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# Latent structure of the hospital anxiety and depression scale: a 10 year systematic review

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*Manuscript



**Title:** Latent structure of the Hospital Anxiety and Depression Scale: A 10-year systematic review

**Running Head:** HADS Review

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**Keywords:** factor structure, Hospital Anxiety and Depression Scale, systematic review, psychometric properties

**Title:** Latent structure of the Hospital Anxiety and Depression Scale: A 10-year systematic review

**Objective:** To systematically review the latent structure of the Hospital Anxiety and Depression scale (HADS).

**Methods:** A systematic review of the literature was conducted across Medline, ISI Web of Knowledge, CINAHL, PsycINfo and EmBase databases spanning articles published between May 2000 and May 2010. Studies conducting latent variable analysis of the HADS were included.

**Results:** Twenty-five of the 50 reviewed studies revealed a two-factor structure, the most commonly found HADS structure. Additionally, five studies revealed unidimensional, 17 studies revealed three-factor, and two studies revealed four-factor structures. One study provided equal support for two- and three-factor structures. Different latent variable analysis methods revealed correspondingly different structures: exploratory factor analysis studies revealed primarily two-factor structures, confirmatory factor analysis studies revealed primarily three-factor structures, and item response theory studies revealed primarily unidimensional structures.

**Conclusion:** The heterogeneous results of the current review suggest that the latent structure of the HADS is unclear, and dependent on statistical methods invoked. **While the HADS has been shown to be an effective measure of emotional distress, its inability to consistently differentiate between the constructs of anxiety and depression means that its use needs to be targeted to more general measurement of distress.**

**Introduction**

Anxiety and depression are two of the most common psychological disorders (1), existing comorbidly with other psychological disorders, somatic disorders, and each other. Due to the high levels of comorbidity, the degree of symptom overlap, and the inextricable links between the symptoms of these disorders, they are often very difficult to differentiate (1-3). However, the Hospital Anxiety and Depression Scale (HADS) was created specifically to accomplish this task and to assess possible and probable cases of anxiety and depression in non-psychiatric hospital outpatients (4). The HADS is an important psychometric tool in the assessment of individuals with somatic illnesses, notably for coronary heart disease patients, predicting cardiovascular morbidity and mortality (5, 6). The 14-item HADS is composed of two 7-item subscales, the HADS-A and HADS-D, intended to measure mutually exclusive levels of anxiety and depression, respectively. Although the HADS has been used prolifically, a considerable level of controversy has arisen regarding the validity of the original anxiety and depression bidimensional structure. While a latent variable analysis was not conducted during the creation of the HADS, numerous studies have subsequently examined the validity of the originally proposed bidimensional anxiety-depression structure.

Although other psychometric aspects of the HADS have been shown to be consistently satisfactory, i.e. sensitivity, specificity, reliability, (7-9), the proposed bidimensional factor structure has come under significant scrutiny. In spite of the robustness of all other psychometric properties of the HADS, if Zigmond &

Snaith's original bidimensional structure is shown to be erroneous it cannot be conclusively deduced that the HADS is accurately measuring, and differentiating between, anxiety and depression (10). While two previous systematic reviews (7, 8) have supported the original bidimensional structure, the last of these was published over 10 years ago, and more recent studies have been adopting more sophisticated analyses.

There is a great degree of variance in the statistical robustness of the methods used to determine the latent structure of a psychometric measure. Exploratory factor analysis (EFA) methods summarise patterns of correlations among observed variables and reduce these observed variables into a smaller set of underlying variables, using largely arbitrary and subjective criteria to select the appropriate number of factors (10, 11), namely Kaiser criterion (Eigenvalues > 1) and Scree plots (extraction of factors above an inflection point on a graph of plotted Eigenvalues)(12). Confirmatory factor analysis (CFA), however, is an advanced model of classical test theory (CTT) factor analysis, allowing for the fitting of established factor models to the data, comparing and contrasting models for best-fit (10, 11, 13, 14). Based on a non-linear function created from item and ability parameters, item response theory (IRT) models, for example Rasch analysis, provide many advantages over CTT methods (15).

**The main advantages of IRT are centered on the scale (or item) and group (or examinee) independence (16). This item and ability parameter invariance is due to the incorporation of item information into the ability-estimation process and conversely the incorporation of examinee ability**

**into item-parameter estimation (15). In CTT, examinee and scale characteristics cannot be separated; the ability of the examinee and test can only be interpreted within the context of one another. Therefore, results derived from CTT method can only be interpreted within the context of the original sample population (15)**. In contrast, IRT results can be generalised to populations outside of the scope of the original study (15). Therefore, the strength and robustness of evidence provided by each of these methods increases from EFA to CFA to IRT.

The current study conducts a systematic review of studies examining the latent structure of the HADS, aiming to summarise evidence of extant HADS structures and of the existence of the bidimensional anxiety-depression structure, updating existing reviews.

## Methods

### *Search Strategy*

A systematic review of the literature was conducted across Medline, ISI Web of Knowledge, CINAHL, PsycINfo and EmBase databases spanning articles published between May 2000 (the cut-off date of the most recent systematic review (7)), but inclusive of articles not identified in the 2002 review, and May 2010. The words “hospital anxiety and depression scale,” “hospital anxiety and depression,” “HADS,” and “HAD scale” were combined with the Boolean operator “OR”. The HADS related search terms were then combined with the Boolean operator “AND” with psychometric search terms, ex. “factor analysis,” “factor structure,” “principal component analysis,” “psychometrics,” “validation,” “validity,”

“item response theory,” “reliability” etc. Where applicable, these terms were searched both as categorical search terms (i.e. MeSH) and as a keyword. An example search in PubMed is as follows: Factor Analysis, Statistical[Mesh] AND ("hospital anxiety and depression scale"[All Fields] OR "hospital anxiety depression scale"[All Fields] OR "HADS"[All Fields] OR "HAD"[All Fields])’.

*Study Inclusion*

Original studies conducting a latent variable analysis of the full HADS and published in English were included; therefore, duplicate articles, articles conducting only other forms of HADS analyses (ex. sensitivity and specificity), articles **conducting** analyses on only one of the HADS subscales **and** ineligible types of articles (ex. editorials, commentaries, retractions, etc.) were excluded from the review.

*Data Extraction*

The aforementioned search strategy was employed, extracting citations and abstracts. After eliminating duplicate articles, a comprehensive and independent abstract screening was conducted by TDC and FD. Lists of relevant articles were compiled and full-text articles extracted. Chosen articles were then independently examined for content by TDC and FD, accepting articles meeting inclusion criteria for further analysis. Data concerning the demographics of the study (e.g. sample size, sample population) as well **as** the methods of (e.g. factor analysis method, rotation used, variance explained), and results from (e.g. latent structure) latent variable analysis were extracted from the accepted studies. **Anomalous factor loadings, i.e. anxiety items significantly loaded (>.4) on**

**depression factor(s), depression items significantly (>.4) loaded on anxiety factor(s), insignificant factor loadings (<.4) on any factor, and/or significant loadings (>.4) on more than one factor, were noted.**

Results

The literature search identified 1666 unique studies, 199 of which were identified as an appropriate article conducting an analysis of the HADS; 50 articles met inclusion criteria (see Figure I).

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Insert Figure I here

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The latent structure of the HADS was examined using CTT methods **such as** principal components analysis, EFA, CFA, **as well as using** IRT methods, **notably** Differential Item Functioning (DIF) and Rasch analysis. CTT methods were utilized in all but four studies; 36 studies employed EFA and 24 CFA, 14 employed both.

*Exploratory Factor Analysis*

Within the EFA studies, the sample populations, methods and results were largely heterogeneous (Table I). Of the studies using exclusively EFA methods (n=22) to determine factor structure, i.e. excluding studies using both EFA and CFA, 18 studies found a two-factor structure, two found a three-factor structure and **two** found a four-factor structure. Of the 18 EFA studies finding two-factor structures, anomalous factor loadings (>.4) were revealed in 12 of the 14 studies

listing HADS factor loadings. **The median sample sizes for studies, utilizing exclusively EFA, finding two-, three- and four-factor structure were 521, 1405 and 100, respectively.**

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Insert Table I here

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*Confirmatory Factor Analysis*

CFA studies compared a number of varying latent structure models, with largely heterogeneous results (Table II). A single study found a one-factor structure, seven found a two-factor structure, 15 found a three-factor structure and one study provided equivocal evidence for both two- and three-factor models. The most commonly fit model was that of Dunbar (2000) – a three-factor model consisting of Autonomic Anxiety (Items 3, 9, 13), Anhedonic Depression (Items 2, 4, 6, 8, 10, 12, 14), and Negative Affectivity (Items 1, 5, 7, 11), based on Clark & Watson's tripartite theory of anxiety and depression (17). **Other best-fit models included three-factor models by Caci (18) (Anxiety - Items 1, 3, 5, 9, 13; Depression - Items 2, 4, 6, 8, 10, 12; Restlessness – Items 7, 11, 14) and Friedman (19) (Psychic Anxiety – Items 3, 5, 9, 13; Depression – Items 2, 4, 6, 8, 10, 12, 14; Psychomotor Agitation - Items 1, 7, 11) as well as a two-factor model by Moorey (20) (Anxiety – Items 1, 3, 5, 9, 11, 13; Depression – Items 2, 4, 6, 7, 8, 10, 12, 14). The median sample sizes for studies finding one-, two- and three-factor structures were 434, 1322, and 314, respectively.**

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Insert Table II here

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*Item Response Theory*

**Just four studies employed IRT methods, three using Rasch analysis and one differential item functioning. All four studies (21-24) conducted with participants with Parkinson's' disease, musculoskeletal pain, cancer and breast cancer, respectively, revealed a unidimensional latent structure. The average sample size of the IRT studies was 856, with a range of 387-1855.**

## Discussion

The HADS is a prolifically administered self-report psychometric tool; however, despite its popularity, the latent structure remains unclear. The current study conducts a systematic review of HADS studies, published after the most recent systematic review (7), in order to examine the latent structure of the HADS and the existence of Zigmond & Snaith's originally proposed bidimensional anxiety-depression structure. The 50 extracted studies revealed a variety of methods and structures providing inconclusive evidence as to the latent structure of the HADS.

Although the greatest number of studies (25) indicate a two-factor structure, as revealed by EFA, CFA and IRT, an equal number of studies found alternative structures. Within studies finding a two-factor structure, 16 had

anomalous factor loadings (>.4), four of which had six or more anomalous factor loadings. **Notably, Item 7 was found to anomalously load in 20 studies, indicating that it is a particularly poor item.** The failure to consistently load on Zigmond & Snaith's original anxiety-depression factors provides strong evidence against this structure model.

Studies using EFA methods traditionally use factor extraction methods based on Eigenvalues, i.e. Kaiser criterion or Scree plots; however, the largest study in the current review, Mykletun et al. (2001; n=51,930), forced the extraction of two factors, thus preventing the possibly of alternative factor structure extraction. Although strengthened by the quantity of respondents, the methodological rigor is severely compromised by the elimination of alternative solutions by forced extraction of a two-factor structure.

Although Kaiser criterion and Scree plots could be considered more objective methods of factor extraction than forced extraction, the efficacy of these methods has been questioned. The Kaiser criterion has been almost universally criticized as an arbitrary cutoff point (25). In practice, a factor with an Eigenvalue of 1.01 is virtually equivalent to a factor with an Eigenvalue of .99; however, the Kaiser criterion deems the former, and not the latter, as a factor to be extracted (26). Although Scree plots are an advance over Kaiser criterion extraction, no objective definition of a "clear break" in the graph has been established, leading to a large degree of subjective interpretation and, subsequently, criticism (26). The flaws inherent in the methods used to determine the number of extracted factors draws attention to the inferiority of EFA methods in comparison to CFA

and IRT methods. Consequently, the ability of EFA methods to objectively extract the appropriate number of factors from the data is debatable, as reflected in the heterogeneous results produced by EFA methods.

CFA methods provide more compelling evidence of latent structure than EFA methods; however, these methods produced equally heterogeneous results. The ability to fit existing models, often derived from EFA methods, provides the advantage of testing specific models (and specific latent structures) for fit to the data. In contrast to the primarily two-factor structures revealed by EFA studies, CFA studies found primarily three-factor structures. There have been many proponents of the three-factor structure (10, 18, 19, 27), each with unique combinations and distributions of items within factors. In the current study, Dunbar's (2000) model has received the most support. Despite fitting neatly within the theoretical framework set out by Clark & Watson (17), Dunbar's three-factor structure (and all other three-factor structures, for that matter) of the HADS would require a complex scoring algorithm to interpret the result (28); thus, detracting from the attractive simplicity of interpretation found in the original HADS.

**The heterogeneity of factor structures is highlighted by a side by side comparison of the structures revealed in the three most commonly used sample populations in the current review (Table III). The largest degree of heterogeneity occurs in studies of cancer patients; two studies revealed unidimensional structures, four revealed two-factor structures, one revealed a three-factor structure and another a four-factor structure. In**

**studies conducted in non-clinical populations four of six studies revealed two-factor structures; however, in studies conducted in cancer populations five of seven studies revealed three-factor structures. These results highlight the large degree of variance within, and across, sample populations and the influence of statistical methodology on latent structure. Within the six non-clinical studies, three of three EFA studies revealed two-factor structure and two of three CFA studies revealed three-factor structures. Similarly, amongst cardiac populations five of seven CFA studies revealed three-factor structures and amongst cancer populations two of two IRT studies revealed unidimensional structures, three of four EFA studies revealed two-factor structures and one of two CFA studies revealed a three-factor structure. Although the vast majority of studies employed CTT studies, unlike IRT methods, these results cannot be generalised beyond the study's specific sample population.**

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Insert Table III here

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Although present in limited numbers, studies employing IRT methods provided the only homogenous latent structure results. An inherent advantage of IRT methods is the ability of the results to be generalised to populations other than the one specified in the study (15). The current study revealed that the

unidimensional model suggested by IRT studies was tested in the majority of reviewed CFA studies; however, only one study (29) identified it as the best fit model. While more compelling evidence is provided by IRT methods, the presence of a single study, out of the 46 using alternative methods, identifying a unidimensional best-fit structure suggests that an increase in IRT studies will be necessary to fortify the unidimensional findings of the extant studies.

**Although providing numerous advantages over CTT methods, IRT methods are not infallible. The degree to which an IRT method is able to provide robust statistical evidence depends largely on the method itself. For example, although Rasch analysis provides strong evidence of scale unidimensionality, it is subject to many limitations (30), and more flexible IRT methods, such as Mokken scaling (a non-parametric IRT model) should be adopted. Unfortunately, the application of nonparametric IRT procedures on HADS data has been limited.**

Previous systematic reviews (7, 8) have attested to the suitability of the HADS for the assessment of anxiety and depression; however, the current review suggests that the underlying structure of the HADS, and therefore it's ability to assess anxiety and depression, is uncertain. **However, a recent systematic review and meta-analysis of the case-finding ability of the HADS attests to the practical value of the HADS (9), suggesting that the HADS is an effective tool in the identification of "emotional distress".** The current review supports this finding, suggesting that the phenomena captured by the HADS are unclear, as revealed by the heterogeneity of the latent structure across a variety

of sample populations and employed statistical methods. **Several sample populations, notably cancer patients and pregnant women, demonstrated particularly poor psychometric properties; therefore, results from these populations must be interpreted with caution. While the theoretical, and statistical, underpinnings of the original HADS structure may be flawed, the HADS has remained a prolifically used assessment tool because it is a valuable clinical assessment tool (9). The HADS has been shown to be an effective measure of emotional distress, but its ability to differentiate between the constructs of anxiety and depression is unclear.**

**Future research should concentrate on more robust statistical procedures, i.e. IRT methods, and empirically assessing whether such psychometric scales perform similarly across populations. Such analyses may also have implications for theoretical developments of anxiety and depression, notably with regards to the Clark and Watson's tripartite theory (17), see Dia et al. (32). However, given the profound heterogeneity revealed in extant studies, this issue is unlikely to be resolved. The current review reveals an inconclusive latent structure, suggesting inconsistent evidence as to the ability of the HADS to assess and differentiate between anxiety and depression. Despite deviating from the intended bidimensional structure originally posited by Zigmond and Snaith (4), the HADS is a clinically useful scale of emotional distress, notably regarding case finding ability (9). The HADS has been shown to have strong practical value for clinicians; however, the absence of psychometric robustness suggests that**

**researchers should interpret subscale scores with caution or use the total HADS score.**

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**Table(s)**

Table I: Structure and methods of studies employing EFA

| Citation | N | Population | Method | Structure | Anomalous FLs (>.4) |
|---|---|---|---|---|---|
| Johnston, et al. (2000) | 434 | Breast Disease Outpatient, Myocardial Infarction, Stroke | EFA and CFA | 1 | 2,8,12 |
| Gough & Hudson (2009) | 106 | Caregivers | EFA | 2 | 7 |
| Andrea, et al. (2004) | 7472 | Non-Clinical | EFA | 2 | 7 |
| Quintana, et al. (2003) | 685 | Eating Disorders, Ulcerative Colitis, Chronic Inflammatory Bowel Disease, | EFA | 2 | 1,2,3,4,5,6,7,8, 10,11,12,13,14 |
| Olsson, et al. (2005) | 1781 | General Practitioners' Patients | EFA | 2 | n/a |
| Smith, et al. (2002) | 1474 | Cancer | EFA | 2 | 7 |
| Leung, et al. (1999) | 93 | Hospital In-Patients | EFA | 2 | 5,7,11 |
| Flint & Rifat (2002) | 213 | Major Depressive Disorder | EFA | 2 | 8 |
| Marinus, et al. (2002) | 177 | Parkinson's Disease | EFA | 2 | 7,8, |
| Herrero, et al. (2003) | 385 | Hospital Outpatients | EFA | 2 | 6 |
| Michopoulos, et al. (2008) | 521 | Elderly/Outpatients | EFA | 2 | 1,9,14 |
| Muszbek, et al. (2006) | 715 | Cancer | EFA | 2 | 1,7 |
| Rodriguez-Blazquez, et al. (2009) | 387 | Parkinson's Disease | EFA | 2 | n/a |
| Hansson, et al. (2009) | 737 | Reported Depressive Symptoms | EFA | 2 | n/a |
| Mystakidou, et al. (2004) | 120 | Cancer | EFA | 2 | - |
| Woolrich, et al. (2006) | 963 | Spinal Cord Injury | PCA | 2 | 7 |
| Mykletun, et al. (2001) | 51930 | Non-Clinical | PCA | 2 | - |
| Dagnan, et al. (2008) | 187 | Intellectual Disabilities | PCA | 2 | 2,7,8,13 |
| Pais-Ribeiro, et al. (2007) | 1322 | Cancer, Stroke, Epilepsy, Coronary Heart Disease, Diabetes, Myotonic Dystrophy, Obstructive Sleep Apnea, Depression, Non-Clinical | EFA and CFA | 2 | 1,5,6,7,9,13 |
| Pallant, et al. (2005) | 296 | Musculoskeletal pain | EFA and CFA | 2 | 1,4,5,6,7,10 |
| Gale, et al. (2010) | 5153 | 4 Cohort Groups | EFA and CFA | 2 | n/a |
| Matsudaira, et al. (2009) | 1477 | Psychiatric Outpatients, Non-clinical | EFA and CFA | 2 | 6,7,10 |
| Thomas, et al. (2005) | 236 | Cancer | PAF and CFA | 2 | 5,7,8,10,12,14 |
| Roberts, et al. (2001) | 167 | Female Cardiac patients | PCA and CFA | 2 | - |
| White, et al. (1999) | 334 | Non-Clinical | PCA and HCA | 2 | n/a |
| Dawkins, et al. (2006) | 140 | Acquired Brain Injury | PCA | 3 | 7 |
| Friedman, et al. (2001) | 2669 | Major Depressive Disorder | PCA | 3 | 7,8 |
| Barth & Martin (2005) | 1320 | Coronary Heart Disease | EFA and CFA | 3 | 7,8 |
| Martin, et al. (2004) | 160 | End-stage Renal Disease | EFA and CFA | 3 | 8,14 |
| McCue, et al. (2003) | 117 | Chronic Fatigue Syndrome | EFA and CFA | 3 | 8 |
| Rodgers, et al. (2005) | 110 | Cancer | EFA and CFA | 3 | 10 |
| Jomeen & Martin (2004) | 101 | Pregnant | EFA and CFA | 3 | 7 |
| Martin & Newell (2004) | 376 | Facial Disfigurement | EFA and CFA | 3 | 7,8,14 |
| Allan, et al. (2009) | 100 | Schizophrenia | EFA and CFA | 3 | 6,7,8 |
| Lloyd-Williams, et al. (2001) | 100 | Terminal Cancer Inpatients | EFA | 4 | 2,4,6,7,10,13 |
| Karimova & Martin (2003) | 100 | Pregnant | MLA | 4 | n/a |

Table I: FL = Factor Loading, EFA = Exploratory Factor Analysis, CFA = Confirmatory Factor Analysis, PAF = Principal Axis Factoring, PCA = Principal Components Analysis, HCA =Hierarchical Cluster Analysis, MLA = Maximum Likelihood Analysis, - = No Anomalous Factor Loading, n/a = Information unavailable

Table II: Structure and methods of studies employing CFA

| Citation | n | Population | (R-)CFI | R-RMSEA | Structure | Best Fit Model |
|---|---|---|---|---|---|---|
| Johnston, et al. (2000) | 434 | Breast Disease Outpatient, Myocardial Infarction, Stroke | - | - | 1 | - |
| Chan, et al. (2010) | 5857 | Non-Clinical | 0.91 | 0.05 | 2 | - |
| Gale, et al. (2010) | 5153 | 4 Cohort Groups | 0.94 | 0.04 | 2 | - |
| Matsudaira, et al. (2009) | 1477 | Psychiatric Outpatients, Non-Clinical | 0.96 | 0.05 | 2 | - |
| Pais-Ribeiro, et al. (2007) | 1322 | Cancer, Stroke, Epilepsy, Coronary Heart Disease, Diabetes, Myotonic Dystrophy, Obstructive Sleep Apnoea, Depression, Non-Clinical | 0.95 | 0.05 | 2 | - |
| Pallant, et al. (2005) | 296 | Musculoskeletal pain | 0.96 | 0.06 | 2 | - |
| Thomas, et al. (2005) | 236 | Cancer | - | - | 2 | - |
| Roberts, et al. (2001) | 167 | Female Cardiac patients | - | 0.06 | 2 | - |
| Jomeen & Martin (2004) | 101 | Pregnant | 0.82 | 0.09 | 3 | Caci |
| Hunt-Shanks, et al. (2010) | 801 | Cardiac Inpatients | 0.93 | 0.12 | 3 | Dunbar |
| Martin, et al. (2006) | 314 | Non-Clinical | 0.98 | 0.06 | 3 | Dunbar |
| McCue, et al. (2004) | 494 | Chronic Fatigue Syndrome | 0.95 | 0.06 | 3 | Dunbar |
| Martin, et al. (2004) | 160 | End-stage renal disease | 0.96 | 0.07 | 3 | Dunbar |
| McCue, et al. (2003) | 117 | Chronic Fatigue Syndrome | 0.94 | 0.07 | 3 | Dunbar |
| Rodgers, et al. (2005) | 110 | Cancer | 0.96 | 0.05 | 3 | Dunbar |
| Desmond & (2005) | 680 | Amputees | 0.98 | 0.04 | 3 | Dunbar |
| Martin, et al. (2004) | 138 | Acute Coronary Syndrome | 0.88 | 0.07 | 3 | Dunbar and Caci |
| Martin, et al. (2003) | 335 | Post-Myocardial Infarction | 0.97 | 0.04 | 3 | Dunbar's Hierarchical |
| Martin, et al. (2008) | 1793 | Coronary Heart Disease | 0.96 | 0.05 | 3 | Friedman |
| Martin & Newell (2004) | 376 | Facial Disfigurement | 0.96 | 0.07 | 3 | Friedman |
| Caci, et al. (2003) | 195 | Non-Clinical | 0.98 | 0.04 | 3 | - |
| Allan, et al. (2009) | 100 | Schizophrenia | - | - | 3 | - |
| Barth & Martin (2005) | 1320 | Coronary Heart Disease | 0.96 | 0.05 | 3 | - |
| Wang, et al. (2006) | 154 | Coronary Heart Disease | 0.96 | 0.07 | 2 or 3 | Moorey or Dunbar |

Table II: (R-)CFI = (Robust) Comparative Fit Index , RMSEA = Root Mean Squared Error of Approximation

Table III. Structure and methods by population

| Population | Citation | n | Method | Structure |
|---|---|---|---|---|
| Non-Clinical | Andrea, et al. (2004) | 7472 | EFA | 2 |
| | Mykletun, et al. (2001) | 51930 | PCA | 2 |
| | White, et al. (1999) | 334 | PCA and HCA | 2 |
| | Chan, et al. (2010) | 5857 | CFA | 2 |
| | Martin, et al. (2006) | 314 | CFA | 3 |
| | Caci, et al. (2003) | 195 | CFA | 3 |
| Cardiac | Roberts, et al. (2001) | 167 | PCA and CFA | 2 |
| | Wang, et al. (2006) | 154 | CFA | 2 or 3 |
| | Barth & Martin (2005) | 1320 | EFA and CFA | 3 |
| | Martin, et al. (2004) | 138 | CFA | 3 |
| | Martin, et al. (2003) | 335 | CFA | 3 |
| | Martin, et al. (2008) | 1793 | CFA | 3 |
| | Hunt-Shanks, et al. (2010) | 801 | CFA | 3 |
| Cancer | Smith, et al. (2006) | 1855 | Rasch | 1 |
| | Osborne, et al. (2004) | 885 | DIF | 1 |
| | Smith, et al. (2002) | 1474 | EFA | 2 |
| | Muszbek, et al. (2006) | 715 | EFA | 2 |
| | Mystakidou, et al. (2004) | 120 | EFA | 2 |
| | Thomas, et al. (2005) | 236 | PAF and CFA | 2 |
| | Rodgers, et al. (2005) | 110 | EFA and CFA | 3 |
| | Lloyd-Williams, et al. (2001) | 100 | EFA | 4 |

Table 3: EFA = Exploratory Factor Analysis, CFA = Confirmatory Factor Analysis, DIF = Differential Item Functioning, PAF = Principal Axis Factoring, PCA = Principal Components Analysis, HCA =Hierarchical Cluster Analysis, MLA = Maximum Likelihood Analysis

**Figure(s)**

Figure I.

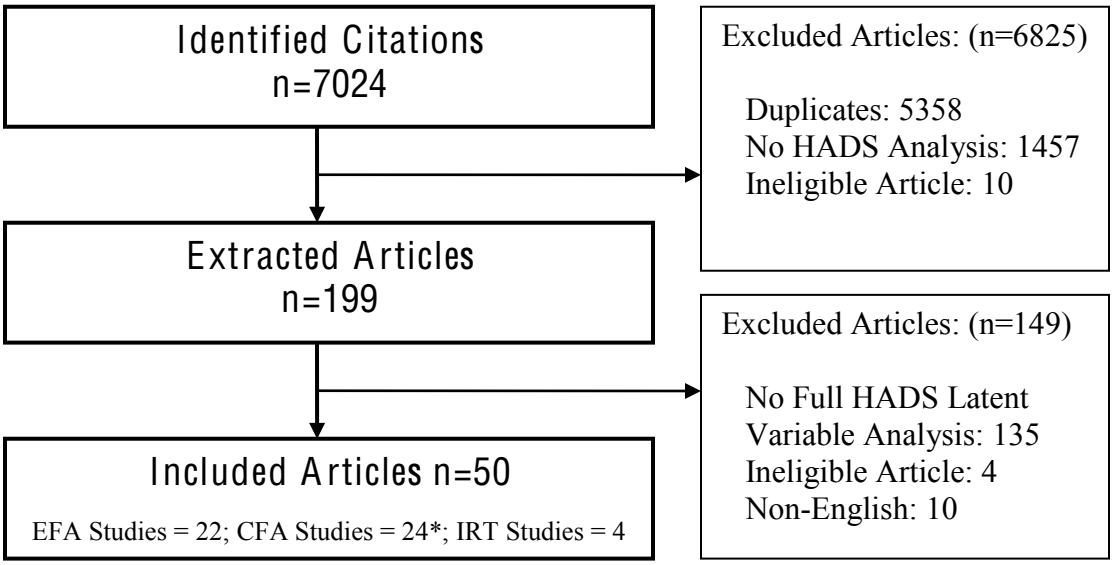

Figure I. * 14 CFA studies also employed EFA methods