Revalidation of the global health questionnaire-12: factor analysis and demographic correlation

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Article Info

ABSTRACT

Global Health Questionnaire-12 (GHQ12) is the most common instrument used to measure mental health. However, the factor structure of the GHQ12 has not been fully explored. This study aims to assess the factorial structure of the GHQ12 and explore demographic factors associated with mental well-being in a population of prospective biology teachers in Indonesia. This cross-sectional survey was conducted for two weeks in July 2023 by recruiting 1186 students who were predominantly female (85.92%), over 20 years old (68.79%), only studying without working (90.47%), and third year (33.81%). Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to extract and assess the suitability of the resulting models. GHQ12 scores were also reviewed concerning demographic characteristics using comparison tests. Two factors including depression and social dysfunction accounted for 58.78% of the variance. This two-factor model was confirmed to fit the actual data. Additionally, we found differences between men and women on both factors and total scores. In addition, there are differences between students who only study and those who work on depression factors. This study suggests that the factor structure of the GHQ12 is a valid and reliable measurement for evaluating the mental health of prospective biology teachers.

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1. INTRODUCTION

The global health questionnaire (GHQ) was first developed by Goldberg to assess a person's self-reported mental health condition [1]–[3]. There are several versions of GHQ based on the number of items including GHQ1, GHQ12, GHQ20, GHQ28, GHQ30, and GHQ60 as the original version [4], [5]. However, the most popular short version used is GHQ12 for a number of reasons, namely ease of use, reporting format [6]–[9], simplicity [10], [11], good reliability [12], [13], and good specificity [14], [15].

On the other hand, although this instrument has been widely applied in different populations in various countries, both based on age groups including teenagers [8] and mature [16] as well as occupational groups such as teachers [4] and civil servants [1], however, the structure of GHQ12 is still unconvincing and prone to controversy [17], [18]. The original version of the GHQ12 was unidimensional, unfortunately, there is little to support the findings using such a single factor [19], [20]. The unidimensional version is

questionable regarding its ability to provide sufficient information [19]. Meanwhile, a number of other studies project GHQ12 into two or three factors [4], [5]. Therefore, exploration and verification of the factor structure of the GHQ-12 should be examined in new populations to ensure its reliability is similar to that of the original version.

In Indonesia, little research has focused on the implementation of GHQ12 [21], [22]. In addition, there are limitations that currently prevent its use in the context of student Biology teachers. First, research by Prabowo *et al.* [22] covers the female population in the context of the pandemic and Anjara *et al.* [21] includes clinical patients. In this study, we explored the population of prospective Biology teacher students. Second, the average age of the sample in Prabowo *et al.* [22] research is 29 years old and Anjara *et al.* [21] study is 46 years old, our population is represented by teacher candidates who are much younger by an average of 20 years.

On the other hand, there are aspects that need to be considered when using questionnaires, for example, the characteristics of the research sample, the need for validated language translations, and the psychometric properties of the instrument [4]. Psychometric properties may vary among groups with different cultures [7]. Thus, it would be a mistake to translate psychometric findings obtained from an adult population to a student-teacher population as in this study. This deficiency indicates the need for research to detect the factor structure of GHQ12 through investigations of prospective Biology teachers. Although issues related to mental health are common among many groups, concerns about student teachers and their impact on their academic work are of individual and social significance [23].

Discussions of mental health and emotional competence of prospective teachers have become a major concern [24]–[27]. Factors that cause prospective teachers to experience mental health are behavior management, excessive learning load, and lack of support from the environment [28], [29]. The environmental context can have an impact on the level of mental health of prospective teachers [30]. Another main factor is the low readiness of prospective teachers when faced with pressure in teaching and classroom management [31]. The transition from prospective teacher to educator is particularly vulnerable to mental health decline [32]. Preparing mental health support for this group is crucial to ensuring teachers are prepared to deal with stress in the classroom [33]. It should be noted that this research focuses on supporting the availability of instruments to evaluate the mental health of prospective Biology teachers as an effort to diagnose and prevent the occurrence of mental health disorders when they become novice teachers.

In addition to the unknown factor structure of the GHQ12, structural invariance among demographic factors has also not been identified. In other words, no research has yet thoroughly tested the psychometric properties of the GHQ12 at the item level in a population of prospective biology teachers. To fill this gap, the present survey uses the GHQ12 to analyze the factorial structure, rigorously test psychometrics, and measure the mental health of prospective biology teacher students associated with demographic factors. Demographic factors including age, gender, and level of education have consistently been identified as having an association with levels of depression [34], [35], so it needs to be mapped as a potential predictor of mental health.

Thus, this study has three main objectives as follows: i) Examine the factor structure of GHQ12 through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA); ii) Test the internal consistency of the GHQ12; and iii) Measure the level of mental health of prospective teacher students and its relationship with demographic characteristics. This research is expected to provide broader empirical data in the development of the GHQ12 and promote it in independent mental health assessments in the population of prospective teachers in Indonesia. It cannot be denied that increasing research on mental health has also had an impact on increasing demand for valid and reliable research instruments for a number of vulnerable groups. This evaluation is very important as a basis for planning, implementing, and assessing how prospective teachers can receive social-emotional learning education as mental health support appropriately [36]–[38].

2. METHOD

2.1. Procedure

This research has received ethical approval from the university where the principal investigator works. After obtaining the approval, a preliminary study was carried out involving four prospective teachers as potential participants to obtain information on the readability of the GHQ12 instrument as shown in Table 1. The researchers first met directly with the participants to explain the purpose of the research, the scale used, and how to respond. In this preliminary study, the first researcher noted several things such as the time required, as well as statements that were still considered ambiguous and difficult for participants to understand. From these results, it was revealed that the 12 statement items presented in GHQ12 were found to be easy to understand. Participants took around 15-20 minutes to respond to the Indonesian version of the GHQ12 survey, according to Lee and Kim [4], but longer than reported by Montazeri *et al.* [39] which is only 10 minutes.

After the preliminary study, a main survey was conducted on prospective Biology teachers as targets. The principal researcher sent a request for permission to the head of the biology education study program at a number of state and private universities in Indonesia. The head of the study program who agrees then appoints one of his teaching staff to be the contact person with the principal researcher. Next, the principal researcher sent a survey in the form of a Google Form link that participants needed to fill out to the teaching staff. Thus, participants were recruited through online posts in social media groups, namely the Whatsapp group, which were sent by teaching staff to the students themselves.

In the post, there are a number of explanations such as research objectives and filling instructions. The first page of the Google Form contains a written statement from students that they are participating in this research voluntarily. Thus, returning the completed questionnaire is also considered a form of consent. The completed questionnaire is automatically submitted to the researchers but is anonymous and kept confidential. The survey period is set for approximately two weeks from June 14 to July 1, 2023 to provide flexibility in response time to this survey. To avoid duplicate participants, the Google Form was set to only provide one response. In total, 1,255 questionnaires were collected and 69 of them were excluded for the reason that they did not meet the inclusion criteria.

Table 1. EFA results for the student population of prospective biology teachers

GHQ12 items	Factor loadings	
	Factor 1 Depression	Factor 2 Social dysfunction
Item 1 Able to concentrate		0.642
Item 2 Lost much sleep	0.734	
Item 3 Playing a useful part		0.736
Item 4 Capable of making decisions		0.793
Item 5 Under stress	0.757	
Item 6 Could not overcome difficulties	0.601	
Item 7 Enjoy your day-to-day activities	0.530	
Item 8 Face up to problems		0.632
Item 9 Feeling unhappy and depressed	0.773	
Item 10 Losing confidence		0.552
Item 11 Thinking of self as worthless		0.617
Item 12 Feeling reasonably happy	0.660	
% of variance	49.714	9.067
Cumulative % of variance	49.714	58.781
KMO	0.912	
Bartlett's test of sphericity	χ^2/df= 1277.062/66	Sig. <0.001

2.2. Participants

This research employed a non-random purposive sampling technique. The inclusion criteria applied in our research are as follows: i) students studying in the biology education study program, ii) agree to the informed consent provided and return the complete questionnaire, and iii) did not report having experienced mental or conscious disorders in the last month. Participants involved in this research were 1,186 biology education students (85.92% female). When the survey was conducted, the participants aged less than 20 years were only 382 students (32.21%). A total of 113 (9.53%) participants were students who were working. Judging from the year of study, 139 new students (11.72%), 387 second-year students (32.63%), 401 third-year students (33.81%), 224 fourth-year students (18.89%), and 35 fifth-year students (2.95%).

We followed ethical considerations per the Helsinki Declaration, even though we did not have formal ethical clearance. Before participating in the research, all participants were fully informed about the study's purpose, procedures, and potential risks. The purpose of the study was communicated to the participants, and we guaranteed that their responses would be kept anonymous. We emphasized that participation was voluntary and that participants could withdraw from the study at any time and for any reason. In addition, all participants were secure, and they were neither physically nor mentally mistreated.

2.3. Measurement

The questionnaire given to students includes two main parts, namely general situation and GHQ12. General situations include working status, gender (male and female), age (less than 20 years or equal to or more than 20 years), and year of study (freshman, second year, third year, fourth year, and fifth year). (GHQ12) adapted from Lee and Kim [4]. This questionnaire has been translated from English to Indonesian using the back-to-back translation method. The translation results are validated by expert lecturers in the fields of evaluation and language. This questionnaire contains 12 items, scored on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree) [5]. Thus, the scores obtained range from 12 to 48 with higher

scores indicating worse conditions. GHQ levels are divided into 4 categories adapted from Liu *et al.* [40], namely 12-20 (healthy), 21-29 (fairly healthy), 30-38 (unhealthy), and 39-48 (very unhealthy).

2.4. Statistical analysis

The 1,186 participants were divided into three parts with the following details. The first 220 participants were taken for the exploration stage of the factorial structure of the student population of Biology teacher candidates. The next 216 participants were used for the factorial confirmatory analysis stage. The final 750 participants were prepared to measure the GHQ12 scores of prospective biology teacher students and their relationship with demographic factors. The analysis used in the first stage is EFA through main factor analysis (PCA). Test the adequacy of sampling using the Bartlett test and Kaiser–Meyer–Olkin (KMO). The number of factors retained was assessed based on eigenvalues >1. The varimax rotation technique was used to interpret the rotation structure. Items are retained if the item loading factor value is equal to or more than 0.5 [5].

Factorial (CFA) was conducted to assess various latent structure models of GHQ12. The model obtained from the results of this research was evaluated for suitability using a number of indices including chi-square (χ^2) <3 [41]; comparative fit index (CFI) ≥0.90 [42]; goodness-of-fit index (GFI) ≥0.90; standardized root mean square residual (SRMR) <0.08 [43], root mean square error of approximation (RMSEA) <0.08 [44]. To prove that the proposed model has a satisfactory model fit compared to other alternative models, this research was also compared with several other models, for example, the unidimensional model by Goldberg [2], two factors are correlated by Andrich and Schoubroeck [45] and Gouveia *et al.* [46] as well as a three-factor model correlated by Graetz [47], Martin [48], Worsley and Gribbin [49], and Lee and Kim [4]. A lower Akaike's information criterion (AIC) indicates a better model fit [4]. Meanwhile, internal consistency is calculated using three parameters, namely the assessment of the average variance related to the extracted factors (AVE) ≥0.50 [50], composite reliability (CR) ≥0.60 [51], and Cronbach α ≥0.70 [52] suggested in this research model.

Finally, we summarized the GHQ12 scores of prospective biology teachers with descriptive and inferential statistics. Descriptive statistics in the form of frequencies and percentages are used for categorical (demographic) data, while the mean and standard deviation are for the scores for each factor and the total GHQ12. Unpaired t-test to calculate GHQ12 traits related to factors of working status, gender, and age. One-way ANOVA was used to differentiate GHQ12 scores by year of study.

3. RESULTS AND DISCUSSION

3.1. EFA of the GHQ-12

The results of EFA show a KMO value of 0.912 and the Bartlett test with χ^2/df= 1277.062/66) as shwon in Table 1. This result is greater than the recommended 0.6 and is statistically significant (p-value <0.001) [53]. Based on eigenvalues and examination of the scree plot, two factors were found to explain the population of prospective biology teachers. Factor 1 consists of 6 items including items 2, 5, 6, 7, 9, 12 (factor loading from 0.53 to 0.77) with a contribution of 49.71% of variance. Factor 2 also consists of 6 items including items 1, 3, 4, 8, 10, 11 (factor loading from 0.55 to 0.79) with a contribution of 9.07% of variance. In total, the contribution of these two factors can explain the GHQ of prospective biology teachers by 58.78%.

3.2. Confirmatory factor analysis

Evaluation carried out with (CFA) using two correlated models achieved the best suitability as presented in Figure 1. More details, rate χ^2, comparative fit index (CFI), goodness-of-fit index (GFI), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR) achieve value 2.106, 0.945, 0.922, 0.072, and 0.028. Based on the criteria used in this research, it can be said that the fit is very satisfactory across all model fit indices. Across samples, the overall fit indices of the eight-factor models were examined across samples using various fit indices. The results show that all single, two, and three-factor models are quite appropriate and acceptable. However, the evaluation carried out using the mentioned model fit indices revealed that the three models proposed in this study achieved the best fit in the population of prospective biology Teacher students. Akaike's information criterion (AIC) statistics further confirmed the superior fit of the proposed three-factor model (model 8), as its AIC was 161.495, which was lower than the other models tested in this study as presented in Table 2.

Internal consistency with extracted factors (AVE), (CR), and Cronbach's α also showed encouraging results with scores as shown in Table 3. The AVE values obtained were 0.471 and 0.405, while the CR and Cronbach α values reached more than 0.80. In total, the Cronbach α value for GHQ12 with the two correlated models is 0.893 in the good category.
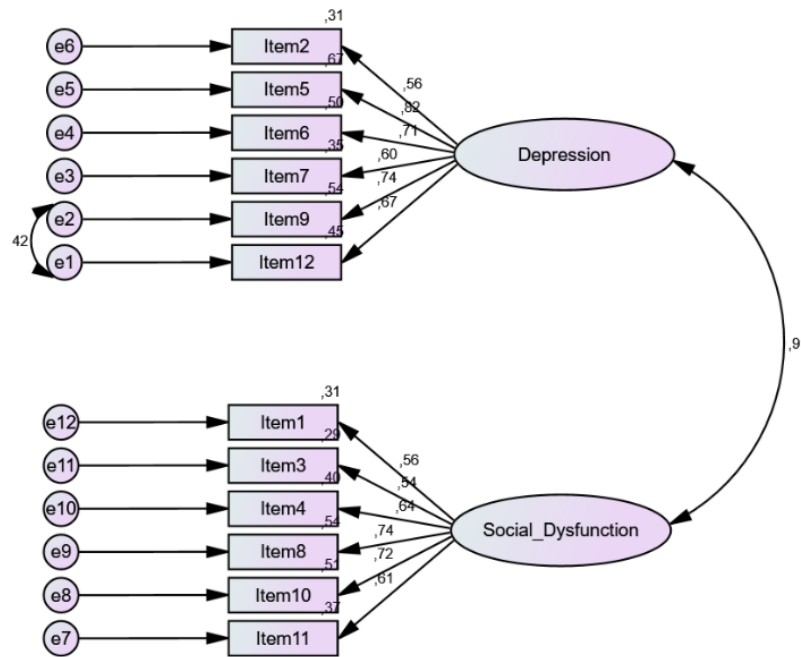
Figure 1. Two-factor correlated GHQ12 model for biology prospective teachers

Table 2. Goodness-of-fit indices for GHQ-12 models in CFA

Models	k	χ^2	df	χ^2/df	CFI	GFI	RMSEA	RMR	AIC
Goldberg [2]	12	163.604	54	3.030	0.896	0.880	0.097	0.034	211.604
Andrich and Schoubroeck [45]	12	163.521	53	3.085	0.895	0.880	0.098	0.034	213.512
Gouveia et al. [46]	12	163.406	53	3.083	0.895	0.881	0.098	0.034	213.406
Graetz [47]	12	149.772	51	2.937	0.906	0.890	0.095	0.032	203.772
Martin [48]	12	148.352	51	2.909	0.907	0.889	0.094	0.032	202.352
Worsley and Gribbin [49]	12	149.521	51	2.932	0.906	0.891	0.095	0.032	203.521
Lee and Kim [4]	12	159.272	51	3.123	0.897	0.883	0.099	0.033	213.272
Proposed model (this study)	12	109.495	52	2.106	0.945	0.992	0.072	0.028	161.495

Table 3. Internal consistency of GHQ 12 with 2-factor model

Dimensions/Factors	Items	Mark λ	AVE	CR	Cronbach α
Depression	2	0.557			
	5	0.819			
	6	0.710	0.471	0.840	0.843
	7	0.595			
	9	0.736			
	12	0.667			
Social dysfunction	1	0.556			
	3	0.539			
	4	0.636	0.405	0.801	0.800
	8	0.737			
	10	0.716			
	11	0.609			
Total GHQ12					0.893

3.3. Association with GHQ-12 factors

The total (GHQ) score for prospective biology teachers is 27.80±5.85 points. Scores for depression and social dysfunction each amounted to 14.53±3.31 dan 13.26±3.03. The results of this study also show that only 8.13% of students are classified as healthy, 57.47% have an adequate level of general health, 30.40% are classified as unhealthy, and another 4% are classified as very unhealthy. In other words, one-third of the participants showed worrying general health as shwon in Table 4.

Table 4. Analysis of GHQ12 degrees

Score	GHQ level	N	f (%)
12-20	Healthy	61	8.13
21-29	Pretty healthy	431	57.47
30-38	Not healthy	228	30.40
39-48	Very unhealthy	30	4.00

In more detail, female students have higher GHQ12 scores than male students, both on factors 1, 2 and total. The results of statistical analysis show that the differences between the two are significant. Meanwhile, even though students are of age <20 showed higher GHQ12 scores than the general group ≥20 but did not show a significant difference. Judging from the status aspect, students with study only status show poorer general health than students who also work. However, the results of the unpaired t-test showed that only factor 1 (depression) was significantly different. Finally, regarding GHQ12 scores based on year of study, fourth year students had lower scores compared to the other groups, but there were no significant differences either in each factor or in total as shwon in Table 5.

Table 5. Comparison of GHQ scores with different demographic characteristics

Variables		N	Factor 1			Factor 2			Total		
			Mean	SD	t/F	Mean	SD	t/F	Mean	SD	t/F
Gender	Female	647	14.66	3.29	2.661**	13.37	3.02	2.412**	28.03	5.81	2.756**
	Male	103	13.73	3.33		12.60	2.98		26.33	5.91	
Age	<20	270	14.79	3.23	1.605	13.54	3.08	1.879	28.33	5.79	1.881
	≥20	480	14.39	3.35		13.11	2.99		27.50	5.86	
Status	Study only	682	14.61	3.30	1.968*	13.32	3.03	1.566	27.93	5.83	1.924
	Study and working	68	13.80	3.32		12.72	2.98		26.50	5.85	
Year of study	1	99	14.40	2.83	1.829	13.59	2.93	0.501	27.99	5.22	0.901
	2	277	14.75	3.34		13.28	3.04		28.03	5.88	
	3	240	14.70	3.50		13.22	3.07		27.91	6.09	
	4	110	13.82	3.18		13.02	2.99		26.84	5.78	
	5	24	14.21	3.13		13.46	3.05		27.67	5.77	

In this study, we also predicted GHQ12 as a function of demographic characteristics, where general health was the dependent variable, while gender, age, status, and years of study were predictors. The calculation results show the following equation: $R = 0.135$; $R^2 = 0.018$; Durbin–Watson coefficient = 0.037; Gender: $\beta = -0.095$, $t = -2.594$, $P = 0.010$. In other words, only gender is a significant predictor of poor general health. Learning status ($\beta = -0.057$, $t = -1.547$, $P = 0.122$), age ($\beta = -0.050$, $t = -1.236$, $P = 0.217$), and years of study ($\beta = -0.027$, $t = -0.682$, $P = 0.495$) taken out of the equation.

3.4. Discussion

This study tested the psychometric properties of the Indonesian version of the (GHQ12) and used it to research prospective biology teachers. Previously there were research reports on GHQ12 in the Indonesian population [21], [22], however, as far as we know, this is the first study using EFA and CFA for prospective biology teachers. We studied the factor structure of the Indonesian version of the GHQ12 to provide more empirical evidence about the GHQ12 instrument and progress in measuring mental health in Biology teacher candidates as a vulnerable group that is rarely exposed.

EFA of the GHQ12 in our sample resulted in the extraction of two factors labeled as depression (factor 1) and social dysfunction (factor 2). Both explained 58.78% of the overall variance and 49.71% and 9.07%, respectively. These results rarely seem to be consistent with previous research, only a few studies have reached the same conclusion, namely two factors [45], [54], [55]. This EFA result was obtained because it was extracted based on eigenvalue criteria without being driven by theory [56]. Research conducted by Andrich & Schoubroeck [45] found two dimensions based on a collection of positive and negative words. Meanwhile, Schrnitz et al. [55] and Politi et al. [54] found two factors, namely anxiety/depression/dysphoria and social dysfunction/social performance. In other words, the two-factor structure better fits the GHQ12 in a sample of prospective biology teachers. The differences in factors obtained from a number of studies vary both in terms of item distribution and factor naming, perhaps influenced by norms and socio-cultural values.

Our CFA findings by comparing seven other models [2], [4], [45]–[49] show that only the model we proposed as an EFA result with a good goodness-of-fit index. CFA uses many fitness indices so the results are more accurate than EFA [57]. Thus, the overall CFA revealed that the original unidimensional model as

the initial form of the GHQ12, and the two-factor and three-factor multidimensional models as developments in the current study, proved to be less suitable with low incremental indices. Viewed from other aspects, the correlation between the two factors is moderate, reflecting the low amount of covariance. These results further support that the two-factor model in our study can be the best explanation of mental health in a sample of prospective biology teachers.

The findings in this study show the GHQ12 with satisfactory internal consistency for prospective biology teachers in Indonesia, which is similar to scores reported in other populations [4]. Reliability estimates via Cronbach alpha and CR for each factor and the total ranged from good to very good. Meanwhile, the AVE value is lower than the recommended value. A low AVE relates more to a rule of thumb than to a statistical testing procedure; for example different sampling [58].

This research involved respondents who were mostly women, aged ≥ 20 years, just studying without working, and in their second year. Our results showed that there were significant differences between men and women on the factors and overall scores. In other words, being female was significantly associated with both depression and social dysfunction factor scores. The results of this research are in line with a number of previous studies [59]–[61], but it contradicts other research [62]–[64]. Prowse *et al.* [65] reported that women were more likely to report physical and emotional symptoms related to stress experienced than men. Men reporting low levels of stress are less likely to be active in eliminating and managing stress [66].

Apart from that, it is viewed from another aspect, namely work. Students who simultaneously work have lower stress levels than those who only study depression factors. On the social dysfunction factor, students who also work also show lower scores than those who only study, but this is not significant. A possible explanation that can be put forward is that students who simultaneously work experience benefits such as social support which can be associated with improved academic performance at university and mental health [67], [68]. Students who simultaneously work also note other positive things such as interpersonal skills, better time management, and quite high self-confidence [69]. Students who work can have the ability to view themselves so as to avoid depression and carry out social functions [70].

The advantage of this research is that the CFA results show that the proposed model is better than the other seven models for comparison [2], [4], [45]–[49]. Thus, we accurately identified and determined the factor structure of the GHQ-12. However, there are limitations that need to be considered. First, prospective biology teachers are included in the occupational group that is vulnerable to mental health disorders, and it is confirmed that students who are below the threshold for showing good mental health are less than 10% of the total participants. Thus, EFA and CFA findings need to be interpreted with caution, and may not apply to different groups. Second, gender imbalance where women outnumber men. The reason for this gender imbalance may be due to society's perspective which views being a biology teacher as a woman's job. Testing the GHQ12 with a large and balanced sample of men and women will provide more accurate psychometric evidence. Third, our sampling strategy of only students for whom their study program had given permission may thus not result in a random sample. More research with random samples is needed to achieve further analysis, as well as verify the reliability and validity of the GHQ-12, especially its high AVE values.

These GHQ12 psychometric results have important implications for the diagnosis and assessment of mental health problems among prospective biology teachers in Indonesia. This research provides a reliable and valid instrument that can be used to recognize mental health conditions and measure the success of interventions to reduce the impact of mental health disorders in prospective teachers. The Indonesian version of the questionnaire can also be a sample size for non-clinical populations thereby adding practical value to the GHQ12.

4.   CONCLUSION

This research addresses the gap regarding the absence of research testing the psychometric properties of the GHQ12 in relation to prospective biology teachers in Indonesia. The findings of this study suggest that the GHQ12 is best understood as a two-factor rather than a unidimensional and three-factor tool. EFA results revealed two factors, namely depression and social dysfunction, and confirmed with CFA that this model offered the best fit to the data. This research also provides information regarding the internal consistency of the Indonesian version of GHQ12 through satisfactory Cronbach alpha, AVE, and CE. Thus, the Indonesian version of the GHQ12 can be used as an effective tool to measure the mental health disorders of prospective biology teachers. Furthermore, this research also provides information that the majority of prospective biology teachers are in poor mental health. Judging from demographic factors, there are significant differences between men and women. Gender was the only significant predictor of mental health in our population.

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