HEALTH PSYCHOLOGY OPEN

Report of empirical study

Health Psychology Open
July-December 2016: 1–10

DOI: 10.1177/2055102916676211
hpo.sagepub.com
SAGE

The health locus of control concept: Factorial structure, psychometric properties and form equivalence of the Multidimensional Health Locus of Control scales

Angelos P Kassianos[1], Maria Symeou[2] and Myria Ioannou[2]

Abstract

Contradictory evidence exists on the Multidimensional Health Locus of Control scale's factor structure and the psychometric equivalence between Form A and Form B. University students ($N = 359$) completed the Multidimensional Health Locus of Control and General Self-Efficacy scales. The three-factor model had better fit and parsimony in both Forms. 'Internal' scale negatively correlated with 'chance' but positively with 'others'. The two external scales positively correlated. The scales' reliability was satisfactory, but the two Forms were not psychometrically equivalent. Convergent validity was confirmed. The evidence suggests a three-factor structure and psychometric non-equivalence of the two Forms. Researchers should make an informed choice on which Form to use.

Keywords

confirmatory factor analysis, Multidimensional Health Locus of Control, reliability, self-efficacy, validity

Introduction

Perceived control refers to the degree to which individuals believe they have the power to control various factors that affect their lives. Likewise, health-related locus of control refers to individuals' perceptions of what controls their health (Wallston et al., 1976; Wallston and Wallston, 1982). In effect, the term 'locus' refers to the location where control is thought to reside – either internally to the individual or externally (Luszczynska and Schwarzer, 2005; Rotter, 1966).

To measure health-related control beliefs, the Multidimensional Health Locus of Control (MHLC) questionnaire (Wallston et al., 1978) was developed which is considered as one of the most widely used instruments in health psychology research (Wallston, 2005). The MHLC scales are based on the expectancy construct from Rotter's social learning theory (Rotter, 1954) and modelled after Levenson's I, P and C scales that conceptualized external locus of control as either due to chance or the influence of powerful other people (Levenson, 1973, 1974). Internal Locus of Control (IHLC) reflects the internal part of perceived control and refers to the individual's tendency to believe that health outcomes are principally due to the individual's own behaviour and within their own control. In contrast, Powerful others Locus of Control (PHLC) and Chance Locus of Control (CHLC) reflect the external parts of perceived control and they refer to the individual's tendency to believe that health outcomes are principally due to either other people or chance factors. Differences between ethnic groups have been identified on the CHLC recently (LaNoue et al., 2015).

The MHLC has multiple uses in health-related research. First, it is used to predict or explain a number of health behaviours for several health conditions. For example, patients with higher external locus of control are more likely to be passive

[1]University College London, UK
[2]University of Cyprus, Cyprus

Corresponding author:
Angelos P Kassianos, Department of Applied Health Research, University College London, 1-19 Torrington Place, London WC1E 7HB, UK.
Email: angelos.kassianos@ucl.ac.uk

(Sørlie and Sexton, 2001). On the other hand, patients with higher IHLC are more likely to return earlier to work, adhere to health-promoting lifestyle changes and illness-preventing behaviours and have higher survival rates (Bergvik et al., 2012; Burker et al., 2005). Higher PHLC is associated with trust in health professionals while higher CHLC with mistrust (Brincks et al., 2010). Second, the MHLC is used to assess the level of perceived control of patients with chronic disease (Bergvik et al., 2010; Maunsell et al., 2002).

The MHLC questionnaire is intended mainly for health-related researchers working with either clinical or non-clinical populations. Even though the empirical findings on the impact of locus of control on health behaviours are inconsistent (Wallston, 2005), this mainly reflects methodological weaknesses which include problems with measuring MHLC (Steptoe and Wardle, 2001). Therefore, the MHLC scales present two main problems: first, there is contradictory evidence on the scale's factorial structure with some supporting a three-dimensional structure (IHLC, CHLC and PHLC) and others a two-dimensional structure of internal–external locus of control. Second, there are two Forms used in the general population: Forms A and B that were considered in their conception as 'equivalent' and are used interchangeably. There are some indications that the Forms are not psychometrically equivalent but more evidence is needed (Ross et al., 2015). The decision on which Form to use is usually dependent on the researcher so studies that report the psychometric properties of the different Forms can inform decision-making. Further from these two main conceptual problems, the evidence on the scale's validity is limited and mixed (Norman et al., 1998), especially on the scale's convergent validity (Armitage et al., 2002).

There is currently no Greek validated version of the scale. Even though a translated version of the scales in Greek is reported (Theofilou, 2012), the translation procedures and the psychometric properties of a Greek version of the MHLC scales were not previously assessed. The growing interest in using the MHLC scales especially in studies with chronic patients reflects the need to translate and assess the validity and reliability of the MHLC scales in Greek. If validated, the translated questionnaire will advance studies related to the role of health beliefs in various clinical outcomes in Greece and in other countries with Greek-speaking immigrants especially in times when health is deteriorated in Greece as a result of the financial crisis (Vandoros et al., 2013). Therefore, the aim of this study is to examine the psychometric properties and form equivalence of Forms A and B of the MHLC scales among a Greek-speaking population.

Material and methods

Recruitment

A convenience sample of Greek-speaking undergraduate and postgraduate students were approached in two Universities to complete the study questionnaires in their classrooms after obtaining ethical approval. They were informed of their rights to refuse or withdraw from the study and provided written informed consent. Half of the participants completed Form A first with the other half completing Form B first to counterbalance for the effect of questionnaires' administration. All participants completed the MHLC Forms before completing the self-efficacy scale.

Instruments

MHLC scales. Forms A and B of the MHLC questionnaire (Wallston et al., 1978) were used. Each form consists of three scales: IHLC, PHLC and CHLC. Each scale consists of six items and each item is rated on a 6-point Likert-type scale, ranging from strongly disagree (1) to strongly agree (6), with higher scores indicative of a stronger tendency towards that type of control. A rigorous procedure using the forward and backward method of translation was followed with no major discrepancies found. The face validity was assessed using the method of cognitive debriefing (Wild et al., 2005) using five University students who reported no difficulties responding to any of the items. The final Greek version is available in Table 1 of Supplemental Material.

General self-efficacy scale. To measure the confidence in one's ability to succeed in specific situations (Bandura, 1997), the General Self-Efficacy Scale (Jerusalem et al., 1992; Schwarzer and Jerusalem, 1995) was used. This scale was used to examine the MHLC construct validity as it correlates positively with IHLC and negatively with PHLC and CHLC in healthy (Bonetti et al., 2001; Waller and Bates, 1992) and non-healthy (De Las Cuevas et al., 2015) populations. The scale has 10 items scored on a 4-point Likert-type scale, ranging from not at all true (1) to exactly true (4). The Greek version of the scale was used (Mystakidou et al., 2008).

Data analysis

First, the factorial structure of the MHLC scales was tested with confirmatory factor analysis (CFA) using the maximum likelihood estimation. For an adequate model fit of the separate Forms, most of the indices should be met with the Bentler's comparative fit index (CFI) $>.90$, the goodness-of-fit index (GFI) $>.90$, root mean square error of approximation (RMSEA) $<.05$ and the standardized root mean square residual (SRMR) $<.08$ (Hu and Bentler, 1999). Both Forms were tested as models with one factor (unidimensional), with a two-factor solution (internal–external) and with the three inter-correlated first-order factors. Since the difference in degrees of freedom between the models with second-order factor and three inter-correlated first-order factors was zero, the significance of their difference could not be estimated based on the chi square (Pandey and

Table 1. Descriptive information and patterns of the MHLC scales responses.

	Female ($n=266$)		Male ($n=93$)		t	p
	M	*SD*	*M*	*SD*		
Form A						
IHLC	25.71	4.66	26.71	4.81	−1.77	.077
CHLC	17.40	4.91	18.43	5.84	−1.65	.099
PHLC	19.42	5.39	18.05	4.76	2.17	.03*
Form B						
IHLC	24.98	4.85	26.62	4.72	−2.82	.005**
CHLC	17.64	4.72	18.82	4.91	−2.06	.04*
PHLC	20.03	5.31	19.82	4.96	0.34	.73

SD: standard deviation; IHLC: Internal Locus of Control; CHLC: Chance Locus of Control; PHLC: Powerful others Locus of Control; MHLC: Multidimensional Health Locus of Control.
*$p<.05$, **$p<.01$.

Bright, 2008). Therefore, the value of the data point was presented (Yu, 2009) and parsimony was addressed using the index of Akaike information criterion (AIC) to compare the two models and provide a criterion for model selection. Second, inter-item correlations were performed between the three MHLC scales.

Third, the scales' congeneric and tau-equivalent models were tested for reliability using parallel models and the ρ coefficient. These methods were preferred to the alpha coefficient which often underestimates reliability (Graham, 2006). To be more specific, the tau-equivalent model takes into account the unique error of each item even if all true scores are equal (Raykov, 1997a, 1997b). The essentially tau-equivalent model further assumes that true scores can also differ in terms of precision. The congeneric model uses less assumptions and in particular assumes a linear association between score items which should measure the same latent variable probably with different degrees of precision and amounts of error (Raykov, 1997a). Therefore, these parallel models assume that items measure the same latent variable and scale with equal degrees of precision and error (Raykov, 1997a, 1997b). Following relevant guidelines (Gignac, 2015), the omega reliability coefficient (McDonald, 1999) was calculated when the essentially tau-equivalent model could not be assumed.

Fourth, form equivalence of Forms A and B was assessed using structural equation modelling (SEM) including both Forms to assess whether the ranking of scores is similar between the Forms (i.e. IHLC in Form A with IHLC in Form B) and the analogy of correlations among different factors between the two Forms (i.e. if the correlation between IHLC of Form A and PHLC of Form B is analogous to the correlation between PHLC of Form A and IHLC of Form B). Multi-group analyses were used using the scores of the same participants across the two Forms to test the equivalence of the means of the scales and to determine equality of scores between the same participants in both Forms (Byrne, 2013).

Fifth, construct validity was examined using the Pearson correlation coefficients between MHLC scales and self-efficacy. The statements for each item in English are available in Box 1 of the Supplemental Material. The analyses were run using AMOS 19 and SPSS (version 22) for Windows (SPSS Inc., Chicago, IL).

Results

Study population

A total of 359 ($N=359$) University students consented and participated in the study with their age ranging from 18 to 48 years old ($M=21.1$, standard deviation (SD)$=2.7$). The majority were females (74.1%) studied at an undergraduate level (96.7%) and lived with their parents (54.9%). A fewer participants lived alone (29%) or with a partner/roommate (16.1%). Only 1.7 per cent was married or had children. Participants scored higher in IHLC and then CHLC and finally PHLC in both Forms (Table 1).

Factorial structure

Confirmatory factor analyses were used to assess whether there is a three-structure (IHLC, CHLC and PHLC) or a two structure (internal–external) in the two Forms. For both Forms, the models with the three inter-correlated factors (IHLC, CHLC and PHLC) had a slightly more acceptable fit (Figure 1) and all the items of the three scales had significant estimates in both Forms (Table 2). The model for Form A with one first-order factor (unidimensional) had a clearly non-acceptable fit and the model with the second-order factor (internal–external) had an almost acceptable fit. The model using the three inter-correlated factors had a very similar fit with the model with a two-factor solution of internal and external control and showed again a non-acceptable fit. Moreover, the one-factor model was significantly worse than the model with the three factors. We also looked at the χ^2 difference ($\Delta\chi^2$), which assesses the difference in χ^2 and degrees of freedom between two models and improvement in model's fit compared to another model. As a result, the three-factor model was better than the two-factor model, with $\Delta\chi^2$ $(3)=630.81$ ($p<.001$) and the two-factor model was also significantly worse than the others, with $\Delta\chi^2$ $(2)=207.885$ ($p<.001$). Therefore, parsimony was used for model selection because it makes a trade-off between fit and simplicity. Parsimony was better for the three-factor model compared to the two-factor model based on the AIC (Table 2). Moreover, the model with the three factors was more appropriate because the correlations between the three factors were not high between IHLC and CHLC ($r=-.036$), IHLC and PHLC ($r=.147$) and PHLC and CHLC ($r=.393$) and also because the loadings from the first-order factors on the two-factor

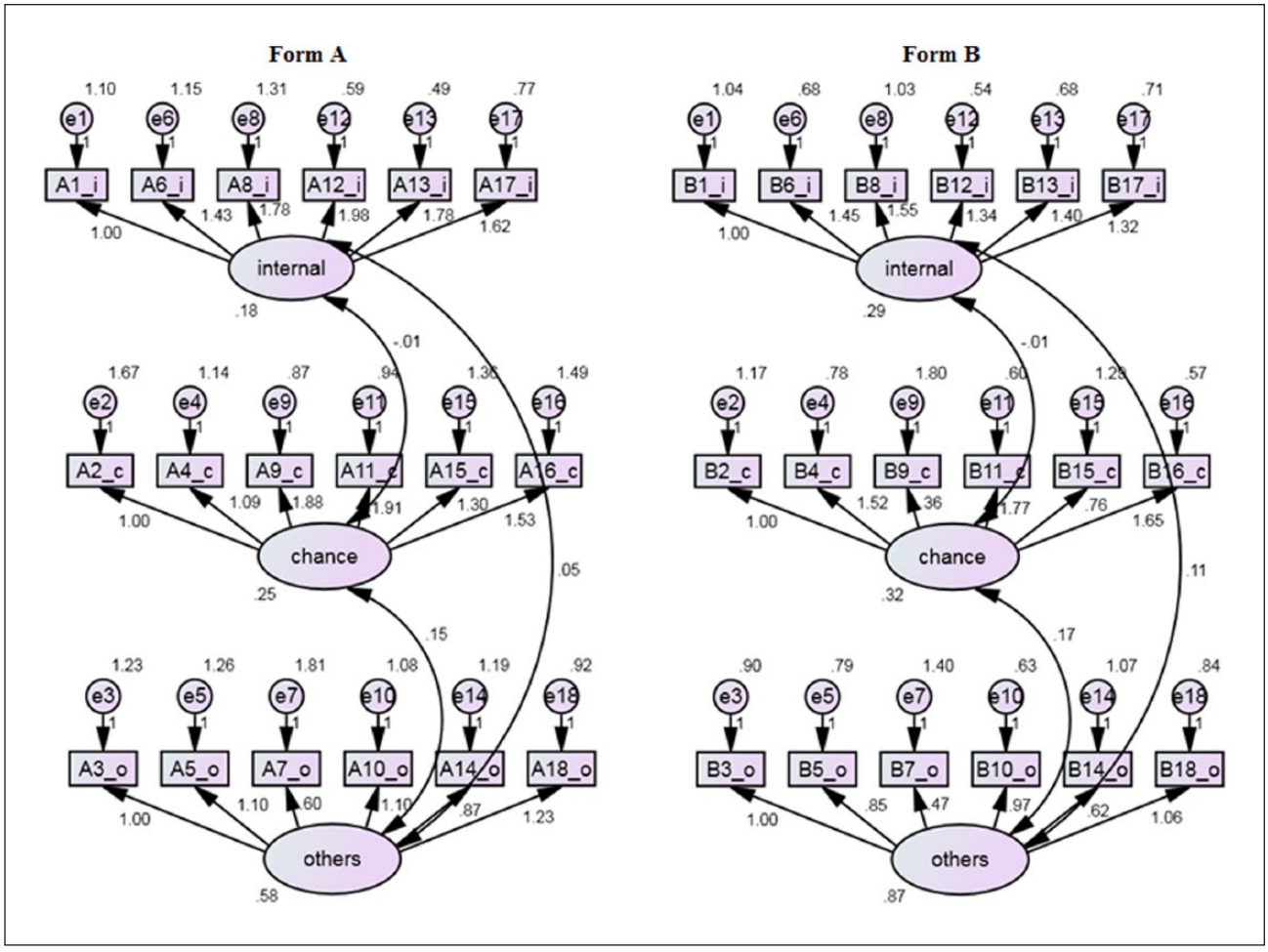

Figure 1. Factorial structure of Forms A and B with three inter-correlated factors.
Notes: (a) The unstandardized estimates are reported (standard factor loadings are reported in Table 2). (b) The statements for each item are available in Supplemental Material (Box 1).

model were rather low and none of them was significant (.138 for IHLC, .389 for CHLC and 1.00 for PHLC), suggesting limited ability of the two-factor model to explain the associations behind the factors. As the model was not accepted based on the CFI index, we considered the modifications with the higher Measurement Invariance (MI >20) and parameter change. As a result, the errors of three dyads of questions were correlated (A2_c and A16_c, A7_o and A14_o, A9_c and A11_c) due to their similar wording in Greek language (refer to Supplemental Material for all the question items). All the dyads were from the same locus of control factors (IHLC, PHLC and CHLC). The model fit was then significantly improved, with $\Delta\chi^2$ (3)=54.772 ($p<.001$).

Similar findings were found for Form B, where the one-factor model had a non-acceptable fit as well and had a significantly worse fit compared to the three-factor model, with $\Delta\chi^2$ (3)=885.6 ($p<.001$). The difference between the three-factor and the two-factor models was significant, with $\Delta\chi^2$ (2)=376.563 ($p<.001$). Parsimony was better for the three-factor model compared to the two-factor model based on the AIC. Similar to Form A, the solution with the three-factor model was more appropriate because of the low correlation between IHLC and CHLC ($r=-.040$), IHLC and PHLC ($r=.226$), CHLC and PHLC ($r=.321$) and the low standardized estimates of the loadings on the two-factor model (.219 for IHLC, .315 for CHLC and 1.00 for PHLC). However, the model fit was still unacceptable, and modifications were considered. Three modifications were made in dyads of items with high MI and similar wording in Greek (B2_c and B15_c, B7_o and B14_o, and a negative correlation between the errors of B3_o and B6_i). The model fit significantly improved, with $\Delta\chi^2$ (3)=885.6 ($p<.001$). All goodness-of-fit indicators are presented in Table 3.

Congeneric and (essentially) tau-equivalent estimates of reliability

Overall, the reliability of the subscales was acceptable. The model fit of each subscale was better than that of the whole Forms, suggesting that the MHLC includes three

Table 2. Item estimates of CFA models for Forms A and B.

Form A				Form B			
Items[a,b]	Standardized estimate	SE	*p*	Items	Standardized estimate	SE	*p*
A1_i	.393			B1_i	.493		
A6_i	.496	.241	***	B6_i	.687	.169	***
A8_i	.556	.286	***	B8_i	.638	.188	***
A12_i	.741	.289	***	B12_i	.698	.154	***
A13_i	.722	.256	***	B13_i	.662	.163	***
A17_i	.611	.246	***	B17_i	.648	.159	***
A2_c	.360			B2_c	.467		
A4_c	.453	.218	***	B4_c	.699	.194	***
A9_c	.711	.327	***	B9_c	.151	.143	.012
A11_c	.698	.330	***	B11_c	.794	.217	***
A15_c	.487	.253	***	B15_c	.356	.144	***
A16_c	.529	.287	***	B16_c	.781	.203	***
A3_o	.568			B3_o	.701		
A5_o	.598	.137	***	B5_o	.665	.079	***
A7_o	.320	.120	***	B7_o	.350	.080	***
A10_o	.629	.134	***	B10_o	.750	.081	***
A14_o	.518	.119	***	B14_o	.489	.076	***
A18_o	.700	.141	***	B18_o	.733	.090	***

CFA: confirmatory factor analysis.
[a]Lower case letters next to each item indicate the scale (i for internal, c for chance and o for others).
[b]The statements for each item are available in Electronic Supplemental Material, Box 1.
***$p < .001$.

Table 3. Goodness-of-fit indicators of the Multidimensional Health Locus of Control scales ($N = 359$).

Model	χ^2	df	RMSEA	GFI	CFI	SRMR	Parsimony (AIC)
Form A							
One factor	944.857*	135	.129	.714	.396	.1304	1016.857
Second-order factor (unidimensional)	316.068*	132	.062	.909	.863	.0657	394.068
Two factors (internal–external)	521.933*	134	.09	.832	.711	.0847	595.933
Three factors (IHLC, CHLC, PHLC)	314.048*	132	.062	.909	.864	.0643	392.048
Three factors modified model	259.276*	129	.054	.928	.905	.0614	345.276
Form B							
One factor	1280.823*	135	.154	.629	.378	.1535	1352.823
Second-order factor (unidimensional)	395.539*	132	.075	.890	.855	.788	476.539
Two factors (internal–external)	771.786*	134	.115	.761	.654	.1076	845.786
Three factors (IHLC, CHLC, PHLC)	395.223*	132	.075	.889	.857	.0764	473.223
Three factors modified model	307.507*	129	.063	.915	.901	.0614	393.507

IHLC: Internal Locus of Control; CHLC: Chance Locus of Control; PHLC: Powerful others Locus of Control; RMSEA: root mean square error of approximation; GFI: goodness-of-fit index; CFI: comparative fit index; SRMR: standardized root mean square residual; AIC: Akaike information criterion.
Adequate model fit: CFI > .90, GFI > .90, RMSEA < .05 and SRMR < .08.
*$p < .001$.

distinct subscales representing three separate factors of control orientation that could be potentially administered as separate indications of health locus of control. Model fit and reliability estimates were slightly better for Form B when each subscale was separately tested.

The congeneric and tau-equivalent models were used to estimate reliability (Table 4). When the congeneric model had better fit it was preferred. In Form A, the congeneric model was used for IHLC to estimate reliability ($\rho = .92$) and was confirmed by the omega coefficient ($\omega = .74$) as

Table 4. Goodness-of-fit indicators for equivalence of factor structure.

Measurement model	χ^2 (df)	*p*	GFI	CFI	RMSEA	Rel. *p*[a]	$\Delta\chi^2$ (df)	*p*
Form A								
IHLC								
Congeneric	24.484 (9)	.004	.980	.966	.069	**.921**		
Tau-equivalent	53.727 (14)	<.001	.953	.912	.089	.924	29.243 (5)	<.001
Parallel	123.69 (19)	<.001	.905	.769	.124	.921	69.963 (5)	<.001
CHLC								
Congeneric	50.472 (9)	<.001	.952	.888	.113	**.911**		
Tau-equivalent	79.767 (14)	<.001	.928	.822	.115	.912	29.295 (5)	<.001
Parallel	96.009 (19)	<.001	.922	.792	.106	.912	16.242 (5)	.01
PHLC								
Congeneric	45.808 (9)	<.001	.961	.907	.107	**.915**		
Tau-equivalent	74.91 (14)	<.001	.929	.845	.110	.918	29.102 (5)	<.001
Parallel	99.926 (19)	<.001	.901	.795	.109	.864	25.016 (5)	<.001
Form B								
IHLC								
Congeneric	16.2 (9)	.063	.986	.987	.047	.936		
Tau-equivalent	30.717 (14)	.006	.973	.970	.058	**.936**	14.517	.025
Parallel	75.022 (19)	<.001	.933	.899	.091	.936	44.305 (5)	<.001
CHLC								
Congeneric	47.757 (9)	<.001	.957	.921	.110	**.912**		
Tau-equivalent	151.823 (14)	<.001	.860	.718	.166	.922	104.066 (5)	<.001
Parallel	224.528 (19)	<.001	.821	.580	.174	.907	72.705 (5)	<.001
PHLC								
Congeneric	64.736 (9)	<.001	.943	.907	.132	**.934**		
Tau-equivalent	126.766 (14)	<.001	.873	.811	.150	.936	62.03 (5)	<.001
Parallel	163.718 (19)	<.001	.831	.758	.146	.932	36.952 (5)	<.001

IHLC: Internal Locus of Control; CHLC: Chance Locus of Control; PHLC: Powerful others Locus of Control; RMSEA: root mean square error of approximation; GFI: goodness-of-fit index; CFI: comparative fit index.
[a]Bold values represent the estimates of reliability used for each scale (congeneric, tau-equivalent and parallel).

well as in CHLC ($\rho = .91$), confirmed by the omega coefficient ($\omega = .70$). For PHLC, the congeneric model had an acceptable fit except the index of RMSEA and the fit was significantly better than more restricting models with acceptable reliability ($\rho = .92$ and $\omega = .73$).

In Form B, all the models used for reliability for IHLC had an excellent fit. The essentially tau-equivalent model was not significantly worse than the congeneric until the significance level of $p = .025$, with $\Delta\chi^2$ (5) = 14.517. The parallel model was significantly worse compared to the tau-equivalent model, with $\Delta\chi^2$ (5) = 44.305, $p < .001$ so the latter was used for estimating reliability ($\rho = .94$). For CHLC, the congeneric model was used for estimating reliability ($\rho = .91$) and was confirmed by the omega coefficient ($\omega = .70$). For the PHLC scale, the congeneric model was used for estimating reliability ($\rho = .93$) and was confirmed by the omega coefficient ($\omega = .79$).

Form equivalence

The SEM of the two Forms showed that the same factors in both Forms had high correlation with each other (IHLC: $r = .965$, PHLC: $r = .953$, CHLC: $r = .970$). Multi-group analyses were conducted with the responses in the two Forms modelled as dependent and with the correlated errors of questions 7 and 14 modelled, because of common modification in both Forms. The unconstrained model had an inacceptable fit with χ^2 (262) = 636.074, $p < .001$, GFI = .911, CFI = .882 and RMSEA = .045. This suggests that the two Forms are not psychometrically equivalent.

Inter-item correlations and construct validity

In both Forms, IHLC was negatively correlated with CHLC though this relation was non-significant ($p = .534$) in Form B. CHLC and PHLC were positively correlated in both Forms, and this relationship was significant in both Forms ($p < .001$). The IHLC was positively correlated with PHLC and this relationship was marginally significant in Form A ($p = .042$) and significant in Form B ($p = .001$).

In Form A, self-efficacy had a significant modest, positive correlation with IHLC ($p < .001$), and a non-significant correlation to the other two scales. The correlation with CHLC was small but negative ($p = .470$), whereas with

Table 5. Inter-item correlations and construct validity estimates.

			Correlation estimates[a]	Covariance estimates	SE	*p*
Form A						
IHLC	↔	SE	.368	.051	.013	***
PHLC	↔	SE	.062	.015	.016	.349
CHLC	↔	SE	−.048	−.008	.010	.470
IHLC	↔	PHLC	.147	.050	.025	.042*
IHLC	↔	CHLC	−.032	−.007	.015	.643
CHLC	↔	PHLC	.393	.150	.038	***
Form B						
IHLC	↔	SE	.409	.073	.016	***
PHLC	↔	SE	.047	.014	.019	.458
CHLC	↔	SE	.005	.001	.011	.937
IHLC	↔	PHLC	.226	.119	.037	.001**
IHLC	↔	CHLC	−.04	−.013	.021	.534
CHLC	↔	PHLC	.321	.170	.041	***

IHLC: Internal Locus of Control; CHLC: Chance Locus of Control; PHLC: Powerful others Locus of Control; SE: Self-efficacy.
[a]Pearson correlation coefficients are reported.
*$p < .05$, **$p < .01$, ***$p < .000$.

PHLC was positive but small and non-significant ($p = .349$). In Form B, self-efficacy was significantly correlated with IHLC only ($p < .001$) and non-significantly correlated with the other two scales. More specifically, the correlation with CHLC was positive and almost zero ($p = .937$) and with PHLC was again positive and very small approaching zero ($p = .458$) (Table 5).

Discussion

Previous evidence showed inconsistencies regarding the factorial structure of the MHLC scales. Some of the earlier validations of the original MHLC scales suggested a two-factor structure (internal–external) (Cooper and Fraboni, 1990; Gutkin et al., 1985; O'Looney and Barrett, 1983; Rogers, 1995). Even though studies with healthy (Chaplin et al., 2001) and clinical (Athale et al., 2010) populations have suggested independence between PHLC and CHLC as far as we are concerned this is the first study assessing one-, two- and three-factor models of the scales.

There was moderate independence across the scales even if theoretically their associations should be orthogonal with small inter-factor correlations. Thus, IHLC theoretically should moderately and negatively correlate with CHLC and orthogonally relate with PHLC (Wallston et al., 1978). In this study, the correlation coefficients between PHLC and CHLC were both positive and significant in both Forms. On the other hand, IHLC had a negative even non-significant correlation with CHLC and a positive and significant correlation with PHLC in both Forms. In the original validation, similar patterns were observed but contrary to this study, IHLC was also independent from PHLC (Chaplin et al., 2001; Wallston et al., 1976). Also, IHLC had the weakest correlations with other factors in both Forms compared to the ones between the external scales. The low or absent negative correlations between IHLC and the external scales suggests divergent validity (Baken and Stephens, 2005).

To our knowledge, this is the first study using the congeneric and tau-equivalent models to estimate the MHLC subscales' reliability, which were acceptable for both Forms but slightly better for Form B. In both Forms, there was a clear lack of equivalence of the subscales' items to one another, as the tau-equivalent and the parallel models were not confirmed. This suggests that all items do not measure the same latent factor of health locus of control, even if we allow for different error variances (tau-equivalent model) or for different degree of precision (essentially tau-equivalent model) (Graham, 2006). The indications of congeneric reliability suggest a linear relationship between item scores of each subscale that allows for an additive and also for a multiplicative constant between each dyad of item true scores (Raykov, 1997a). On the other hand, the two Forms were not psychometrically equivalent, even though the same scales positively and strongly correlated between the two Forms. Moreover, even though the two Forms had similar reliability coefficients, they did not have similar discriminant and convergent validity estimates that could suggest parallelism (Gulliksen, 2013). For example, in Form B, the association between CHLC and IHLC was negative but not significant whereas with self-efficacy was positive. In Form A, the CHLC was significantly and negatively associated with IHLC and negatively correlated with self-efficacy.

The scales' factorial structure and psychometric invariance in Forms A and B has clinical and research

implications. Researchers and clinicians should use available evidence to make an informed decision on which Form they use. Based on the findings of this study, Form B was shown to have slightly better subscale consistency and reliability. Estimates of reliability suggest that the items of each factor (IHLC, PHLC, CHLC) violate the assumption of tau-equivalence, and hence studies reporting coefficient alpha only, may underestimate the reliability of the true scores, as the subscales better fit a congeneric model. The use of a congeneric measure of reliability over the coefficient alpha seems particularly important for research using the MHLC, so as an accurate estimate of reliability is obtained.

Our findings suggest that all items for each subscale should be used, as we have demonstrated that items of the same subscale measure the same latent factor but have possibly different scales, different degrees of precision and different amounts of error. Items of the MHLC have the same scale, but these findings may suggest the different variance of true scores in each item. This may hold implications for the difficulty to discriminate among the responses (i.e. strongly, moderately and slightly agree/disagree) and the need to evaluate health locus of control in a more tangible way in clinical practice. Perceptions of locus of control are likely to reflect temporary sources of control that are not stable over time (O'Brien, 1984), thus the responses to the MHLC should allow for a similar conceptualization of the instability of sources of health locus of control (e.g. always or 6–7 days of the week, usually or 4–5 days of the week, sometimes or 2–3 days of the week, rarely or 1 day of the week and never or 0 days of the week).

The previous suggestion of using the Forms interchangeably needs to be addressed carefully, as evidence from previous studies and our findings do not support that the two Forms are equivalent. The positive correlation between IHLC and PHLC may be culture-specific. Individualistic cultures have usually more internal orientation of control, whereas collectivistic countries tend to have more external orientation of control centralized on other people (Stocks et al., 2012). Cypriot culture even if currently a more individualistic one, still includes a range of collectivistic characteristics.

The study used a convenience sample and therefore students may differ from the general population in terms of their health experiences and health beliefs. It is also important to consider that a student population can be younger, healthier and more highly educated than the general population usually responding to the MHLC scales in other studies. Also, this study did not use health behaviours to assess the scales' predictive validity. Despite these limitations, this study provides evidence on the MHLC scales' factorial structure, convergent validity and congeneric reliability using SEM. Inter-item validity evidence suggests that the construct validity of the scales may be context-dependent. Further research is needed to examine further the convergent and discriminant validity of the scales using more measures and to extend the Form's equivalence assessment using measurement invariance methods.

The factorial structure of both Forms revealed a three-dimensional structure and the internal–external discrimination were not confirmed. Even though in terms of parsimony the difference between the three-factor models and fit was not large, the evidence supporting the conceptualization of health locus of control as a second-order factor was considerably less than the evidence supporting a three-factor structure. Moreover, the three-factor model was more appropriate than the two-factor model based on low inter-subscales correlations and standardized estimates of the first-order factors on second-order factor of health locus of control. Further evidence is needed on the discriminant validity of PHLC and CHLC.

Acknowledgements

The authors would like to thank the following for their contribution in recruitment and data entry: Alexandros Kliris, Christina Koumarela, Maria Eleni Alexiadou and Niki Soulioti.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethical approval

The study obtained written ethical approval from the Cyprus Bioethics Committee.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

References

Armitage CJ, Norman P and Conner M (2002) Can the theory of planned behaviour mediate the effects of age, gender and multidimensional health locus of control? *British Journal of Health Psychology* 7(3): 299–316.

Athale N, Aldridge A, Malcarne VL, et al. (2010) Validity of the multidimensional health locus of control scales in American sign language. *Journal of Health Psychology* 15(7): 1064–1074.

Baken D and Stephens C (2005) More dimensions for the multidimensional health locus of control: Confirmatory factor analysis of competing models of the structure of control beliefs. *Journal of Health Psychology* 10(5): 643–656.

Bandura A (1997) *Self-Efficacy: The Exercise of Control*. New York: W.H. Freeman and Company.

Bergvik S, Sørlie T and Wynn R (2010) Approach and avoidance coping and regulatory focus in patients having coronary artery bypass graft surgery. *Journal of Health Psychology* 15(6): 915–924.

Bergvik S, Sørlie T and Wynn R (2012) Coronary patients who returned to work had stronger internal locus of control beliefs

than those who did not return to work. *British Journal of Health Psychology* 17(3): 596–608.

Bonetti D, Johnston M, Rodriguez-Marin J, et al. (2001) Dimensions of perceived control: A factor analysis of three measures and an examination of their relation to activity level and mood in a student and cross-cultural patient sample. *Psychology & Health* 16(6): 655–674.

Brincks AM, Feaster DJ, Burns MJ, et al. (2010) The influence of health locus of control on the patient–provider relationship. *Psychology, Health & Medicine* 15(6): 720–728.

Burker EJ, Evon DM, Galanko J, et al. (2005) Health locus of control predicts survival after lung transplant. *Journal of Health Psychology* 10(5): 695–704.

Byrne BM (2013) *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*. New York: Routledge.

Chaplin WF, Davidson K, Sparrow V, et al. (2001) A structural evaluation of the expanded multidimensional health locus of control scale with a diverse sample of Caucasian/European, native, and Black Canadian women. *Journal of Health Psychology* 6(4): 447–455.

Cooper D and Fraboni M (1990) Psychometric study of Forms A and B of the multidimensional health locus of control scale. *Psychological Reports* 66(3): 859–864.

De Las Cuevas C, Peñate W, Betancort M, et al. (2015) What do psychiatric patients believe regarding where control over their illness lies? Validation of the multidimensional health locus of control scale in psychiatric outpatient care. *The Journal of Nervous and Mental Disease* 203(2): 81–86.

Gignac GE (2015) On the inappropriateness of using items to calculate total scale score reliability via coefficient alpha for multidimensional scales. *European Journal of Psychological Assessment* 30: 130–139.

Graham JM (2006) Congeneric and (essentially) tau-equivalent estimates of score reliability what they are and how to use them. *Educational and Psychological Measurement* 66(6): 930–944.

Gulliksen H (2013) *Theory of Mental Tests*. London: Routledge.

Gutkin TB, Robbins JR and Andrews L (1985) The health locus of control scale: Psychometric properties. *Educational and Psychological Measurement* 45(2): 407–409.

Hu L and Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal* 6(1): 1–55.

Jerusalem M and Schwarzer R (1992) Self-efficacy as a resource factor in stress appraisal processes. In: Jerusalem M and Schwarzer R (eds) *Self-Efficacy: Thought Control of Action*. New York: Routledge, pp. 195–213.

LaNoue M, Harvey A, Mautner D, et al. (2015) Confirmatory factor analysis and invariance testing between Blacks and Whites of the Multidimensional Health Locus of Control scale. *Health Psychology Open* 2(2): 2055102915615045.

Levenson H (1973) Multidimensional locus of control in psychiatric patients. *Journal of Consulting and Clinical Psychology* 41(3): 397.

Levenson H (1974) Activism and powerful others: Distinctions within the concept of internal-external control. *Journal of Personality Assessment* 38(4): 377–383.

Luszczynska A and Schwarzer R (2005) Multidimensional health locus of control: Comments on the construct and its measurement. *Journal of Health Psychology* 10(5): 633–642.

McDonald RP (1999) *Test Theory: A Unified Treatment*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Maunsell E, Drolet M, Brisson J, et al. (2002) Dietary change after breast cancer: Extent, predictors, and relation with psychological distress. *Journal of Clinical Oncology* 20(4): 1017–1025.

Mystakidou K, Parpa E, Tsilika E, et al. (2008) General perceived self-efficacy: Validation analysis in Greek cancer patients. *Supportive Care in Cancer* 16(12): 1317–1322.

Norman P, Bennett P, Smith C, et al. (1998) Health locus of control and health behaviour. *Journal of Health Psychology* 3(2): 171–180.

O'Brien GE (1984) Locus of control, work and retirement. In: Lefcourt HM (ed.) *Research with the Locus of Control Construct: Extensions and Limitations*, vol. 3. London: Academic Press, Inc., pp. 7–72.

O'Looney BA and Barrett PT (1983) A psychometric investigation of the Multidimensional Health Locus of Control questionnaire. *British Journal of Clinical Psychology* 22(3): 217–218.

Pandey S and Bright CL (2008) What are degrees of freedom? *Social Work Research*: 32(2): 119.

Raykov T (1997a) Estimation of composite reliability for congeneric measures. *Applied Psychological Measurement* 21(2): 173–184.

Raykov T (1997b) Scale reliability, Cronbach's coefficient alpha, and violations of essential tau-equivalence with fixed congeneric components. *Multivariate Behavioral Research* 32(4): 329–353.

Rogers WS (1995) Deconstructing the health locus of control scale. *Studia Psychologica* 37(3): 165–167.

Ross TP, Ross LT, Short SD, et al. (2015) The multidimensional health locus of control scale: Psychometric properties and form equivalence. *Psychological Reports* 116(3): 889–913.

Rotter JB (1954) *Social Learning and Clinical Psychology*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Rotter JB (1966) Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied* 80(1): 1–28.

Schwarzer R and Jerusalem M (1995) Generalized self-efficacy scale: Measures in health psychology: A user's portfolio. *Causal and Control Beliefs* 1: 35–37.

Sørlie T and Sexton HC (2001) Predictors of the process of coping in surgical patients. *Personality and Individual Differences* 30(6): 947–960.

Steptoe A and Wardle J (2001) Locus of control and health behaviour revisited: A multivariate analysis of young adults from 18 countries. *British Journal of Psychology* 92(4): 659–672.

Stocks A, April KA and Lynton N (2012) Locus of control and subjective well-being – A cross-cultural study. *Problems and Perspectives in Management* 10(1): 17–25.

Theofilou P (2012) Self-esteem in Greek dialysis patients: The contribution of health locus of control. *Iranian Journal of Kidney Diseases* 6(2): 136–140.

Vandoros S, Hessel P, Leone T, et al. (2013) Have health trends worsened in Greece as a result of the financial crisis? A quasi-experimental approach. *European Journal of Public Health* 23(5): 727–731.

Waller KV and Bates RC (1992) Health locus of control and self-efficacy beliefs in a healthy elderly sample. *American Journal of Health Promotion* 6(4): 302–309.

Wallston BS, Wallston KA, Kaplan GD, et al. (1976) Development and validation of the health locus of control (HLC) scale. *Journal of Consulting and Clinical Psychology* 44(4): 580.

Wallston KA (2005) Overview of the special issue on research with the multidimensional health locus of control (MHLC) scales. *Journal of Health Psychology* 10(5): 619–621.

Wallston KA and Wallston BS (1982) Who is responsible for your health? The construct of health locus of control. In: Sanders GS and Suls JM (eds) *Social Psychology of Health and Illness*. Hillsdale, NJ: Lawrence Erlbaum Associates, pp. 65–88.

Wallston KA, Wallston BS and DeVellis R (1978) Development of the multidimensional health locus of control (MHLC) scales. *Health Education & Behavior* 6(1): 160–170.

Wild D, Grove A, Martin M, et al. (2005) Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: Report of the ISPOR task force for translation and cultural adaptation. *Value in Health* 8(2): 94–104.

Yu CHA (2009) Illustrating degrees of freedom in terms of sample size and dimensionality. Available at: http://creative-wisdom.com/computer/sas/df.html (accessed 28 October 2015).