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Single-instrument factor analyses

This supplement reports the results for the factor analyses of item sets comprising each instrument. We assessed for each instrument (GHQ-12, WEMWBS, EQ-5D) the fit of exploratory one- and two-dimensional models to assess the potential multidimensionality of each item set. All of these analyses were performed with MPlus 7.11[29] in the estimation sample.

GHQ-12

Exploratory factor analyses (N = 6015; GHQ-12 data were not collected in 2011, see table 1 main document) showed that a single factor described the responses reasonably well (lowest loading r = 0.62; GHQ3, "playing a useful part in things"). Since previous research has focussed on a method factor for the negatively phrased items we tested this solution as well. An exploratory two-factor solution with a highly correlated second factor (r = 0.65; log Likelihood(LL) = -45 415, BIC = 91 343 and BIC_{adj} = 91 156) as well as a confirmatory model with one general factor and an orthogonal method factor underpinning the negative items (LL = -45 377; BIC = 91 215; BIC_{adj} = 91 047) showed better fit than the one-factor model (LL = -46 368, BIC = 93 154, BIC_{adj} = 93 002). This bifactor model is our preferred solution since it is the best-fitting as well as theoretically most appropriate of these models.

WEMWBS

A one factor solution fitted the responses reasonably well (lowest loading WEMWBS4, "interested in other people", r = 0.60; N = 9569), but the exploratory two-factor solution (LL = -136 312; BIC = 273 385; BIC_{adj} = 273 121) provided a better description of the data than one-factor solution (LL = -137 929; BIC = 276 500; BIC_{adj} = 276 278). The two factors were highly correlated (r = 0.82) and item 1 ("optimistic about the future"), item 4 ("interested in other people"), item 9 ("feeling close to other people"), item 12 ("been feeling loved") and item 13 ("interested in new things") loaded on this factor, capturing additional variance from items of the interest/social domain.

EQ-5D

The one-factor solution revealed evidence of one relatively low factor loading (r = 0.50; item 5, "anxiety and depression"; N = 9607) compared to those of the other four (0.85 to 0.93), indicating that the EQ-5D covers more than one latent dimension. Extending the modelling to a two-factor solution (LL = -20 653; BIC = 41 480; BIC_{adj} = 41 419) provides a slightly better description of the data than the one-factor solution (LL = -20 696; BIC = 41 531; BIC_{adj} = 41 484). These two dimensions are highly correlated (r = 0.71). The two dimensions separate the first four items (on one factor with loadings above r = 0.73) from the last item, which loads highly on the second factor (r = 0.68) and not at all on the first factor.

TRANSLATION INTO THE JOINT MODELLING APPROACH

Overall these results suggest that the GHQ-12 as well as the WEMWBS assess mainly one dimension. The second dimension that is extracted for these two instruments is always highly correlated with the first one and the loadings of the items from the models with only one dimension are already very high, indicating a high degree of shared variance between the items. In contrast, the EQ-5D shows the clear need for the extraction of a second dimension.

As described in the paper, the joint modelling proceeded in three steps. The first was fitting a single factor model (model 1) to the data and the second estimating a three-dimensional model (model 2). These two analyses were exploratory in nature to provide a baseline for the comparison between the models in terms of relative fit (single factor model) and to investigate the degree of separation between the three instruments (three factor model). Both did not build on any information gathered in the single scale models described above.

The third step involved fitting a confirmatory bifactor model. After fitting a model solely based on the three instruments (model 3), this step had to build on information gathered on the functioning of the individual instruments (model 4). While the structure of the GHQ-12 and EQ-5D was straightforwardly translated into the bifactor model (for the GHQ-12 a bifactor structure was already the best-fitting model; for the EQ-5D the final solution presented in online Table DS1 shows loadings of the same magnitude as identified by the single scale analysis presented in this supplement), the translation of the WEMWBS needed a slight adjustment. While fitting a bifactor model with the goal to generate independently interpretable scores for general and domain factors[32] (all WEMWBS items loading on the general factor as well as the orthogonal domain factor), we tried to estimate a second domain factor that was correlated with the first one to mirror the structure identified in the single scale analysis as closely as possible. Nevertheless, this revealed that insufficient variance was left to be explained in the WEMWBS items. Instead we added an orthogonal factor for the items of the interest/social domain to take some of the insight gathered from the single scale analysis over into the bifactor model.

Table DS1 Standardised factor loadings of the three discussed models

	Model 2: geomin exploratory			Model 1: single factor	Model 4: bifactor analysis					
	Factor 1	Factor 2	Factor 3		General	GHQ-12	WEMWBS	EQ-5D	Wording	Interest/ social
GHQ1, able to concentrate	0.34	0.52		0.58	0.63	0,42				
GHQ2, lost sleep		0.70		0.54	0.65	-0.09			**0.35**	
GHQ3 play useful part	0.36	0.40		0.54	0.59	0.44				
GHQ4, capable of making decisions	0.32	0.54		0.59	0.65	0.51				
GHQ5, under strain		0.82		0.59	0.72	-0.10			**0.49**	
GHQ6, not overcome difficulties		0.81		0.68	0.81	-0.06			0.26	
GHQ7, enjoy day to day activities	0.47	0.47		0.55	0.63	0.44				
GHQ8, able to face problems		0.64		0.65	0.72	0.39				
GHQ9, unhappy		0.84		0.73	0.87	-0.13			0.11	
GHQ10, lose confidence		0.78		0.75	0.89	-0.15			-0.11	
GHQ11, worthless person		0.70		0.72	0.85	-0.18			-0.15	
GHQ12, reasonably happy		0.61		0.65	0.75	0.24				
WEMWBS1, optimistic			0.60	0.61	0.43		**0.46**			0.10
WEMWBS2, feeling useful			0.69	0.71	0.48		**0.55**			
WEMWBS3, feeling relaxed			0.57	0.74	0.60		0.46			
WEMWBS4, interested in other people			0.72	0.56	0.31		**0.52**			**0.31**
WEMWBS5, energy to spare	0.36		0.50	0.64	0.49		**0.41**			
WEMWBS6, deal well with problems			0.68	0.79	0.58		**0.58**			
WEMWBS7, thinking clearly			0.69	0.78	0.56		**0.60**			
WEMWBS8, feel good about myself			0.73	0.88	0.67		**0.60**			

WEMWBS9, feel close to other people			0.81	0.71	0.45		**0.57**			**0.51**
WEMWBS10, feel confident			0.76	0.87	0.64		**0.63**			
WEMWBS11 make up own mind			0.66	0.70	0.48		**0.57**			
WEMWBS12, felt loved			0.69	0.62	0.43		**0.47**			**0.46**
WEMWBS13, interested in new things			0.72	0.68	0.44		**0.54**			0.17
WEMWBS14, felt cheerful			0.75	0.86	0.65		**0.58**			
EQ-5D1, mobility	0.96			0.36	0.36			**0.87**		
EQ-5D2, self-care	0.89			0.54	0.48			**0.78**		
EQ-5D3, usual activities	0.91			0.47	0.48			**0.79**		
EQ-5D4, pain	0.83			0.32	0.37			**0.77**		
EQ-5D5, anxiety/depression		0.53		0.71	0.79			0.15		
Omega estimates	--	--	--	--	$\omega = 0.98$ $\omega_h = 0.81$	$\omega = 0.96$ $\omega_s = 0.11$	$\omega = 0.95$ $\omega_s = 0.44$	$\omega = 0.94$ $\omega_s = 0.61$	--	--

GHQ-12, 12-item General Health Questionnaire; WEMWBS, Warwick-Edinburgh Mental Well-being Scale.

Item responses were recoded where necessary, so that higher values indicate a more positive response from the participant. For readability factor loadings <|0.30| are blanked for the exploratory model. Loadings >|0.30| on domain factors in the bifactor model equal (±0.1) or higher than those on the general factor are set in bold face for the three instruments (indication of multidimensionality).

Factor loadings for unidimensional model in the middle to ease comparison with the two other models; correlation between factors for geomin-rotated exploratory model: r(F1, F2) = 0.34; r(F1, F3) = 0.29; r(F2, F3) = 0.51.