging the gap between rehabilitation and community-based exercise. *PM R* 2012;**4**:857-61.

53. van der Ploeg HP, Streppel KR, van der Beek AJ, et al. Counselling increases physical activity behaviour nine weeks after rehabilitation. *Br J Sports Med* 2006;**40**:223-9.

54. Rimmer J, Lai B. Framing new pathways in transformative exercise for individuals with existing and newly acquired disability. *Disabil Rehabil* 2017;**39**:173-80.

55. Hoekstra F, Hoekstra T, van der Schans CP, Hettinga FJ, van der Woude LHV, Dekker R. The implementation of a physical activity counseling program in rehabilitation care: Findings from the respact study. *Disability and Rehabilitation* 2019;**43**:1710-21.

56. Kemper HCG, Ooijendijk WTM, Stiggelbout M. Consensus over de nederlandse norm voor gezond bewegen. *TSG: Tijdschrift voor gezondheidswetenschappen* 2000;**78**:180-3.

57. Perrier MJ, Stork MJ, Martin Ginis KA, Group S-SR. Type, intensity and duration of daily physical activities performed by adults with spinal cord injury. *Spinal Cord* 2017;**55**:64-70.

649 58. Swann C, Rosenbaum S, Lawrence A, Vella SA, McEwan D, Ekkekakis P. Updating goal-
650 setting theory in physical activity promotion: A critical conceptual review. *Health*
651 *Psychol Rev* 2021;**15**:34-50.
652 59. Ma JK, McCracken LA, Voss C, Chan FHN, West CR, Martin Ginis KA. Physical activity
653 measurement in people with spinal cord injury: Comparison of accelerometry and
654 self-report (the physical activity recall assessment for people with spinal cord injury).
655 *Disabil Rehabil* 2020;**42**:240-6.
656 60. Nigg CR, Fuchs R, Gerber M, et al. Assessing physical activity through questionnaires –
657 a consensus of best practices and future directions. *Psychol Sport Exerc* 2020;**50**.
658 61. Martin Ginis KA, West CR. From guidelines to practice: Development and
659 implementation of disability-specific physical activity guidelines. *Disabil Rehabil*
660 2020:1-8.
661 62. Carty C, van der Ploeg HP, Biddle SJH, et al. Response to "commentary on: The first
662 global physical activity and sedentary behavior guidelines for people living with
663 disability". *J Phys Act Health* 2021;**18**:350-1.
664 63. van der Ploeg HP, van der Beek AJ, van der Woude LH, van Mechelen W. Physical
665 activity for people with a disability: A conceptual model. *Sports Med* 2004;**34**:639-49.

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Table 1. Descriptive statistics of included participants at each measurement occasion (T0-T3) and excluded participants at T0.

	Included				**Excluded**
	T0	T1	T2	T3	
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
% Neurologic 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	3.4	3.5	3.2	2.8	3.5
% Middle	63.6	64.3	65.0	66.7	44.1
% 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 center	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 counseling moments					**
% 0	11.4	11.0	10.8	10.0	21.0
% 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 %

Note: For some participants information was missing, leading to not all percentages adding up to a 100%. There was more missing data in the excluded group of participants compared to the included group of participants.

* and ** Significant difference between the included and excluded participants based on independent sample t-tests for continuous variables and based on Chi-square tests for categorical variables without unknown category between baseline participants and those excluded. (*$p<0.05$; **$p<0.001$).

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Table 2. Physical activity behavior 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 (852.5 - 2453)	1770 (990 - 2780)	1830 (981 - 2730)	1710 (960 - 2730)
Light (min/week)	900 (360 - 1680)	997.5 (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
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 is presented in median (interquartile range) or percentage.

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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 behavior and the distribution in the four settings per measurement occasion of each diagnosis.

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% confidence interval. *significant difference between groups at baseline (p<.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<.05).

Image 1.

Image 2.