

1 ***Psychosocial Factors of Physical Activity among People with Disabilities: Prospective Cohort Study***

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Abstract

7 **Purpose/objective:** This study aimed to 1) explore the associations between psychosocial factors and
8 physical activity behavior in people with physical disabilities and/or chronic diseases, both between
9 and within persons over time; and 2) examine whether these associations differ for people initiating
10 and people maintaining physical activity behavior.

11 **Research methods/design:** Data of 1256 adults with physical disabilities and/or chronic diseases
12 enrolled in the prospective cohort study Rehabilitation, Sports and Active lifestyle (ReSpAct) were
13 analyzed. Self-reported physical activity and four main psychosocial factors (i.e. self-efficacy,
14 attitude, motivation, social support) were measured with questionnaires 3-6 weeks before discharge
15 (T0) and 14 (T1), 33 (T2) and 52 (T3) weeks after discharge from rehabilitation. Hybrid multilevel
16 regression models (corrected for age, sex, education level, diagnosis, counseling support) were used.

17 **Results:** Multivariable significant between-subject associations were found for self-efficacy ($\beta=.094$
18 [95%CI .035 – .153]) and intrinsic motivation ($\beta=.114$ [95%CI .036 – .192]). Multivariable significant
19 within-subject associations were found for identified regulation ($\beta=-.038$ [95%CI -.072 – -.005]) and
20 intrinsic motivation ($\beta=.049$ [95%CI .016 – .082]). Effect modification of initiating or maintaining
21 physical activity was found for the between-subject association of attitude ($p=.035$). No significant
22 associations were found for social support, amotivation, external regulation and introjected
23 regulation.

24 **Conclusion/implications:** This study is the first that explored the between- and within-subject
25 associations between psychosocial factors and physical activity over time in a large cohort of adults
26 with physical disabilities and/or chronic diseases. The findings indicate the importance of intrinsic

27 motivation, identified regulation and self-efficacy in initiating and maintaining physical activity
28 behavior.

29 **Keywords:** Physical activity, Behavior change, Psychosocial factors, Hybrid multilevel regression
30 analysis

31 **Impact**

- 32 • The theoretical framework Physical Activity for people with Disabilities (PAD) model
33 emphasizes the importance of psychosocial factors, including motivation, self-efficacy, attitude
34 and social support, on physical activity behavior of people with physical disabilities and/or
35 chronic diseases.
- 36 • Informed by the PAD model, the ReSpAct (Rehabilitation, Sports and Active Lifestyle) study is
37 the largest multicenter prospective cohort study including self-reported physical activity data
38 from a diverse group of adults with physical disabilities or chronic diseases during and after
39 rehabilitation care.
- 40 • This study is the first that disentangles the between- and within-subject associations between
41 these key psychosocial factors and physical activity behavior in a large group of adults with
42 physical disabilities and/or chronic diseases. Disentangling these associations helps better
43 understand the relationships between psychosocial factors and physical activity, which in turn
44 can help improve physical activity counseling and promoting activities during and after
45 rehabilitation.
- 46 • Increasing intrinsic motivation within participants is associated with improvements in physical
47 activity behavior after rehabilitation. These findings indicate the value of integrating physical
48 activity counseling support activities focusing on increasing intrinsic motivation during and
49 after rehabilitation.
- 50 • Providing tailored physical activity counseling during and after rehabilitation is a promising
51 approach to improve physical activity in people with disabilities.

52 **Introduction**

53 Despite the numerous health benefits of physical activity (PA) in people with physical disabilities
54 and/or chronic diseases (Martin Ginis et al., 2021; Martin, 2013), many tend to have an inactive
55 lifestyle. To illustrate, around 50% of people with physical disabilities and/or chronic diseases are
56 inactive, defined as less than 10 minutes per week of moderate to vigorous activities (Carroll et al.,
57 2014; Hollis et al., 2020). People with physical disabilities and/or chronic diseases are also 16-62% less
58 likely to meet PA recommendations than people without disabilities (such as the 150-300 minute of
59 moderate to vigorous activities per week guideline of the World Health Organization) (de Hollander &
60 Proper, 2018; Martin Ginis et al., 2021). People with physical disabilities and/or chronic diseases are
61 particularly at risk of developing an inactive lifestyle after rehabilitation (Rimmer, 2012). However,
62 when PA is supported and promoted during and after rehabilitation, an active lifestyle can be
63 maintained (Brandenburg et al., 2022; van der Ploeg et al., 2006, 2007). These findings illustrate the
64 importance of PA promotion and counseling during and after rehabilitation to increase PA in people
65 with physical disabilities and/or chronic diseases.

66 Behavior change theories can help understand PA behavior and inform and improve PA
67 promotion interventions and programs. There are numerous behavior change theories (Gainforth et
68 al., 2021), such as Health Action Process Approach (HAPA)) (Schwarzer et al., 2011) and Self-
69 determination theory (Deci & Ryan, 2000). The Physical Activity for people with a Disability (PAD)
70 model is a disability-specific theoretical framework, developed to describe and understand the
71 relationship between PA, its determinants and functioning of people with disabilities (van der Ploeg et
72 al., 2004). The PAD model integrates the Attitude, Social influence and self-Efficacy model (de Vries et
73 al., 1988) with the International Classification of Functioning, Disability and Health model (World
74 Health Organization, 2001).

75 According to the PAD model, psychosocial factors are important determinants for improving
76 PA; four of which are self-efficacy, motivation, social support and attitude (van der Ploeg et al., 2004).
77 First, self-efficacy is defined as one's beliefs in their capabilities to exercise control over challenging
78 demands and over their own function (Bandura, 1997). Various literature reviews reported positive

79 associations between self-efficacy and PA behavior in both people with disabilities (Jaarsma & Smith,
80 2018) and people without disabilities (Bauman et al., 2012; Rhodes et al., 2017). Second, motivation
81 can be divided into amotivation, more controlled forms extrinsic motivation (i.e. external regulation,
82 introjected regulation), more autonomous forms of extrinsic motivation (identified regulation) and
83 intrinsic motivation (Deci & Ryan, 2000). To engage in behavior, amotivation is considered as a lack of
84 any intention, external regulation to avoid punishment or for external rewards, introjected regulation
85 to maintain self-approval or avoid guilt, identified regulation as leading to personally valued outcomes,
86 and intrinsic motivation for enjoyment and satisfaction itself (Deci & Ryan, 2000). Literature reviews
87 found consistent associations between motivation and PA, with more autonomous forms of
88 motivation positively associated with exercise (Bauman et al., 2012; Rhodes et al., 2017; Teixeira et al.,
89 2012). Third, social support are social relationships that give people emotional and practical resources
90 they need and can encourage healthier behavioral patterns (Wilkinson et al., 2003). Literature reviews
91 found social support to be positively associated with PA behavior in older adults and students (Lindsay
92 Smith et al., 2017; Van Luchene & Delens, 2021), positively associated with leisure time PA
93 participation in people with physical disabilities (Martin Ginis et al., 2016) and an effective element of
94 PA interventions for people with physical disabilities (Jaarsma & Smith, 2018). Finally, attitude is
95 considered to be an important determinant of the intention to be physically active according to
96 behavior change theory (Ajzen, 1985; de Vries et al., 1988). In people with physical disabilities,
97 literature reviews found moderate effects of attitude on intention to PA (Sur et al., 2022), and attitude
98 to be positively associated with leisure time PA participation (Martin Ginis et al., 2016).

99 A major limitation of the existing literature on associations between psychosocial factors and
100 PA, is that most of the studies have a cross-sectional design (Bauman et al., 2012; Jaarsma & Smith,
101 2018; Lindsay Smith et al., 2017; Rhodes et al., 2017; Sur & Shapiro, 2022). Prospective studies
102 assessing the associations between psychosocial factors and PA in people with various physical
103 disabilities/chronic diseases are scarce. Prospective studies provide opportunities to study changes in
104 psychosocial factors and PA behavior over time, both between persons and within a person (Twisk &

105 de Vente, 2019). Such prospective data are important to improve our understanding of behavior
106 change in PA and to improve PA promotion interventions and programs in people with disabilities.

107 An important aspect in the PA behavior change literature is the distinction between PA
108 initiation and PA maintenance (Marcus et al., 2000; Nigg et al., 2008; Sallis et al., 1986; van Stralen et
109 al., 2009). PA maintenance is recently conceptualized as “a process marked by a shift in the
110 mechanisms of action determining behavioral performance” (Rhodes & Sui, 2021). Behavior change
111 theories applying a stage model typically support this conceptualization, as these stage models
112 theorizes that certain determinants are more important during initiation and others more important
113 during maintenance (Dekker et al., 2018; Lippke & Ziegelmann, 2008; Prochaska & DiClemente, 1982;
114 Schwarzer et al., 2011). Indeed, studies have shown that the effects of psychosocial factors may be
115 different for people with physical disabilities and/or chronic diseases initiating PA behavior compared
116 with those maintaining PA behavior (Chiu et al., 2012; Ginis et al., 2013; Perrier et al., 2015; Schwarzer
117 et al., 2011). However, it is currently unknown if adults with physical disabilities and/or chronic
118 diseases initiating PA have different associations between the development of PA after rehabilitation
119 and changes in psychosocial factors compared with people maintaining PA. This might be relevant
120 information to further tailor PA promotion and counseling.

121 Using the PAD model as theoretical basis, the evidence-based Rehabilitation, Sport and
122 Exercise program (RSE; Dutch: Revalidatie, Sport en Bewegen) was developed to promote initiating
123 and maintaining PA using tailored counseling in people with physical disabilities and/or chronic
124 diseases during and after rehabilitation (Alingh et al., 2015; Hoekstra et al., 2014; van der Ploeg et al.,
125 2006, 2007). And even though the randomized controlled trial underlying the RSE program showed
126 promising results, there was a large variability in the extent to which participants benefitted from the
127 PA counseling (van der Ploeg et al., 2007), suggesting need and opportunities to further improve the
128 PA counseling support (Noar et al., 2007; Williams et al., 2011).

129 Therefore this study aimed to 1) explore the between- and within-subject associations
130 between psychosocial factors (motivation, self-efficacy, social support, attitude) and PA behavior in

131 people with physical disabilities and/or chronic diseases over time during and up to one year after
132 rehabilitation; and 2) explore whether the associations between psychosocial factors and PA differ
133 between people initiating and people maintaining PA behavior. We expect that people with more
134 positive outcomes on the psychosocial factors are more physically active, and that improving
135 psychosocial factors within a person leads to an increase in PA. We expect the associations between
136 psychosocial factors and PA behavior to be different between people initiating and people maintaining
137 PA behavior, although we do not have specific expectations regarding the directions of these
138 associations.

139 **Methods**

140 **Study design and participants**

141 This study is part of the Rehabilitation, Sports and Active lifestyle (ReSpAct) study, a
142 multicenter prospective cohort study designed to evaluate the PA and sports stimulation program RSE
143 (Alingh et al., 2015; Brandenbarg et al., 2022; Hoekstra et al., 2014). Participants were included
144 between May 2013 and August 2015, and followed over time with a set of questionnaires: 3-6 weeks
145 before discharge of rehabilitation (Baseline: T0), and at 14 (T1), 33 (T2) and 52 (T3) weeks after
146 discharge of rehabilitation. Participants included in the ReSpAct study: 1) were 18 years or older; 2)
147 were diagnosed with a physical disability and/or chronic disease; 3) received inpatient, outpatient or
148 consultancy rehabilitation treatment; and 4) participated in the RSE program. People were excluded
149 from participation in the ReSpAct study when they: 1) were unable to complete questionnaires, even
150 with help; or 2) participated in a PA program other than RSE. The study was approved by the Ethical
151 Committee of the Center for Human Movement Sciences of the University Medical Center Groningen
152 (reference: ECB/2013.02.28_1). All participants signed an informed consent and participated
153 voluntarily.

154 **Self-reported PA**

155 Self-reported PA behavior was measured using the Adapted version of the Short Questionnaire
156 to ASsess Health enhancing physical activity (Adapted-SQUASH) (Seves et al., 2020), a 19-item recall

157 questionnaire to assess PA among adults with disabilities based on an average week of the past month.
158 Participants had to report the frequency (number of days), duration (hours and minutes per day), and
159 perceived intensity of activities, pre-structured in four settings (commuting activities, activities at work
160 and school, household activities and leisure time activities). The Adapted-SQUASH is reliable (ICC = .67
161 for total activity score and ICC = .76 for total minutes of activity per week), and has comparable validity
162 to other PA questionnaires when compared to accelerometer derived PA ($\rho = .40$ for total activity score
163 and ICC = .22 for total minutes of activity per week) (Seves et al., 2020).

164 Using a custom created syntax (SPSS statistics 26, IBM), raw Adapted-SQUASH data was
165 processed into the total activity score, to include the intensity of PA behavior. Total activity score was
166 calculated by multiplying duration by intensity of each activity, and then adding this together. Intensity
167 was based on self-reported intensity combined with a set metabolic equivalent of task (MET) value
168 based on the Ainsworth compendium of physical activities (Ainsworth et al., 2011) and a compendium
169 of energy costs of physical activities for wheelchair dependent individuals (Conger & Bassett, 2011).
170 Adapted-SQUASH data of a measurement occasion was invalid when more than one of the pre-
171 structured settings was missing, when total minutes PA per week was higher than 6720 minutes (on
172 average 16 hours/day) or when the total activity score was higher than 155520.

173 **Psychosocial factors**

174 Motivation for PA was measured using the Behavioral Regulation in Exercise Questionnaire
175 (BREQ-2) (Markland & Tobin, 2004), a 19-item questionnaire with a 5 point Likert scale. It consists of
176 five subscales (amotivation, external regulation, introjected regulation, identified regulation and
177 intrinsic motivation), being the dimensions of motivation according to the Self-determination theory
178 (Ryan & Deci, 2000). Since there is debate on whether the use of the combined Relative Autonomy
179 Index score does justice to the multidimensionality of motivation (Chemolli & Gagne, 2014), we used
180 the scores of each subscale separately.

181 We assessed self-efficacy towards PA using five items developed by Marcus et al. (1992) which
182 showed good internal consistency (Cronbach's $\alpha = .82$), to which we added two items to assess a more

183 comprehensive self-efficacy construct. The addition of the two items improved the internal
184 consistency of the questionnaire assessed in the ReSpAct cohort (n = 1719). More information on the
185 internal consistency of this 7-item questionnaire can be found on Open Science Framework
186 (<https://osf.io/9e3pw>). Scoring ranged from 0 (not at all confident) to 10 (very confident) for the
187 individual items, and the total score was the sum of the seven items.

188 Attitude towards PA was assessed with three items, which were based on previous research
189 (Biddle et al., 1994; Marttila & Nupponen, 2006). On a five point Likert scale, participants were asked
190 if they believe being regularly active was 1) very good to very bad, 2) very important to totally not
191 important and 3) very fun to totally no fun. A lower score represents a more positive attitude towards
192 PA. For better interpretability in further analysis, items were recoded so that higher scores indicate
193 better attitude towards PA. A sum score of the recoded items was used as the final attitude score.

194 Perceived social support was measured using seven items with strong factor loadings from the
195 Social Support for Exercise Behavior questionnaire (Sallis et al., 1987), partly based on a previous
196 selection of Papandonatos et al. (Papandonatos et al., 2012). Items were scored on a 5 point ordinal
197 scale, ranging from 1 “never” to 5 “very often”. The final score was calculated as the sum score of the
198 7 items.

199 **Personal factors and diagnosis**

200 Personal factors included age, sex, body mass index (BMI), education level and stage of change
201 regarding PA. Education level was dichotomized into high (university and higher) and low, for
202 international comparability. Stage of change was assessed with one question with 5 answers options
203 corresponding with the precontemplation, contemplation, preparation, action and maintenance stage
204 (Marcus et al., 1992). We dichotomized the stages of change for two reasons. First, a pragmatic reason,
205 as using the full five stages would decrease the interpretability of the results. Second, there is
206 discussion on the demarcation of the different stages of change based on the passage of time
207 (Bandura, 1997). In line with previous research (Ginis et al., 2013; McEwan et al., 2022) and behavior
208 change theories (Nigg et al., 2008; Schwarzer et al., 2011), the stages of change were dichotomized

209 into two meaningful groups representing initiating PA behavior and maintaining PA behavior.
210 Participants scoring precontemplation, contemplation or preparation were categorized as initiating PA
211 behavior. Participants scoring action or maintenance were categorized as maintaining PA behavior.
212 Diagnoses were grouped according to diagnosis groups of the Dutch Diagnose-Treatment
213 Combinations, which are based on the International Classification of Diseases (ICD-10) structure:
214 amputation (both upper and lower extremities), brain disease (e.g. stroke, congenital brain disease),
215 chronic pain, musculoskeletal disease (e.g. conditions of upper-, lower extremities and spine,
216 rheumatic conditions), neurologic disease (e.g. multiple sclerosis, Parkinson's disease), organ disease
217 (e.g. chronic obstructive pulmonary disease, heart disease), spinal cord injury (SCI) and other (e.g.
218 medically unexplained symptoms, chronic fatigue syndrome) (World Health Organization, 2004). Age,
219 sex and diagnosis were reported by the RSE counselor, BMI, education level and initiating or
220 maintaining were self-reported by the participant.

221 **Statistical analysis**

222 Participants of the ReSpAct study were included in the analysis of the current study when there
223 was availability of data on the diagnosis of the participants, together with availability of valid data of
224 the Adapted-SQUASH at baseline and at least one follow-up measurement of the participants.
225 Descriptive information of the population is shown in mean \pm standard deviation or median
226 (interquartile range) for continuous variables, and percentages for categorical variables. Differences
227 of baseline characteristics between participants included and excluded in the analysis were tested with
228 independent samples t-test or Mann-Whitney U test for continuous variables (depending on normality
229 of data) and Pearson χ^2 test for categorical variables.

230 Besides the overall longitudinal relationship between psychosocial factors and PA, hybrid
231 multilevel regression models were also used to disentangle the between- and within-subject effects of
232 psychosocial factors on PA (Twisk & de Vente, 2019). To do so, for each psychosocial factor, for each
233 participant we created a mean score over the four measurement occasions (time independent) and a
234 deviation score for each measurement occasion (time dependent), calculated as the deviation

235 between the score on the measurement occasion and the individual mean score. Both (time
236 independent) mean score and (time dependent) deviation score were inserted as an independent
237 variable in the hybrid multilevel regression models. The standardized regression coefficient of the
238 mean score then describes the between-subject effect, indicating the effect of a difference in a certain
239 psychosocial factor on PA between persons. The standardize regression coefficient of the deviation
240 score describes the within-subject effect, indicating the effect of a change of the psychosocial factor
241 on PA within a person over time. Random intercepts were included in all models to adjust for
242 correlated observations within participants and within rehabilitation institutes.

243 ***'Univariable' models***

244 For each of the four psychosocial factors, we first applied 'univariable' overall models with the
245 PA total activity score as dependent variable and the psychosocial factors as independent variables.
246 This was followed by the 'univariable' hybrid models, with the PA total activity score as dependent
247 variable and the mean and deviation score of the psychosocial factors as independent variables. All
248 'univariable' models were corrected for age, sex, BMI, education level, diagnosis group and number of
249 counseling sessions.

250 ***Multivariable model***

251 To correct for potential overlapping effects of the psychosocial factors, a multivariable overall
252 model and multivariable hybrid model were then applied. All psychosocial factors were included in the
253 multivariable models, as there was no multicollinearity among the psychosocial factors. The
254 multivariable model was corrected for age, sex, BMI, education level, diagnosis group and number of
255 counseling sessions

256 ***Effect modification***

257 To analyze whether the effect of the psychosocial factors differs between people initiating or
258 maintaining PA, i.e. effect modification, we added initiators and maintainers and an interaction term
259 between both mean and deviation score of a psychosocial factor and initiators and maintainers to the
260 'univariable' hybrid models.

261 ***Transparency and openness***

262 The ReSpAct study was preregistered in the Dutch Trial Register (NTR3961/NL3788). All
263 analysis and data processing code are available on Open Science Framework (<https://osf.io/f4myq/>).
264 De-identified data supporting the findings of this study are available from the corresponding author
265 upon reasonable request. Analyses were performed in R and R studio (RStudio Team, 2020), using the
266 lmerTest package for multilevel regression analyses (Kuznetsova et al., 2017), and ggplot2 and sjPlot
267 packages for graphics (Lüdtke, 2021; Wickham, 2016). As there is no obvious gain to address missing
268 values using multiple imputations when using multilevel longitudinal regression models (Twisk et al.,
269 2013), this was not done in the current study. A table with the number of available data points per
270 measurement occasion for the dependent and independent variables is presented in supplemental
271 table S1. Significance level was set at .05.

272 **Results**

273 Of the 1719 participants who participated in the ReSpAct study, 1256 participants were
274 included in the analysis of the current study. Participants were on average 50.7 ± 13.4 years old, 47.3
275 % were male and had a median PA score of 4560 (range: 2600-7380) at baseline. The three largest
276 diagnosis groups were brain disease (27.1%), musculoskeletal disease (18.6%) and chronic pain (15.8%)
277 (table 1). Excluded participants were significantly younger and received less counseling sessions at
278 baseline (table 1). A descriptive analysis of PA over time can be found in a previous published study
279 (Brandenburg et al., 2022), and a descriptive analysis of the different psychosocial factors over time
280 can be found on OSF (<https://osf.io/s8u7r>).

281 **'Univariable' models**

282 Results of the corrected 'univariable' multilevel regression models are shown in table 2. We
283 found significant overall associations for intrinsic motivation (standardized regression coefficient (std
284 β) = .123 [95% CI .073 – .172]), self-efficacy (std β = .087 [95% CI .052 – .122]) and attitude (std β = .045
285 [95% CI .012 – .078]). Disentangling these overall associations, we found significant within-subject
286 associations for two subscales of motivation: identified regulation (std β = -.033 [95% CI -.065 – -.002])

287 and intrinsic motivation (std β = .049 [95% CI .018 – .080]). Significant between-subject associations
288 were found for intrinsic motivation (std β = .113 [95% CI .041 – .184]), self-efficacy (std β = .141 [95%
289 CI .095 – .186]) and attitude (std β = .110 [95% CI .063 – .156]). Figures of the significant corrected
290 ‘univariable’ associations can be found in supplemental figures S1-S5.

291 **Multivariable model**

292 Table 2 shows the results of the multivariable hybrid multilevel regression analysis. In the
293 corrected multivariable model, the between-subject associations of attitude was not significant
294 anymore. The between-subject association of self-efficacy and intrinsic motivation, as well as the
295 within-subject association of identified regulation and intrinsic motivation remained statistically
296 significant.

297 **Effect modification**

298 We found significant effect modification of initiating vs maintaining PA behavior for the
299 ‘univariable’ between-subject effect of attitude ($p=.035$). The between-subject effect of attitude on
300 PA, with people with a more positive attitude being more physically active, was more pronounced in
301 people initiating their PA behavior (see figure 1). No other significant effect modification was found
302 (supplemental table S2).

303 **Discussion**

304 To our knowledge, this is the first study to explore the associations between psychosocial
305 factors and PA behavior over time, both between and within participants, in a large cohort of people
306 with various physical disabilities and/or chronic diseases. In this relatively physically active cohort, we
307 found that participants with higher intrinsic motivation and higher self-efficacy scores were more
308 physically active than those with lower scores in these psychosocial factors during and after
309 rehabilitation. We found that an increase of intrinsic motivation after rehabilitation within a person
310 was associated with an increase in PA, whereas an increase in identified regulation after rehabilitation
311 was associated with a decrease in PA. There was a significant effect modification between people

312 initiating or maintaining for the between-subject effect of attitude. No other significant effect
313 modification was found for the studied psychosocial factors.

314 In line with our hypothesis, we found significant between-subject and within-subject
315 associations between intrinsic motivation and between-subject associations between self-efficacy and
316 PA during and after rehabilitation. This aligns with various behavior change theories (Bandura, 1986;
317 Deci & Ryan, 2000; Schwarzer et al., 2011) and previous studies among persons with physical
318 disabilities and/or chronic diseases (Jaarsma & Smith, 2018; Teixeira et al., 2012). These results
319 highlight the potential value of focusing on self-efficacy and intrinsic motivation in the rehabilitation
320 context.

321 Contrary to what we expected and what previous research has shown (Bauman et al., 2012;
322 Lindsay Smith et al., 2017; Teixeira et al., 2012), we found a small negative association between
323 identified regulation and PA and no associations between other motivation aspects, attitude or social
324 support. Additionally, the significant associations of intrinsic motivation and self-efficacy had small
325 effect sizes. We suggest three potential reasons explaining the lack of significant, strong associations
326 between psychosocial factors and PA behavior in our cohort. First, participants had on average high
327 baseline scores on the psychosocial factors. Scores on social support were much higher compared to
328 a previous study using the same scale (Papandonatos et al., 2012) and BREQ-2 results were comparable
329 with previous studies in populations that followed PA programs (Cho et al., 2017; Markland & Tobin,
330 2004). The median attitude on baseline was 13 on a scale of 3 to 15, suggesting a positive attitude
331 towards PA. These high baseline scores in the psychosocial factors could indicate a decreased potential
332 for further improvement in these psychosocial factors, explaining the lack of significant relationships
333 with changes in PA. Additionally, our cohort is a relatively active cohort compared to a typical
334 population of people with physical disabilities and/or chronic diseases (Brandenburg et al., 2022; de
335 Hollander & Proper, 2018). Together, this indicates the importance of these psychosocial factors in
336 initiating and maintaining PA during and after rehabilitation. Second, there was a large variability in PA
337 behavior in our cohort, both between participants and within participants. A study on the validity and

338 reliability of the Adapted-SQUASH showed that although the questionnaire had good reproducibility,
339 the questionnaire had wide limits of agreement (Seves et al., 2020). Wide limits of agreement for
340 reliability mean a large variability within a person between two measurement occasions, which reduce
341 the chance of detecting relationships between PA and measures of health (Arvidsson et al., 2019).
342 Third, there may be determinants that are of influence on PA behavior in people with physical
343 disabilities and/or chronic diseases other than psychosocial factors (e.g. barriers regarding PA, implicit
344 attitudes towards PA, rehabilitation processes) (Chevance et al., 2017; Jaarsma et al., 2014; Martin
345 Ginis et al., 2021). For example, previous studies showed that people with physical disabilities and/or
346 chronic diseases experience many barriers regarding PA that differ from the barriers that people
347 without physical disabilities and/or chronic diseases experience (Jaarsma et al., 2014; Martin Ginis et
348 al., 2016). Furthermore, previous research showed that reducing barrier beliefs in primary care
349 patients is related to an increase in PA behavior (Bouma, 2018; Bouma et al., 2018). It could be that
350 changes in barriers regarding PA are equally or more impactful on a person's PA behavior compared
351 with changes in psychosocial factors. Future research should further investigate on how changes in
352 barriers regarding PA, and in other determinants, effect PA behavior, especially in people with physical
353 disabilities and/or chronic diseases.

354 In contrast to our hypotheses, we did not find effect modification between people initiating or
355 maintaining PA behavior and the studied psychosocial factors of PA. The exception being the finding
356 that a better attitude to be more positively associated with PA behavior in people initiation compared
357 to people maintaining PA behavior. Previous cross-sectional studies did find differences in psychosocial
358 factors between people in different stages of behavior change (Chiu et al., 2012; Ginis et al., 2013;
359 Perrier et al., 2015; Schwarzer et al., 2011). However, these studies looked at specific components of
360 the psychosocial factors related to different stages, as theorized by the HAPA model (Schwarzer et al.,
361 2011). We did not measure the psychosocial factors in such detail, but in a more general manner.
362 Future research is needed to explore the differences in effect of changing these specific components

363 of psychosocial factors on PA behavior between people initiating or people maintaining their PA
364 behavior.

365 **Scientific and practical implications**

366 For improving PA counseling support, and PA promotion in general, it is important to advance
367 our understanding of how changes in psychosocial factors within a person are associated with changes
368 in their PA behavior over time. This study adds to existing PA behavior change and rehabilitation
369 literature, by providing insights into associations between key psychosocial factors and PA behavior,
370 both *between* and *within* persons over time. Changes within a person are particular important for
371 improving PA counseling support intervention. The contradictory findings of the overall-, between- and
372 within-associations reported in our study highlight the potential relevance of disentangling these
373 associations to advance our understanding of how psychosocial factors influence PA behavior in people
374 with and without disabilities. We encourage researchers to use similar techniques to provide both
375 between- and within-subject effects in future prospective research on determinants of PA.

376 The findings of this study suggest the importance of increasing intrinsic motivation for PA
377 behavior in people with physical disabilities and/or chronic diseases during and after rehabilitation.
378 Motivational interviewing is a technique where the recipient rather than the counselor is encouraged
379 to voice the arguments for change, eliciting intrinsic motivation for change (Miller & Rose, 2009).
380 Providing tailored PA counseling support using this technique is a promising approach to substantially
381 improve PA behavior in people with physical disabilities and/or chronic diseases during and after
382 rehabilitation.

383 **Strengths and Limitations**

384 An important strength of this study is the inclusion of a large, diverse group of adults with
385 physical disabilities and/or chronic diseases who were followed over time during and up to one year
386 after discharge from rehabilitation. Uniquely, participants in the study took part in an evidence-based
387 PA promotion intervention (RSE) that was offered as part of their regular rehabilitation treatment
388 (Hoekstra et al., 2014). Another strength of the study is the strong disability-specific theoretical

389 foundation (PAD-model) of the PA promotion intervention that was used to inform the design and
390 measures of our study (Alingh et al., 2015). Furthermore, this study is the first that used a rigorous
391 statistical method to disentangle the between- and within-subject associations between psychosocial
392 factors and PA in adults with physical disabilities and/or chronic diseases.

393 Some limitations should be acknowledged. First, there is potential bias in the ReSpAct cohort.
394 The cohort is on average relatively active compared to a typical population of people with disabilities
395 and/or chronic diseases (Brandenbarg et al., 2022; de Hollander & Proper, 2018). This might indicate
396 that the ReSpAct cohort consists of people who were most engaged in and benefited the most from
397 the rehabilitation treatment. Therefore, it is questionable if the results can be translated to a less active
398 group of adults with physical disabilities or chronic disease. This study, however, does give a unique
399 insight in adults with physical disabilities and/or chronic diseases who are physically active. Second, in
400 the analysis we did not control for severity of disability. As the severity of disability could potentially
401 influence the results, it is important to take this into consideration for future research. Third, this study
402 used self-reported questionnaires to assess PA behavior. Questionnaires are subjected to bias, most
403 notably recall bias and social desirable answers (Choi & Pak, 2005). In the case of PA, questionnaires
404 mostly overestimate actual PA behavior. However, for practical reasons (i.e. costs, logistics) PA was
405 self-reported in this prospective cohort study. Fourth, we only focused on four key psychosocial
406 factors. Future research is needed to explore associations between other determinants and PA
407 behavior. Fifth, we dichotomized participants into those initiating PA and those maintaining PA based
408 on the five stages of change of the transtheoretical model, which is not supported by the model. The
409 dichotomization does not make a distinction between people ready and people not ready to change
410 their behavior, as proposed by the transtheoretical model. However, we studied participants of an PA
411 promotion rehabilitation program, suggesting that participants were ready to become more active.
412 Indeed, only 1.2% of the participants self-reported being in the precontemplation stage. Furthermore,
413 the dichotomization was informed by previous literature and other behavior change theories (e.g.
414 HAPA). Lastly, aligning with behavior change theory, we hypothesized that changes in psychosocial

415 factors of PA would result in changes in PA behavior. It is possible that these associations are
416 bidirectional (McAuley & Elavsky, 2008). Future research is needed to improve our understanding on
417 the working mechanisms of the associations between psychosocial factors and PA behavior.

418 **Conclusion**

419 This is the first large scale, multicenter cohort study that explored the between- and within-
420 subject associations between psychosocial factors and PA behavior over time in people with physical
421 disabilities and/or chronic diseases. The study demonstrates the variability and complexity of how
422 psychosocial factors affect PA levels in people with disabilities and/or chronic diseases during and after
423 rehabilitation. We found small significant associations of intrinsic motivation and self-efficacy between
424 persons and small significant associations of intrinsic motivation and identified regulation within a
425 person. This may suggest the importance of motivation and self-efficacy in counseling people with
426 physical disabilities and/or chronic diseases initiating or maintaining PA during or after rehabilitation.

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670

671 **Table 1.**

672 *Baseline characteristics of in- and excluded participants*

	Included (N=1256)	Excluded (N=463)
Personal factors		
Age (years)	50.7 ± 13.4	47.5 ± 14.3 *
Sex (% male)	47.3	42.1
BMI (kg/m ²)	27.5 ± 8.6	27 ± 5.9
Education level (% High) ^a	25.1	21.1
Physical activity score	4560 (2600 - 7380)	4320 (2055 - 7552) ^b
Initiation vs maintaining		
% Initiation	40.8	42.7
% Maintaining	59.2	57.3
Rehabilitation factors		
Disease group		
% Brain disease	27.1	25.7
% Musculoskeletal disease	18.6	19.1
% Chronic pain	15.8	19.1
% Neurologic disease	15.0	13.2
% Organ disease	12.1	10.5
% Amputation	4.5	4.5
% Spinal cord injury	3.0	4.5
% Other diseases	3.8	3.4
Rehabilitation context		
% Rehabilitation center	71.6	75.4
% Hospital	28.4	24.6
Rehabilitation form		
% Inpatient	2.8	3.7
% Outpatient	89.8	90.1
% Consultancy	7.4	6.3
Number of counseling sessions		
0%	11.4	21.0
% 1-3	56.4	55.3
% 4 or more	32.2	23.8
Psychosocial factors		
Motivation		
Amotivation	0 (0 - 0.2)	0 (0 - 0.5)
External regulation	0.2 (0 - 0.8)	0.2 (0 - 1)
Introjected regulation	1 (0.3 - 1.7)	1 (0.3 - 1.7)
Identified regulation	3 (2.2 - 3.5)	3 (2.2 - 3.5)
Intrinsic motivation	3 (2.2 - 3.5)	3 (2.2 - 3.8)
Self-efficacy	42 (34 - 49)	41 (33 - 49)
Attitude	13 (11 - 15)	13 (11 - 15)
Social support	19 (14 - 23)	18 (14 - 23)

673 *Note: Data presented as mean ± standard deviation, median (interquartile range) or percentage.*

674 ^aCompleted higher education

675 ^b Based on data of 344 excluded participants, as 119 participants were excluded due to no physical
676 activity data.

677 * Significant difference on baseline between in- and excluded participants based on independent
678 sample t-tests for normally distributed continuous variables, Mann-Whitney U tests for non-normally
679 distributed continuous variables and Chi-square tests for categorical variables (*significant result,
680 $p < .001$)

681

682 **Table 2.**

683 *Standardized associations between psychosocial factors and PA using 'univariable' and multivariable*
 684 *hybrid (multilevel) models corrected for age, sex, body mass index, education level, diagnosis and*
 685 *number of counseling sessions.*

	Overall effect			Between-subjects effect			Within-subjects effect		
	Std β	95% CI	p-value	Std β	95% CI	p-value	Std β	95% CI	p-value
'Univariable' models									
Motivation									
<i>Amotivaton</i>	.003	-.034 .040	.878	-.003	-.060 .054	.916	.006	-.020 .032	.662
<i>External regulation</i>	-.013	-.052 .025	.497	-.009	-.062 .045	.747	-.002	-.028 .024	.855
<i>Introjected regulation</i>	-.001	-.039 .037	.957	-.013	-.066 .040	.635	.001	-.025 .027	.941
<i>Identified regulation</i>	-.030	-.079 .020	.246	.025	-.053 .104	.530	-.033	-.065 -.002	.037
<i>Intrinsic motivation</i>	.123	.073 .172	.000	.113	.041 .184	.002	.049	.018 .080	.002
Self-efficacy	.087	.052 .122	.000	.141	.095 .186	.000	.017	-.007 .041	.168
Attitude	.045	.012 .078	.008	.110	.063 .156	.000	.001	-.024 .026	.927
Social support	.012	-.023 .046	.516	.022	-.024 .068	.347	.001	-.023 .025	.949
Multivariable models									
Motivation									
<i>Amotivaton</i>	.019	-.020 .057	.341	.004	-.056 .063	.906	.017	-.011 .044	.240
<i>External regulation</i>	-.018	-.059 .022	.377	-.004	-.061 .054	.902	-.008	-.036 .020	.567
<i>Introjected regulation</i>	.006	-.034 .046	.769	.005	-.051 .061	.855	.002	-.025 .029	.872
<i>Identified regulation</i>	-.049	-.103 .005	.076	-.016	-.102 .070	.716	-.038	-.072 -.005	.024
<i>Intrinsic motivation</i>	.125	.071 .179	.000	.114	.036 .192	.004	.049	.016 .082	.003
Self-efficacy	.065	.023 .107	.002	.094	.035 .153	.002	.015	-.013 .043	.283
Attitude	.002	-.036 .040	.908	.003	-.060 .065	.934	-.004	-.031 .023	.767
Social support	-.006	-.044 .032	.753	-.008	-.059 .042	.740	-.001	-.028 .026	.924

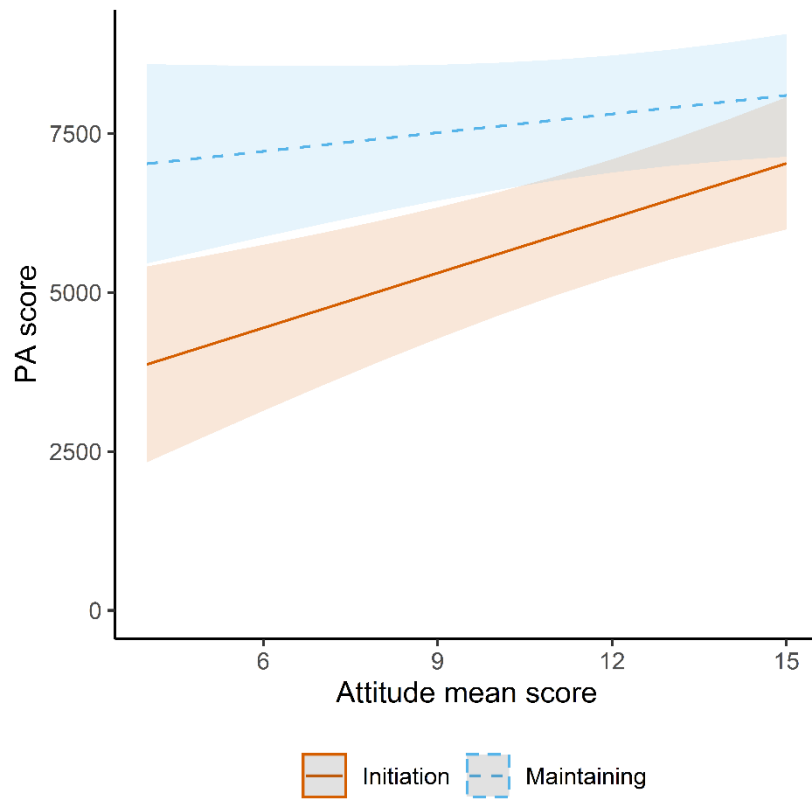
686 *Note: The regression coefficient of the overall association is a weighted average of the within and*
 687 *between regression coefficient.*

688 Std = standardized, CI = confidence intervals

689

690 **Figure 1**

691 *Effect modification of initiating or maintaining PA behavior on the association between the mean*
692 *score of attitude and PA behavior*



693

694