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Biopsychosocial Profiles of People With and Without Chronic Somatic Symptoms: Association Between Variables of the Biopsychosocial Model of Pain and Pain severity.

Master's thesis Clinical Psychology

Yvonne Poel
6536964
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Supervisor:
Prof. Dr. Rinie Geenen
Faculty of Social and Behavioral Sciences

Abstract

Objectives. With a focus on psychological flexibility, this study examined the association between variables of the Biopsychosocial model of pain (BMI, disease activity, sleep, physical activity and psychological flexibility) and pain severity and aimed to identify subgroups that can be distinguished from each other based on these variables. **Methods.** 334 Dutch participants aged between 18 and 75 (88.9% female) were included in analysis. Measurements of psychological flexibility (FIT-60), pain severity (RAND-36), physical activity (SQUASH), sleep (ISI), disease activity and body mass index (BMI) were used in hierarchical regression and cluster analyses. **Results.** Together, a significant association was found of pain with a combination of BMI, disease activity, sleep, physical activity and psychological flexibility. Four of the five independent variables (BMI, disease activity, sleep and physical activity) accounted for a significant percentage of the variance in pain, with small to medium effect sizes. Hierarchical cluster analysis yielded 3 profiles: Fit (n = 145), Adapted (n = 90), and Maladapted (n = 99). **Discussion.** This study did not find psychological flexibility to account for variation in pain, beyond that explained by other variables. However, together with four other biopsychosocial factors it showed significance for pain. Moreover, this study found three distinctive profiles that could be used to develop personalized treatment in common health care worldwide. The results provide a tentative suggestion that a combination of factors should be targeted in prevention or treatment of pain.

Introduction

Pain is something that everyone has come across in their lives. However, for some people pain is a predominant factor in their lives. It impacts daily life and may interfere greatly with functioning by decreasing quality of life, sleep, work and socialization (Crofford, 2015; Geenen, et al., 2018; Merskey & Bogduk, 1994). Also, it is a significant public health problem (Blyth, Macfarlane, & Nicholas, 2007), as it comes with an increase in health care use (Geenen, et al., 2018). Pain is subjective (Meints & Edwards, 2018) and is perceived and dealt with in an individual's own way (Merskey & Bogduk, 1994). It is influenced by cognitive, behavioral, and affective constructs and processes of a broad range (Meints & Edwards, 2018). Therefore, pain may be hard to explain based on objective findings (Vlaeyen, et al., 1989). The biopsychosocial model of pain looks at all these different factors as possible influencers of pain experience and describes the model as multidimensional: a dynamic interaction among physiological, psychological, and social factors (Meints & Edwards, 2018). The experience and impact of pain is a function of interacting combinations of these three overarching factors according to this model (Blyth, Macfarlane, & Nicholas, 2007; Crofford, 2015). The factors have an interaction, reciprocity and influence on and with each other, with factors that differ in importance between individuals (Geenen, et al., 2018). This perspective on the biopsychosocial model thus bring us back to the personal experience of pain.

Previous researched focused on variables that could be directly translated to treatment recommendations in common health centers worldwide and provided evidence of effects on pain of multiple treatment modalities, which led to recommendations regarding assessment and pain treatment (Geenen, et al., 2018). Five of these variables are used in the present study: body mass index (BMI), disease activity, physical activity, sleep and psychological flexibility, which is a core variable of psychological functioning. 67-88% of people with chronic pain disorders are experiencing sleeping difficulties (Crofford, 2015; Finan, Goodin, & Smith,

2013; Racine, 2018; Velly & Mohit, 2018; Wiklund, Linton, Alfoldi, & Gerdle, 2018). Besides being a consequence of pain, sleep is also considered to influence pain (Crofford, 2015; Geenen, et al., 2018), as up to 50% of people with insomnia suffer from chronic pain (Finan, Goodin, & Smith, 2013). Moreover, more that 90% of patients with a pain-related disease experience some form of impaired sleep quality, which impacted pain sensitivity (Yeung, Morgan, & Mckenna, 2017). Other factors that may influence pain, among others, are obesity (Apkarian, Baliki, & Farmer, 2013; Geenen, et al., 2018), disease activity (Crofford, 2015; Geenen, et al., 2018), physical activity (Geenen, et al., 2018), and psychological status (Apkarian, Baliki, & Farmer, 2013; Attal, et al., 2014; Geenen, et al., 2018; McCracken & Morley, 2014).

Pain cannot always be avoided and might not be entirely resolved by treatment (Turk & Okifuji, 2002). Then, it is helpful to be able to deal with pain or even accept it as it presents itself. Acceptance and Commitment Therapy (ACT) is a third-generation intervention with emphasis on acceptance and mindfulness within cognitive behavior therapy (Hayes, 2004). In ACT, psychological flexibility is at the core of treatment. The psychological flexibility model fully integrates both behavioral as well as cognitive factors, seems capable of creating treatment implementation in multiple modes of delivery for a wide range of conditions, and is increasingly supported by evidence (McCracken & Morley, 2014). Differences in psychological flexibility can be linked to differences in reactivity of a person to a stressful situation, where people with limited psychological flexibility are at greater risk of experiencing pain (Attal, et al., 2014). Psychological flexibility could be described as the ability to persist or to change behavior and integrates behavioral as well as cognitive factors (McCracken & Morley, 2014). Its value on the levels of treatment as well as outcome levels is supported by evidence (Hayes, 2004; McCracken & Morley, 2014). Being psychological flexible may therefore be helpful to people with pain symptoms.

The previously described variables that may be associated with pain severity, could occur in certain combinations (clusters). These clusters could help suggest and evaluate tailored interventions for individuals experiencing pain. A literature review yielded 14 studies using one or more of the variables used in the present study (see Appendix B for studies). Clusters of low, moderate and high symptom severity were found (Kang, Chen, Chen, & Jaw, 2012), as well as dysfunctional profiles with severe clinical presentation and profiles with less or no dysfunction (Billis, et al., 2013; Estévez-López, et al., 2017), and profiles in between with specific low and high scores on different variables (Estévez-López, et al., 2017). Taken together, these studies found high sensitivity or severity of pain to be clustered together with more sleeping problems, functional problems, and other symptoms (e.g., Billis, et al., 2013; Estévez-López, et al., 2017; Kang, Chen, Chen, & Jaw, 2012; Rabey, Slater, O'Sullivan, Beales, & Smith, 2015).

There is still limited information available about the role of psychological flexibility among other variables within the biopsychosocial model of pain (Apkarian, Baliki, & Farmer, 2013). It may be interesting to investigate what variables are associated with (development of) pain (Larner, 2014), as clarification is needed on what we are targeting in treatment when psychosocial factors are involved and what treatment outcomes to expect (Blyth, Macfarlane, & Nicholas, 2007). Although there are several studies that include one or more of the chosen variables as predictors of pain, or that correlated with pain, to our knowledge no study has used all five variables together.

The aim of this study is to examine the association of pain with psychological flexibility, BMI, disease activity, sleep and physical activity in people with and without chronic somatic symptoms. Moreover, it aims to identify clusters of people characterized by these six variables. This new insight may be helpful for future research as well as future education and may support personalized treatment to patients in daily clinical practice for

somatic symptoms, which may lead to better pain-related outcomes. By using variables that can directly be connected to treatment, this study tries to bridge the gap between practice and research.

First, it is expected that sleep difficulties, low physical activity, high body weight (BMI), high disease activity, and a low score on psychological flexibility, are associated with a higher score on pain. Figure 1 shows the regression model. Second, based on the literature review, the expectation is that cluster analysis will identify a dysfunctional profile, where more pain would go together with sleep problems, higher BMI, lower physical activity, more disease activity, and worse outcomes on psychological flexibility. More functional profiles are also expected to be found, with better outcomes on all variables. Lastly, profiles with low scores on one or two variables of the biopsychosocial model of pain might be found.

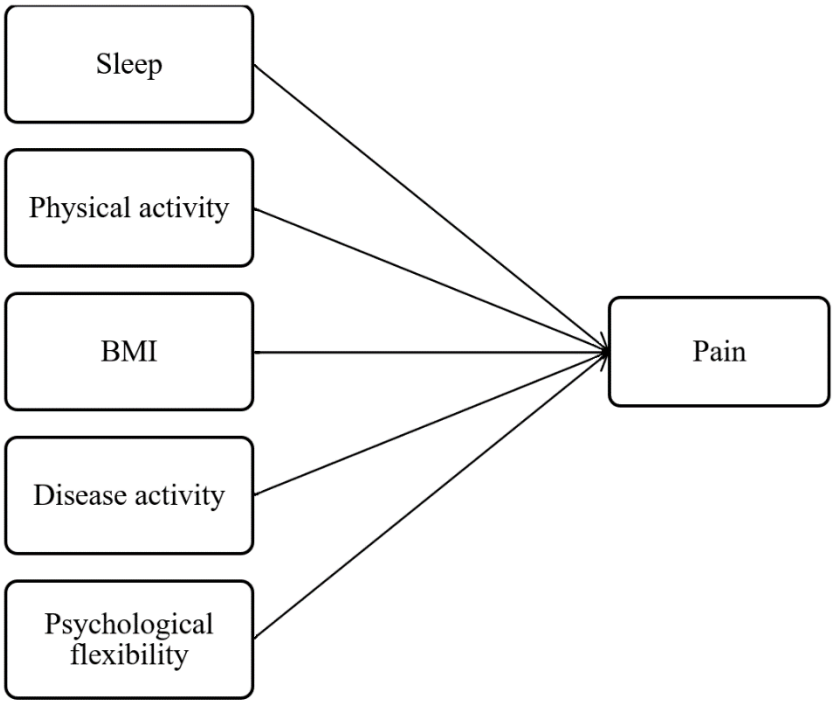

Figure 1. Regression Model with the Independent and Outcome Variables

Methods

Participants

Participants had to be 18 years or older, master the Dutch language and have access to the online survey. LimeSurvey was used to collect data online. Participants that did not finish the entire survey were excluded from analyses. Of 846 participants that clicked on the online survey, 335 respondents filled in all instruments and were included in analyses. Of the excluded respondents, 94 stopped before or at the informed consent question, another 56 did not complete the demographics questions. There was a total of 173, 295, 316, 487, and 499 missing scores on respectively BMI, psychological flexibility, pain, physical activity and sleep. After excluding one participant with an extreme score of more than 40000 (*z*–score > 9) on physical activity, a sample of 334 participants remained. There were differences in gender between the included and excluded participants: 86 of the original 123 men were excluded, which resulted in a significant difference in gender between the included and excluded participants (χ^2 (1, N = 696) = 19.195, p < .001). Also, the excluded participants were significantly younger (M = 38.80, SD = 15.73) compared to the included participants (M = 44.61, SD = 14.12), (t (688.97) = -4.24, p < .001. No other demographic differences were found between the excluded and included participants.

Design and procedure

Participants with and without chronic somatic symptoms were recruited through calls on social media and the network of the research student. The design was cross-sectional and observational. In the recruiting process, participants were informed about the content and design of the study (Appendix A1). At the beginning of the survey, respondents were asked to read and agree to the informed consent page (Appendix A2) before being able to start filling in the questionnaires.

Measures and materials

A survey comprising of four questionnaires and demographic questions was used in this study.

Demographics. Data on gender, age, relationship status, level of education, weight, height and disease activity were collected in this part of the survey (Appendix A3). Weight and height were used to compute a BMI score for further analysis. Disease activity was a categorical variable with either existing disease activity (causing pain or fatigue) or no existing disease activity.

Flexibiliteits Index Test (FIT-60). The FIT-60 (Batink, Jansen, & De Mey, 2012) was used to measure psychological flexibility. The questionnaire consists of 60 items, with each of the 6 subscales consisting of 10 items (Appendix A4). The subscales represent the six domains of psychological flexibility: acceptance, cognitive defusion, observing the self, present moment, values and committed action. Items were rated on a 7-point Likert scale from 0 (totally disagree) to 6 (totally agree). A lower score reflects a lower level of psychological flexibility. In the current study, the reliability of the FIT-60 scale (Appendix C1) was good ($\alpha = .89$). The subscales all had high reliabilities (Acceptance $\alpha = .85$, Cognitive defusion $\alpha = .89$, Present moment $\alpha = .81$, Values $\alpha = .76$, Committed action $\alpha = .83$), except for the Observing the self-scale which had a low reliability score ($\alpha = .58$).

Short Form Health Survey (SF-36). This questionnaire (Appendix A5) was used to measure pain (Van der Zee & Sanderman, 2012) and consists of eight scales: physical functioning, social functioning, role limitations (physical problems), role limitations (emotional problems), mental health, vitality, pain, overall health perception, and health changes. Only the pain scale was used, which combined the two following items: ‘How much pain did you experience in the last 4 weeks?’ and ‘To what extent did the pain cause

limitations in your normal activities (both in work outside of the house and household chores) in the past four weeks?'. Items were rated on a 6- and 5-point Likert scale respectively. The first item had ratings from 1 (none) to 6 (very severe), while the second item had ratings from 1 (not at all) to 5 (extremely), with a higher score reflecting a worse pain severity. Reliability of this scale in the present study (Appendix C2) was high ($\alpha = .87$).

Insomnia Severity Index (ISI). The ISI (Appendix A6) provided the sleep variable (Morin, 1993). It is designed to assess the perceived severity of insomnia. In this study, an additional eighth question was added to the questionnaire: 'To what extent do you wake up tired in the morning?'. The final 8 items were all rated on a 5-point Likert scale ranging from 0 (none/not at all) to 4 (very severe/very much), with a higher score indicating more sleeping problems. The ISI scale including the extra 8^{th} item had a high reliability score ($\alpha = .90$) (Appendix C3).

Short Questionnaire to Assess Health-enhancing physical activity (SQUASH). This questionnaire (Appendix A7) was used to measure physical activity (Wendel-Vos, Schuit, Saris, & Kromhout, 2003). It comprises of 4 parts: travel from home to work or school, physical activity at work/school, household activities, and free time activities. Within each part, activities are scored, how many days per week, the average time per day, and in some cases the intensity of the activity is asked. Next, a subscore is calculated for each part. A total metabolic equivalent task (MET) score is calculated using the 4 subscores. A higher score indicated more physical activity.

Statistical Analyses

Most of the data collected in this study are categorical or continuous and are presented quantitatively. Missing data were labelled as missing. IBM SPSS Statistics 24 was used for analysis, significance levels were set at $p < .05$ (two-tailed). First, the data was inspected for

missing and remarkable data twice, once before and once after computing the variables needed for analysis. Cronbach's alpha was then calculated to determine reliability and internal consistency of the scales. Data was checked for univariate as well as multivariate outliers, normality, linearity, homoscedasticity and independence of residuals using visual inspection of graphs, skewness scores (< 2), Mahalanobis Distance (< 20.515, $p < .001$) in combination with Cooks Distance (< 1), Tolerance value (> .10) and VIF value (< 10). After excluding one participant based on an extreme score on physical activity, no new violations of the assumptions were found.

Second, a linear multiple regression analysis was performed to test the hypothesis that sleep difficulties, low physical activity, high body weight (BMI), high disease activity, and a low score on psychological flexibility, are associated with a higher score on pain severity. Before conducting the multiple regression analysis, existence of possible demographic covariates for pain was examined using the Pearson Correlation and the one-way analysis of variance (ANOVA). Possible covariates were included in the linear multiple regression analysis. For this, ordinal data was dichotomized. Effect size was measured with interpretation of the Beta, where a value of >.10, >.30 and >.50 reflect a small, medium and large effect respectively (Cohen, 1988).

Third, *z*-scores were computed for all six variables and a hierarchical cluster analysis was performed using Ward's method and squared Euclidian distances to get an indication of the number of clusters. Dendrograms were visually examined to find the optimal fit. Next, participants were allocated to the clusters using a *k*-means cluster analysis. Iteration history, the number of individuals in each cluster and significance of the *F* statistics was checked to decide the exact number of clusters. This data was used to check if the minimum of 15% of the total sample was present in each cluster, a clear difference between groups was found, and

the cluster solution was stable, which were all criteria in selecting the exact number of clusters.

Fourth, to analyze differences between the profiles, chi square tests and one-way between-groups analysis of variance (ANOVA) were performed. In case the groups differed significantly from each other, post hoc comparisons between the profiles were used with a Bonferroni correction.

Results

Demographics

Demographics are shown in table 1. Of the 334 participants, the majority was female. Age ranged from 18 to 75 years. Education ranged from lower vocational to higher scientific education, with a preponderance highly educated participant. Most participants were married or living together with a partner.

Table 1
Demographics of the Participants (N = 334)

Characteristics	*n* (%)
Age (*M*=44.6, *SD*=14.1)	
18-30	77 (23.1%)
31-45	79 (23.7%)
46-60	131 (39.2%)
61-75	47 (14.1%)
Gender (*SD*=.3)	
Male	37 (11.1%)
Female	297 (88.9%)
Education level (*SD*=1.4)	
Low	39 (11.7%)
Middle	114 (34.1%)
High	177 (53%)
Other	4 (1.2%)
Relationship status (*SD*=.8)	
Alone	73 (21.9%)
Married/living together	227 (68%)
Divorced	18 (5.4%)
Widow/widower	4 (1.2%)
Other	12 (3.6%)
Disease activity *(SD*=.46)	
Yes	149 (44.6%)
No	185 (55.4%)

Note. M = mean; *SD* = standard deviation; Education level: Low = lower vocational education, Middle = vocational education, High = university and university of applied sciences.

Table 2 shows correlations between dependent and independent variables. Existence of possible demographic covariates for pain was examined using the Pearson Correlation and the one-way ANOVA. Pearson Correlation showed a significant association between age and pain, r (332) = .162, p = .003. ANOVA testing revealed significant differences in pain

between different genders (F (1, 332) = 16.79, $p < .001$) and education levels (F (5, 324) = 5.32, $p < .001$). Multiple regression analysis was performed to test the hypothesis that sleep difficulties, low physical activity, high body weight (BMI), high disease activity, and a low score on psychological flexibility are associated with a higher score on pain severity. Education level was dichotomized to reflect academic level education versus other education levels. Gender, education level and age were included in the regression analysis as covariates in block 1. The independent variables were included in the analysis in block 2. Characteristics of the independent and dependent variables used in this analysis are shown in table 3.

Table 2
Correlations Between the Dependent and Independent Variables of the Regression Analysis

		1	2	3	4	5	6
1	Pain	-					
2	BMI	.294***	-				
3	Disease activity	.334***	.182**	-			
4	Sleep difficulty	.548***	.139*	.240***	-		
5	Physical activity	-.312***	-.087	-.066	-.187**	-	
6	Psychological flexibility	-.313***	-.025	-.029	-.473***	.198***	-

Note. *$p < .05$, **$p < .01$, ***$p < .001$, two-tailed.

Table 3
Characteristics of Continuous Variables Used in Regression Analysis (N = 334)

Variable	*M*	*SD*	Min	Max
BMI	26.63	5.15	16.46	48.98
Sleep difficulty (ISI)	12.52	7.72	0	32
Physical activity (SQUASH)	4964.49	3735.49	0	23160
Psychological flexibility (FIT-60)	222.49	46.90	102	333
Pain (SF-36)	69.84	43.55	6	161

Note. *M* = mean; *SD* = standard deviation; Min = minimum; Max = maximum; ISI = Insomnia Severity Index; SQUASH = Short Questionnaire to Assess Health-enhancing physical activity; FIT-60 = Flexibiliteits Index Test; SF-36 = Short Form Health Survey.

Table 4 shows the hierarchical regression analysis results. On step 1 of the hierarchical MRA, gender, age and education accounted for a significant 12.3% of the variance in pain, $R^2 = .123$, F (3, 326) = 15.24, $p < .001$. On step 2, BMI, disease activity, sleep difficulties,

physical activity and psychological flexibility were added to the equation and accounted for an additional 32.7% of the variance in pain, $\Delta R^2 = .327$, ΔF (5, 321) = 38.14, $p < .001$. In combination, the covariates and predictor variables explained 45% of the variance in pain, $R^2 = .450$, F (8, 321) = 32.80, adjusted $R^2 = .436$, $p < .001$. While taking account of the other variables, sleep had the strongest association with pain severity (see table 3), with a medium effect size (β = .391). Gender, education, BMI, disease activity and physical activity were also significantly and independently associated with pain and had a small effect size (β = .147, β = -.133, β = .148, β = .170, β = -.195 respectively). Psychological flexibility did not significantly account for variance in pain severity beyond that which can also be explained by the other variables. To make sure psychological flexibility did not account for additional explained variance, an ad hoc hierarchical regression analysis was performed replacing the total psychological flexibility score in step 2 with the six subscores on psychological flexibility. None of the subscores on psychological flexibility significantly accounted for additional explained variance in pain.

Table 4
Unstandardized (B) and Standardized (β) *Regression Coefficients and Squared Semi-Partial Correlations* (sr^2) *For Each Independent Variable in a Regression Model For Pain Outcome.*

Variable	*B* [95% CI]	β	sr^2
Block 1			
Gender	32.416 [18.350, 46.483] ***	.236	.235
Age	.446 [.125, .768] **	.146	.142
Education	-17.622 [-26.700, -8.544] ***	-.203	-.198
Block 2			
Gender	20.173 [8.792, 31.554] **	.147	.144
Age	.097 [-.189, .383]	.032	.028
Education	-11.510 [-19.029, -3.991] **	-.133	-.125
BMI	1.250 [.529, 1.970] **	.148	.141
Disease activity	14.814 [6.876, 22.753] ***	.170	.152
Sleep difficulty	2.211 [1.667, 2.755] ***	.391	.331
Physical activity	-.002 [-.003, -.001] ***	-.195	-.189
Psychological flexibility	-.044 [-.134, .046]	-.048	-.040

Note. N = 334; CI = confidence interval; * $p < .05$. ** $p < .01$ *** $p < .001$.

A hierarchical cluster analysis was performed using Ward's method and squared Euclidian distances followed by a *k*-means cluster analysis. The dendrogram after hierarchical cluster analysis suggested a cluster solution between two and four clusters. A three-cluster solution was supported by the *k*-means cluster analysis: Fit (n = 145; 43.4%), Adapted (n = 90; 26.9%) and Maladapted (n = 99; 29.6%). This solution was chosen over the two and four-cluster solution as it showed the best face validity, while still having a low amount of iterations needed to stabilize (8 iterations), at least 15% the total sample in each cluster, and significant between group differences for all variables ($p < .001$). The two-cluster solution was not chosen as it placed two clusters together resulting in a loss of information. The four-cluster solution was not chosen as it had one subgroup that became too small (n < 15% of the total sample).

The sociodemographic characteristics of the 334 participants are shown in table 5. They are presented for the entire group as well as per profile. Participants in the fit profile had relatively low levels of pain disease activity, BMI, and sleep difficulty and relatively high levels of physical activity. Participants in the adapted profile reported the most disease activity and had a relatively higher score on BMI and pain. Although participants in this profile had the increased scores on BMI, pain and disease activity, they seemed to experience relatively few sleep difficulties and had the highest score on psychological flexibility. Lastly, participants belonging to the maladapted profile showed a combination of unwanted characteristics with the highest scores on BMI, pain and sleeping difficulties relative to scores in the other two profiles. Moreover, they had a relatively high score on disease activity and the lowest scores on physical activity and psychological flexibility compared to the other profiles. Figure 2 provides a visualization of the mean *z*-scores of the independent variables in each profile.

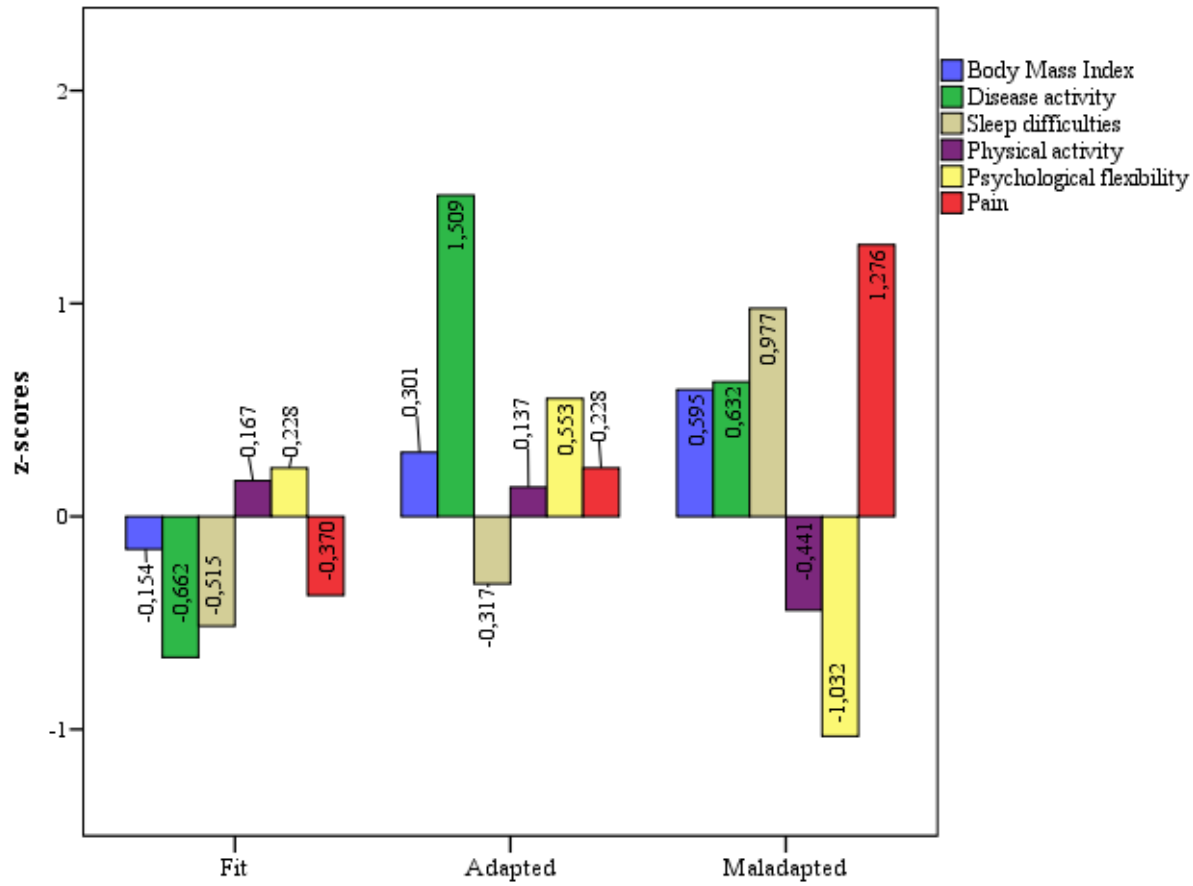

Figure 2. Visual Overview of the Biopsychosocial Profiles

Table 5

Sociodemographic Characteristics Overall and For Each Profile

Characteristics	Fit (*n* = 145)	Adapted (*n* = 90)	Maladapted (*n* = 99)	Total (*n* = 334)
Age, *M (SD)*	39.8 (14.18)	51.7 (12.97)	45.2 (12.18)	44.6 (14.12)
Gender, *n* (%)				
Male	21 (15.5%)	14 (15.6%)	2 (2%)	37 (11.1%)
Female	124 (85.5%)	76 (84.4%)	97 (98%)	297 (88.9%)
Education level, *n* (%)				
Low	8 (5.5%)	9 (10%)	22 (22.2%)	39 (11.7%)
Middle	44 (30.4%)	34 (37.8%)	36 (36.4%)	114 (34.1%)
High	93 (64.1%)	46 (51.1%)	38 (38.4%)	177 (53%)
Other	0 (0%)	1 (1.1%)	3 (3%)	4 (1.2%)
Relationship status, *n* (%)				
Alone	36 (24.8%)	17 (18.9%)	20 (20.2%)	73(21.9)
Married/living together	97 (66.9%)	64 (71.1%)	66 (66.7%)	227 (68%)
Divorced	4 (2.8%)	7 (7.8%)	7 (7.1%)	18 (5.4%)
Widow/widower	0 (0%)	1 (1.1%)	3 (3%)	4 (1.2%)
Other	8 (5.5%)	1 (1.1%)	3 (3%)	12 (3.6%)

Note. *M* = mean; *SD* = standard deviation; *n* = number of participants; Education level: Low = lower vocational education, Middle = vocational education, High = university and university of applied sciences.

The one-way between groups ANOVA showed a significant difference in age (F (2, 331) = 22.346, $p < .001$) and education (F (2, 327) = 15.558, $p < .001$) between profiles. Bonferroni post hoc analysis (using an α of .05) indicated that the fit profile consisted of significantly younger participants than the adapted and maladapted profiles. The adapted profile consisted of significantly older participants than the maladapted profile. Moreover, it indicated that participants in the fit profile had a significantly higher education than participants in the maladapted profile and the adapted profile consisted of significantly higher educated participants than the maladapted profile. The three profiles did not differ significantly on relationship status. Chi square independence test showed a significant association between profiles and gender (χ^2 (2, N = 334) = 11.78, p = .003), where over half (56.8%) of all male participants were included in the fit profile and just 2 (5.4%) of all males were included in the maladapted profile.

Table 6 shows the post hoc differences between the three profiles on all six variables. Difference between profiles on the six variables that were used in cluster analysis was tested using ANOVA and post hoc Bonferroni tests. This analysis indicated that the three profiles differed significantly in BMI (F (2, 331) = 17.704, $p < .001$), disease activity (F (2, 331) = 407.471, $p < .001$), sleep (F (2, 331) = 127.709, $p < .001$), physical activity (F (2, 331) = 17.598, $p < .001$), psychological flexibility (F (2, 331) = 115.936, $p < .001$) and pain (F (2, 331) = 150.504, $p < .001$). In the post hoc analysis (using an α of .05) we see that the fit profile scores lowest on BMI, disease activity and pain severity. The adapted profile shows the highest scores on disease activity and psychological flexibility, while the maladapted profile has the highest scores on BMI, sleep difficulties and pain, and the lowest scores on physical activity and psychological flexibility.

Table 6

Post Hoc Test Results of Differences Between the Three Profiles on All Six Variables

Variable	Post hoc differences	*F*	*p*
BMI	Fit < Adapted, Maladapted	17.704	<.001
Disease activity	Fit < Maladapted <Adapted	407.471	<.001
Sleep difficulties	Fit, Adapted < Maladapted	127.709	<.001
Physical activity	Maladapted < Adapted, Fit	17.598	<.001
Psychological flexibility	Maladapted < Fit < Adapted	115.936	<.001
Pain	Fit < Adapted < Maladapted	150.504	<.001

Note. Lower scores indicate better outcomes, except for physical activity and psychological flexibility, where a higher score is preferred.

Discussion and conclusion

Discussion

The present study provided insight into the association between pain and five biopsychosocial factors which can be targeted in treatment. Moreover, it presented three distinctive clusters which showed possible combinations of the biopsychosocial factors as a next step toward personalized treatment.

The first hypothesis of the present study was partially met, as a low score on physical activity and a high score on BMI, disease activity, and especially a high score on sleep difficulty, were found to be associated with more severe pain. This relationship is supported throughout several previously conducted studies (Apkarian, Baliki, & Farmer, 2013; Crofford, 2015; Geenen, et al., 2018), with the importance of sleep in pain outcome being highlighted in various research (Crofford, 2015; Finan, Goodin, & Smith, 2013; Racine, 2018; Velly & Mohit, 2018; Wiklund, Linton, Alfoldi, & Gerdle, 2018; Yeung, Morgan, & Mckenna, 2017). Yet, while taking account of the other variables, psychological flexibility was not found to be independently associated with pain. This finding is not in line with previous research (Apkarian, Baliki, & Farmer, 2013; Attal, et al., 2014; Geenen, et al., 2018; McCracken & Morley, 2014). However, this finding could be explained by looking at the biopsychosocial model of pain, which posits that pain impact and pain experience are dependent on a combination of interacting biological, psychological and social factors (Blyth, Macfarlane, & Nicholas, 2007; Meints & Edwards, 2018). As each factor is of influence to the other factors and the importance of each factor can differ between individuals (Geenen, et al., 2018), it seems that, in this case, psychological flexibility as a whole, and divided over the six subscales of psychological flexibility, does not account for a significant percentage of variance beyond the variance already explained by the other variables. This implies that pain was not influenced as much by psychological flexibility as it was by other variables. Even if

psychological flexibility as an independent is of less importance to pain compared to the other factors in this study, the negative correlation with a small effect size found between psychological flexibility and pain was significant. Furthermore, the psychological flexibility score was significantly associated with two other independent variables. This may indicate that psychological flexibility by itself may still be predictive of pain.

Second, the clusters identified in this study were in agreement with the second hypothesis, where profiles with more dysfunction, less dysfunction and a profile with low scores on one or two variables were expected to be found, which resulted in the hypothesis being met. No study has been found that used all six factors used in the present study. However, previous research reported profiles that differentiated between participants with more dysfunction, participants with less dysfunction and participants with both favorable and unfavorable scores (Billis, et al., 2013; Estévez-López, et al., 2017; Gyurcsik, Cary, Sessford, Flora, & Brawley, 2015; Kang, Chen, Chen, & Jaw, 2012; Marks, 2007; Nguyen, Ayers, Li, Harrold, & Franklin, 2016), which are comparable to the profiles found in the present study. This implies that there are distinct profiles in health related variables in the population which could be used to develop profile specific interventions for better health outcomes.

The fit profile was the most favorable, with the lowest scores on BMI, disease activity, sleep difficulties and pain, in combination with better scores on physical activity and psychological flexibility. This result was expected based on the biopsychosocial model of pain (Meints & Edwards, 2018; Geenen, et al., 2018), where all the variables influence each other. There are no variables negatively influencing the others and it seems this profile consists of healthy participants who are doing well and there seems to be no need for targeting specific variables. Thus, no implications on profile-specific treatment modalities are made for this profile. However, the cluster does provide insight into the combination of factors that form the favorable scores, which might be helpful to target when performing preventative

interventions. This in turn could result in fewer people belonging to the less favorable profiles, thus improving scores on all variables in the overall population and reducing the need for health care use.

The adapted profile was an interesting profile, as it consisted of favorable as well as unfavorable scores. This profile showed a pronounced highest score on disease activity, and less pronounced increased scores on BMI and pain, while also having less sleep difficulties, an increased score on physical activity and the highest score on psychological flexibility out of all three profiles. The high score on disease activity indicates that more people in this profile are suffering from illnesses that could cause pain or fatigue, compared to the other two profiles. The most important target in treatment for the individuals belonging to this profile, seems to be disease activity and there may be several treatment modalities for different diseases (e.g., Geenen, et al., 2018). Even though some disease activity could be targeted through use of the medical field, not all complaints may be resolved by this trajectory. Other ways of targeting these factors may therefore be of great value for some patients. It seems like this profile shows the power of coping, where psychological flexibility does seem to influence outcome, as pain is at the core of the disease activity variable (Crofford, 2015; Geenen, et al., 2018). The impact of psychological flexibility is shown throughout many years in many studies (see for example: Hayes, Strosahl, & Wilson, 2011; Hayes S. C., 2004; Öst, 2014), where some research suggest that psychological flexibility appears to be highly relevant to treatment improvements for people with chronic pain (Vowles & McCracken, 2010). Therefore, treatment targeting psychological flexibility may be effective for reducing the impact of pain and should be considered in clinical practice.

The maladapted profile was the most unfavorable profile and included participants with the worst scores on biopsychosocial variables in combination with the most pain. One of these variables was sleeping difficulties. The co-occurrence of pain and sleep difficulties is

common, with high numbers of people with chronic pain also experiencing difficulty sleeping (Crofford, 2015; Finan, Goodin, & Smith, 2013; Racine, 2018; Tang, 2018; Velly & Mohit, 2018; Wiklund, Linton, Alfoldi, & Gerdle, 2018; Yeung, Morgan, & Mckenna, 2017). The maladapted profile shows the same pattern, as they represent the group with the most pain and sleeping problems. As sleep has been found to be associated with pain in both this study and previous research (Crofford, 2015; Geenen, et al., 2018) it seems to direct us toward a networkmodel, where both variables are included and targeted in treatment. In this network model, the most influential factor(s) for an individual should be detected and targeted in treatment, which in turn can influence the other variables as well. For example, behavioral interventions on sleep outcomes have been found effective in improving sleep and pain outcomes (Geenen, et al., 2018). Moreover, the maladapted profile shows the lowest score on physical activity, and the highest score on BMI, which could be targeted to improve pain outcomes as well (Geenen, et al., 2018). Lastly, the maladapted profile shows the lowest score on psychological flexibility. This factor is of importance as not all complaints can be avoided or resolved by treatment. Besides for reduction of pain, to improve or maintain quality of life it is important to perform valued activities in daily life, even when experiencing pain or other discomfort (Rickardsson, et al., 2019). Mindfulness and acceptance-based interventions target the psychological flexibility factor and showed positive results in people with pain disorders and various chronic diseases (Schwartz & Margolies, 2019; Veehof, Trompetter, Bohlmeijer, & Schreurs, 2016). Interventions such Acceptance and Commitment Therapy (ACT) are increasingly supported by evidence of its value on the levels of treatment process as well as outcome levels for a wide range of conditions. It integrates both behavioral as well as cognitive factors and seems capable of creating treatment implementations in multiple modes of delivery (Hayes, 2004; McCracken & Morley, 2014). With help of interventions such as ACT, time and energy can be invested in commitment and action toward improving quality of

life (Hayes, Strosahl, & Wilson, 2011), and may as a result improve scores on all biopsychosocial factors.

The current study had some limitations. First, incomplete participation of participants resulted in the loss of information, primarily of younger participants and men. Second, the sample used in this study was unbalanced and did not represent the overall Dutch population well, with most participants being female and highly educated. This could have affected the outcome of all analysis in this study, including the number and types of profiles found in this study. Moreover, a new distribution would be expected as more participants would be included with the male gender and a younger age. Also, a representative sample could result in a better distribution of participants over the clusters, with about the same amount of participants in each cluster. Future research could look at the exact association between psychological flexibility and the other factors used in this study using a larger sample with a more balanced demographics. This could give an indication of the role of psychological flexibility in the context of the biopsychological model with factors that can be targeted in treatment. More knowledge about the efficacy of possible treatment interventions, for clusters like those found in this study, is needed.

Conclusion

This study aimed to provide insight into the association between psychological flexibility, BMI, disease activity, sleep, physical activity and pain, and to identify clusters of people based on these variables. All variables can be targeted in treatment in common health centers worldwide and are part of the biopsychosocial model of pain, which resulted in their inclusion in this study. Together, BMI, disease activity, sleep, physical activity and psychological flexibility were found to be associated with pain scores. When taking account of the other variables, each of these variables were found to be associated with pain, except

for psychological flexibility. Furthermore, based on the six used variables, this study has found three distinctive profiles: fit, adapted and maladapted. Significant differences between the three profiles were found on measures of all six variables.

This study supports the idea that the chosen six variables based on the biopsychosocial profiles are of importance and could be used to develop personalized treatment in common health care worldwide. The results provide a tentative suggestion that a combination of factors should be targeted in prevention or treatment of pain, and that the factors differ in importance between individuals.

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Appendices

Appendix A: Materials

Appendix A1: Survey information.

Beste lezer,

Hierbij nodig ik u uit om mee te doen met een vragenlijstonderzoek naar het belang van flexibiliteit voor welbevinden en lichamelijke klachten. Dit is mijn afstudeeronderzoek bij de Universiteit Utrecht. Ik voer het onderzoek uit met Tim Koppert, professor Rinie Geenen, Dr. Sibe Doosje en studenten van de Universiteit Utrecht. Iedere volwassene kan aan het onderzoek meedoen. Het invullen van mijn vragenlijsten duurt **ongeveer 20 minuten**, afhankelijk van de snelheid waarmee u werkt. Vrij vooraan zit een behoorlijk lange vragenlijst (de fit-60). Dit is niet alleen de langste vragenlijst, het is ook de lastigste vragenlijst om in te vullen. Hopelijk gaat u toch gewoon door met invullen. Daarna volgen vragenlijsten die makkelijker zijn in te vullen.

Het eerste deel van de enquête bevat mijn vragenlijsten en eindigt met de vraag of u verder wilt deelnemen door ook het vragenlijstenonderzoek van een andere student in te vullen. Ook het invullen van die vragenlijsten zal ongeveer 20 minuten duren. Uw gegevens worden vertrouwelijk verwerkt. Er wordt geen naam gekoppeld aan de resultaten. U kunt informatie over dit onderzoek inwinnen bij Tim Koppert: T.Y.Koppert@fsw.leidenuniv.nl. Om te kunnen deelnemen aan het onderzoek is het wettelijk verplicht dat u eerst toestemming geeft. Dat doet u op de volgende pagina. Ik hoop zeer dat u het onderzoek wilt afmaken en dank u bij voorbaat.

Met vriendelijke groet,

Yvonne Poel

Mede namens Tim Koppert, MSc., prof. dr. Rinie Geenen, dr. Sibe Doosje, Regina Pilz, Maaike Meerveld, Daniela del Carpio, Giorgos Zachariadis

Deze enquête is anoniem.

De gegevens die worden vastgelegd over de enquête die u heeft ingevuld bevatten geen gegevens die tot u zijn te herleiden. Behalve als er in een vraag naar is gevraagd.

Als u een toegangscode heeft gebruikt om deze enquête te kunnen invullen, dan verzekeren wij u dat deze toegangscode niet bij uw ingevulde gegevens wordt opgeslagen. Het wordt in een aparte database opgeslagen en het wordt alleen gewijzigd om aan te geven of u de enquête wel of niet helemaal heeft ingevuld. De toegangscodes worden niet gecombineerd met uw ingevulde gegevens.

Appendix A2: Informed consent.

Toestemmingsverklaring vragenlijstonderzoek naar ‘het belang van flexibiliteit voor welbevinden en lichamelijke klachten’.

Ik heb de informatie over dit onderzoek gelezen. Ik kon via de e-mail aanvullende vragen stellen bij de onderzoeker. Ik had genoeg tijd om te beslissen of ik meedoe. Ik weet dat meedoen helemaal vrijwillig is. Ik weet dat ik op ieder moment kan beslissen om toch niet mee te doen; daarvoor hoef ik geen reden te geven. Ik geef toestemming om mijn antwoorden op de vragen te gebruiken, voor het doel dat in de informatiebrief staat. Ik geef toestemming om gegevens nog maximaal 15 jaar na afloop van dit onderzoek te bewaren. Kruis nu één van de onderstaande vakjes aan.

Kies 'ja' als u het goed vindt om aan dit onderzoek mee te doen. Als u verklaart dat u 18 jaar of ouder bent en dat u kennis heeft genomen van de reden van dit onderzoek. U geeft de onderzoeker toestemming om uw gegevens te gebruiken.

Kies 'nee' als u niet mee wilt doen aan dit onderzoek

Ja/Nee

Appendix A3: Demographics.

1. Geslacht
   Kies één van de volgende antwoorden.
   a. Man
   b. Vrouw
   c. Anders

2. Leeftijd
   Uw antwoord moet tussen 9 en 99 liggen.
   In dit veld mag alleen een geheel getal worden ingevoerd.

3. Wat is uw lengte (in centimeters)?
   In dit veld mag alleen een geheel getal worden ingevoerd.

4. Wat is uw gewicht (in kilogram)?
   In dit veld mag alleen een geheel getal worden ingevoerd.

5. Wat is uw burgerlijke status?
   Kies één van de volgende antwoorden.
   a. Alleenstaand
   b. Gehuwd/samenwonend
   c. Gescheiden
   d. Weduwe/weduwnaar
   e. Anders

6. Wat is uw opleidingsniveau?
   Kies één van de volgende antwoorden.
   a. Lager onderwijs (basisschool).
   b. Lager beroepsonderwijs (LHNO/huishoudschool/LTS/VMBO-basis, VMBO-kader).
   c. Middelbaar algemeen onderwijs (MULO/MAVO/VMBO-gemengd, VMBO-theoretisch, 3 jaar HAVO of VWO), Middelbaar beroepsonderwijs (MBO) niveau 1.
   d. Middelbaar beroepsonderwijs MBO (niveau 2, 3 of 4), MTS, MEAO etc.
   e. Voortgezet algemeen onderwijs (HBS/MMS/HAVO/VWO/Gymnasium/Atheneum).
   f. Hoger beroepsonderwijs (HBO, HTS, HEAO etc.).
   g. Wetenschappelijk onderwijs (universiteit, ingenieursexamen).
   h. Overig.

7. Heeft u een aandoening met chronisch lichamelijke klachten?
   Kies één van de volgende antwoorden.
   a. Ja
   b. Nee

8. Wat voor aandoening heeft u?
   Meerdere antwoorden mogelijk. Selecteer alle mogelijkheden.
   a. Een psychiatrische ziekte (b.v. schizofrenie, depressie, angst, persoonlijkheidsstoornis).
   b. Artrose
   c. Fibromyalgie
   d. Een reumatische aandoening (b.v. reumatoïde artritis. Vink deze optie NIET aan als u artrose of fibromyalgie heeft, maar geen andere reumatische aandoening).
   e. Een longziekte (longemfyseem, COPD, astma, bronchitis).
   f. Diabetes (suikerziekte).
   g. Chronische huidaandoening.
   h. Epilepsie.
   i. Dementie.
   j. Ziekte van Parkinson.
   k. Overspannen, burn-out.
   l. Kanker.
   m. Hart- en vaatziekten (ook hoge bloeddruk valt hieronder).
   n. Chronisch vermoeidheidssyndroom.
   o. Prikkelbare darm syndroom (ibs).
   p. Somatoforme stoornis, somatisch-symptoomstoornis.
   q. Migraine.
   r. Chronische hoofdpijn (niet migraine).
   s. Chronische pijn elders in het lichaam dan hoofd.
   t. Verslaving (roken, alcohol).
   u. Ernstig overgewicht.
   v. Geen.
   w. Anders, namelijk …

Appendix A4: Flexibiliteits Index Test (FIT-60).

Instructie voor het invullen:

Deze vragenlijst bestaat uit 60 stellingen. Lees elke stelling aandachtig door en geef daarna aan in welke mate onderstaande stellingen van toepassing zijn op u. Hoe meer deze stelling van toepassing is op u, hoe verder naar rechts u het bolletje selecteert. Hoe minder deze stelling van toepassing is op u, hoe verder naar links u het bolletje selecteert.
Let erop dat u bij alle stellingen een antwoord geeft.

Kies het toepasselijke antwoord voor elk onderdeel:

0 – Helemaal oneens 6 – Helemaal eens.

1	Zorgen staan mijn succes in de weg.	0	1	2	3	4	5	6
2	Ik voel me vaak beperkt door alles wat ik van mezelf moet.	0	1	2	3	4	5	6
3	Ik kan negatieve gedachten over mijzelf hebben en tegelijkertijd weten dat ik oké ben.	0	1	2	3	4	5	6
4	Als ik iets wil doen, dan ga ik er voor.	0	1	2	3	4	5	6
5	Ik ben goed in staat om lange termijn doelen op te delen in korte termijn mogelijkheden.	0	1	2	3	4	5	6
6	Mijn leven is goed in balans.	0	1	2	3	4	5	6
7	Ik vind het moeilijk om doelgericht bezig te blijven.	0	1	2	3	4	5	6
8	Ik heb voldoende vrienden.	0	1	2	3	4	5	6
9	Mijn gedachten bezorgen mij ongemak of emotionele pijn.	0	1	2	3	4	5	6
10	Het is OK als ik me iets onaangenaams herinner.	0	1	2	3	4	5	6
11	Ik maak regelmatig concrete plannen voor de toekomst.	0	1	2	3	4	5	6
12	Als iets me niet lukt dan zet ik door, en probeer ik het op een andere manier aan te pakken.	0	1	2	3	4	5	6
13	Ik ga graag naar mijn werk.	0	1	2	3	4	5	6
14	Ik ben bereid om mijn angst volledig toe te laten.	0	1	2	3	4	5	6
15	Ik vind het moeilijk om mijn aandacht te houden bij wat er in het hier en nu gebeurt.	0	1	2	3	4	5	6
16	Ik ben snel afgeleid.	0	1	2	3	4	5	6
17	Ik vind van mezelf dat ik altijd aardig moet zijn.	0	1	2	3	4	5	6

18	Het is moeilijk voor me om de woorden te vinden die mijn gedachten beschrijven.	0	1	2	3	4	5	6
19	Ik besef dat mijn zelfbeeld niet zoveel over mij als persoon zegt.	0	1	2	3	4	5	6
20	Ik observeer mijn gevoelens zonder dat ik me erin verlies.	0	1	2	3	4	5	6
21	Als ik thuis ben voel ik me op mijn gemak.	0	1	2	3	4	5	6
22	Ik doe mijn best om geen negatieve dingen te hoeven ervaren.	0	1	2	3	4	5	6
23	Ik heb last van een negatief zelfbeeld.	0	1	2	3	4	5	6
24	Als ik iets niet goed doe, dan reken ik dat mezelf aan.	0	1	2	3	4	5	6
25	Ik besef dat ik de dingen die ik doe, zelf heb gekozen.	0	1	2	3	4	5	6
26	Als ik pijnlijke gevoelens toelaat, dan ben ik bang dat ze niet meer verdwijnen.	0	1	2	3	4	5	6
27	Er zijn een aantal dingen die ik doe, die ik belangrijk vind.	0	1	2	3	4	5	6
28	Ik heb last van het gevoel dat ik door de bomen het bos niet meer zie.	0	1	2	3	4	5	6
29	Ik heb de neiging mijn pijn erger te maken met mijn gedachten.	0	1	2	3	4	5	6
30	Ik vind het makkelijk om mijn gedachten van een andere kant te bekijken.	0	1	2	3	4	5	6
31	Mijn pijnlijke ervaringen en herinneringen maken het me moeilijk om een waardevol leven te leiden.	0	1	2	3	4	5	6
32	Als iemand een vervelende opmerking maakt, kan ik daar nog lang last van hebben.	0	1	2	3	4	5	6
33	Ik hoef dingen niet altijd goed te doen van mezelf.	0	1	2	3	4	5	6
34	Mijn werk en/of studie speelt een belangrijke rol in mijn leven.	0	1	2	3	4	5	6
35	Gedachten die bij me opkomen moet ik onder controle houden.	0	1	2	3	4	5	6
36	Ik kan goed beschrijven wat ik voel.	0	1	2	3	4	5	6
37	Ik vind mijn leven waardevol.	0	1	2	3	4	5	6
38	Ik geloof dat sommige van mijn gedachten abnormaal of slecht zijn en dat ik niet zo zou moeten denken.	0	1	2	3	4	5	6
39	Sommige woorden kunnen mij heel hard raken.	0	1	2	3	4	5	6

40	Ik ben onderweg om mijn doelen en dromen te bereiken.	0	1	2	3	4	5	6
41	Ik besteed regelmatig tijd aan mijn hobbys.	0	1	2	3	4	5	6
42	Ik heb de neiging erg sterk te reageren op mijn eigen negatieve gedachten.	0	1	2	3	4	5	6
43	Ik keur mezelf af als ik rare gedachten heb.	0	1	2	3	4	5	6
44	Ik kan makkelijk mijn overtuigingen en meningen onder woorden brengen.	0	1	2	3	4	5	6
45	Emoties (zoals boosheid, verdriet) veroorzaken problemen in mijn leven.	0	1	2	3	4	5	6
46	Ik sta los van mijn omgeving.	0	1	2	3	4	5	6
47	Ik doe meerdere dingen die ik belangrijk vind.	0	1	2	3	4	5	6
48	Ik vind het leuk om nieuwe uitdagingen aan te gaan.	0	1	2	3	4	5	6
49	Ik kan goed beschrijven wat ik ervaar met mijn zintuigen, zoals wat ik hoor, zie en ruik.	0	1	2	3	4	5	6
50	Ik vind steun bij de mensen in mijn omgeving.	0	1	2	3	4	5	6
51	De gedachten die ik over mijzelf heb, bepalen niet wie ik ben.	0	1	2	3	4	5	6
52	Ik schrik soms van de gedachten die ik heb.	0	1	2	3	4	5	6
53	Ik ben bang voor mijn gevoelens.	0	1	2	3	4	5	6
54	Mijn gedachten en gevoelens staan de manier waarop ik wil leven niet in de weg.	0	1	2	3	4	5	6
55	Ik vind familie en/of vrienden belangrijk.	0	1	2	3	4	5	6
56	Wanneer ik mezelf vergelijk met andere mensen, lijkt het dat de meesten onder hen hun leven beter in de hand hebben dan ik.	0	1	2	3	4	5	6
57	Het is erg moeilijk om verontrustende gedachten los te laten, zelfs wanneer ik weet dat los laten mij zou helpen.	0	1	2	3	4	5	6
58	Van sommige gedachten raak ik van streek.	0	1	2	3	4	5	6
59	Ik ben erop uit om nieuwe dingen te doen.	0	1	2	3	4	5	6
60	Ik denk dat mijn emoties soms slecht of ongepast zijn en dat ik ze niet zou moeten voelen.	0	1	2	3	4	5	6

Appendix A5: Short Form Health Survey (SF-36).

In deze vragenlijst wordt naar uw gezondheid gevraagd. Wilt u elke vraag beantwoorden door het juiste hokje aan te kruisen? Wanneer u twijfelt over het antwoord op een vraag, probeer dan het antwoord te geven dat het meest van toepassing is.

1. Wat vindt u, over het algemeen genomen, van uw gezondheid?

Uitstekend	Zeer goed	Goed	Matig	Slecht

2. In vergelijking met een jaar geleden, hoe zou u nu uw gezondheid in het algemeen beoordelen?

Veel beter dan een jaar geleden	Iets beter dan een jaar geleden	Ongeveer hetzelfde als een jaar geleden	Iets slechter dan een jaar geleden	Veel slechter dan een jaar geleden

De volgende vragen gaan over dagelijkse bezigheden.

3. Wordt u door uw gezondheid op dit moment beperkt bij uw dagelijkse bezigheden? Zo ja, in welke mate?

Forse inspanning zoals hardlopen, zware voorwerpen tillen, inspannend sporten	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Matige inspanning zoals het verplaatsen van een tafel, stofzuigen, fietsen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Tillen of boodschappen dragen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Een paar trappen oplopen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Eén trap oplopen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Buigen, knielen of bukken	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Meer dan een kilometer lopen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Een halve kilometer lopen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Honderd meter lopen	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt
Uzelf wassen en aankleden	Ja, ernstig beperkt	Ja, een beetje beperkt	Nee, helemaal niet beperkt

4. Had u, ten gevolge van uw lichamelijke gezondheid, de afgelopen 4 weken één van de volgende problemen bij uw werk of andere bezigheden?

U heeft minder tijd kunnen besteden aan werk of andere bezigheden.	Ja	Nee
U heeft minder bereikt dan u zou willen.	Ja	Nee
U was beperkt in het soort werk of het soort bezigheden.	Ja	Nee
U had moeite met werk of andere bezigheden (het kostte u bijvoorbeeld extra inspanning).	Ja	Nee

5. Had u, ten gevolge van een emotioneel probleem (bijvoorbeeld doordat u zich depressief of angstig voelde), de afgelopen 4 weken één van de volgende problemen bij uw werk of andere dagelijkse bezigheden?

U heeft minder tijd kunnen besteden aan werk of andere bezigheden.	Ja	Nee
U heeft minder bereikt dan u zou willen.	Ja	Nee
U heeft het werk of andere bezigheden niet zo zorgvuldig gedaan als u gewend bent.	Ja	Nee

6. In hoeverre heeft uw lichamelijke gezondheid of hebben uw emotionele problemen u de afgelopen 4 weken belemmerd in uw normale sociale bezigheden met gezin, vrienden, buren of anderen?

Helemaal niet	Enigszins	Nogal	Veel	Heel erg veel

7. Hoeveel pijn had u de afgelopen 4 weken?

Geen	Heel licht	Licht	Nogal	Ernstig	Heel ernstig

8. In welke mate heeft pijn u de afgelopen vier weken belemmerd bij uw normale werkzaamheden (zowel werk buitenshuis als huishoudelijk werk)?

Helemaal niet	Een klein beetje	Nogal	Veel	Heel erg veel

Deze vragen gaan over hoe u zich de afgelopen 4 weken heeft gevoeld. Wilt u bij elke vraag het antwoord aankruisen dat het beste aansluit bij hoe u zich heeft gevoeld?

9. Hoe vaak gedurende de afgelopen 4 weken:

voelde u zich levenslustig?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich erg zenuwachtig?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
zat u zo erg in de put dat niets u kon opvrolijken?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich kalm en rustig?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich erg energiek?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich neerslachtig en somber?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich uitgeblust?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich gelukkig?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit
voelde u zich moe?	Voortdurend	Meestal	Vaak	Soms	Zelden	Nooit

10. Hoe vaak hebben uw lichamelijke gezondheid of emotionele problemen gedurende de afgelopen 4 weken uw sociale activiteiten (zoals bezoek aan vrienden of naaste familieleden) belemmerd?

Voortdurend	Meestal	Soms	Zelden	Nooit

11. Wilt u het antwoord kiezen dat het beste weergeeft hoe juist of onjuist u elk van de volgende uitspraken voor uzelf vindt?

Ik lijk gemakkelijker ziek te worden dan andere mensen.	Volkomen juist	Grotendeels juist	Weet ik niet	Grotendeels onjuist	Volkomen onjuist
Ik ben net zo gezond als andere mensen die ik ken.	Volkomen juist	Grotendeels juist	Weet ik niet	Grotendeels onjuist	Volkomen onjuist
Ik verwacht dat mijn gezondheid achteruit zal gaan.	Volkomen juist	Grotendeels juist	Weet ik niet	Grotendeels onjuist	Volkomen onjuist
Mijn gezondheid is uitstekend.	Volkomen juist	Grotendeels juist	Weet ik niet	Grotendeels onjuist	Volkomen onjuist

Appendix A6: Insomnia Severity Index (ISI).

1. U wordt verzocht de ERNST van uw huidige slaapproble(e)m(en) aan te geven (d.w.z. gedurende de afgelopen 2 weken)

	geen	een beetje	behoorlijk	veel	zeer veel
Moeite met in slaap vallen	0	1	2	3	4
Moeite om door te slapen	0	1	2	3	4
Probleem door te vroeg ontwaken	0	1	2	3	4

2. Hoe TEVREDEN/ontevreden bent u over uw huidige slaappatroon?

zeer tevreden				zeer ontevreden
0	1	2	3	4

3. In welke mate denkt u dat uw slaapprobleem een BELEMMERENDE FACTOR is bij uw dagelijks functioneren (b.v. vermoeidheid overdag, goed functioneren op het werk/uitvoeren van dagelijkse taken, concentratie, geheugen, stemming, etc.)

helemaal niet belemmerend	een klein beetje	een beetje	behoorlijk	bijzonder belemmerend
0	1	2	3	4

4. In welke mate denkt u dat ANDEREN KUNNEN ZIEN dat uw slaapprobleem een negatieve invloed heeft op de kwaliteit van uw leven?

helemaal niet	nauwelijks	een beetje	duidelijk	zeer duidelijk
0	1	2	3	4

5. In welke mate MAAKT U ZICH ZORGEN over uw huidige slaapprobleem?

helemaal niet	een klein beetje	een beetje	veel	heel erg veel
0	1	2	3	4

6. In welke mate STAAT U VERMOEID OP in de ochtend?

helemaal niet	een klein beetje	een beetje	veel	heel erg veel
0	1	2	3	4

Appendix A7: Short Questionnaire to Assess Health-enhancing physical activity (SQUASH).

De CBS-versie van de SQUASH

Neem in uw gedachten een normale week in de afgelopen maanden.
Wilt u aangeven hoeveel dagen per week u de onderstaande activiteiten verrichtte, hoeveel tijd u daar gemiddeld op zo'n dag mee bezig was en hoe inspannend deze activiteiten waren?

Woon/werkverkeer (heen en terug)

	aantal dagen per week	**gemiddelde tijd per dag**	**inspanning**
a. lopen van/naar het werk of school	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
b. fietsen van/nar het werk of school	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
c. niet van toepassing	☐		

Lichamelijke activiteit op werk of school

	aantal uren per week
a. licht en matig inspannend werk (zittend/staand werk, met af en toe lopen, zoals bureauwerk of lopend werk met lichte lasten)	☐☐ uur
b. zwaar inspannend werk (lopend werk of werk waarbij regelmatig zware dingen moeten worden opgetild)	☐☐ uur
c. niet van toepassing	☐

Huishoudelijke activiteiten

	aantal dagen per week	**gemiddelde tijd per dag**
a. licht en matig inspannend huishoudelijk werk (staand werk, zoals koken, afwassen, strijken, kind eten geven / in bad doen en lopend werk, zoals stofzuigen, boodschappen doen)	☐ dagen	☐☐ uur ☐☐ min.
b. zwaar inspannend huishoudelijk werk (vloer schrobben, tapijt uitkloppen, met zware boodschappen lopen)	☐ dagen	☐☐ uur ☐☐ min.

c. niet van toepassing ☐

Vrije tijd

	aantal dagen per week	**gemiddelde tijd per dag**	**inspanning**
a. wandelen	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
b. fietsen	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
c. tuinieren	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
d. klussen/doe-het-zelven	☐ dagen	☐☐ uur ☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel

Sport (hier maximaal 4 sporten opschrijven)
Bijv. tennis, handbal, gymnastiek, fitness, schaatsen, zwemmen

		aantal dagen per week	**gemiddelde tijd per dag**		**inspanning**
a.	☐	☐ dagen	☐☐ uur	☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
b.	☐	☐ dagen	☐☐ uur	☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
c.	☐	☐ dagen	☐☐ uur	☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel
d.	☐	☐ dagen	☐☐ uur	☐☐ min.	☐ langzaam ☐ gemiddeld ☐ snel

Totaal
Op gemiddelde hoeveel dagen per week bent u, allse bij elkaar opgeteld, tenminste en halfu ur bezig met fietsen, klussen, tuinieren of sporten of andere inspannedne activiteiten?

☐ dagen per week

Appendix B: Literature study

A literature study was performed primarily using the advanced search option in Web of Science. Combinations of words are used to find literature to support the hypotheses, such as: psychological flexibility, chronic pain, biopsychosocial, sleep, weight, illness, physical activity, cluster analysis, profiles and so on. An example of a combination of words is as follows: “TI=((cluster analys*) OR profile*) AND TI=(pain) AND TS=(sleep OR weight OR (physical activity) OR (psychological flexibility) OR illness)”. Beside using Web of Science as a search engine, the reference lists of found (research) articles were also be used to find new literature. From this search, 14 articles on profiles or clusters were selected based on the contents of their abstract.

Appendix C: Assumptions and Reliability analysis

Assumptions. Before interpreting the results of the analyses, several assumptions were checked. First, normality and the existence of univariate outliers were tested for all variables used in this study. There were no univariate outliers detected for Pain (Skewness = .268), Sleep (Skewness = .369) or psychological flexibility (Skewness = -.217). For BMI (Skewness = .845) we found 4 cases that could be regarded as outliers, with a score of 43 or higher. Upon checking these scores, they seem to be plausible scores in this variable. Moreover, 13 outliers were found for physical activity, with one score being regarded as extreme. As the Skewness score was also 3.075, an outlier needed to be removed. After removal of this outlier, tests for univariate outliers were done again, with all scores now within reason and no extreme scores present. All variables now have a roughly normal distribution.

Second, for Multiple Regression Analysis, the assumptions of multivariate outliers, normality, linearity, homoscedasticity, independence of residuals, and multicollinearity were checked. No possible outliers were detected from the Scatterplot. Looking at the Mahalanobis Distance and Cook's Distance, which together indicate no influential multivariate outliers. Given the size of the data file, the slight heightened Mahalanobis Distance in just three cases and the low scores on Cook's Distance (maximum of .03351) for all cases, there seems to be no need to exclude any case based on multivariate outliers. Based on the Normal P-P Plot together with the descriptive statistics of the residuals and standardized residuals ($M = 0$) and a Scatterplot, the assumption of normality is met. The Scatterplot of the standardized residuals also shows no deviations from linearity or homoscedasticity assumptions. As the data was collected independently from each other, the assumption of independence of residuals is also met. Moreover, the assumption of multicollinearity is also met (lowest Tolerance = .712, highest VIF score = 1.404).

Third, for the Cluster analysis, all variables were roughly normally distributed and had no multivariate outliers based on Cook's Distance.

Appendix C1: Reliability analysis Flexibiliteits Index Test (FIT-60).

FIT-60 subscales	α	Standardized α
Acceptance	.849	.847
Cognitive defusion	.886	.884
Observing the self	.579	.559
Present moment	.809	.808
Values	.757	.754
Committed action	.832	.836
Total psychological flexibility	.891	.894

Appendix C2: Reliability analysis Short Form Health Survey (SF-36).

SF-36 question 7+8	α	Standardized α
Pain	.865	.877

Appendix C3: Reliability analysis Insomnia Severity Index (ISI).

ISI total	α	Standardized α
Without the extra question	.887	.889
With the extra question	.897	.898