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Factor analysis of the My Positive Health dialogue tool: the first steps towards a measurement tool

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Factor analysis of the My Positive Health dialogue tool: the first steps towards a measurement tool

Abstract

OBJECTIVES: The My Positive Health (MPH) dialogue tool is increasingly adopted by healthcare professionals in the Netherlands as well as abroad to support people in their health. Given this trend, the need arises to measure effects of interventions on the Positive Health dimensions. However, the dialogue tool was not developed for this purpose. Therefore, this study aims to work towards a suitable measurement instrument using the My Positive Health (MPH) dialogue tool as starting point.

DESIGN: A cross-sectional study design

PARTICIPANTS AND SETTINGS: A total of 708 respondents, who were all members of the municipal health service panel in the eastern part of the Netherlands, completed the MPH dialogue tool.

METHODS: The factor structure of the MPH dialogue tool was explored through exploratory factor analysis (EFA) using maximum likelihood extraction. Next, the fit of the extracted factor structure was tested through confirmatory factor analysis (CFA). Reliability and discriminant validity of both a new model and the MPH scales was assessed through Cronbach's alpha tests.

RESULTS: Similar to the MPH dialogue tool, the extracted 17-item model has a six factor structure but named differently, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Health management. The reliability tests suggest good to very good reliability of the aimed measurement tool and MPH model (Cronbach's alpha values ranging from respectively .820 to .920 and .882 to .933). The measurement model shows acceptable discriminant validity, whereas the MPH model suggests overlap between domains.

CONCLUSION: The results suggest that the current MPH dialogue tool seems reliable as a dialogue, but is not suitable as a measurement tool. We therefore propose a 17-item model with improved, acceptable psychometric properties which can serve as a basis for further development of a measurement tool.

Article Summary

Strengths and limitations of this study

* The study sets the first steps for an additional measurement tool to evaluate interventions with a focus on Positive Health.

* Data from a large group of respondents (N= 708) with suitable characteristics for factor analysis were used.

* The study evaluated the reliability of the MPH dialogue tool, which is widely used in the Netherlands.

* Given the demographic origin and the relatively low response rate (22%) of the sample, the generalizability of the results of the study for the whole Dutch population should be studied.

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Introduction

Over the last years, the European healthcare system is increasingly shifting its focus from cure and disease towards health and healthy behaviour[1, 2]. In the Netherlands, more attention is given to health-oriented approaches, which focus on health promotion, vitality and possibilities rather than on imperfections[3]. This process was accelerated by the demographic situation of an increasing number of elderly people with one or more chronic disease, increasing healthcare expenditures and an increasing wish of citizens for an active and autonomic role during medical consultation[1, 4, 5]. Within the shift towards health-oriented approaches, a focus on health which is broader than only biomedical aspects, and which contributes to achieving a more meaningful life, has gained more interest[6-10]. Furthermore, it is increasingly recognized that understanding patients' experiences about living with a disease, is of vital importance in the management of chronic diseases[11].

Taking this broader focus into mind, Huber et al. (2011)[12] proposed a new concept of health, which describes health "as the ability to adapt and self-manage, in the face of physical, mental and social challenges". According to this concept, being healthy reflects the capacity to deal with internal and external stressors, despite possible limitations – and the tendency to adapt to changing conditions. This opposes to the more static current definition of the WHO, which regards health "as a complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". Although this definition was not intended as such, critics express that the very high ambition has resulted in a major focus on the diagnosis and treatment of symptoms and disease[13-16]. However, people with chronic diseases do not automatically see themselves as being unhealthy[17]. Similarly, many elderly people consider themselves to be healthy, even if their physical abilities are significantly reduced. To them, being healthy often means to have the ability to fulfil one's life[10, 18, 19]. This is fully in line with the content of the new concept of 2011.

The Dutch government considered the dynamic concept of health by Huber et al. (2011)[12] to serve well as a framework for the new strategy within the Dutch healthcare system and required an operationalisation study to make the concept useful for practice[20]. During this study the concept has been further elaborated into the concept of Positive Health, nowadays written with capitals as to express the specific content. The content of the concept is derived from interviews and focus groups with different stakeholder groups (e.g. patients, healthy citizens, healthcare professionals, etc.) This inductive, bottom-up approach enabled the researchers to gain a thorough insight into the perceptions about the health of patients and other stakeholders themselves. Positive Health represents a broad perception of health, expressed by six dimensions with 32 underlying aspects, representing indicators for health. The dimensions were by then named: bodily functions, mental functions and perception, spiritual existential dimension, quality of life, social and societal participation and daily functioning. The six dimensions were visualized in a spider web with six axes, representing these six dimensions and ranging from value 0 (in the centre for poor) to 10 (on the periphery, for excellent). Soon people in practice started to use the spiderweb in dialogue with patients.

Also soon after the spiderweb became available an attempt started to transform the dimensions and 32 aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health. However, this attempt failed[21]. The results of the validity study suggested that the tool was not suitable as a measurement instrument[21]. It appeared that the goal of a measurement tool to express outcomes in health in a fixed number was too far from the experienced reality of an individual. Moreover, the 32 items appeared to be rather long for measurement purposes but also interviews made clear that the language of the present spiderweb was too complex for many people. Because of this feedback the six dimensions and the underlying 32 aspects

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of Positive Health were elaborated by an expert panel group into a more simple language and into 42 aspects, including now (as exceptions) the determinants living conditions and having enough money. The dimensions were renamed as bodily functions, mental well-being, meaningfulness, quality of life, participation and daily functioning. The result was called: the My Positive Health (MPH) dialogue tool (see www.MijnPositieveGezondheid.nl).

This MPH tool aims to provide individuals insight in their own health and stimulate self-reflection. By completing 42 statements, mean scores for each of the dimensions are graphically displayed in a spider web. See Supplementary file 1. This spider web can be used during consultations with (for example) healthcare professionals, to discuss one's perceived health and to reveal one's needs, desires and abilities.. Thereby it could lead to identifiable statements which would find connection with the people concerned. This recognition was confirmed by a user evaluation among populations of healthy citizens, elderly, and chronically ill. The vast majority of the respondents rated the MPH dialogue tool good to excellent[22]. The tool is widely used in the Netherlands, with more than 100.000 unique users for the digital version since its introduction in 2016 (see MijnPositieveGezondheid.nl ("MyPositiveHealth.nl")). In addition, a paper version of the MPH tool is used across a wide range of care centres.

INSERT FIGURE 1 HERE.

Along with the extensive use of the dialogue tool, a growing interest is once again observed for a measurement instrument that measure changes in a person's Positive Health. Such a measurement tool could provide stakeholders in various domains and levels (e.g. healthcare professionals, national and local policy makers and insurers) with valid information on the effectiveness of a Positive Health approach. Such insight could support them during the decision-making process and thereby enable a more structural implementation of interventions that improve people's (positive) health. As far as we were aware, since Prinsen no new attempt was made to develop a measurement instrument that covers the broad concept of Positive Health[23, 24]. Therefore, the objective of this present study was to set first steps in a new attempt towards a suitable measurement instrument with adequate psychometric properties and scale brevity. In order to reach this objective, we first aimed to extract an improved model to measure (positive) health by performing an Exploratory Factor Analysis (EFA) and to test it through confirmatory factor analysis (CFA). Next, we also aim to determine the reliability of the MPH dialogue tool.

Methods

Design

This study comprised a cross-sectional quantitative survey study. Data from the quantitative survey was used to develop a new model to measure health by performing an Exploratory Factor Analysis (EFA) following a confirmatory factor analysis (CFA).

The instrument

We use the digital version of the MPH dialogue tool (MijnPositieveGezondheid.nl; "MyPositiveHealth.nl") in this study. In this digital version, 42 statement are proposed (7 for each dimension) on an 11-point scale. 0 means totally disagree and 10 means totally agree. Target population are Dutch citizens, with or without a chronic disease.

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Participants and data collection

Members of the citizens' panel of GGD Twente (regional municipal health service) were asked to fill out the 42 questions of the MPH dialogue tool. This panel comprises adults (19+) who took part in the national health survey of GGD Twente in the east of the Netherlands. This survey is carried out every four years to monitor the general state of health of Dutch citizens. At the end of that health survey, the participants were asked whether they were willing to participate in other, future studies by GGD Twente. For the present study, 3218 participants were invited by e-mail to enrol in the study. Of these, 708 participants (46% female, *M* age = 62, *SD* age = 15) completed the questionnaire (response rate is 22%). Data collection took place from January to February 2018.

Analytical plan

To examine the construct validity of the MPH tool, we used a split-half validation method in which we randomly divided the participants into two groups. We used one of these groups to explore the factor structure through exploratory factor analysis (EFA) and the other group to test the goodness of fit of the extracted factor structure through confirmatory factor analysis (CFA). In conducting the factor analyses, we followed best practices described by Brown[25], Costello and Osborne[26], and Cabrera-Nguyen[27].

Through EFA, we explored the factor structure using maximum likelihood (ML) extraction. Because we expected our factors to be interdependent aspects of Positive Health, we used ML extraction with direct oblimin rotation. We considered items with cross loading values of ≤ .32 on at least two factors as weak (and thereby as candidates for deletion)[26]. And we considered items with factor loading of ≥ .60 as strong[28].

We strove for a model with improved psychometric properties and scale brevity, while maintaining enough items to create stable factors. We therefore aimed to reduce each factor to three items with highest factor loadings.

Through CFA, we evaluated the goodness of fit of the factor structure extracted during EFA. With the CFA evaluation we compared the extracted factor structure with two baseline models containing all 42 items of the MPH dialogue tool: the original 6-factor structure that includes the six dimensions of health and a 1-factor structure which considers all items belonging to one health domain. This comparison helps to understand the degree to which our extracted factor structure fits unseen data better than respectively the original 6-factor structure and the 1-factor structure. We evaluated the goodness of fit using several indices: Pearson's Chi-squared test, comparative fit index (CFI; > .95 is acceptable), Tucker Lewis index (TLI; > .95 is acceptable), the root mean square error of approximation (RMSEA; < .06 is acceptable), and standardized root mean square residual (SRMR; < .08 is acceptable). These indices reflect model fit (Pearson's Chi-squared test), incremental fit (CFI, TLI), and absolute fit (RMSEA, SRMR). The threshold values we applied are cut-off values recommended by Hu and Bentler (1999)[29] and endorsed by both Brown (2014)[25] and Cabrera-Nguyen (2010)[27]. For fitting the models, we used lavaan version 0.6-3[30] in R version 3.5.1[31]. We used maximum likelihood estimation and standardized the latent factors to allow free estimation of all factor loadings.

Finally, we examined the reliability and discriminant validity of the factors of both the original 6-factor model (MPH dialogue tool) and the new experimental model. We examined the reliability by evaluating the Cronbach's alpha coefficients and tested the discriminant validity by evaluating the factor correlations.

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Ethical considerations

Due to the harmless and non-invasive character of the study, this study was exempt from medical ethical approval. Prior to completion of the questionnaire, informed consent for the use of data for scientific purposes was asked in the invitation email to the participants. All data are handled anonymously.

Results

Exploratory Factor Analysis

Our exploration showed that the data are suitable for EFA. Our sample had both an acceptable size of 356[32 33] and a very common participant-to-item ratio (8.5:1). The Kaiser–Meyer–Olkin (KMO) statistic of sampling adequacy and the Bartlett's of sphericity are both positive indicators for EFA suitability as well. The KMO test yielded a statistic of 0.97, implying that the dataset contains a significant number of factors, and the Bartlett's test of sphericity yielded significant results, χ^2 (41) = 318.368, $p < .001$, implying that the correlations among variables are greater than one would expect by chance.

Common approaches for determining the number of factors to extract, showed support for the theoretically suggested 6-factor structure. First, the Kaiser criterion suggests that the data clusters in 6 factors, as they contain 6 factors with eigenvalues greater than one[34 35].Second, the scree plot (see Figure 1) suggests 2, 4, or 6 factors because the eigenvalues level off after these amount of factors. Third, parallel analysis (see Figure 2), through which one compares the actual scree plot with the possible scree plot based on randomly resampled data, suggest a structure of 6 factors – the crossing point of the two plots. A 6-factor structure account for 67.5% of the total item variance.

INSERT FIGURE 1 HERE.

INSERT FIGURE 2 HERE.

Factor loadings are shown in Table 1. In this table, factor names for the experimental model are displayed in the second horizontal row. Overall, the items that group together in our EFA mostly group together in the original model as well.

Table 1 shows that the first factor has factor loadings above .40 for several items originating from the dimension Social and Societal Participation (SP). These items are: SP29 Social contacts, SP30 Being taken seriously, SP31 Doing fun things together, SP32 Having the support of others, SP33 Belonging. We selected the tree highest factor loadings (SP29, SP32, and SP33) and labelled this factor 'Social relations'.

The second factor showed loadings above .40 on items from the original dimension Daily Functioning (DF). These items are: DF36 Looking after yourself, DF37 Knowing your limitations, DF38 Knowledge of health, DF39 Managing time, DF40 Managing money. We selected the three highest factor loadings (DF37, DF38, DF39) and labelled this factor 'Daily life-management'.

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The third factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from the original dimension Bodily Functions (BF). These items are: BF1 Feeling healthy, BF2 Feeling fit, BF5 Eating pattern, BF6 Physical condition, and BF7 Exercise. We included the three items with highest factor loadings (BF2, BF6, and BF7) and labelled this factor 'Physical fitness'.

The fourth factor showed loadings above .40 on items across three dimensions of the dialogue tool: Mental Well-being (MW), Meaningfulness (MF), and Quality of Life (QL). These items are: MW11 Being cheerful, MW12 Accepting yourself, MW14 having control, MF16 Being high spirited, and MF19 Accepting life, QL22 Enjoyment, QL23 Being happy, QL24 Feeling good, and QL25 Feeling well-balanced. We selected the three highest factor loadings (QL23, QL24, and QL25) and labelled this factor 'Contentment'.

The fifth factor showed loadings above .40 on items from one dimension of the dialogue tool: Mental Wellbeing (MW) and Meaningfulness (MF). These items are: MW13 Being able to handle changes, MF17 Wanting to achieve ideals, MF18 Feeling confident about own future, MF21 Continue learning, and SP34 Doing meaningful things. We selected the three highest factor loadings (MW13, MF17, and MF18) and labelled this factor 'Future perspectives'.

The last factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from one dimension of the dialogue tool: Mental Well-being (MW). These items are: MW8 Being able to remember things and MW9 Being able to concentrate. We selected these two highest factor loadings (MW8 and MW9) and labelled this factor 'Mental functioning', as these aspects solely focus on cognitive abilities and do not concern any emotional aspects or feelings.

In our exploration for a measurement instrument model, we were successful in reducing the number of items for five factors from 7 to 3 items and for one factor to 2 items. The final factor structure we extracted thus contained 17 items.

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Table 1. Factor Pattern/Structure Rotated to the Oblimin Criterion

Item number*	Description	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	
		Social relations	Daily-management	Physical fitness	Contentment	Future achievements	Mental functioning	h^2
BF1	**Feeling healthy**	-0.03	0.05	***0.82***	0.12	-0.02	0.03	0.807
BF2	**Feeling fit**	-0.04	0.03	***0.86***	0.12	-0.07	0.07	0.826
BF3	Having complaints or pain	0.10	-0.07	0.37	-0.11	0.10	0.13	0.250
BF4	Sleeping pattern	0.10	-0.10	0.36	0.25	0.01	0.21	0.464
BF5	Eating pattern	0.17	-0.01	0.43	0.12	0.04	0.13	0.517
BF6	Physical condition	0.09	-0.02	*0.73*	-0.08	0.12	0.02	0.675
BF7	**Exercise**	0.02	0.09	***0.74***	-0.17	0.16	-0.01	0.698
MW8	**Being able to remember things**	-0.03	-0.01	0.00	-0.08	0.01	***0.95***	0.820
MW9	**Being able to concentrate**	0.03	0.02	0.07	0.13	-0.01	***0.77***	0.817
MW10	Being able to communicate	0.10	0.36	0.08	-0.22	0.22	0.20	0.487
MW11	Being cheerful	0.24	0.03	0.12	*0.46*	0.07	0.19	0.775
MW12	Accepting yourself	0.21	0.14	0.13	*0.46*	-0.01	0.10	0.689
MW13	**Being able to handle changes**	0.10	0.10	0.05	-0.01	***0.48***	0.11	0.506
MW14	Having control	0.13	0.22	0.03	*0.42*	0.09	0.15	0.695
MF15	Having a meaningful life	0.28	0.17	0.05	0.35	0.20	0.06	0.795
MF16	Being high-spirited	0.13	0.13	0.20	*0.41*	0.17	0.08	0.784
MF17	**Wanting to achieve ideals**	-0.06	-0.05	0.06	0.01	***0.87***	0.07	0.770
MF18	**Feeling confident about own future**	0.12	0.03	0.01	0.19	***0.68***	0.00	0.801
MF19	Accepting life	0.06	0.18	0.08	0.41	0.21	0.00	0.570
MF20	Being grateful	0.24	0.09	0.04	0.31	0.32	0.03	0.680
MF21	Continue learning	0.06	0.13	0.15	-0.08	*0.43*	0.05	0.433
QL22	Enjoyment	0.16	0.14	0.15	*0.50*	0.19	0.00	0.828
QL23	**Being happy**	0.11	0.13	0.08	***0.56***	0.17	0.06	0.793
QL24	**Feeling good**	0.09	0.07	0.16	***0.58***	0.14	0.12	0.864
QL25	**Feeling well-balanced**	0.08	0.12	0.16	***0.56***	0.13	0.11	0.852

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QL26	Feeling safe	0.30	0.22	0.08	0.26	0.09	0.07	0.673
QL27	Living conditions	0.37	0.13	0.02	0.26	0.09	0.04	0.568
QL28	Having enough money	0.24	0.34	0.11	-0.10	0.15	0.05	0.480
SP29	**Social contacts**	***0.88***	0.02	0.00	-0.08	0.04	0.05	0.819
SP30	Being taken seriously	0.66	0.17	-0.10	-0.03	0.15	0.05	0.719
SP31	Doing fun things together	*0.81*	-0.02	0.08	0.07	0.03	-0.05	0.769
SP32	**Having the support of others**	***0.88***	0.03	-0.01	0.02	-0.09	0.05	0.761
SP33	**Belonging**	***0.88***	-0.04	0.03	0.08	0.01	-0.02	0.837
SP34	Doing meaningful things	0.21	0.12	0.04	0.12	*0.43*	0.04	0.629
SP35	Being interested in society	0.11	0.40	-0.03	0.11	0.20	0.10	0.553
DF36	Looking after yourself	0.13	*0.68*	0.13	-0.09	0.02	-0.06	0.633
DF37	**Knowing your limitations**	-0.06	***0.88***	-0.02	0.13	0.00	0.02	0.805
DF38	**Knowledge of health**	0.08	***0.72***	0.20	-0.03	-0.03	-0.03	0.714
DF39	**Managing time**	0.01	***0.71***	-0.07	0.14	-0.01	0.17	0.719
DF40	Managing money	0.13	*0.58*	0.02	-0.08	0.07	0.15	0.623
DF41	Being able to work	0.04	0.33	0.18	-0.05	0.29	0.02	0.492
DF42	Asking for help	0.18	0.20	0.01	-0.11	0.16	0.24	0.360
% of variance		15.1	12.8	11.2	10.9	10.3	7.2	67.5

Notes: Coefficients greater than |.40| are italicized. The items in bold are retained for that factor.

* BF refers to Bodily functions; MW refers to Mental well-being; MF refers to meaningfulness; QL refers to Quality of life; SP refers to Social and societal participation; DF refers to daily functioning

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Confirmatory Factor Analysis

The two baseline models, against which we compared the factor structure we extracted during our EFA, had low fits. First, the original 6-factor structure had a CFI of .846, TLI of .835, RMSEA of .086 with 90% confidence interval (CI) [.082, .089], and an SRMR of 0.063. Second, the 1-factor structure had a CFI of .731, TLI of .717, RMSEA of .112 with 90% confidence interval (CI) [.109, .115], and an SRMR of 0.066. The factor structure we extracted during the EFA, in contrast, had an acceptable fit, with a CFI of .964, TLI of .953, RMSEA of .071 with 90% confidence interval (CI) [.062, .081], and an SRMR of 0.036. This fit was significantly better than the fit of both the original 6-factor solution ($\chi 2$ (700) = 2604.48, $p < .001$) and the 1-factor solution ($\chi 2$(715) = 4174.19, $p < .001$).

The items we selected during the EFA all showed positive factor loadings on their respective domains, with standardized coefficients ranging from .714 to .971 (see Table 2), supporting the factor structure. As we report in Table 3, the items within each factor yielded highly consistent response. More specifically, the Cronbach's alpha values of the factors ranged from .820 to .920. The six factors correlated significantly positively among each other (see Table 3), indicating that individuals that score higher on one domain typically score higher on the other domains. The factor correlations did not exceed .80, which suggest acceptable discriminant validity[25]. In comparison, the factor correlations of the original model suggest overlap between Meaningfulness and Mental well-being, Mental well-being and Quality of Life, Quality of life and Meaningfulness, Quality of Life and Social and societal participation, and Social and societal participation and Daily functioning (see Table 4). Cronbach alpha values from this original model range from .882 to .933.

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Table 2. Parameter Estimates Confirmatory Factor Analysis

Latent factor	Item	Description	B	SE	Z	Beta	p
Social relations	29	Social contacts	1.000	0.000		0.844	
Social relations	32	Having the support of others	1.096	0.056	19.485	0.841	***
Social relations	33	Belonging	1.180	0.054	21.956	0.911	***
Daily life-management	37	Knowing your limitations	1.000	0.000		0.892	
Daily life-management	38	Knowledge of health	1.046	0.039	26.516	0.933	***
Daily life-management	39	Managing time	1.093	0.055	19.895	0.803	***
Physical fitness	1	Feeling healthy	1.000	0.000		0.945	
Physical fitness	2	Feeling fit	1.046	0.042	24.890	0.882	***
Physical fitness	7	Exercise	1.027	0.057	17.969	0.742	***
Contentment	23	Being happy	1.000	0.000		0.870	
Contentment	24	Feeling good	1.104	0.043	25.949	0.938	***
Contentment	25	Feeling well-balanced	1.010	0.045	22.283	0.867	***
Future perspective	13	Being able to handle changes	1.000	0.000		0.714	
Future perspective	17	Wanting to achieve ideals	1.188	0.092	12.915	0.734	***
Future perspective	18	Feeling confident about own future	1.321	0.089	14.902	0.863	***
Mental functioning	8	Being able to remember things	1.000	0.000		0.833	
Mental functioning	9	Being able to concentrate	1.148	0.059	19.528	0.971	***

Notes: *** = p < .001, B = unstandardized estimates, Beta = standardized estimates.

Table 3. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the extracted factors (new model).

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Factor	*M*	*SD*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) Physical fitness	7.60	1.70	(.879)					
(2) Mental functions	7.76	1.58	.575***	(.894)				
(3) Future perspective	7.73	1.45	.550***	.573***	(.820)			
(4) Contentment	7.92	1.59	.638***	.626***	.730***	(.920)		
(5) Social relations	8.42	1.35	.538***	.576***	.640***	.698***	(.899)	
(6)Daily life-management	8.52	1.35	.573***	.619***	.666***	.691***	.720***	(.899)

Notes: *** = p < .001.

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Table 4. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the original factors (MPH dialogue tool).

Factor	***M***	***SD***	***(1)***	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***
(1) Bodily functions	7.60	1.70	(.882)					
(2) Mental well-being	7.76	1.58	.720***	(.902)				
(3) Meaningfulness	7.73	1.45	.650***	.831***	(.904)			
(4) Quality of life	7.92	1.59	.723***	.833***	.875***	(.921)		
(5) Social and societal participation	8.42	1.35	.608***	.767***	.774***	.808***	(.933)	
(6) Daily functioning	8.52	1.35	.653***	.786***	.744***	.777***	.815***	(.901)

Notes: *** = p < .001.

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Discussion

The results of our factor analysis support a factor structure of six dimensions. The model we extracted contained 17 items, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Daily life-management. The extracted model showed improved construct validity compared to the original model with good fit, high reliability and acceptable discriminant validity. For the MPH tool our reliability tests suggest good to very good reliability (Cronbach alpha values ranging from .882 to .933). Furthermore, our factor analysis suggests overlap across the dimensions Mental wellbeing, Meaningfulness, Quality of life, and Social and societal participation, making the MPH tool less suitable as a measurement tool.

This study addresses the difference in aims and thereby required properties between a dialogue tool and a measurement tool. The results show that a 17- item model has better psychometric properties, and can thereby serve as a strong basis for the development of a Positive Health measure. However, the 17-item scale neglects several aspects relevant to address when determining and discussing an individual's perception of health. For example, for bodily functions, the ignored items about sleeping and eating patterns can inspire ideas and improve dialogue about improving bodily functions. Similarly, it ignores the aspect *accepting yourself*, whereas this was considered the most important aspect of Mental well-being by respondents (18-25 years) in a study that focused on the development of an adolescent version of the tool[36]. Importance of this aspect came forward in studies regarding the development of health-related quality of life and subjective well-being scales as well[6, 37]. Furthermore, research shows that poor living conditions and financial problems are often accompanied by considerable physical and mental problems[38-40]. Inclusion of these aspects in the MPH dialogue tool provides a broader understanding of the multiple needs of an individual. This enables individuals to express their needs during the dialogue about the results and enables to refer them, if required, to appropriate providers. Overall, for two statements within the MPH dialogue tool it can be argued that they also function as determinants - which influence people's perceived health – like patients themselves expressed during the original study, or consequences of health as well. While such determinants and consequences of health are not appropriately represented in the measurement of health itself, we suggest that they may still be relevant in a dialogue tool.

Difficulties to blend the two goals of both a dialogue tool and a measurement tool were noted earlier. During the development process, an attempt to transform the dimensions and underlying aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health has failed[21]. At this stage it appeared that the goal of a measurement tool to express outcome in health in (a) fixed number(-s) was too far from the experienced reality of an individual. Based on the results of our study and the previous attempt, we therefore suggest the use of two separate tools: (1) a dialogue tool with the aim to elucidate a broad representation of a person's perceived health status, comprising a broad range of aspects and (2) a measurement tool with improved psychometric properties that is able to capture broad health in a valid an reliable way. For this second purpose, our extracted 17-item model may serve as a basis.

When further developing a measurement tool to the measure (positive) health, several issues need to be addressed. First, concepts like salutogenesis, sence of coherence, and resilience form a strong basis of Positive Health, focussing on the abilities of individuals to handle changes and experience meaningfulness. It should be further investigated whether these concepts are sufficiently addressed in

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the current 17-item experimental model. For example, the included aspects from the dimension of Meaningfulness solely focus on future achievements, while meaningfulness can be regarded as an integration of past, present and future[41]. Second, in line with the concept of health as the ability to adapt and to self-manage, one could expect that an individual with poor objective health status can still experience good health when being capable to deal well with the situation, while another individual with better objective health status can experience lower health. It would be a challenge to develop a measurement tool that does not reflect health by one continuum, but that can capture both realities.

Methodological considerations

This study was based on a survey among a citizen panel in eastern part of the Netherlands, with a mean age of 62 (*SD* = 15) and 46% women. This relatively higher age of the study population compared to the whole adult population in this region (M age = 51) may be the result of the relatively low response rate of 22%. To be able to draw more firm conclusions about the psychometric properties of the MPH tool, this should be investigated among other populations as well.

In our study we have focused on the construct validity. Therefore, other psychometric properties such as the predictive validity and discriminant validity of the 17- item model remain still unknown. Such issues should be addressed in future studies. Also, we made a first attempt to label the identified factors with factor names. The appropriateness of these names should be further investigated.

We based the choice to select three items per factor on both practical and theoretical arguments. From practical point of view, it is desirable to have a short and easy to use scale with acceptable psychometric properties. A scale of 17 items can be completed within a short amount of time. From a theoretical perspective, factors with fewer than three items are often weak and unstable[26].

Conclusion

Overall, we conclude that the overall structure of the MPH dialogue tool, seems reliable. While the 42-item model might be suitable as a dialogue tool, this study shows that it is not suitable as a measurement tool. Instead, we propose a 17-item model with a six factor structure, comprising the factors Physical fitness, Mental functions, Future perspective, Contentment, Social relations, and Daily life-management, which can serve as a basis for the development of an additional measurement tool. Given the prevailing healthcare trend towards a focus on health and wellbeing, expressed by an increased number of practices based on a Positive Health approach, the existence of such measurement tool is of great importance.

Author contributions

SB collected the data. BD performed the statistical analysis. MV interpreted the results and wrote the manuscript in collaboration with BD and EA. All authors commented and agreed on the final version.

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Competing interest

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The authors declare no conflict of interest.

Data sharing statement

A request for sharing data can be made by sending an email to the corresponding author.

References

1. Johansen F, Loorbach D, Stoopendaal A. Exploring a transition in Dutch healthcare. *J Health Organ Manag* 2018;32(7):875-90 doi: 10.1108/JHOM-07-2018-0185.
2. Palmer K, Marengoni A, Forjaz MJ, et al. Multimorbidity care model: Recommendations from the consensus meeting of the Joint Action on Chronic Diseases and Promoting Healthy Ageing across the Life Cycle (JA-CHRODIS). *Health Policy* 2018;122(1):4-11 doi: 10.1016/j.healthpol.2017.09.006.
3. Hoeymans N, Van Loon AJM, Van den Berg M, et al. A healthier Netherlands: the key findings of the sixth Public Health Status and Foresight Bilthoven, The Netherlands: National Institute for Public Health and the environment (RIVM), 2014.
4. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: A cross-sectional study. *Lancet* 2012;380(9836):37-43 doi: 10.1016/S0140-6736(12)60240-2.
5. Butalid L, Verhaak PF, Boeije HR, Bensing JM. Patients' views on changes in doctor-patient communication between 1982 and 2001: a mixed-methods study. *BMC Fam Pract* 2012;13:80 doi: 10.1186/1471-2296-13-80.
6. De Vries M, Emons WHM, Plantinga A, et al. Comprehensively Measuring Health-Related Subjective Well-Being: Dimensionality Analysis for Improved Outcome Assessment in Health Economics. *Value Health* 2016;19(2):167-75 doi: 10.1016/j.jval.2015.11.010.
7. Al-Janabi H, Flynn TN, Coast J. Development of a self-report measure of capability wellbeing for adults: the ICECAP-A. *Qual Life Res* 2012;21(1):167-76 doi: 10.1007/s11136-011-9927-2.
8. NWA. Portfolio for research and innovation - Health care research, sickness prevention and treatment. The Hague, 2016.
9. Smid HJ, Wydoodt A. ZonMW signalement over zingeving in zorg: de mens centraal [ZonMW description about meaningfulness in care: focus on the individual]. 2nd edition ed. Den Haag: ZonMw, 2017.
10. Vanderweele TJ. On the promotion of human flourishing. *Proc Natl Acad Sci U S A*, 2017:8148-56 doi: 10.1073/pnas.1702996114.
11. Stucki G, Bickenbach J. Health, Functioning, and Well-being: Individual and Societal. *Arch Phys Med Rehabil* 2019;100(9):1788-92 doi: 10.1016/j.apmr.2019.03.004.
12. Huber M, Knottnerus A, Green L, et al. How should we define health? *BMJ* 2011;343(7817):1-3 doi: 10.1136/bmj.d4163.
13. Editorial. What is health? The ability to adapt. *Lancet* 2009;373(9666):781-81 doi: 10.1016/S0140-6736(09)60456-6.
14. Jadad AR, O'Grady L. How should health be defined? *BMJ* 2008;337:a2900 doi: 10.1136/bmj.a2900.
15. Larson JS. The conceptualization of health. *Med Care Res Rev* 1999;56:123-36 doi: 10.1177/107755879905600201.

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16. Smith R. The end of disease and the beginning of health - *BMJ*, 2008.
17. Van der Lucht F, Polder JJ. Towards better health - The Dutch 2010 Public Health Status and Forecasts Report. Bilthoven: RIVM, 2010.
18. Bircher J. Towards a dynamic definition of health and disease. *Med Health Care Philos* 2005;8(3):335-41 doi: 10.1007/s11019-005-0538-y.
19. Kooiker SE. Nederlanders aan het woord over gezondheid en gezond leven. Achtergrond bij VTV 2010 Van Gezond naar Beter [Stories from Dutch citizens about health and healthy living. Background to the Dutch 2010 Public Health Status and Forecasts Report]. Bilthoven: RIVM, 2011.
20. Huber M, van Vliet M, Giezenberg M, et al. Towards a 'patient-centred' operationalisation of the new dynamic concept of health: a mixed methods study. *BMJ open* 2016;6(1):e010091 doi: 10.1136/bmjopen-2015-010091.
21. Prinsen CAC, Terwee CB. Measuring positive health: for now, a bridge too far. *Public Health* 2019;170:70-77 doi: 10.1016/j.puhe.2019.02.024.
22. Al Shamma S, Van den Dries L, Van Wezep M, Wolf J. Ervaringen met de gesprekstool 'Mijn Positieve Gezondheid' [Experiences with the dialogue tool 'My Positive Health']. Nijmegen, 2018:1-40.
23. Hendrikx RJP, Spreeuwenberg MD, Drewes HW, Ruwaard D, Baan CA. How to Measure Population Health: An Exploration Toward an Integration of Valid and Reliable InstrumentsThis study was presented as a poster presentation at the International Conference on Integrated Care 2017, held May 8–10, 2017 in Dublin, Ireland. *Popul Health Manag* 2018;21(4):323-30 doi: 10.1089/pop.2017.0097.
24. Linton M, Dieppe P, Medina-Lara A. Review of 99 self-report measures for assessing well-being in adults: exploring dimensions of well-being and developments over time. *BMJ open* 2016;6(7):e010641-e41 doi: 10.1136/bmjopen-2015-010641.
25. Brown TA. Confirmatory factor analysis for applied research. New York, NY: The Guilford Press, 2014.
26. Costello AB, Osborne JW. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pract Assess Res Eval* 2005;10:1-9 doi: 10.1.1.110.9154.
27. Cabrera-Nguyen P. Author Guidelines for Reporting Scale Development and Validation Results in the Journal of the Society for Social Work and Research. *J Soc Social Work Res* 2010;1(2):99-103 doi: 10.5243/jsswr.2010.8.
28. Garson GD. Factor Analysis. Asheboro, NC: Statistical Associates Publishers, 2013.
29. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equ Modeling* 1999;6(1):1-55 doi: 10.1080/10705519909540118.
30. Rosseel Y. Lavaan: An R package for structural equation modeling. *J Stat Softw* 2012;48(2):1-36
31. Team RC. R: A Language and Environment for Statistical Computing. Vienna: R Foundation for Statistical Computing, 2018.
32. Comrey AL, Lee HB. A First Course in Factor Analysis. Hillsdale, NJ: Lawrence Erlbaum, 1992.
33. Worthington RL, Whittaker TA. Scale development research: A content analysis and recommendations for best practices. *Couns Psychol* 2006;34(6):806-38
34. Kaiser HF. The Application of Electronic Computers to Factor Analysis. *Educ Psychol Meas* 1960;20(1):141-51 doi: 10.1177/001316446002000116.
35. Kaiser HF, Rice J. Little Jiffy, Mark Iv. *Educ Psychol Meas* 1974;34(1):111-17 doi: 10.1177/001316447403400115.
36. Van Vliet M, Van der Zanden S, Huber M. Ontwikkeling van de 'Mijn Positieve Gezondheid' jongerentool [Development of the My Positive Health adolescent tool]. Utrecht: Institute for Positive Health, 2019.
37. Pietersma S, de Vries M, van den Akker-van Marle ME. Domains of quality of life: results of a three-stage Delphi consensus procedure among patients, family of patients, clinicians, scientists and the general public. *Qual Life Res* 2014;23(5):1543-56 doi: 10.1007/s11136-013-0578-3.

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38. Bodden DHM, Deković M. Multiproblem Families Referred to Youth Mental Health: What's in a Name? *Fam Process* 2016;55(1):31-47 doi: 10.1111/famp.12144.
39. Moorhead R, Robinson M. A trouble shared – legal problems clusters in solicitors' and advice agencies. London: Department for Constitutional Affairs, 2006.
40. Smith M, Buck A, Sidaway J, Scanlan L. Bridging the Empirical Gap: New Insights into the Experience of Multiple Legal Problems and Advice Seeking. *J Empir Leg Stud* 2013;10(1):146-70 doi: 10.1111/jels.12006.
41. Baumeister RF, Vohs KD, Aaker JL, Garbinsky EN. Some key differences between a happy life and a meaningful life. *J Posit Psychol* 2013;8(6):505-16 doi: 10.1080/17439760.2013.830764.

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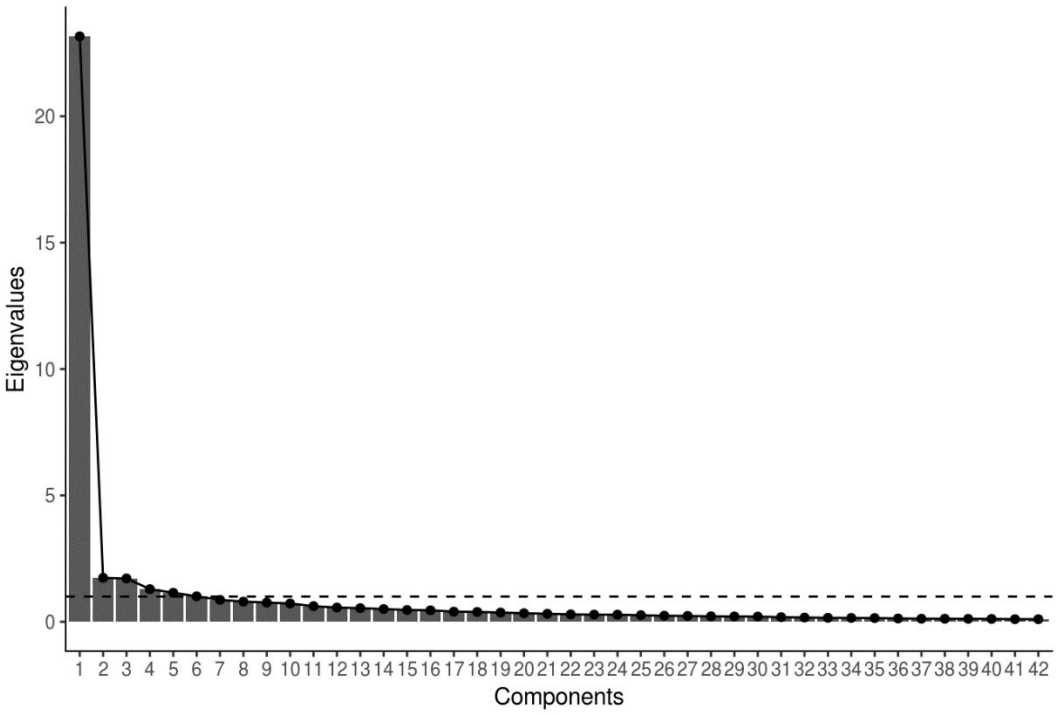

Figure 1. Scree plot. *Note:* Kaiser criterion is shown by the black dashed line.

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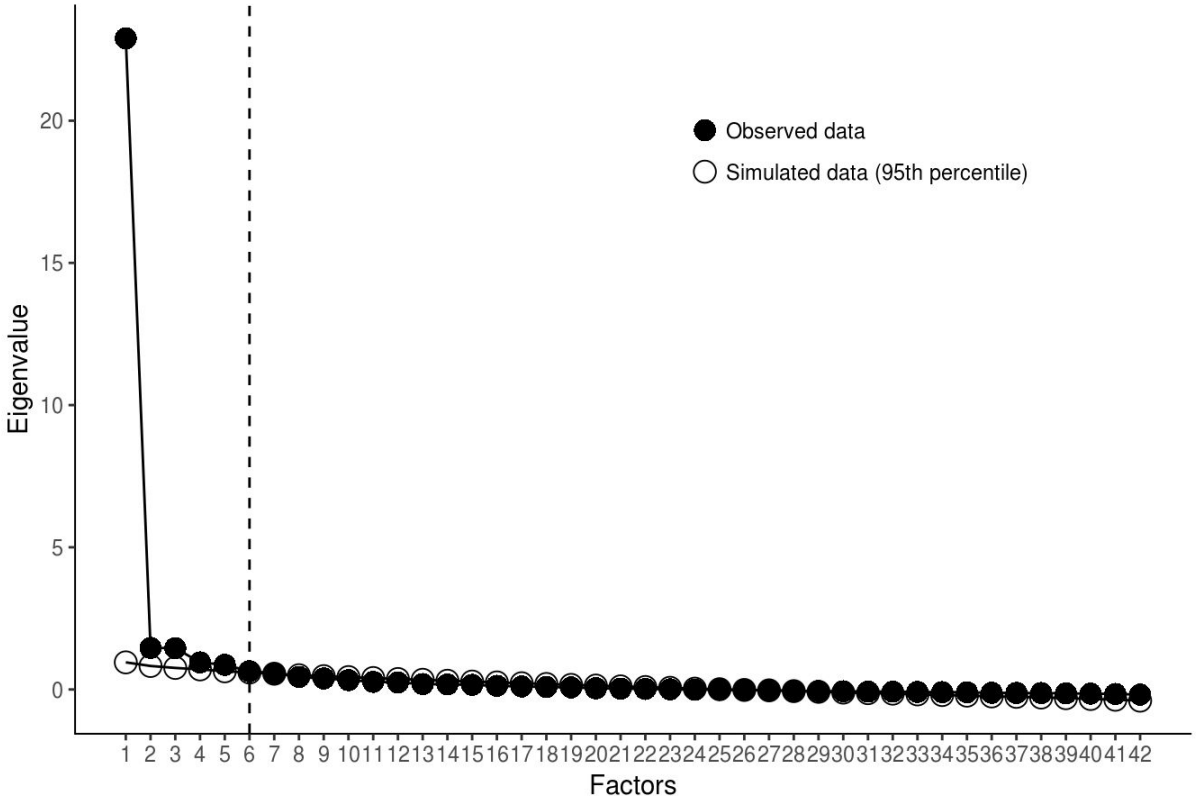

Figure 2. Parallel Analysis. *Note:* The 6-factor structure is shown by the black dashed line.

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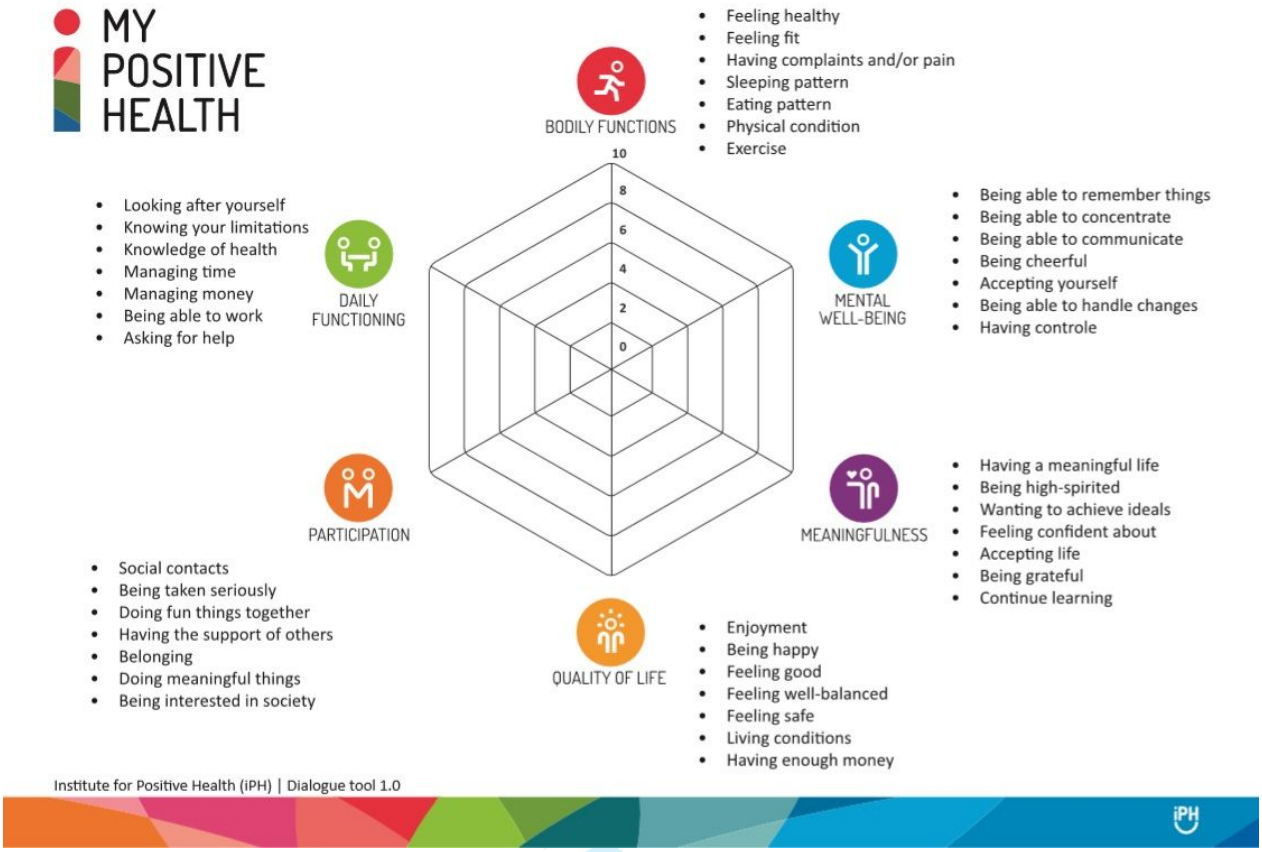

Supplementary file 1. My Positive Health spiderweb comprising 6 dimensions and 42 aspects

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Factor analysis of the My Positive Health dialogue tool: the first steps towards a measurement tool

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Factor analysis of the My Positive Health dialogue tool: the first steps towards a measurement tool

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Factor analysis of the My Positive Health dialogue tool: the first steps towards a measurement tool

Abstract

OBJECTIVES: The My Positive Health (MPH) dialogue tool is increasingly adopted by healthcare professionals in the Netherlands as well as abroad to support people in their health. Given this trend, the need arises to measure effects of interventions on the Positive Health dimensions. However, the dialogue tool was not developed for this purpose. Therefore, this study aims to work towards a suitable measurement instrument using the My Positive Health (MPH) dialogue tool as starting point.

DESIGN: A cross-sectional study design

PARTICIPANTS AND SETTINGS: A total of 708 respondents, who were all members of the municipal health service panel in the eastern part of the Netherlands, completed the MPH dialogue tool.

METHODS: The factor structure of the MPH dialogue tool was explored through exploratory factor analysis (EFA) using maximum likelihood extraction. Next, the fit of the extracted factor structure was tested through confirmatory factor analysis (CFA). Reliability and discriminant validity of both a new model and the MPH scales was assessed through Cronbach's alpha tests.

RESULTS: Similar to the MPH dialogue tool, the extracted 17-item model has a six factor structure but named differently, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Health management. The reliability tests suggest good to very good reliability of the aimed measurement tool and MPH model (Cronbach's alpha values ranging from respectively .820 to .920 and .882 to .933). The measurement model shows acceptable discriminant validity, whereas the MPH model suggests overlap between domains.

CONCLUSION: The results suggest that the current MPH dialogue tool seems reliable as a dialogue, but is not suitable as a measurement tool. We therefore propose a 17-item model with improved, acceptable psychometric properties which can serve as a basis for further development of a measurement tool.

Article Summary

Strengths and limitations of this study

* The study sets the first steps for an additional measurement tool to evaluate interventions with a focus on Positive Health.

* Data from a large group of respondents (N= 708) with suitable characteristics for factor analysis were used.

* The study evaluated the reliability of the MPH dialogue tool, which is widely used in the Netherlands.

* Given the demographic origin and the relatively low response rate (22%) of the sample, the generalizability of the results of the study for the whole Dutch population should be studied.

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Introduction

Over the last years, the European healthcare system is increasingly shifting its focus from cure and disease towards health and healthy behaviour[1, 2]. In the Netherlands, more attention is given to health-oriented approaches, which focus on health promotion, vitality and possibilities rather than on imperfections[3]. This process was accelerated by the demographic situation of an increasing number of elderly people with one or more chronic disease, increasing healthcare expenditures and an increasing wish of citizens for an active and autonomic role during medical consultation[1, 4, 5]. Within the shift towards health-oriented approaches, a focus on health which is broader than only biomedical aspects, and which contributes to achieving a more meaningful life, has gained more interest[6-10]. Furthermore, it is increasingly recognized that understanding patients' experiences about living with a disease, is of vital importance in the management of chronic diseases[11].

Taking this broader focus into mind, Huber et al. (2011)[12] proposed a new concept of health, which describes health "as the ability to adapt and self-manage, in the face of physical, mental and social challenges". According to this concept, being healthy reflects the capacity to deal with internal and external stressors, despite possible limitations – and the tendency to adapt to changing conditions. This opposes to the more static current definition of the WHO, which regards health "as a complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". Although this definition was not intended as such, critics express that the very high ambition has resulted in a major focus on the diagnosis and treatment of symptoms and disease[13-16]. However, people with chronic diseases do not automatically see themselves as being unhealthy[17]. Similarly, many elderly people consider themselves to be healthy, even if their physical abilities are significantly reduced. To them, being healthy often means to have the ability to fulfil one's life[10, 18, 19]. This is fully in line with the content of the new concept of 2011.

The Dutch government considered the dynamic concept of health by Huber et al. (2011)[12] to serve well as a framework for the new strategy within the Dutch healthcare system and required an operationalisation study to make the concept useful for practice[20]. During this study the concept has been further elaborated into the concept of Positive Health, nowadays written with capitals as to express the specific content. The content of the concept is derived from interviews and focus groups with different stakeholder groups (e.g. patients, healthy citizens, healthcare professionals, etc.) This inductive, bottom-up approach enabled the researchers to gain a thorough insight into the perceptions about the health of patients and other stakeholders themselves. Positive Health represents a broad perception of health, expressed by six dimensions with 32 underlying aspects, representing indicators for health. The dimensions were by then named: bodily functions, mental functions and perception, spiritual existential dimension, quality of life, social and societal participation and daily functioning. The six dimensions were visualized in a spider web with six axes, representing these six dimensions and ranging from value 0 (in the centre for poor) to 10 (on the periphery, for excellent). Soon people in practice started to use the spiderweb in dialogue with patients.

Also soon after the spiderweb became available an attempt started to transform the dimensions and 32 aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health. However, this attempt failed[21]. The results of the validity study suggested that the tool was not suitable as a measurement instrument[21]. It appeared that the goal of a measurement tool to express outcomes in health in a fixed number was too far from the experienced reality of an individual. Moreover, the 32 items appeared to be rather long for measurement purposes but also interviews made clear that the language of the present spiderweb was too complex for many people. Because of this feedback the six dimensions and the underlying 32 aspects

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of Positive Health were elaborated by an expert panel group into a more simple language and into 42 aspects, including now (as exceptions) the determinants living conditions and having enough money. The dimensions were renamed as bodily functions, mental well-being, meaningfulness, quality of life, participation and daily functioning. The result was called: the My Positive Health (MPH) dialogue tool (see www.MijnPositieveGezondheid.nl).

This MPH tool aims to provide individuals insight in their own health and stimulate self-reflection. By completing 42 statements, mean scores for each of the dimensions are graphically displayed in a spider web. See Supplementary file 1. This spider web can be used during consultations with (for example) healthcare professionals, to discuss one's perceived health and to reveal one's needs, desires and abilities. Thereby it could lead to identifiable statements which would find connection with the people concerned. This recognition was confirmed by a user evaluation among populations of healthy citizens, elderly, and chronically ill. The vast majority of the respondents rated the MPH dialogue tool good to excellent[22]. The tool is widely used in the Netherlands, with more than 100.000 unique users for the digital version since its introduction in 2016 (see MijnPositieveGezondheid.nl ("MyPositiveHealth.nl")). In addition, a paper version of the MPH tool is used across a wide range of care centres.

INSERT SUPPLEMENTARY FILE 1 HERE.

Along with the extensive use of the dialogue tool, a growing interest is once again observed for a measurement instrument that measure changes in a person's Positive Health. Such a measurement tool could provide stakeholders in various domains and levels (e.g. healthcare professionals, national and local policy makers and insurers) with valid information on the effectiveness of a Positive Health approach. Such insight could support them during the decision-making process and thereby enable a more structural implementation of interventions that improve people's (positive) health. As far as we were aware, no other validated questionnaire is available that covers the broad concept of Positive Health and since Prinsen no new attempt was made to develop such measurement instrument [23, 24]. The objective of this present study was to set first steps in a new attempt towards a suitable measurement instrument with adequate psychometric properties and scale brevity. This instrument could meet the needs of professionals wishing to evaluate their Positive Health interventions. In order to reach this objective, we aimed to extract an improved model to measure (positive) health by performing an Exploratory Factor Analysis (EFA) and to test it through confirmatory factor analysis (CFA). Performing a factor analysis will not only help to identify items to measure (positive) health, it will also provide insight into the adequacy of the current arrangement of dimensions and aspects of the MPH dialogue tool. Furthermore, we also aimed to examine the reliability of the MPH dialogue tool.

Methods

Design

This study comprised a cross-sectional quantitative survey study. Data from the quantitative survey was used to develop a new model to measure health by performing an Exploratory Factor Analysis (EFA) following a confirmatory factor analysis (CFA).

The instrument

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We use the digital version of the MPH dialogue tool (MijnPositieveGezondheid.nl; "MyPositiveHealth.nl") in this study. In this digital version, 42 statement are proposed (7 for each dimension) on an 11-point scale. 0 means totally disagree and 10 means totally agree. Target population are Dutch citizens, with or without a chronic disease.

Participants and data collection

Members of the citizens' panel of GGD Twente (regional municipal health service) were asked to fill out the 42 questions of the MPH dialogue tool and were asked for their age, gender, educational level, poverty (difficulty getting around), and health literacy (difficulty understanding health information such as leaflets).This panel comprises adults (19+) who took part in the national health survey of GGD Twente in the east of the Netherlands. This survey is carried out every four years to monitor the general state of health of Dutch citizens. At the end of that health survey, the participants were asked whether they were willing to participate in other, future studies by GGD Twente. Participants were invited by email to complete the questionnaire. Data collection took place from January to February 2018.

Analytical plan

To examine the construct validity of the MPH tool, we used a split-half validation method in which we randomly divided the participants into two groups. We used one of these groups to explore the factor structure through exploratory factor analysis (EFA) and the other group to test the goodness of fit of the extracted factor structure through confirmatory factor analysis (CFA). In conducting the factor analyses, we followed best practices described by Brown[25], Costello and Osborne[26], and Cabrera-Nguyen[27]. Suitability of the data for EFA was examined based on the Kaiser–Meyer–Olkin (KMO) statistic of sampling adequacy and the Bartlett's test of sphericity[28 29].

Through EFA, we explored the factor structure using maximum likelihood (ML) extraction. Because we expected our factors to be interdependent aspects of Positive Health, we used ML extraction with direct oblimin rotation. Kaiser criterion, scree plot analysis, and parallel analysis were used to determine the numbers of factors to extract[30 31]. We considered items with cross loading values of ≤ .32 on at least two factors as weak (and thereby as candidates for deletion)[26]. And we considered items with factor loading of ≥ .60 as strong[32].

We strove for a model with improved psychometric properties and scale brevity, while maintaining enough items to create stable factors. We therefore aimed to reduce each factor to three items with highest factor loadings.

Through CFA, we evaluated the goodness of fit of the factor structure extracted during EFA. With the CFA evaluation we compared the extracted factor structure with two baseline models containing all 42 items of the MPH dialogue tool: the original 6-factor structure that includes the six dimensions of health and a 1-factor structure which considers all items belonging to one health domain. This comparison helps to understand the degree to which our extracted factor structure fits unseen data better than respectively the original 6-factor structure and the 1-factor structure. We evaluated the goodness of fit using several indices: Pearson's Chi-squared test, comparative fit index (CFI; > .95 is acceptable), Tucker Lewis index (TLI; > .95 is acceptable), the root mean square error of approximation (RMSEA; < .06 is acceptable), and standardized root mean square residual (SRMR; < .08 is acceptable). These indices reflect model fit (Pearson's Chi-squared test), incremental fit (CFI, TLI), and absolute fit (RMSEA, SRMR). The threshold values we applied are cut-off values recommended by Hu and Bentler (1999)[33] and endorsed by both Brown (2014)[25] and Cabrera-Nguyen (2010)[27]. For fitting the models, we used lavaan version 0.6-3[34] in R version 3.5.1[35].

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We used maximum likelihood estimation and standardized the latent factors to allow free estimation of all factor loadings.

Finally, we examined the reliability and discriminant validity of the factors of both the original 6-factor model (MPH dialogue tool) and the new experimental model. We examined the reliability by evaluating the Cronbach's alpha coefficients and tested the discriminant validity by evaluating the factor correlations.

Ethical considerations

Due to the harmless and non-invasive character of the study, this study was exempt from medical ethical approval. Prior to completion of the questionnaire, informed consent for the use of data for scientific purposes was asked in the invitation email to the participants. All data are handled anonymously.

Results

Characteristics of respondents

In total, 3218 participants were invited to enrol in the study. Of those, 708 participants completed the questionnaire (response rate is 22%). The mean age of the respondents was 62 years (SD = 15) and 46% of them were female. Most respondents had a high educational level 44% (medium 34%; low 22%). And 9% of the respondents indicated some to severe difficulty in getting around (poverty). Low health literacy (difficulty understanding health information such as leaflets) was indicated by 5% of the respondents. Comparing to the general 19+ population in the region Twente the respondents were older (Twente: mean age = 51); were higher educated (Twente: high educational level = 30%); had higher health literacy (Twente: 9%) and had less difficulty in getting around (Twente: 17%).

Exploratory Factor Analysis

Our exploration showed that the data are suitable for EFA. Our sample had both an acceptable size of 356[32 33] and a very common participant-to-item ratio (8.5:1). The KMO test yielded a statistic of 0.97, implying that the dataset contains a significant number of factors, and the Bartlett's test of sphericity yielded significant results, χ^2 (41) = 318.368, $p < .001$, implying that the correlations among variables are greater than one would expect by chance.

Common approaches for determining the number of factors to extract showed support for a 6-factor structure. First, the Kaiser criterion method showed that the data contain 6 factors with eigenvalues greater than one, suggesting that the data clusters in 6 factors. . Second, the scree plot suggested 2, 4, or 6 factors because the eigenvalues level off after these amount of factors (see Figure 1). Third, parallel analysis (see Figure 2) suggested a structure of 6 factors – the crossing point of the actual scree plot with the possible scree plot based on randomly resampled data. A 6-factor structure accounts for 67.5% of the total item variance.

INSERT FIGURE 1 HERE.

INSERT FIGURE 2 HERE.

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Factor loadings are shown in Table 1. In this table, factor names for the experimental model are displayed in the second horizontal row. Overall, the items that group together in our EFA mostly group together in the original model as well.

Table 1 shows that the first factor has factor loadings above .40 for several items originating from the dimension Social and Societal Participation (SP). These items are: SP29 Social contacts, SP30 Being taken seriously, SP31 Doing fun things together, SP32 Having the support of others, SP33 Belonging. We selected the tree highest factor loadings (SP29, SP32, and SP33) and labelled this factor 'Social relations'.

The second factor showed loadings above .40 on items from the original dimension Daily Functioning (DF). These items are: DF36 Looking after yourself, DF37 Knowing your limitations, DF38 Knowledge of health, DF39 Managing time, DF40 Managing money. We selected the three highest factor loadings (DF37, DF38, DF39) and labelled this factor 'Daily life-management'.

The third factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from the original dimension Bodily Functions (BF). These items are: BF1 Feeling healthy, BF2 Feeling fit, BF5 Eating pattern, BF6 Physical condition, and BF7 Exercise. We included the three items with highest factor loadings (BF2, BF6, and BF7) and labelled this factor 'Physical fitness'.

The fourth factor showed loadings above .40 on items across three dimensions of the dialogue tool: Mental Well-being (MW), Meaningfulness (MF), and Quality of Life (QL). These items are: MW11 Being cheerful, MW12 Accepting yourself, MW14 having control, MF16 Being high spirited, and MF19 Accepting life, QL22 Enjoyment, QL23 Being happy, QL24 Feeling good, and QL25 Feeling well-balanced. We selected the three highest factor loadings (QL23, QL24, and QL25) and labelled this factor 'Contentment'.

The fifth factor showed loadings above .40 on items from one dimension of the dialogue tool: Mental Wellbeing (MW) and Meaningfulness (MF). These items are: MW13 Being able to handle changes, MF17 Wanting to achieve ideals, MF18 Feeling confident about own future, MF21 Continue learning, and SP34 Doing meaningful things. We selected the three highest factor loadings (MW13, MF17, and MF18) and labelled this factor 'Future perspectives'.

The last factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from one dimension of the dialogue tool: Mental Well-being (MW). These items are: MW8 Being able to remember things and MW9 Being able to concentrate. We selected these two highest factor loadings (MW8 and MW9) and labelled this factor 'Mental functioning', as these aspects solely focus on cognitive abilities and do not concern any emotional aspects or feelings.

In our exploration for a measurement instrument model, we were successful in reducing the number of items for five factors from 7 to 3 items and for one factor to 2 items. The final factor structure we extracted thus contained 17 items.

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Table 1. Factor Pattern/Structure Rotated to the Oblimin Criterion

Item number*	Description	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	
		Social relations	Daily-management	Physical fitness	Contentment	Future achievements	Mental functioning	h^2
BF1	**Feeling healthy**	-0.03	0.05	***0.82***	0.12	-0.02	0.03	0.81
BF2	**Feeling fit**	-0.04	0.03	***0.86***	0.12	-0.07	0.07	0.83
BF3	Having complaints or pain	0.10	-0.07	0.37	-0.11	0.10	0.13	0.25
BF4	Sleeping pattern	0.10	-0.10	0.36	0.25	0.01	0.21	0.46
BF5	Eating pattern	0.17	-0.01	0.43	0.12	0.04	0.13	0.52
BF6	Physical condition	0.09	-0.02	*0.73*	-0.08	0.12	0.02	0.68
BF7	**Exercise**	0.02	0.09	***0.74***	-0.17	0.16	-0.01	0.70
MW8	**Being able to remember things**	-0.03	-0.01	0.00	-0.08	0.01	***0.95***	0.82
MW9	**Being able to concentrate**	0.03	0.02	0.07	0.13	-0.01	***0.77***	0.82
MW10	Being able to communicate	0.10	0.36	0.08	-0.22	0.22	0.20	0.49
MW11	Being cheerful	0.24	0.03	0.12	*0.46*	0.07	0.19	0.78
MW12	Accepting yourself	0.21	0.14	0.13	*0.46*	-0.01	0.10	0.69
MW13	**Being able to handle changes**	0.10	0.10	0.05	-0.01	***0.48***	0.11	0.51
MW14	Having control	0.13	0.22	0.03	*0.42*	0.09	0.15	0.70
MF15	Having a meaningful life	0.28	0.17	0.05	0.35	0.20	0.06	0.80
MF16	Being high-spirited	0.13	0.13	0.20	*0.41*	0.17	0.08	0.78
MF17	**Wanting to achieve ideals**	-0.06	-0.05	0.06	0.01	***0.87***	0.07	0.77
MF18	**Feeling confident about own future**	0.12	0.03	0.01	0.19	***0.68***	0.00	0.80
MF19	Accepting life	0.06	0.18	0.08	0.41	0.21	0.00	0.57
MF20	Being grateful	0.24	0.09	0.04	0.31	0.32	0.03	0.68
MF21	Continue learning	0.06	0.13	0.15	-0.08	*0.43*	0.05	0.43
QL22	Enjoyment	0.16	0.14	0.15	*0.50*	0.19	0.00	0.83
QL23	**Being happy**	0.11	0.13	0.08	***0.56***	0.17	0.06	0.79
QL24	**Feeling good**	0.09	0.07	0.16	***0.58***	0.14	0.12	0.86
QL25	**Feeling well-balanced**	0.08	0.12	0.16	***0.56***	0.13	0.11	0.85

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QL26	Feeling safe	0.30	0.22	0.08	0.26	0.09	0.07	0.67
QL27	Living conditions	0.37	0.13	0.02	0.26	0.09	0.04	0.57
QL28	Having enough money	0.24	0.34	0.11	-0.10	0.15	0.05	0.48
SP29	**Social contacts**	***0.88***	0.02	0.00	-0.08	0.04	0.05	0.82
SP30	Being taken seriously	0.66	0.17	-0.10	-0.03	0.15	0.05	0.72
SP31	Doing fun things together	*0.81*	-0.02	0.08	0.07	0.03	-0.05	0.77
SP32	**Having the support of others**	***0.88***	0.03	-0.01	0.02	-0.09	0.05	0.76
SP33	**Belonging**	***0.88***	-0.04	0.03	0.08	0.01	-0.02	0.84
SP34	Doing meaningful things	0.21	0.12	0.04	0.12	*0.43*	0.04	0.63
SP35	Being interested in society	0.11	0.40	-0.03	0.11	0.20	0.10	0.55
DF36	Looking after yourself	0.13	*0.68*	0.13	-0.09	0.02	-0.06	0.63
DF37	**Knowing your limitations**	-0.06	***0.88***	-0.02	0.13	0.00	0.02	0.81
DF38	**Knowledge of health**	0.08	***0.72***	0.20	-0.03	-0.03	-0.03	0.71
DF39	**Managing time**	0.01	***0.71***	-0.07	0.14	-0.01	0.17	0.72
DF40	Managing money	0.13	*0.58*	0.02	-0.08	0.07	0.15	0.62
DF41	Being able to work	0.04	0.33	0.18	-0.05	0.29	0.02	0.49
DF42	Asking for help	0.18	0.20	0.01	-0.11	0.16	0.24	0.36
% of variance		15.1	12.8	11.2	10.9	10.3	7.2	67.5

Notes: Coefficients greater than |.40| are italicized. The items in bold are retained for that factor.

* BF refers to Bodily functions; MW refers to Mental well-being; MF refers to meaningfulness; QL refers to Quality of life; SP refers to Social and societal participation; DF refers to daily functioning

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Confirmatory Factor Analysis

The two baseline models, against which we compared the factor structure we extracted during our EFA, had low fits. First, the original 6-factor structure had a CFI of .846, TLI of .835, RMSEA of .086 with 90% confidence interval (CI) [.082, .089], and an SRMR of 0.063. Second, the 1-factor structure had a CFI of .731, TLI of .717, RMSEA of .112 with 90% confidence interval (CI) [.109, .115], and an SRMR of 0.066. The factor structure we extracted during the EFA, in contrast, had an acceptable fit, with a CFI of .964, TLI of .953, RMSEA of .071 with 90% confidence interval (CI) [.062, .081], and an SRMR of 0.036. This fit was significantly better than the fit of both the original 6-factor solution ($\chi 2$ (700) = 2604.48, $p < .001$) and the 1-factor solution ($\chi 2$(715) = 4174.19, $p < .001$).

The items we selected during the EFA all showed positive factor loadings on their respective domains, with standardized coefficients ranging from .71 to .97 (see Table 2), supporting the factor structure. As we report in Table 3, the items within each factor yielded highly consistent response. More specifically, the Cronbach's alpha values of the factors ranged from .82 to .92. The six factors correlated significantly positively among each other (see Table 3), indicating that individuals that score higher on one domain typically score higher on the other domains. The factor correlations did not exceed .80, which suggest acceptable discriminant validity[25]. In comparison, the factor correlations of the original model suggest overlap between Meaningfulness and Mental well-being, Mental well-being and Quality of Life, Quality of life and Meaningfulness, Quality of Life and Social and societal participation, and Social and societal participation and Daily functioning (see Table 4). Cronbach alpha values from this original model range from .88 to .93.

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Table 2. Parameter Estimates Confirmatory Factor Analysis

Latent factor	Item	Description	B	SE	Z	Beta	p
Social relations	29	Social contacts	1.00	0.00		0.84	
Social relations	32	Having the support of others	1.10	0.06	19.49	0.84	***
Social relations	33	Belonging	1.18	0.05	21.96	0.91	***
Daily life-management	37	Knowing your limitations	1.00	0.00		0.89	
Daily life-management	38	Knowledge of health	1.05	0.04	26.52	0.93	***
Daily life-management	39	Managing time	1.09	0.06	19.90	0.80	***
Physical fitness	1	Feeling healthy	1.00	0.00		0.95	
Physical fitness	2	Feeling fit	1.05	0.04	24.89	0.88	***
Physical fitness	7	Exercise	1.03	0.06	17.97	0.74	***
Contentment	23	Being happy	1.00	0.00		0.87	
Contentment	24	Feeling good	1.10	0.04	25.95	0.94	***
Contentment	25	Feeling well-balanced	1.01	0.05	22.28	0.87	***
Future perspective	13	Being able to handle changes	1.00	0.00		0.71	
Future perspective	17	Wanting to achieve ideals	1.19	0.09	12.92	0.73	***
Future perspective	18	Feeling confident about own future	1.32	0.09	14.90	0.86	***
Mental functioning	8	Being able to remember things	1.00	0.00		0.83	
Mental functioning	9	Being able to concentrate	1.15	0.06	19.53	0.97	***

Notes: *** = p < .001, B = unstandardized estimates, Beta = standardized estimates.

Table 3. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the extracted factors (new model).

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Factor	*M*	*SD*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) Physical fitness	7.60	1.70	(.88)					
(2) Mental functions	7.76	1.58	.58***	(.89)				
(3) Future perspective	7.73	1.45	.55***	.57***	(.82)			
(4) Contentment	7.92	1.59	.64***	.63***	.73***	(.92)		
(5) Social relations	8.42	1.35	.54***	.58***	.64***	.70***	(.90)	
(6)Daily life-management	8.52	1.35	.57***	.62***	.67***	.69***	.72***	(.90)

Notes: *** = p < .001.

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Table 4. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the original factors (MPH dialogue tool).

Factor	***M***	***SD***	***(1)***	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***
(1) Bodily functions	7.60	1.70	(.88)					
(2) Mental well-being	7.76	1.58	.72***	(.90)				
(3) Meaningfulness	7.73	1.45	.65***	.83***	(.90)			
(4) Quality of life	7.92	1.59	.72***	.83***	.88***	(.92)		
(5) Social and societal participation	8.42	1.35	.61***	.77***	.77***	.81***	(.93)	
(6) Daily functioning	8.52	1.35	.65***	.79***	.74***	.78***	.82***	(.90)

Notes: *** = p < .001.

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Discussion

The results of our factor analysis support a factor structure of six dimensions. The model we extracted contained 17 items, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Daily life-management. The extracted model showed improved construct validity compared to the original model with good fit, high reliability and acceptable discriminant validity. For the MPH tool our reliability tests suggest good to very good reliability (Cronbach alpha values ranging from .88 to .93). Furthermore, our factor analysis suggests overlap across the dimensions Mental wellbeing, Meaningfulness, Quality of life, and Social and societal participation, making the MPH tool less suitable as a measurement tool.

This study addresses the difference in aims and thereby required properties between a dialogue tool and a measurement tool. The results show that a 17-item model has better psychometric properties, and can thereby serve as a strong basis for the development of a Positive Health measure. However, the 17-item scale neglects several aspects relevant to address when determining and discussing an individual's perception of health. For example, for bodily functions, the ignored items about sleeping and eating patterns can inspire ideas and improve dialogue about improving bodily functions. Similarly, it ignores the aspect *accepting yourself*, whereas this was considered the most important aspect of Mental well-being by respondents (18-25 years) in a study that focused on the development of an adolescent version of the tool[36]. Importance of this aspect came forward in studies regarding the development of health-related quality of life and subjective well-being scales as well[6, 37]. Furthermore, research shows that poor living conditions and financial problems are often accompanied by considerable physical and mental problems[38-40]. Inclusion of these aspects in the MPH dialogue tool provides a broader understanding of the multiple needs of an individual. This enables individuals to express their needs during the dialogue about the results and enables to refer them, if required, to appropriate providers. Overall, for two statements within the MPH dialogue tool it can be argued that they also function as determinants - which influence people's perceived health – like patients themselves expressed during the original study, or consequences of health as well. While such determinants and consequences of health are not appropriately represented in the measurement of health itself, we suggest that they may still be relevant in a dialogue tool.

Difficulties to blend the two goals of both a dialogue tool and a measurement tool were noted earlier. During the development process, an attempt to transform the dimensions and underlying aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health has failed[21]. At this stage it appeared that the goal of a measurement tool to express outcome in health in (a) fixed number(-s) was too far from the experienced reality of an individual. Based on the results of our study and the previous attempt, we therefore suggest the use of two separate tools: (1) a dialogue tool with the aim to elucidate a broad representation of a person's perceived health status, comprising a broad range of aspects and (2) a measurement tool with improved psychometric properties that is able to capture broad health in a valid an reliable way. For this second purpose, our extracted 17-item model may serve as a basis.

When further developing a measurement tool to the measure (positive) health, several issues need to be addressed. First, concepts like salutogenesis, sense of coherence, and resilience form a strong basis of Positive Health, focussing on the abilities of individuals to handle changes and experience meaningfulness. It should be further investigated whether these concepts are sufficiently addressed in

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the current 17-item experimental model. For example, the included aspects from the dimension of Meaningfulness solely focus on future achievements, while meaningfulness can be regarded as an integration of past, present and future[41]. Second, in line with the concept of health as the ability to adapt and to self-manage, one could expect that an individual with poor objective health status can still experience good health when being capable to deal well with the situation, while another individual with better objective health status can experience lower health. It would be a challenge to develop a measurement tool that does not reflect health by one continuum, but that can capture both realities.

Methodological considerations

This study was based on a survey among a citizen panel in eastern part of the Netherlands (Twente), with a mean age of 62 (*SD* = 15) and 46% women. This relatively higher age of the study population compared to the whole adult population in this region (M age = 51) could reflect a higher interest in the topic of personal positive health status in older adults, and may be the result of the relatively low response rate of 22%. To be able to draw more firm conclusions about the psychometric properties of the MPH tool, this should be investigated among other populations as well. This will reveal to which extent difference in age, education level, health literacy and poverty level affects our findings.

In our study we have focused on the construct validity. Therefore, other psychometric properties such as the predictive validity, discriminant validity, and responsiveness of the 17- item model remain still unknown. Such issues should be addressed in future studies. Also, we made a first attempt to label the identified factors with factor names. The appropriateness of these names should be further investigated as well.

We based the choice to select three items per factor on both practical and theoretical arguments. From practical point of view, it is desirable to have a short and easy to use scale with acceptable psychometric properties. A scale of 17 items can be completed within a short amount of time. From a theoretical perspective, factors with fewer than three items are often weak and unstable[26]. Due to low factor loadings (< .40) we were not able to select a third item for the factor Mental functions. To increase stability within this factor and to improve overall balance of the scale, we suggest to investigate the possibility to develop and include a third item for the factor Mental functions in future studies.

Conclusion

Overall, we conclude that the overall structure of the MPH dialogue tool, seems reliable. While the 42-item model might be suitable as a dialogue tool, this study shows that it is not suitable as a measurement tool. Instead, we propose a 17-item model with a six factor structure, comprising the factors Physical fitness, Mental functions, Future perspective, Contentment, Social relations, and Daily life-management, which can serve as a basis for the development of an additional measurement tool. Given the prevailing healthcare trend towards a focus on health and wellbeing, expressed by an increased number of practices based on a Positive Health approach, the existence of such measurement tool is of great importance.

Author contributions

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SB collected the data. BD performed the statistical analysis. MV interpreted the results and wrote the manuscript in collaboration with BD and EA. All authors commented and agreed on the final version.

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Competing interest

The authors declare no conflict of interest.

Data sharing statement

A request for sharing data can be made by sending an email to the corresponding author.

Patient and Public involvement statement

Patients and/ or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

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References

1. Johansen F, Loorbach D, Stoopendaal A. Exploring a transition in Dutch healthcare. *J Health Organ Manag* 2018;32(7):875-90 doi: 10.1108/JHOM-07-2018-0185.
2. Palmer K, Marengoni A, Forjaz MJ, et al. Multimorbidity care model: Recommendations from the consensus meeting of the Joint Action on Chronic Diseases and Promoting Healthy Ageing across the Life Cycle (JA-CHRODIS). *Health Policy* 2018;122(1):4-11 doi: 10.1016/j.healthpol.2017.09.006.
3. Hoeymans N, Van Loon AJM, Van den Berg M, et al. A healthier Netherlands: the key findings of the sixth Public Health Status and Foresight Bilthoven, The Netherlands: National Institute for Public Health and the environment (RIVM), 2014.
4. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: A cross-sectional study. *Lancet* 2012;380(9836):37-43 doi: 10.1016/S0140-6736(12)60240-2.
5. Butalid L, Verhaak PF, Boeije HR, Bensing JM. Patients' views on changes in doctor-patient communication between 1982 and 2001: a mixed-methods study. *BMC Fam Pract* 2012;13:80 doi: 10.1186/1471-2296-13-80.
6. De Vries M, Emons WHM, Plantinga A, et al. Comprehensively Measuring Health-Related Subjective Well-Being: Dimensionality Analysis for Improved Outcome Assessment in Health Economics. *Value Health* 2016;19(2):167-75 doi: 10.1016/j.jval.2015.11.010.
7. Al-Janabi H, Flynn TN, Coast J. Development of a self-report measure of capability wellbeing for adults: the ICECAP-A. *Qual Life Res* 2012;21(1):167-76 doi: 10.1007/s11136-011-9927-2.
8. NWA. Portfolio for research and innovation - Health care research, sickness prevention and treatment. The Hague, 2016.
9. Smid HJ, Wydoodt A. ZonMW signalement over zingeving in zorg: de mens centraal [ZonMW description about meaningfulness in care: focus on the individual]. 2nd edition ed. Den Haag: ZonMw, 2017.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

10. Vanderweele TJ. On the promotion of human flourishing. *Proc Natl Acad Sci U S A*, 2017:8148-56 doi: 10.1073/pnas.1702996114.
11. Stucki G, Bickenbach J. Health, Functioning, and Well-being: Individual and Societal. *Arch Phys Med Rehabil* 2019;100(9):1788-92 doi: 10.1016/j.apmr.2019.03.004.
12. Huber M, Knottnerus A, Green L, et al. How should we define health? *BMJ* 2011;343(7817):1-3 doi: 10.1136/bmj.d4163.
13. Editorial. What is health? The ability to adapt. *Lancet* 2009;373(9666):781-81 doi: 10.1016/S0140-6736(09)60456-6.
14. Jadad AR, O'Grady L. How should health be defined? *BMJ* 2008;337:a2900 doi: 10.1136/bmj.a2900.
15. Larson JS. The conceptualization of health. *Med Care Res Rev* 1999;56:123-36 doi: 10.1177/107755879905600201.
16. Smith R. The end of disease and the beginning of health - *BMJ*, 2008.
17. Van der Lucht F, Polder JJ. Towards better health - The Dutch 2010 Public Health Status and Forecasts Report. Bilthoven: RIVM, 2010.
18. Bircher J. Towards a dynamic definition of health and disease. *Med Health Care Philos* 2005;8(3):335-41 doi: 10.1007/s11019-005-0538-y.
19. Kooiker SE. Nederlanders aan het woord over gezondheid en gezond leven. Achtergrond bij VTV 2010 Van Gezond naar Beter [Stories from Dutch citizens about health and healthy living. Background to the Dutch 2010 Public Health Status and Forecasts Report]. Bilthoven: RIVM, 2011.
20. Huber M, van Vliet M, Giezenberg M, et al. Towards a 'patient-centred' operationalisation of the new dynamic concept of health: a mixed methods study. *BMJ open* 2016;6(1):e010091 doi: 10.1136/bmjopen-2015-010091.
21. Prinsen CAC, Terwee CB. Measuring positive health: for now, a bridge too far. *Public Health* 2019;170:70-77 doi: 10.1016/j.puhe.2019.02.024.
22. Al Shamma S, Van den Dries L, Van Wezep M, Wolf J. Ervaringen met de gesprekstool 'Mijn Positieve Gezondheid' [Experiences with the dialogue tool 'My Positive Health']. Nijmegen, 2018:1-40.
23. Hendrikx RJP, Spreeuwenberg MD, Drewes HW, Ruwaard D, Baan CA. How to Measure Population Health: An Exploration Toward an Integration of Valid and Reliable InstrumentsThis study was presented as a poster presentation at the International Conference on Integrated Care 2017, held May 8–10, 2017 in Dublin, Ireland. *Popul Health Manag* 2018;21(4):323-30 doi: 10.1089/pop.2017.0097.
24. Linton M, Dieppe P, Medina-Lara A. Review of 99 self-report measures for assessing well-being in adults: exploring dimensions of well-being and developments over time. *BMJ open* 2016;6(7):e010641-e41 doi: 10.1136/bmjopen-2015-010641.
25. Brown TA. Confirmatory factor analysis for applied research. New York, NY: The Guilford Press, 2014.
26. Costello AB, Osborne JW. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pract Assess Res Eval* 2005;10:1-9 doi: 10.1.1.110.9154.
27. Cabrera-Nguyen P. Author Guidelines for Reporting Scale Development and Validation Results in the Journal of the Society for Social Work and Research. *J Soc Social Work Res* 2010;1(2):99-103 doi: 10.5243/jsswr.2010.8.
28. Comrey AL, Lee HB. A First Course in Factor Analysis. Hillsdale, NJ: Lawrence Erlbaum, 1992.
29. Worthington RL, Whittaker TA. Scale development research: A content analysis and recommendations for best practices. *Couns Psychol* 2006;34(6):806-38
30. Kaiser HF. The Application of Electronic Computers to Factor Analysis. *Educ Psychol Meas* 1960;20(1):141-51 doi: 10.1177/001316446002000116.
31. Kaiser HF, Rice J. Little Jiffy, Mark Iv. *Educ Psychol Meas* 1974;34(1):111-17 doi: 10.1177/001316447403400115.
32. Garson GD. Factor Analysis. Asheboro, NC: Statistical Associates Publishers, 2013.

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33. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equ Modeling* 1999;6(1):1-55 doi: 10.1080/10705519909540118.
34. Rosseel Y. Lavaan: An R package for structural equation modeling. *J Stat Softw* 2012;48(2):1-36
35. Team RC. R: A Language and Environment for Statistical Computing. Vienna: R Foundation for Statistical Computing, 2018.
36. Van Vliet M, Van der Zanden S, Huber M. Ontwikkeling van de 'Mijn Positieve Gezondheid' jongerentool [Development of the My Positive Health adolescent tool]. Utrecht: Institute for Positive Health, 2019.
37. Pietersma S, de Vries M, van den Akker-van Marle ME. Domains of quality of life: results of a three-stage Delphi consensus procedure among patients, family of patients, clinicians, scientists and the general public. *Qual Life Res* 2014;23(5):1543-56 doi: 10.1007/s11136-013-0578-3.
38. Bodden DHM, Deković M. Multiproblem Families Referred to Youth Mental Health: What's in a Name? *Fam Process* 2016;55(1):31-47 doi: 10.1111/famp.12144.
39. Moorhead R, Robinson M. A trouble shared – legal problems clusters in solicitors' and advice agencies. London: Department for Constitutional Affairs, 2006.
40. Smith M, Buck A, Sidaway J, Scanlan L. Bridging the Empirical Gap: New Insights into the Experience of Multiple Legal Problems and Advice Seeking. *J Empir Leg Stud* 2013;10(1):146-70 doi: 10.1111/jels.12006.
41. Baumeister RF, Vohs KD, Aaker JL, Garbinsky EN. Some key differences between a happy life and a meaningful life. *J Posit Psychol* 2013;8(6):505-16 doi: 10.1080/17439760.2013.830764.

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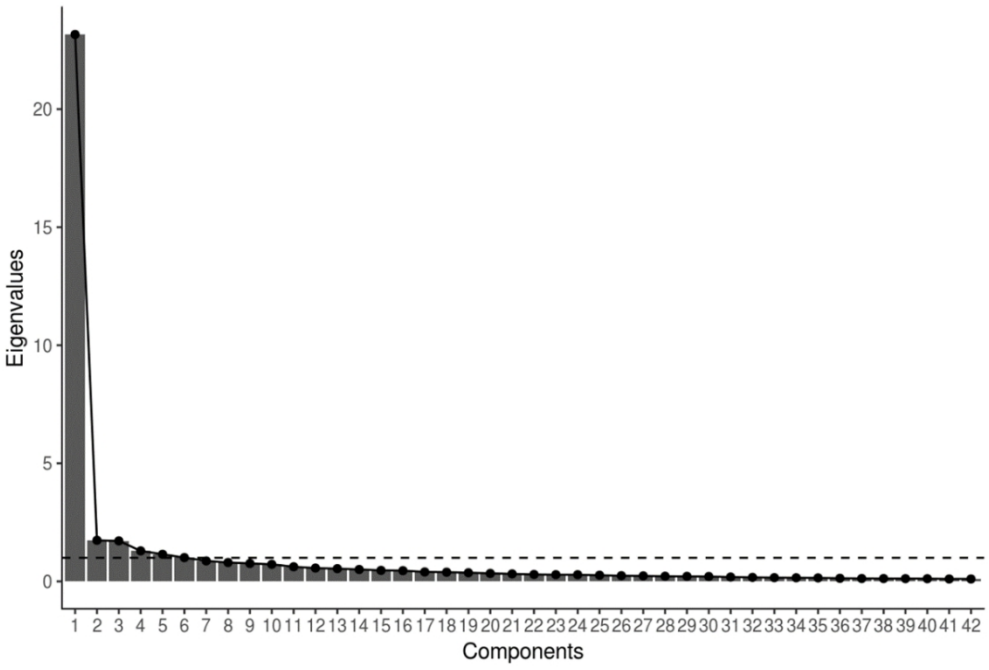

Figure 1. Scree plot. Note: Kaiser criterion is shown by the black dashed line.

141x95mm (220 x 220 DPI)

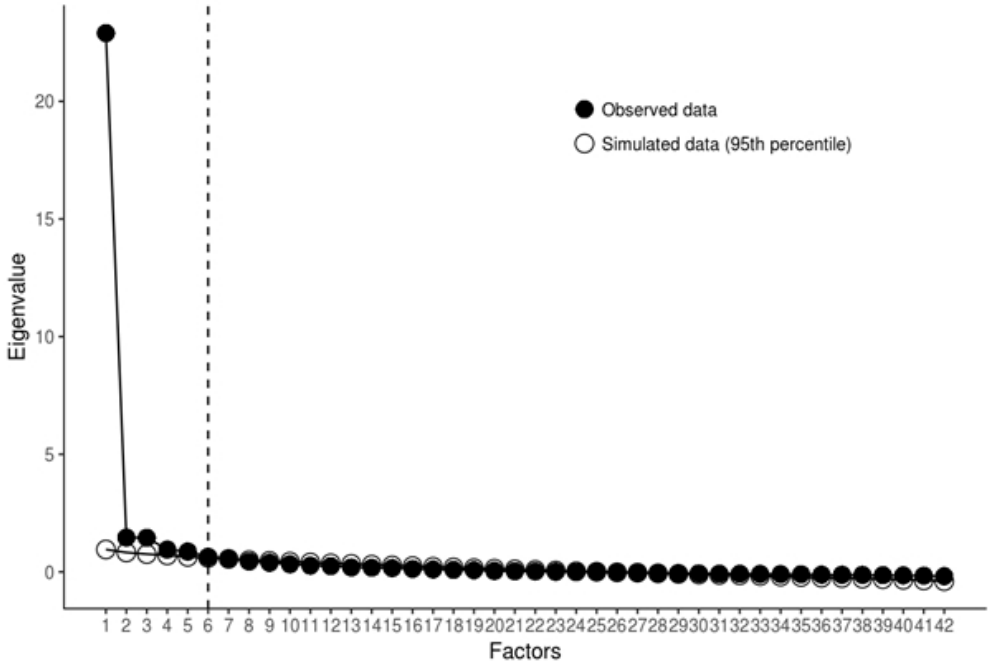

Figure 2. Parallel Analysis. Note: The 6-factor structure is shown by the black dashed line.

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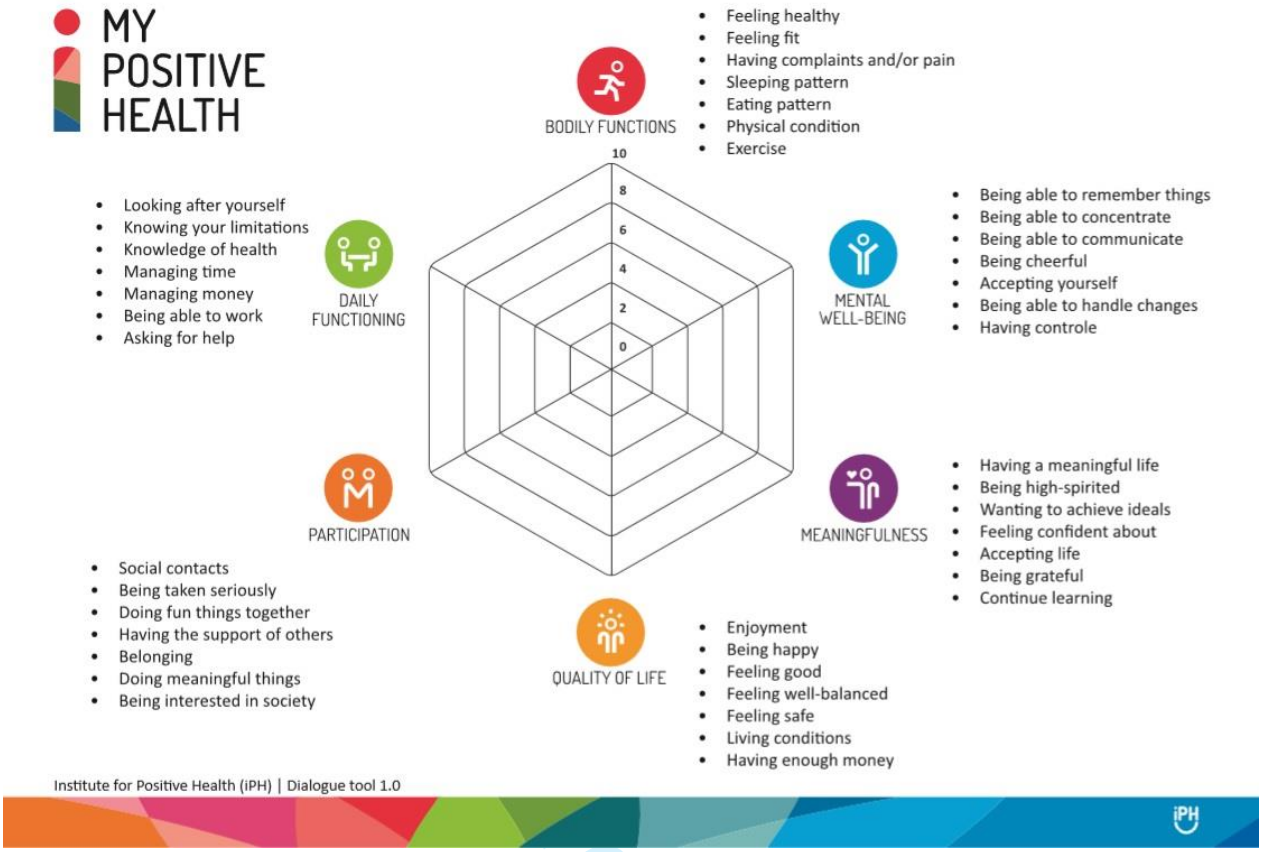

Supplementary file 1. My Positive Health spiderweb comprising 6 dimensions and 42 aspects

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Development and psychometric evaluation of a Positive Health measurement scale: a factor analysis study based on a Dutch population

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Development and psychometric evaluation of a Positive Health measurement scale: a factor analysis study based on a Dutch population

Abstract

OBJECTIVES: The My Positive Health (MPH) dialogue tool is increasingly adopted by healthcare professionals in the Netherlands as well as abroad to support people in their health. Given this trend, the need arises to measure effects of interventions on the Positive Health dimensions. However, the dialogue tool was not developed for this purpose. Therefore, this study aims to work towards a suitable measurement scale using the My Positive Health (MPH) dialogue tool as starting point.

DESIGN: A cross-sectional study design

PARTICIPANTS AND SETTINGS: A total of 708 respondents, who were all members of the municipal health service panel in the eastern part of the Netherlands, completed the MPH dialogue tool.

METHODS: The factor structure of the MPH dialogue tool was explored through exploratory factor analysis (EFA) using maximum likelihood extraction. Next, the fit of the extracted factor structure was tested through confirmatory factor analysis (CFA). Reliability and discriminant validity of both a new model and the MPH scales were assessed through Cronbach's alpha tests.

RESULTS: Similar to the MPH dialogue tool, the extracted 17-item model has a six factor structure but named differently, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Health management. The reliability tests suggest good to very good reliability of the aimed measurement tool and MPH model (Cronbach's alpha values ranging from respectively .820 to .920 and .882 to .933). The measurement model shows acceptable discriminant validity, whereas the MPH model suggests overlap between domains.

CONCLUSION: The results suggest that the current MPH dialogue tool seems reliable as a dialogue, but is not suitable as a measurement scale. We therefore propose a 17-item model with improved, acceptable psychometric properties which can serve as a basis for further development of a measurement scale.

Strengths and limitations of this study

* Main strength of this study was the thorough psychometric analysis to develop a Positive Health measurement scale.

* Data from a large group of respondents (N= 708) with suitable characteristics for factor analysis were used.

* Development of the Positive Health measurement tool was based on the items of the Positive Health dialogue tool, which is widely used in the Netherlands.

* This study had a relatively low response rate (22%), which may have created a sampling bias.

* Given the relatively small geographic area in which the data are collected, wider generalisation of the present results may be restricted.

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Introduction

Over the last years, the European healthcare system is increasingly shifting its focus from cure and disease towards health and healthy behaviour[1, 2]. In the Netherlands, more attention is given to health-oriented approaches, which focus on health promotion, vitality and possibilities rather than on imperfections[3]. This process was accelerated by the demographic situation of an increasing number of elderly people with one or more chronic disease, increasing healthcare expenditures and an increasing wish of citizens for an active and autonomic role during medical consultation[1, 4, 5]. Within the shift towards health-oriented approaches, a focus on health which is broader than only biomedical aspects, and which contributes to achieving a more meaningful life, has gained more interest[6-10]. Furthermore, it is increasingly recognized that understanding patients' experiences about living with a disease, is of vital importance in the management of chronic diseases[11].

Taking this broader focus into mind, Huber et al. (2011)[12] proposed a new concept of health, which describes health "as the ability to adapt and self-manage, in the face of physical, mental and social challenges". According to this concept, being healthy reflects the capacity to deal with internal and external stressors, despite possible limitations – and the tendency to adapt to changing conditions. This opposes to the more static current definition of the WHO, which regards health "as a complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". Although this definition was not intended as such, critics express that the very high ambition has resulted in a major focus on the diagnosis and treatment of symptoms and disease[13-16]. However, people with chronic diseases do not automatically see themselves as being unhealthy[17]. Similarly, many elderly people consider themselves to be healthy, even if their physical abilities are significantly reduced. To them, being healthy often means to have the ability to fulfil one's life[10, 18, 19]. This is fully in line with the content of the new concept of 2011.

The Dutch government considered the dynamic concept of health by Huber et al. (2011)[12] to serve well as a framework for the new strategy within the Dutch healthcare system and required an operationalisation study to make the concept useful for practice[20]. During this study the concept has been further elaborated into the concept of Positive Health, nowadays written with capitals as to express the specific content. The content of the concept is derived from interviews and focus groups with different stakeholder groups (e.g. patients, healthy citizens, healthcare professionals, etc.) This inductive, bottom-up approach enabled the researchers to gain a thorough insight into the perceptions about the health of patients and other stakeholders themselves. Positive Health represents a broad perception of health, expressed by six dimensions with 32 underlying aspects, representing indicators for health. The dimensions were by then named: bodily functions, mental functions and perception, spiritual existential dimension, quality of life, social and societal participation and daily functioning. The six dimensions were visualized in a spider web with six axes, representing these six dimensions and ranging from value 0 (in the centre for poor) to 10 (on the periphery, for excellent). Soon people in practice started to use the spiderweb in dialogue with patients.

Also soon after the spiderweb became available an attempt started to transform the dimensions and 32 aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health. However, this attempt failed[21]. The results of the validity study suggested that the tool was not suitable as a measurement instrument[21]. It appeared that the goal of a measurement tool to express outcomes in health in a fixed number was too far from the experienced reality of an individual. Moreover, the 32 items appeared to be rather long for measurement purposes but also interviews made clear that the language of the present spiderweb was too complex for many people. Because of this feedback the six dimensions and the underlying 32 aspects

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of Positive Health were elaborated by an expert panel group into a more simple language and into 42 aspects, including now (as exceptions) the determinants living conditions and having enough money. The dimensions were renamed as bodily functions, mental well-being, meaningfulness, quality of life, participation and daily functioning. The result was called: the My Positive Health (MPH) dialogue tool (see www.MijnPositieveGezondheid.nl).

This MPH tool aims to provide individuals insight in their own health and stimulate self-reflection. Target population are Dutch citizens, with or without a chronic disease. By completing 42 statements, mean scores for each of the dimensions are graphically displayed in a spider web. See Supplementary file 1. This spider web can be used during consultations with (for example) healthcare professionals, to discuss one's perceived health and to reveal one's needs, desires and abilities. Thereby it could lead to identifiable statements which would find connection with the people concerned. This recognition was confirmed by a user evaluation among populations of healthy citizens, elderly, and chronically ill. The vast majority of the respondents rated the MPH dialogue tool good to excellent[22]. The tool is widely used in the Netherlands, with more than 100.000 unique users for the digital version since its introduction in 2016 (see MijnPositieveGezondheid.nl ("MyPositiveHealth.nl")). In addition, a paper version of the MPH tool is used across a wide range of care centres.

INSERT SUPPLEMENTARY FILE 1 HERE.

Along with the extensive use of the dialogue tool, a growing interest is once again observed for a measurement instrument that measure changes in a person's Positive Health. Such a measurement tool could provide stakeholders in various domains and levels (e.g. healthcare professionals, national and local policy makers and insurers) with valid information on the effectiveness of a Positive Health approach. Such insight could support them during the decision-making process and thereby enable a more structural implementation of interventions that improve people's (positive) health. As far as we were aware, no other validated questionnaire is available that covers the broad concept of Positive Health and since Prinsen no new attempt was made to develop such measurement instrument [23, 24]. The objective of this present study was to set first steps in a new attempt towards a suitable measurement instrument with adequate psychometric properties and scale brevity. This instrument could meet the needs of professionals wishing to evaluate their Positive Health interventions. In order to reach this objective, we aimed to extract an improved model to measure (positive) health by performing an Exploratory Factor Analysis (EFA) and to test it through confirmatory factor analysis (CFA). Performing a factor analysis will not only help to identify items to measure (positive) health, it will also provide insight into the adequacy of the current arrangement of dimensions and aspects of the MPH dialogue tool. Furthermore, we also aimed to examine the reliability of the MPH dialogue tool.

Methods

Design

This study comprised a cross-sectional quantitative survey study. Data from the quantitative survey was used to develop a new model to measure health by performing an Exploratory Factor Analysis (EFA) following a confirmatory factor analysis (CFA).

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The instrument

We use the digital version of the MPH dialogue tool (MijnPositieveGezondheid.nl; "MyPositiveHealth.nl") in this study. In this digital version, 42 statement are proposed (7 for each dimension) on an 11-point scale. 0 means totally disagree and 10 means totally agree. To avoid any missing data, it is not allowed to skip any question.

Participants and data collection

Members of the citizens' panel of GGD Twente (regional municipal health service) were asked to fill out the 42 questions of the MPH dialogue tool and were asked for their age, gender, educational level, poverty (difficulty getting around), and health literacy (difficulty understanding health information such as leaflets).This panel comprises adults (19+) who took part in the national health survey of GGD Twente in the east of the Netherlands. This survey is carried out every four years to monitor the general state of health of Dutch citizens. At the end of that health survey, the participants were asked whether they were willing to participate in other, future studies by GGD Twente. Participants were invited by email to complete the questionnaire. Data collection took place from January to February 2018.

Analytical plan

To examine the construct validity of the MPH tool, we used a split-half validation method in which we randomly divided the participants into two groups. We used one of these groups to explore the factor structure through exploratory factor analysis (EFA) and the other group to test the goodness of fit of the extracted factor structure through confirmatory factor analysis (CFA). In conducting the factor analyses, we followed best practices described by Brown[25], Costello and Osborne[26], and Cabrera-Nguyen[27]. Suitability of the data for EFA was examined based on the Kaiser–Meyer–Olkin (KMO) statistic of sampling adequacy and the Bartlett's test of sphericity[28 29].

Through EFA, we explored the factor structure using maximum likelihood (ML) extraction. Because we expected our factors to be interdependent aspects of Positive Health, we used ML extraction with direct oblimin rotation. Kaiser criterion, scree plot analysis, and parallel analysis were used to determine the numbers of factors to extract[30 31]. We considered items with cross loading values of ≤ .32 on at least two factors as weak (and thereby as candidates for deletion)[26]. And we considered items with factor loading of ≥ .60 as strong[32].

We strove for a model with improved psychometric properties and scale brevity, while maintaining enough items to create stable factors. We therefore aimed to reduce each factor to three items with highest factor loadings.

Through CFA, we evaluated the goodness of fit of the factor structure extracted during EFA. With the CFA evaluation we compared the extracted factor structure with two baseline models containing all 42 items of the MPH dialogue tool: the original 6-factor structure that includes the six dimensions of health and a 1-factor structure which considers all items belonging to one health domain. This comparison helps to understand the degree to which our extracted factor structure fits unseen data better than respectively the original 6-factor structure and the 1-factor structure. We evaluated the goodness of fit using several indices: Pearson's Chi-squared test, comparative fit index (CFI; > .95 is acceptable), Tucker Lewis index (TLI; > .95 is acceptable), the root mean square error of approximation (RMSEA; < .06 is acceptable), and standardized root mean square residual (SRMR; < .08 is acceptable). These indices reflect model fit (Pearson's Chi-squared test), incremental fit (CFI, TLI), and absolute fit (RMSEA, SRMR). The threshold values we applied are cut-off values

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recommended by Hu and Bentler (1999)[33] and endorsed by both Brown (2014)[25] and Cabrera-Nguyen (2010)[27]. For fitting the models, we used lavaan version 0.6-3[34] in R version 3.5.1[35]. We used maximum likelihood estimation and standardized the latent factors to allow free estimation of all factor loadings.

Finally, we examined the reliability and discriminant validity of the factors of both the original 6-factor model (MPH dialogue tool) and the new experimental model. We examined the reliability by evaluating the Cronbach's alpha coefficients and tested the discriminant validity by evaluating the factor correlations.

Ethical considerations

Due to the harmless and non-invasive character of the study, this study was exempt from medical ethical approval. Prior to completion of the questionnaire, informed consent for the use of data for scientific purposes was asked in the invitation email to the participants. All data are handled anonymously.

Patient and Public involvement statement

Patients and/ or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

Characteristics of respondents

In total, 3218 participants were invited to enrol in the study. Of those, 708 participants completed the questionnaire (response rate is 22%). The mean age of the respondents was 62 years (SD = 15) and 46% of them were female. Most respondents had a high educational level 44% (medium 34%; low 22%). And 9% of the respondents indicated some to severe difficulty in getting around (poverty). Low health literacy (difficulty understanding health information such as leaflets) was indicated by 5% of the respondents. Comparing to the general 19+ population in the region Twente the respondents were older (Twente: mean age = 51); were higher educated (Twente: high educational level = 30%); had higher health literacy (Twente: 9%) and had less difficulty in getting around (Twente: 17%).

Exploratory Factor Analysis

Our exploration showed that the data are suitable for EFA. Our sample had both an acceptable size of 356[32 33] and a very common participant-to-item ratio (8.5:1). The KMO test yielded a statistic of 0.97, implying that the dataset contains a significant number of factors, and the Bartlett's test of sphericity yielded significant results, χ^2 (41) = 318.368, $p < .001$, implying that the correlations among variables are greater than one would expect by chance.

Common approaches for determining the number of factors to extract showed support for a 6-factor structure. First, the Kaiser criterion method showed that the data contain 6 factors with eigenvalues greater than one, suggesting that the data clusters in 6 factors. Second, the scree plot suggested 2, 4, or 6 factors because the eigenvalues level off after these amount of factors (see Figure 1). Third, parallel analysis (see Figure 2) suggested a structure of 6 factors – the crossing point of the actual scree plot with the possible scree plot based on randomly resampled data. A 6-factor structure accounts for 67.5% of the total item variance.

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INSERT FIGURE 1 HERE.

INSERT FIGURE 2 HERE.

Factor loadings are shown in Table 1. In this table, factor names for the experimental model are displayed in the second horizontal row. Overall, the items that group together in our EFA mostly group together in the original model as well.

Table 1 shows that the first factor has factor loadings above .40 for several items originating from the dimension Social and Societal Participation (SP). These items are: SP29 Social contacts, SP30 Being taken seriously, SP31 Doing fun things together, SP32 Having the support of others, SP33 Belonging. We selected the tree highest factor loadings (SP29, SP32, and SP33) and labelled this factor 'Social relations'.

The second factor showed loadings above .40 on items from the original dimension Daily Functioning (DF). These items are: DF36 Looking after yourself, DF37 Knowing your limitations, DF38 Knowledge of health, DF39 Managing time, DF40 Managing money. We selected the three highest factor loadings (DF37, DF38, DF39) and labelled this factor 'Daily life-management'.

The third factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from the original dimension Bodily Functions (BF). These items are: BF1 Feeling healthy, BF2 Feeling fit, BF5 Eating pattern, BF6 Physical condition, and BF7 Exercise. We included the three items with highest factor loadings (BF2, BF6, and BF7) and labelled this factor 'Physical fitness'.

The fourth factor showed loadings above .40 on items across three dimensions of the dialogue tool: Mental Well-being (MW), Meaningfulness (MF), and Quality of Life (QL). These items are: MW11 Being cheerful, MW12 Accepting yourself, MW14 having control, MF16 Being high spirited, and MF19 Accepting life, QL22 Enjoyment, QL23 Being happy, QL24 Feeling good, and QL25 Feeling well-balanced. We selected the three highest factor loadings (QL23, QL24, and QL25) and labelled this factor 'Contentment'.

The fifth factor showed loadings above .40 on items from one dimension of the dialogue tool: Mental Wellbeing (MW) and Meaningfulness (MF). These items are: MW13 Being able to handle changes, MF17 Wanting to achieve ideals, MF18 Feeling confident about own future, MF21 Continue learning, and SP34 Doing meaningful things. We selected the three highest factor loadings (MW13, MF17, and MF18) and labelled this factor 'Future perspectives'.

The last factor showed that loadings above .40 were all strong factor loading (≥ .60) on items from one dimension of the dialogue tool: Mental Well-being (MW). These items are: MW8 Being able to remember things and MW9 Being able to concentrate. We selected these two highest factor loadings (MW8 and MW9) and labelled this factor 'Mental functioning', as these aspects solely focus on cognitive abilities and do not concern any emotional aspects or feelings.

In our exploration for a measurement instrument model, we were successful in reducing the number of items for five factors from 7 to 3 items and for one factor to 2 items. The final factor structure we extracted thus contained 17 items.

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Table 1. Factor Pattern/Structure Rotated to the Oblimin Criterion

Item number*	Description	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	
		Social relations	Daily-management	Physical fitness	Contentment	Future achievements	Mental functioning	h^2
BF1	**Feeling healthy**	-0.03	0.05	***0.82***	0.12	-0.02	0.03	0.81
BF2	**Feeling fit**	-0.04	0.03	***0.86***	0.12	-0.07	0.07	0.83
BF3	Having complaints or pain	0.10	-0.07	0.37	-0.11	0.10	0.13	0.25
BF4	Sleeping pattern	0.10	-0.10	0.36	0.25	0.01	0.21	0.46
BF5	Eating pattern	0.17	-0.01	0.43	0.12	0.04	0.13	0.52
BF6	Physical condition	0.09	-0.02	*0.73*	-0.08	0.12	0.02	0.68
BF7	**Exercise**	0.02	0.09	***0.74***	-0.17	0.16	-0.01	0.70
MW8	**Being able to remember things**	-0.03	-0.01	0.00	-0.08	0.01	***0.95***	0.82
MW9	**Being able to concentrate**	0.03	0.02	0.07	0.13	-0.01	***0.77***	0.82
MW10	Being able to communicate	0.10	0.36	0.08	-0.22	0.22	0.20	0.49
MW11	Being cheerful	0.24	0.03	0.12	*0.46*	0.07	0.19	0.78
MW12	Accepting yourself	0.21	0.14	0.13	*0.46*	-0.01	0.10	0.69
MW13	**Being able to handle changes**	0.10	0.10	0.05	-0.01	***0.48***	0.11	0.51
MW14	Having control	0.13	0.22	0.03	*0.42*	0.09	0.15	0.70
MF15	Having a meaningful life	0.28	0.17	0.05	0.35	0.20	0.06	0.80
MF16	Being high-spirited	0.13	0.13	0.20	*0.41*	0.17	0.08	0.78
MF17	**Wanting to achieve ideals**	-0.06	-0.05	0.06	0.01	***0.87***	0.07	0.77
MF18	**Feeling confident about own future**	0.12	0.03	0.01	0.19	***0.68***	0.00	0.80
MF19	Accepting life	0.06	0.18	0.08	0.41	0.21	0.00	0.57
MF20	Being grateful	0.24	0.09	0.04	0.31	0.32	0.03	0.68
MF21	Continue learning	0.06	0.13	0.15	-0.08	*0.43*	0.05	0.43
QL22	Enjoyment	0.16	0.14	0.15	*0.50*	0.19	0.00	0.83
QL23	**Being happy**	0.11	0.13	0.08	***0.56***	0.17	0.06	0.79
QL24	**Feeling good**	0.09	0.07	0.16	***0.58***	0.14	0.12	0.86
QL25	**Feeling well-balanced**	0.08	0.12	0.16	***0.56***	0.13	0.11	0.85

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QL26	Feeling safe	0.30	0.22	0.08	0.26	0.09	0.07	0.67
QL27	Living conditions	0.37	0.13	0.02	0.26	0.09	0.04	0.57
QL28	Having enough money	0.24	0.34	0.11	-0.10	0.15	0.05	0.48
SP29	**Social contacts**	***0.88***	0.02	0.00	-0.08	0.04	0.05	0.82
SP30	Being taken seriously	0.66	0.17	-0.10	-0.03	0.15	0.05	0.72
SP31	Doing fun things together	*0.81*	-0.02	0.08	0.07	0.03	-0.05	0.77
SP32	**Having the support of others**	***0.88***	0.03	-0.01	0.02	-0.09	0.05	0.76
SP33	**Belonging**	***0.88***	-0.04	0.03	0.08	0.01	-0.02	0.84
SP34	Doing meaningful things	0.21	0.12	0.04	0.12	*0.43*	0.04	0.63
SP35	Being interested in society	0.11	0.40	-0.03	0.11	0.20	0.10	0.55
DF36	Looking after yourself	0.13	*0.68*	0.13	-0.09	0.02	-0.06	0.63
DF37	**Knowing your limitations**	-0.06	***0.88***	-0.02	0.13	0.00	0.02	0.81
DF38	**Knowledge of health**	0.08	***0.72***	0.20	-0.03	-0.03	-0.03	0.71
DF39	**Managing time**	0.01	***0.71***	-0.07	0.14	-0.01	0.17	0.72
DF40	Managing money	0.13	*0.58*	0.02	-0.08	0.07	0.15	0.62
DF41	Being able to work	0.04	0.33	0.18	-0.05	0.29	0.02	0.49
DF42	Asking for help	0.18	0.20	0.01	-0.11	0.16	0.24	0.36
% of variance		15.1	12.8	11.2	10.9	10.3	7.2	67.5

Notes: Coefficients greater than |.40| are italicized. The items in bold are retained for that factor.

* BF refers to Bodily functions; MW refers to Mental well-being; MF refers to meaningfulness; QL refers to Quality of life; SP refers to Social and societal participation; DF refers to daily functioning

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Confirmatory Factor Analysis

The two baseline models, against which we compared the factor structure we extracted during our EFA, had low fits. First, the original 6-factor structure had a CFI of .846, TLI of .835, RMSEA of .086 with 90% confidence interval (CI) [.082, .089], and an SRMR of 0.063. Second, the 1-factor structure had a CFI of .731, TLI of .717, RMSEA of .112 with 90% confidence interval (CI) [.109, .115], and an SRMR of 0.066. The factor structure we extracted during the EFA, in contrast, had an acceptable fit, with a CFI of .964, TLI of .953, RMSEA of .071 with 90% confidence interval (CI) [.062, .081], and an SRMR of 0.036. This fit was significantly better than the fit of both the original 6-factor solution ($\chi 2$ (700) = 2604.48, $p < .001$) and the 1-factor solution ($\chi 2$(715) = 4174.19, $p < .001$).

The items we selected during the EFA all showed positive factor loadings on their respective domains, with standardized coefficients ranging from .71 to .97 (see Table 2), supporting the factor structure. As we report in Table 3, the items within each factor yielded highly consistent response. More specifically, the Cronbach's alpha values of the factors ranged from .82 to .92. The six factors correlated significantly positively among each other (see Table 3), indicating that individuals that score higher on one domain typically score higher on the other domains. The factor correlations did not exceed .80, which suggest acceptable discriminant validity[25]. In comparison, the factor correlations of the original model suggest overlap between Meaningfulness and Mental well-being, Mental well-being and Quality of Life, Quality of life and Meaningfulness, Quality of Life and Social and societal participation, and Social and societal participation and Daily functioning (see Table 4). Cronbach alpha values from this original model range from .88 to .93.

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Table 2. Parameter Estimates Confirmatory Factor Analysis

Latent factor	Item	Description	B	SE	Z	Beta	p
Social relations	29	Social contacts	1.00	0.00		0.84	
Social relations	32	Having the support of others	1.10	0.06	19.49	0.84	***
Social relations	33	Belonging	1.18	0.05	21.96	0.91	***
Daily life-management	37	Knowing your limitations	1.00	0.00		0.89	
Daily life-management	38	Knowledge of health	1.05	0.04	26.52	0.93	***
Daily life-management	39	Managing time	1.09	0.06	19.90	0.80	***
Physical fitness	1	Feeling healthy	1.00	0.00		0.95	
Physical fitness	2	Feeling fit	1.05	0.04	24.89	0.88	***
Physical fitness	7	Exercise	1.03	0.06	17.97	0.74	***
Contentment	23	Being happy	1.00	0.00		0.87	
Contentment	24	Feeling good	1.10	0.04	25.95	0.94	***
Contentment	25	Feeling well-balanced	1.01	0.05	22.28	0.87	***
Future perspective	13	Being able to handle changes	1.00	0.00		0.71	
Future perspective	17	Wanting to achieve ideals	1.19	0.09	12.92	0.73	***
Future perspective	18	Feeling confident about own future	1.32	0.09	14.90	0.86	***
Mental functioning	8	Being able to remember things	1.00	0.00		0.83	
Mental functioning	9	Being able to concentrate	1.15	0.06	19.53	0.97	***

Notes: *** = p < .001, B = unstandardized estimates, Beta = standardized estimates.

Table 3. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the extracted factors (new model).

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Factor	*M*	*SD*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) Physical fitness	7.60	1.70	(.88)					
(2) Mental functions	7.76	1.58	.58***	(.89)				
(3) Future perspective	7.73	1.45	.55***	.57***	(.82)			
(4) Contentment	7.92	1.59	.64***	.63***	.73***	(.92)		
(5) Social relations	8.42	1.35	.54***	.58***	.64***	.70***	(.90)	
(6)Daily life-management	8.52	1.35	.57***	.62***	.67***	.69***	.72***	(.90)

Notes: *** = p < .001.

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Table 4. Means, SD, Cronbach's alpha (in correlation matrix diagonal) and correlations of the original factors (MPH dialogue tool).

Factor	***M***	***SD***	***(1)***	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***
(1) Bodily functions	7.60	1.70	(.88)					
(2) Mental well-being	7.76	1.58	.72***	(.90)				
(3) Meaningfulness	7.73	1.45	.65***	.83***	(.90)			
(4) Quality of life	7.92	1.59	.72***	.83***	.88***	(.92)		
(5) Social and societal participation	8.42	1.35	.61***	.77***	.77***	.81***	(.93)	
(6) Daily functioning	8.52	1.35	.65***	.79***	.74***	.78***	.82***	(.90)

Notes: *** = p < .001.

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Discussion

The results of our factor analysis support a factor structure of six dimensions. The model we extracted contained 17 items, comprising the factors Physical fitness, Mental functions, Future perspectives, Contentment, Social relations, and Daily life-management. The extracted model showed improved construct validity compared to the original model with good fit, high reliability and acceptable discriminant validity. For the MPH tool our reliability tests suggest good to very good reliability (Cronbach alpha values ranging from .88 to .93). Furthermore, our factor analysis suggests overlap across the dimensions Mental wellbeing, Meaningfulness, Quality of life, and Social and societal participation, making the MPH tool less suitable as a measurement tool.

This study addresses the difference in aims and thereby required properties between a dialogue tool and a measurement tool. The results show that a 17-item model has better psychometric properties, and can thereby serve as a strong basis for the development of a Positive Health measure. However, the 17-item scale neglects several aspects relevant to address when determining and discussing an individual's perception of health. For example, for bodily functions, the ignored items about sleeping and eating patterns can inspire ideas and improve dialogue about improving bodily functions. Similarly, it ignores the aspect *accepting yourself*, whereas this was considered the most important aspect of Mental well-being by respondents (18-25 years) in a study that focused on the development of an adolescent version of the tool[36]. Importance of this aspect came forward in studies regarding the development of health-related quality of life and subjective well-being scales as well[6, 37]. Furthermore, research shows that poor living conditions and financial problems are often accompanied by considerable physical and mental problems[38-40]. Inclusion of these aspects in the MPH dialogue tool provides a broader understanding of the multiple needs of an individual. This enables individuals to express their needs during the dialogue about the results and enables to refer them, if required, to appropriate providers. Overall, for two statements within the MPH dialogue tool it can be argued that they also function as determinants - which influence people's perceived health – like patients themselves expressed during the original study, or consequences of health as well. While such determinants and consequences of health are not appropriately represented in the measurement of health itself, we suggest that they may still be relevant in a dialogue tool.

Difficulties to blend the two goals of both a dialogue tool and a measurement tool were noted earlier. During the development process, an attempt to transform the dimensions and underlying aspects into a questionnaire that could serve as a validated outcome measurement instrument to measure Positive Health has failed[21]. At this stage it appeared that the goal of a measurement tool to express outcome in health in (a) fixed number(-s) was too far from the experienced reality of an individual. Based on the results of our study and the previous attempt, we therefore suggest the use of two separate tools: (1) a dialogue tool with the aim to elucidate a broad representation of a person's perceived health status, comprising a broad range of aspects and (2) a measurement tool with improved psychometric properties that is able to capture broad health in a valid an reliable way. For this second purpose, our extracted 17-item model may serve as a basis.

When further developing a measurement tool to the measure (positive) health, several issues need to be addressed. First, concepts like salutogenesis, sense of coherence, and resilience form a strong basis of Positive Health, focussing on the abilities of individuals to handle changes and experience meaningfulness. It should be further investigated whether these concepts are sufficiently addressed in

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the current 17-item experimental model. For example, the included aspects from the dimension of Meaningfulness solely focus on future achievements, while meaningfulness can be regarded as an integration of past, present and future[41]. Second, in line with the concept of health as the ability to adapt and to self-manage, one could expect that an individual with poor objective health status can still experience good health when being capable to deal well with the situation, while another individual with better objective health status can experience lower health. It would be a challenge to develop a measurement tool that does not reflect health by one continuum, but that can capture both realities.

Methodological considerations

This study was based on a survey among a citizen panel in eastern part of the Netherlands (Twente), with a mean age of 62 (*SD* = 15) and 46% women. This relatively higher age of the study population compared to the whole adult population in this region (M age = 51) could reflect a higher interest in the topic of personal positive health status in older adults, and may be the result of the relatively low response rate of 22%. To be able to draw more firm conclusions about the psychometric properties of the MPH tool, this should be investigated among other populations as well. This will reveal to which extent difference in age, education level, health literacy and poverty level affects our findings.

In our study we have focused on the construct validity. Therefore, other psychometric properties such as the predictive validity, discriminant validity, and responsiveness of the 17- item model remain still unknown. Such issues should be addressed in future studies. Also, we made a first attempt to label the identified factors with factor names. The appropriateness of these names should be further investigated as well.

We based the choice to select three items per factor on both practical and theoretical arguments. From practical point of view, it is desirable to have a short and easy to use scale with acceptable psychometric properties. A scale of 17 items can be completed within a short amount of time. From a theoretical perspective, factors with fewer than three items are often weak and unstable[26]. Due to low factor loadings (< .40) we were not able to select a third item for the factor Mental functions. To increase stability within this factor and to improve overall balance of the scale, we suggest to investigate the possibility to develop and include a third item for the factor Mental functions in future studies.

Conclusion

Overall, we conclude that the overall structure of the MPH dialogue tool, seems reliable. While the 42-item model might be suitable as a dialogue tool, this study shows that it is not suitable as a measurement scale. Instead, we propose a 17-item model with a six factor structure, comprising the factors Physical fitness, Mental functions, Future perspective, Contentment, Social relations, and Daily life-management, which can serve as a basis for the development of an additional measurement scale. Given the prevailing healthcare trend towards a focus on health and wellbeing, expressed by an increased number of practices based on a Positive Health approach, the existence of such measurement scale is of great importance.

Author contributions

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SB collected the data. BD performed the statistical analysis. MV interpreted the results and wrote the manuscript in collaboration with BD and EA. All authors commented and agreed on the final version.

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Competing interest

The authors declare no conflict of interest.

Data sharing statement

A request for sharing data can be made by sending an email to the corresponding author.

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Figure 1. Scree plot. Note: Kaiser criterion is shown by the black dashed line.

Figure 2. Parallel Analysis. Note: The 6-factor structure is shown by the black dashed line.

References

1. Johansen F, Loorbach D, Stoopendaal A. Exploring a transition in Dutch healthcare. *J Health Organ Manag* 2018;32(7):875-90 doi: 10.1108/JHOM-07-2018-0185.
2. Palmer K, Marengoni A, Forjaz MJ, et al. Multimorbidity care model: Recommendations from the consensus meeting of the Joint Action on Chronic Diseases and Promoting Healthy Ageing across the Life Cycle (JA-CHRODIS). *Health Policy* 2018;122(1):4-11 doi: 10.1016/j.healthpol.2017.09.006.
3. Hoeymans N, Van Loon AJM, Van den Berg M, et al. A healthier Netherlands: the key findings of the sixth Public Health Status and Foresight Bilthoven, The Netherlands: National Institute for Public Health and the environment (RIVM), 2014.
4. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: A cross-sectional study. *Lancet* 2012;380(9836):37-43 doi: 10.1016/S0140-6736(12)60240-2.
5. Butalid L, Verhaak PF, Boeije HR, Bensing JM. Patients' views on changes in doctor-patient communication between 1982 and 2001: a mixed-methods study. *BMC Fam Pract* 2012;13:80 doi: 10.1186/1471-2296-13-80.
6. De Vries M, Emons WHM, Plantinga A, et al. Comprehensively Measuring Health-Related Subjective Well-Being: Dimensionality Analysis for Improved Outcome Assessment in Health Economics. *Value Health* 2016;19(2):167-75 doi: 10.1016/j.jval.2015.11.010.
7. Al-Janabi H, Flynn TN, Coast J. Development of a self-report measure of capability wellbeing for adults: the ICECAP-A. *Qual Life Res* 2012;21(1):167-76 doi: 10.1007/s11136-011-9927-2.
8. NWA. Portfolio for research and innovation - Health care research, sickness prevention and treatment. The Hague, 2016.
9. Smid HJ, Wydoodt A. ZonMW signalement over zingeving in zorg: de mens centraal [ZonMW description about meaningfulness in care: focus on the individual]. 2nd edition ed. Den Haag: ZonMw, 2017.

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10. Vanderweele TJ. On the promotion of human flourishing. *Proc Natl Acad Sci U S A*, 2017:8148-56 doi: 10.1073/pnas.1702996114.
11. Stucki G, Bickenbach J. Health, Functioning, and Well-being: Individual and Societal. *Arch Phys Med Rehabil* 2019;100(9):1788-92 doi: 10.1016/j.apmr.2019.03.004.
12. Huber M, Knottnerus A, Green L, et al. How should we define health? *BMJ* 2011;343(7817):1-3 doi: 10.1136/bmj.d4163.
13. Editorial. What is health? The ability to adapt. *Lancet* 2009;373(9666):781-81 doi: 10.1016/S0140-6736(09)60456-6.
14. Jadad AR, O'Grady L. How should health be defined? *BMJ* 2008;337:a2900 doi: 10.1136/bmj.a2900.
15. Larson JS. The conceptualization of health. *Med Care Res Rev* 1999;56:123-36 doi: 10.1177/107755879905600201.
16. Smith R. The end of disease and the beginning of health - *BMJ*, 2008.
17. Van der Lucht F, Polder JJ. Towards better health - The Dutch 2010 Public Health Status and Forecasts Report. Bilthoven: RIVM, 2010.
18. Bircher J. Towards a dynamic definition of health and disease. *Med Health Care Philos* 2005;8(3):335-41 doi: 10.1007/s11019-005-0538-y.
19. Kooiker SE. Nederlanders aan het woord over gezondheid en gezond leven. Achtergrond bij VTV 2010 Van Gezond naar Beter [Stories from Dutch citizens about health and healthy living. Background to the Dutch 2010 Public Health Status and Forecasts Report]. Bilthoven: RIVM, 2011.
20. Huber M, van Vliet M, Giezenberg M, et al. Towards a 'patient-centred' operationalisation of the new dynamic concept of health: a mixed methods study. *BMJ open* 2016;6(1):e010091 doi: 10.1136/bmjopen-2015-010091.
21. Prinsen CAC, Terwee CB. Measuring positive health: for now, a bridge too far. *Public Health* 2019;170:70-77 doi: 10.1016/j.puhe.2019.02.024.
22. Al Shamma S, Van den Dries L, Van Wezep M, Wolf J. Ervaringen met de gesprekstool 'Mijn Positieve Gezondheid' [Experiences with the dialogue tool 'My Positive Health']. Nijmegen, 2018:1-40.
23. Hendrikx RJP, Spreeuwenberg MD, Drewes HW, Ruwaard D, Baan CA. How to Measure Population Health: An Exploration Toward an Integration of Valid and Reliable InstrumentsThis study was presented as a poster presentation at the International Conference on Integrated Care 2017, held May 8–10, 2017 in Dublin, Ireland. *Popul Health Manag* 2018;21(4):323-30 doi: 10.1089/pop.2017.0097.
24. Linton M, Dieppe P, Medina-Lara A. Review of 99 self-report measures for assessing well-being in adults: exploring dimensions of well-being and developments over time. *BMJ open* 2016;6(7):e010641-e41 doi: 10.1136/bmjopen-2015-010641.
25. Brown TA. Confirmatory factor analysis for applied research. New York, NY: The Guilford Press, 2014.
26. Costello AB, Osborne JW. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pract Assess Res Eval* 2005;10:1-9 doi: 10.1.1.110.9154.
27. Cabrera-Nguyen P. Author Guidelines for Reporting Scale Development and Validation Results in the Journal of the Society for Social Work and Research. *J Soc Social Work Res* 2010;1(2):99-103 doi: 10.5243/jsswr.2010.8.
28. Comrey AL, Lee HB. A First Course in Factor Analysis. Hillsdale, NJ: Lawrence Erlbaum, 1992.
29. Worthington RL, Whittaker TA. Scale development research: A content analysis and recommendations for best practices. *Couns Psychol* 2006;34(6):806-38
30. Kaiser HF. The Application of Electronic Computers to Factor Analysis. *Educ Psychol Meas* 1960;20(1):141-51 doi: 10.1177/001316446002000116.
31. Kaiser HF, Rice J. Little Jiffy, Mark Iv. *Educ Psychol Meas* 1974;34(1):111-17 doi: 10.1177/001316447403400115.
32. Garson GD. Factor Analysis. Asheboro, NC: Statistical Associates Publishers, 2013.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

33. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equ Modeling* 1999;6(1):1-55 doi: 10.1080/10705519909540118.
34. Rosseel Y. Lavaan: An R package for structural equation modeling. *J Stat Softw* 2012;48(2):1-36
35. Team RC. R: A Language and Environment for Statistical Computing. Vienna: R Foundation for Statistical Computing, 2018.
36. Van Vliet M, Van der Zanden S, Huber M. Ontwikkeling van de 'Mijn Positieve Gezondheid' jongerentool [Development of the My Positive Health adolescent tool]. Utrecht: Institute for Positive Health, 2019.
37. Pietersma S, de Vries M, van den Akker-van Marle ME. Domains of quality of life: results of a three-stage Delphi consensus procedure among patients, family of patients, clinicians, scientists and the general public. *Qual Life Res* 2014;23(5):1543-56 doi: 10.1007/s11136-013-0578-3.
38. Bodden DHM, Deković M. Multiproblem Families Referred to Youth Mental Health: What's in a Name? *Fam Process* 2016;55(1):31-47 doi: 10.1111/famp.12144.
39. Moorhead R, Robinson M. A trouble shared – legal problems clusters in solicitors' and advice agencies. London: Department for Constitutional Affairs, 2006.
40. Smith M, Buck A, Sidaway J, Scanlan L. Bridging the Empirical Gap: New Insights into the Experience of Multiple Legal Problems and Advice Seeking. *J Empir Leg Stud* 2013;10(1):146-70 doi: 10.1111/jels.12006.
41. Baumeister RF, Vohs KD, Aaker JL, Garbinsky EN. Some key differences between a happy life and a meaningful life. *J Posit Psychol* 2013;8(6):505-16 doi: 10.1080/17439760.2013.830764.

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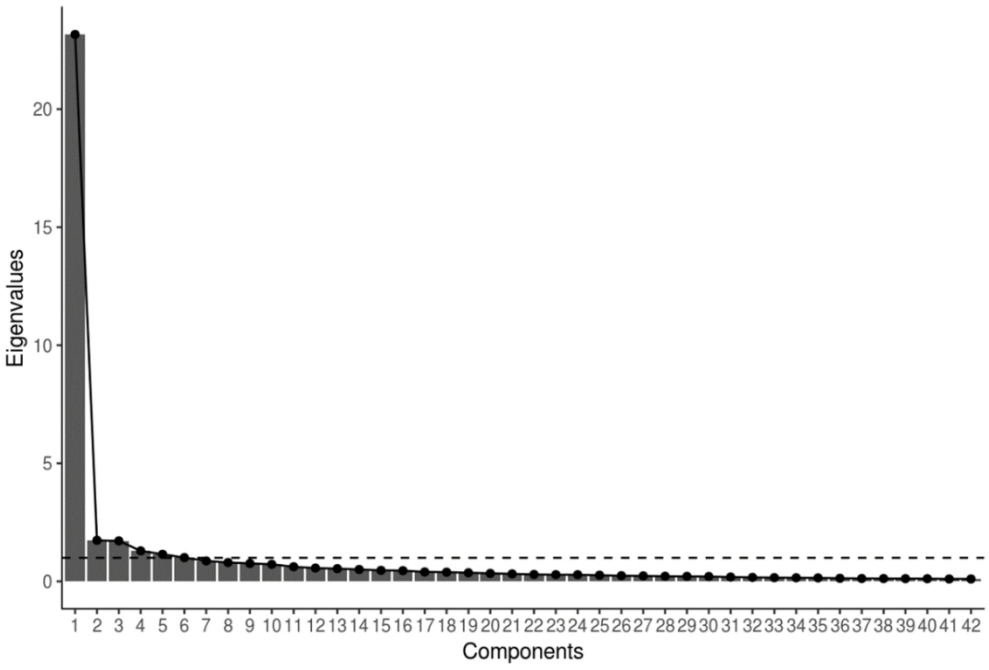

Figure 1. Scree plot. Note: Kaiser criterion is shown by the black dashed line.

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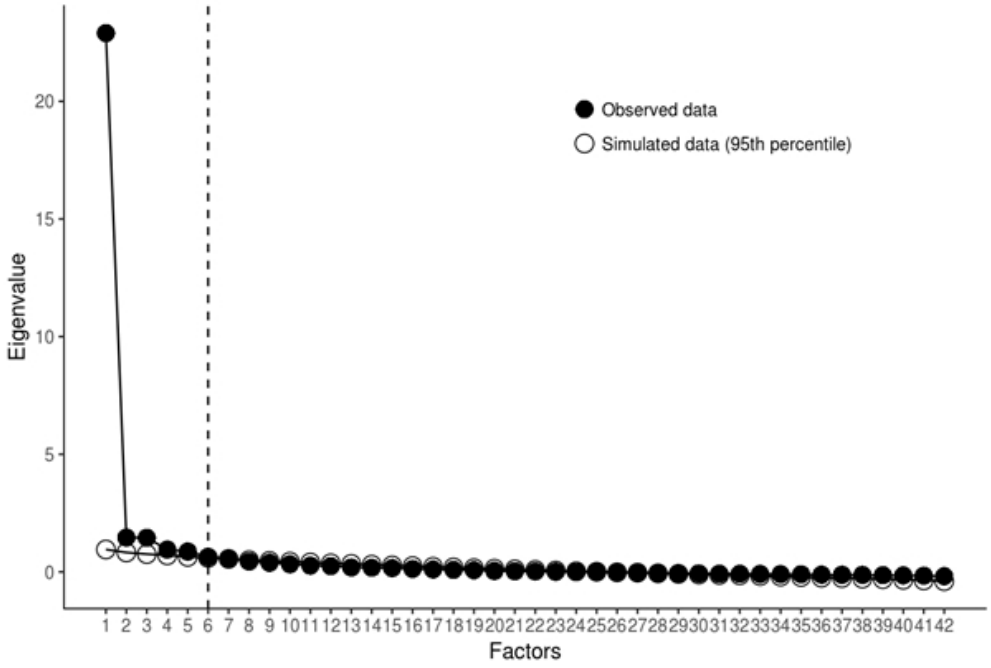
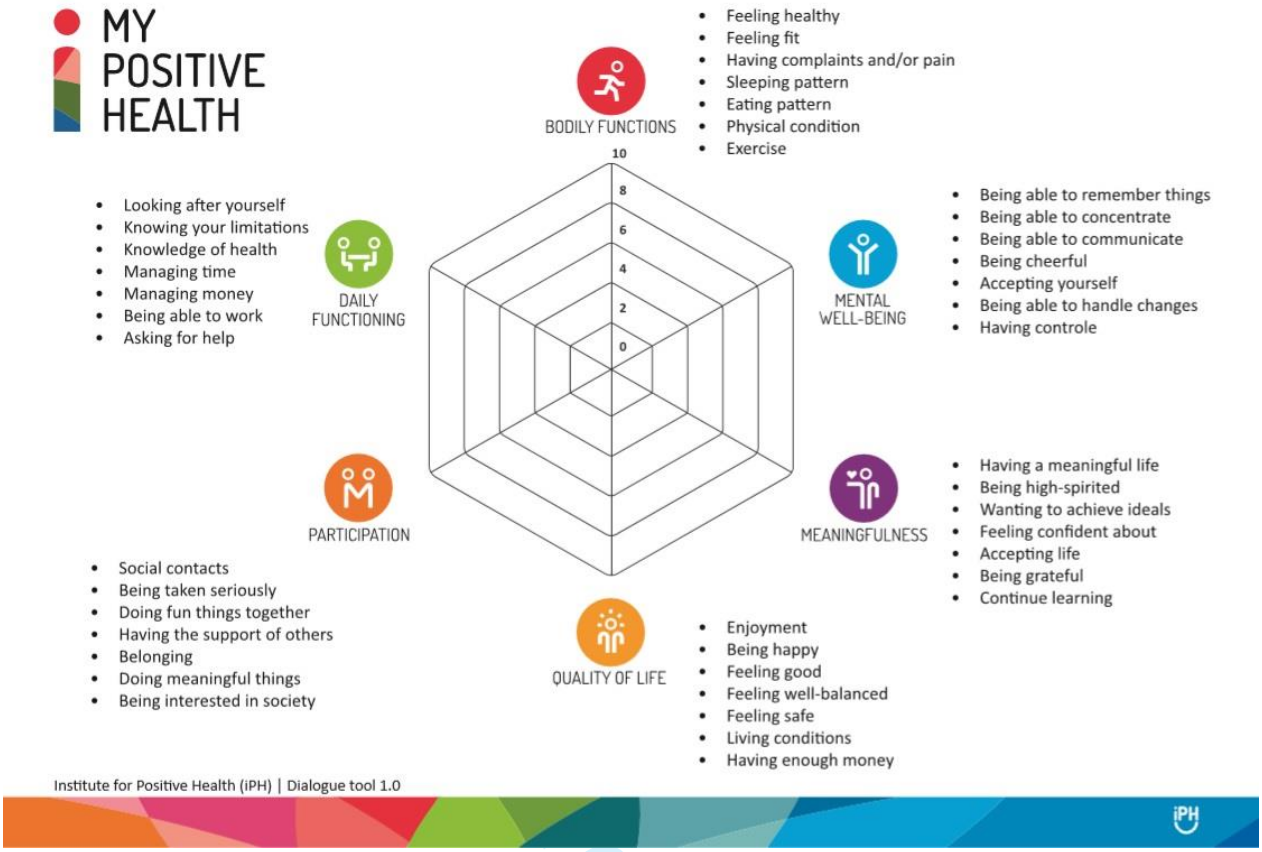


Figure 2. Parallel Analysis. Note: The 6-factor structure is shown by the black dashed line.

160x108mm (96 x 96 DPI)



Supplementary file 1. My Positive Health spiderweb comprising 6 dimensions and 42 aspects

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract p2 / line 1/2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found p2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported p3-4
Objectives	3	State specific objectives, including any prespecified hypotheses p4 line 29 - 34
Methods		
Study design	4	Present key elements of study design early in the paper p4 – line 39-41
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection p5 line 6-15
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants p5 line 6-15
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable p5 line n/a
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group p5 line 1-4
Bias	9	Describe any efforts to address potential sources of bias p5 6-11, p15 9-15
Study size	10	Explain how the study size was arrived at p5 line 22-23
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why p5 line 16 to p6 line 6
Statistical methods p5 line 16 to p6 line 7	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions n/a
		(*c*) Explain how missing data were addressed n/a
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed p6 line 20-21
		(b) Give reasons for non-participation at each stage n/a
		(c) Consider use of a flow diagram n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders p6 line

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		19-27
		(b) Indicate number of participants with missing data for each variable of interest n/a
Outcome data	15*	Report numbers of outcome events or summary measures
Main results Different since factor analysis was performed. Results p6 line 29 to p10 line 20	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results p14 line 2-9	18	Summarise key results with reference to study objectives
Limitations p15 line9-27	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation p 14 line 10 to p15 line 7	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability p15 line 9-15	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding p 16 line 4-5	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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