



Title	Factorial structure of the Chinese version of the 12-item General Health Questionnaire in adolescents
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Abstract

Aims. To evaluate the underlying factor structure of the Chinese version of GHQ-12 using exploratory and confirmatory factor analyses in Chinese adolescents and find out which factor model proposed by previous empirical research is the best-fit model.

Background. The 12-item General Health Questionnaire has been extensively used with adolescents in the West. Yet, it has not been used with adolescents in a Hong Kong Chinese context.

Design. A cross-sectional study was employed.

Method. Chinese students between the ages of 12 and 19 from four secondary schools were invited to participate in the study using the multiple-stage stratified random sampling method during the period from December 2007 - February, 2008. The total sample size included in the final analysed was 1883.

Results. The GHQ-12 was found to be internally consistent. The results of exploratory factor analysis showed that there are two factors underlying the GHQ-12. Of nine factor models were tested by means of confirmatory factor analysis, only three factor model: the eight-item two-factor model, 12-item three-factor model and 10-item two-factor model, demonstrated good model fit across all model fit indices.

Conclusion. This study addressed a gap in the literature by evaluating the factorial structure of the Chinese version of GHQ-12 using exploratory and confirmatory factor analyses in

Chinese adolescents. The findings revealed that the eight-item two-factor model is the best-fit model.

Relevance to clinical practice. The adolescent mental health problem is alarming and aggravating and warrants special attention. It is essential for community nurses to differentiate psychological distress in adolescents and to identify those adolescents who are at a higher risk of suffering from mental health problems. The availability of a valid and reliable instrument that measures adolescents' psychological distress is crucial before any nursing interventions to promote their mental health can be appropriately planned, implemented and evaluated.

Key words: nurses, nursing, general health questionnaire, adolescents, China, factor analysis

Introduction

Mental health problems in adolescents are becoming more serious all over the world and have turned out to be a major public health concern. A review of the literature shows that a lot of studies have been carried out in the West to investigate adolescent mental health (Rivas & Fernandez 1995, Bolognini *et al.* 1996, Byrne 2000, Trzesniewski *et al.* 2006). Nevertheless, there has been very limited research into the mental health problems of adolescents in Hong Kong Chinese Context despite a previous study found that self-report of depressive symptoms among the community of adolescents in Hong Kong was higher when compared with its western counterparts (Stewart *et al.* 1999).

Hong Kong has been undergoing a rapid socio-political transition with major changes in social and economic structures, traditional values, family structure and education curriculum. Lam *et al.* (2004) pointed out that with such changes, adolescents lose a strong sense of purpose in life. A strong purpose in life has been shown to contribute to good mental health in Chinese adolescents (Shek 1996). Besides, the change from an extended to nuclear family structure has had an impact on adolescent mental health. Because there are fewer siblings in nuclear family, children are afforded more attention and are over-protected by parents. Moreover, the increase of single parent families as a result of the sharp increase in the divorce rate in Hong Kong has significant negative and enduring impacts on adolescent mental health (Yip *et al.* 2003). Previous studies have shown that adolescents coming from single parent

families are associated with poorer mental health than adolescents living with both parents (Chung 2000, Chen *et al.* 2007). Additionally, factor that contributes to the increase in adolescent mental health problems in Hong Kong has been the great expectations of academic achievement from both their parents and their schools. In a comprehensive review of the mental health of Hong Kong children, Wong and Tsoi (1999) reported that most parents in Hong Kong have high expectations of their children and they regard academic achievements as the top priority in childcare. This may be due to the common attitude, held by parents and by most of the students, that academic achievement is related to a better career and bright future (Tsoi & Pryde 1999). Given this issue, Hong Kong Chinese children are exposed to considerable stress within the family and school while growing up. Indeed, the adolescent mental health problem in Hong Kong is alarming and aggravating and warrants special attention. It is essential for community nurses to differentiate psychological distress in adolescents and to identify those adolescents who are at a higher risk of suffering from mental health problems. First, however, a valid and reliable instrument that measures adolescents' psychological distress is crucial before any interventions to promote their mental health can be appropriately planned, implemented and evaluated.

The General Health Questionnaire (GHQ) is a widely used self-administered questionnaire designed to assess people's overall psychological health and to screen for general psychological distress symptoms rather than psychotic psychiatric problems (Goldberg 1972).

The GHQ was originally a 60-item questionnaire. In its later development, other shortened versions, such as 30-item version (GHQ-30, Shek 1998) and 12-item version (GHQ-12, Goldberg & Williams 1988) have been modified and used.

The short 12-item version (GHQ-12) has been extensively used in different cultures and translated into several languages, including Chinese (Pan & Goldberg 1990). The Chinese version of the GHQ-12 is widely used in Hong Kong to screen women for any psychological distress during pregnancy and in the postnatal period (Ip & Martin 2006). In a study of measurement invariance in the GHQ-12 in young Australian adolescents (aged 11-15), French and Tait (2004) found out that adolescents interpret the GHQ-12 in a similar manner to adults and the results of the study support for the validity of the survey with younger adolescents. More than twenty years ago, Shek (1988) conducted a comprehensive epidemiological study using the GHQ-30 to assess the mental health status of adolescents in Hong Kong. Yet, a review of literature reveals that the GHQ-12 has not been used with adolescents in a Hong Kong Chinese context. Although the GHQ-12 has been used frequently with adolescents in the West, there is currently no evidence to propose that GHQ-12 is suitable for use in Chinese adolescents. A comprehensive review of mental health in children provides evidence of differences in cognitive behaviour between Western and Hong Kong Chinese children (Wong & Tsoi 1999). Hong Kong Chinese children are more submissive and learnt to inhibit the expression of emotion more than Western children (Tsoi & Pryde 1999). Therefore, the

GHQ-12 has been found to be valid and reliable in measuring psychological distress in one clinical or culture group may be psychometrically compromised in another clinical or culture group.

Most importantly, the factor structure of GHQ-12 examined by previous studies was inconsistent (Vanheule & Bogaerts 2005, Ip & Martin 2006). Of 11 factors structure models were evaluated by means of confirmatory factor analysis based on data in a large Belgian sample, Vanheule and Bogaerts (2005) revealed that the two-factorial model (eight-item) developed by Kalliath *et al.* (2004) is the best fitting model. However, in a similar study using Chinese women at their third trimester of pregnancy as the study population, Ip and Martin (2006) found that the best-fit to the data in their study to be the three-factor model (12-item) of Worsely and Gribbin (1977). Indeed, Campbell *et al.* (2003) and Werneke *et al.* (2000) pointed out that the underlying factor structure of the GHQ-12 may be unstable in different cultural and clinical groups. This study aimed at evaluating the underlying factor structure of the Chinese version of GHQ-12 using exploratory and confirmatory factor analyses in Chinese adolescents.

Methods

Design and sample

A cross-sectional study was employed. Chinese students were selected from four secondary schools in Hong Kong by the multiple-stage stratified random sampling method, with school

types and school location as the stratifying factors.

A total of 1945 secondary school students between the ages of 12-19 (ranging from 7th to 12th grade), who are able to speak Cantonese and read Chinese, were invited to participate in this study after the purpose of the study was explained to them during the period from December 2007 - February, 2008. Although 38 students were absented as reported by the schools on the day of data collection, no student in attendance refused to participate. However, 62 questionnaires were found to be largely incomplete. Therefore, a total of 1883 questionnaires from a total eligible pool of 1945 students were used for the analysis. As the selected participants were from different regions and socio-economic classes in Hong Kong, the sample in this study can be considered as heterogeneous and is representative of the general population.

Measure

The 12-item General Health Questionnaire (GHQ-12) consists of 12 items with an equal number of positive statements, such as 'been able to face up to your problem' and negative statements, such as 'been losing confidence in yourself.' Subjects were asked to rate their responses using a four-point Likert scale ranging from 0 (more so than usual / not at all) - 3 (much less able / much more than usual), with total possible scores ranging from 0-36; the higher the score, the greater the psychological distress.

The Chinese version of the GHQ-12 has been widely used in different clinical populations

(Pan & Goldberg 1990, Ip & Martin 2006). These studies suggest that the GHQ-12 can be a valid screening instrument for psychological distress in epidemiological studies. Moreover, to ensure cultural congruence of a construct, a bilingual clinical psychologist working with Chinese children was consulted to review the context of the Chinese version of the GHQ-12. The items of the Chinese version of the GHQ-12 were found to reflect psychological health and distress symptoms that are also typical for Chinese adolescents. Internal consistency of the GHQ-12 was found to have an alpha coefficient of 0.87 in this study.

Data collection procedures

Study approval was obtained from the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong and the schools. The principal and teachers of each school were fully informed about the study's purpose, nature, design and duration. Besides, parents were sent an information sheet with reply slip via schools to inform them a study was to be conducted to examine issues relevant to adolescent health. Parents were given the option to participate or refuse their child's involvement in the study. This procedure is commonly practiced, which is consistent with authority bestowed on schools in Hong Kong. Additionally, all participants were informed that they had the right to withdraw from the study at any time without prejudice to their academic performance and were assured of the confidentiality of the study. All participants were asked to fill in the demographic data sheet and respond to the Chinese version of the GHQ-12. All the questionnaires were distributed to and collected by

research nurses with assistance from schools' teachers. As students generally required 8 minutes to complete the questionnaires, the survey caused minimal disturbance to the normal class activities.

Data analysis

Internal consistency reliability was assessed by calculating Cronbach's alpha. To examine the underlying factor structure of the Chinese version of GHQ-12, both exploratory and confirmatory factor analyses were performed. As confirmatory factor analysis would need to be performed on a different set of data to confirm the results of an exploratory factor analysis (Floyd & Widaman 1995), the original data set was randomly split into two (dataset A & B). EFA was performed on the dataset A ($n = 942$) and CFA was performed on the dataset B ($n = 941$). Prior to performing EFA and CFA, the suitability of two data sets for factor analyses were confirmed by using Bartlett's test of Sphericity and the Kaiser-Meyer-Okin (KMO) measure of sampling adequacy. In addition, graphical and statistical methods were conducted to check for normality. For graphical method, the two datasets were assessed by inspecting the shape of the distribution (histograms) and normal probability plots (Normal Q-Q Plots). For the statistical method, Kolmogorov-Smirnov statistic was used to assess the normality of the distribution of scores of the two datasets.

Exploratory Factor analysis

To examine the factorial structure of the Chinese version of the GHQ-12, EFA was performed

using the STATISTICAL PACKAGE FOR SOCIAL SCIENCES (spss) software, version 16.0 for Windows (SPSS Inc., Chicago, IL, USA). A principal components analysis was used. Two techniques of factor extraction: Kaiser's criterion and Catell's (1966) scree test were used to assist in the decision regarding the number of factors to be retained for further investigation in this study. With reference to Kaiser's criterion, only factors with an eigenvalue of 1.0 or above are retained for further investigation. For the scree test, Catell (1966) recommends that all factors above the elbow, or break in the plot, should be retained as these factors contribute the most to the explanation of the variance in the data set. As previous study revealed that the extracted factors were positively correlated (Ip & Martin, 2006), both orthogonal and oblique rotation methods were used as recommended by Watson and Thomposn (2006).

Confirmatory Factor Analysis

To allow more precise testing the configuration of the factor structures of the Chinese version of the GHQ-12, CFA using LISREL version 8.8 for Windows (Scientific Software International Inc., USA) was performed. The parameters were then estimated by the generally weighted least squares method using asymptotic covariance matrix. The overall fit of the data-model with the scale was then examined by the goodness of fit indices including chi-square / degrees of freedom ratio (χ^2/df ratio), Root Mean Square Error of Approximation (RMSEA), Comparative Fix Index (CFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Incremental Fix Index (IFI), Normal Fit Index (NFI), Non-Normal Fit

Index (NNFI), Parsimony Goodness of Fit Index (PGFI), Akaike Information Criterion (AIC) and Consistent Akaike Information Criterion (CAIC). The χ^2/df ratio is a measure of global fit. A χ^2/df value between 1 and 5 indicates a good fit (Bollen 1989). The RMSEA is an indication of model fit and is based on the population discrepancy function, which is a standardised measure of error of approximation (Steiger 1979, Li *et al.* 2007). MacCallum (1995) recommended researchers should consider using RMSEA as it is an important measure of lack of fit per degree of freedom. In general, RMSEA values of less than 0.05 indicate a superior model fit. Yet, Browne and Cudeck (1993) argued that RMSEA values of up to 0.08 suggest a reasonable fit of the model in the population. The GFI and AGFI are two measures of global fit between a theoretical model and data. A value of 0.9 or higher is considered indications of good model-data fit (Floyd & Widaman 1995). The CFI, IFI, NFI and NNFI are the indicators that measure how much better the model fits compared with an independence model. These measures vary from zero to one; a value of 0.95 or higher indicates a good fit (Hu & Bentler 1999). The PGFI takes parsimony fit into account with larger values indicate parsimonious fit to the data. Lastly, the model with smallest AIC and CAIC values is taken into account the best model (Jöreskog & Sörbom 1993).

Eight models were tested based on previous CFA on the instrument (Graetz 1991, Politi *et al.* 1994, Kilic *et al.* 1997, Worsley & Gribbin 1997, Goldberg & Williams 1988, Martin 1999, Doi & Minowa 2003, Kalliath *et al.* 2004). A further model based on the result of EEA in this

study was also put into analysis.

Results

The demographic data of the secondary students are shown in Table 1. The results indicate that there were equal numbers of boys and girls. The mean scores of children's ratings on the GHQ-12 were 12.95 (SD 5.71) with a range of 0-36.

Results showed that the internal consistency of the Chinese version of the GHQ-12 was 0.87. These results indicated a reliability of 0.8 or higher, which is acceptable (Nunnally & Bernstein 1994). The item-total correlation data showed that all the items are correlated significantly with the total, with values ranging from 0.40-0.70.

The results showed that the KMO values were 0.86 and 0.89 for data set A and B, respectively, exceeding the recommended value of 0.6 (Kaiser 1970, 1974) and Bartlett's (1954) test of Sphericity reached statistical significance for both set of data, supporting the factorability of the correlation matrix. By inspecting the histograms, the scores of the two sets of data appeared to be reasonably normally distributed. The results were also supported by inspection of the normal probability plots. A reasonably straight diagonal line on all variables for the two sets of data suggested no major deviations from normality. However, the results of Kolmogorov-Smirnov statistic revealed significant findings for all variables, suggesting violation of the assumption of normality for these two sets of data.

Exploratory factor analysis

Principal components analysis revealed the presence of two components with eigenvalues exceeding 1 in this study, explaining 42.89 per cent and 10.38 per cent of the variance respectively. An inspection of the screeplot revealed a clear break after the second component. Therefore, it was decided to retain two components for further investigation. To aid in the interpretation of these two components, both orthogonal and oblique rotation methods were used. Both methods produced similar derived solutions to the factor analysis. However, the rotated solution by oblique via the Direct Oblimin procedure revealed the presence of a simple structure (Thurstone 1947), which is easier to interpret. Therefore, the result of oblique rotation was reported in the present study. Indeed, Watson and Thomposn (2006) claimed that the choice of rotation methods can be arbitrary and in reality both methods trend to give similar derived solutions to a factor analysis. The rotated solution, as shown in Table 2, yielded two interpretable factors anxiety present and anxiety absent, with both components showing several strong loadings and all variables loading substantially on only one component. There was only one item loaded on both factors, with small loadings on one factor and strong loadings on the other. The two-factor solution explained 53.27 percent of the total variance. The characteristics of nine factor model are shown in Table 3.

Confirmatory factor analysis

The overall fit of the nine factor models were examined by a variety of fit indices. The results are summarised in Table 3. The results revealed that all the two- and three-factor models, with

the exception of those of Goldberg and Williams (1988), Kilic *et al.* (1997) and Martin (1999) have acceptable model fit. However, evaluation of model fit indices revealed that the eight-item two-factor model developed by Kalliath *et al.* (2004) is the best-fit model. This model demonstrated highly acceptable model fit across all model fit indices. The parameter estimates of this best-fit model are shown in Figure 1.

Discussion

The GHQ-12 has been extensively used with adolescents in the West. Yet, it has not been used with adolescents in a Hong Kong Chinese context. In addition, the underlying factor structure of GHQ-12 explained by previous studies was inconsistent. The major objective of this study was to evaluate the factorial structure of the Chinese version of the GHQ-12.

Consistent with previous studies on the GHQ-12 (Ip & Martin 2006), the results of this study showed that the internal consistency of the Chinese version of the GHQ-12 was high. The item-total correlation data indicates that all items are highly correlated with the total scores. The findings suggested that these items are relatively homogenous and are measuring same psychological construct and thus, provide empirical evidence of the reliability of the GHQ-12.

The results of exploratory factor analysis provided strong evidence that there are two factors – anxiety/depression and social dysfunction - underlying the GHQ-12. Although the characteristics of factor structure are different, the interpretation of the two components was

consistent with previous factor analytic studies on Chinese (Ip & Martin 2006) and Western (Politi *et al.* 1994, Kilic *et al.* 1997, Doi & Minowa 2003, Kalliath *et al.* 2004) population. The two-factor solution explained 53.27 percent of the total variance, which was higher than the criterion of 50 per cent of the total variance explained as suggested by Streiner (1994).

To allow more precise testing of the instrument's factor structure, confirmatory factor analysis was performed to evaluate whether the proposed factor models by previous and present studies could adequately fit the data. For the parameter estimation in CFA, Maximum Likelihood is the method which is most commonly reported in literature (Aroian & Norris 2001). However, the maximum likelihood estimation procedure in CFA is developed under the assumption of a multivariate normal distribution of observed variables. Some researchers argue that variables obtained using Likert scales should only be treated as ordinal measures and thus the data are not normally distributed. Although some researchers claimed that CFA are robust to violations of normality when the sample size is large (Gorsuch 1983, Chou & Bentler 1995, Hu & Bentler 1995), using maximum likelihood to estimate parameters with violations of multivariate normality might lead researchers to inaccurately represent the degree of true model fit or increase the probability of rejecting a true model (Floyd & Widaman 1995). Therefore, in view of the Likert scale property of the GHQ and the fact that there were violations of the assumption of normality as indicated by the results of Kolmogorov-Smirnov statistic, an alternative estimation method - Generally Weighted Least

Squares, which is suggested by Jöreskog and Sörbom (1993) - was employed in this study.

The generally weighted least squares do not require the assumption of multivariate normality.

The results of exploratory factor analysis provided strong evidence that there are two factors underlying the GHQ-12 in this study. Nevertheless, the results of evaluation fit revealed that this factor model did not offer superior fit over the other factor models proposed by previous empirical research. Indeed, an incongruence finding between EEA and CFA has been demonstrated in previous research (Martin 2005). Martin and Newell (2004) claimed that because EFA uses arbitrary criteria to determine the number of factors and the fact that without a theory-driven framework of model evaluation, inconsistencies between EFA and CFA may be anticipated. In contrast with EFA, CFA using a variety of fit indices allows more precise testing of the instrument's factor structure (Floyd and Widaman, 1995).

Amongst all factor models being evaluated, the unitary (single factor) model was found to be the poorest fit to the data. These findings are consistent with previous studies suggesting that the GHQ-12 is a multi-dimensional scale that measures several distinct aspects of distress, rather than uni-dimensional measure of a general construct (Vanheule & Bogaerts 2005, Ip & Martin 2006).

The overall results of evaluation fit indices revealed that the eight-item two-factor model developed by Kalliath *et al.* (2004), 12-item three-factor model of Worsely and Gribbin (1977) and 10-item two-factor model of Graetz (1991) are the only good-fitting models with REMSA

values equal to 0.05. These three models also demonstrated highly acceptable model fit across other model fit indices (GFI, AGFI, CFI, IFI, NFI, & NNFI). However, by additional taking into consideration PNFI, AIC and CAIC, the factor model proposed by Kalliath *et al.* (2004) showed the largest PNFI with smallest AIC and CAIC suggesting this model is superior over the other factor models. In addition, given that the uni-dimensionality of the subscales (without cross-loadings), the model of Kalliath *et al.* (2004) is more favorable over the model proposed by Worsely and Gribbin (1977). This finding was inconsistent with Ip and Martin (2006) where they found that the 12-item three-factor model of Worsely and Gribbin (1977) was the best-fit model. However, it must be noted that Ip and Martin (2006) did not report the PNFI, AIC and CAIC in their study of CFA despite it is crucial in selecting the best model from competing factor-structure models by taking into consideration both parsimony and model fit.

The Path diagram shown in Fig. 1 represent the factor structure of the eight-item two-factor model developed by Kalliath *et al.* (2004), with all correlation matrices are less than 1 and are positive definite, indicating that the parameter estimated was reasonable. The factor loading for each observed variable was high, ranging from 0.62 to 0.89. The *t* values of all variables were greater than 2, suggesting statistically significant of the loadings. The standard errors range from 0.19-0.57, which is also acceptable. Nevertheless, further research is required to confirm the clinical utility of this eight-item two-factor model.

Conclusion

This study addressed a gap in the literature by evaluating the factorial structure of the Chinese version of GHQ-12 using exploratory and confirmatory factor analyses in Chinese adolescents. The findings suggest that the Chinese version of the GHQ-12 is multi-dimensional in nature rather than presumed uni-dimensional structure. Based on the results of fit indices in CFA, the eight-item two-factor model developed by Kalliath *et al.* (2004) is the best-fit model. Additionally, the results suggest that the Chinese version of the GHQ-12 is a reliable and valid self-report assessment tool in measuring general psychological distress symptoms in Chinese adolescents. The availability of a valid and reliable instrument is crucial for nurses to identify those adolescents who are at a higher risk of suffering from mental health problems so that interventions to promote their mental health can be appropriately planned, implemented and evaluated.

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