Discriminan Analysis and Prediction Power of Mental Testes for Diagnosis of Mental Disorders

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Abstract: Psychological tests for screening of mental health commonly have discriminative error and their accuracy is different. The aim of this study was to determine the power of discrimination and prediction of GHQ-28, BSI and MMPI tests either alone or in combination in diagnosis of mental disorders. **Material and methods:** General health questionnaire (GHQ-28), Brief symptom inventory (BSI) and Minnesota Multiphasic Personality Inventory (MMPI) questionnaires as self assessment were completed by 145 students of Kashan University of Medical Sciences in 2011-12. Next, they were interviewed based on DSM-IV-TR criteria and CIDI checklist by a clinical psychologist. Data analysis was done using Discriminant analysis. Finally, canonical coefficient correlation and corrected classification were calculated for each model. **Results:** Based on clinical interviews 83 subjects (57.2%) were normal. According to Discriminant analysis, corrected classification of GHQ-28, BSI and MMPI tests were 73.8%, 77% and 79.3% respectively. Maximum corrected classification (87.6%) was found in the combination of GHQ-28 and MMPI model. Moreover, canonical correlation coefficients for each test separately, were 0.597, 0.59 and 0.638 respectively and this index was 0.709 for their triplet combination. **Conclusion:** GHQ-28 and MMPI tests in combination had the most accuracy and the power of screening to diagnosis of psychological disorders was more than each test separately or in triple combination.

1. Introduction

Mental health is one of the important dimensions of health[1]. Prevalence of mental disorders varies from 8% (in the Netherlands) to 57% (for young people, California, USA)[2]. This assessment was carried out on students since they may suffer from mental disorders due to various reasons such as being away from family, fear of expressing personality, coping with opposite sex and many other causes[3]. Of course, prevalence measurement of mental disorder depends on the type of the study, diagnostic tools etc [3-5]. Self-report questionnaires, using for psychiatric symptoms measurement, can be used as a method for determination of different levels of symptoms severity. Moreover, they are useful screening devices and specific instruments for psychopathological aspects such as anxiety and depression[6]. Early diagnosis of mental disorders is useful for treatment and it will decrease unforeseen medical expenses[4, 5, 7].In addition, early detection and diagnosis will help to prevent of serious and chronic problems[8]. Screening instruments have important role in early detection of mental disorders in at risk population and they can be used for finding of rare cases of health problems and they can be compared based on their validity and accuracy[9]. In many cases, clinical psychologists doubt to effectiveness of tests, therefore they allocate part of their researches for measuring validity of instruments [3]. There are Different instruments for screening and diagnosis of mental disorders such as General Health Questionnaire (GHQ-28) [10, 11], brief symptom Inventory(BSI)[12] and Minnesota Multiphasic Personality Inventory (MMPI)[13] Tests that they have been made based on psychopathological descriptive and analytical criteria. This study was conducted in order to determine the power of discrimination and prediction of GHQ-28, BSI and MMPI tests either alone or in combination in diagnosis of mental disorders.

2. Material and methods:

Subjects: Participants were 145 volunteer students from four colleges of Kashan University of Medical Sciences, including health sciences, medicine, paramedical and nursing during 2011-12. All participants were enrolled consecutively during the study period.

Study Design: The study was conducted in two stages. Firstly, assistant explained how students must fill-out self- report questionnaires which included general health questionnaire (GHQ-28)[9, 10], BSI [12]and MMPI [12] respectively. Secondly, all

participants were interviewed based on DSM-VI-TR and CIDI checklist by a clinical psychologist.

Instruments:

A) General Health Questionnaire (GHQ-28): Includes 28 items, each item have scores 0 to 3 that overall score is 0 to 84. The questionnaire was designed by the Goldberg[14]. Its validity and reliability were calculated in different studies. Mean sensitivity and specificity of this questionnaire are 84% and 82% respectively, and its cut-off point was determined between 21 and 23 based on different studies.[8, 9, 14] .

B) Brief Symptom Inventory (BSI): It is a short form of the SCL-90-R[12] consists of 53 questions with a score of 0 to 3 and 9 subscales. It was built in 1975 by Derogatis. It's Validity coefficient is between 0.71 and 0.85[12, 15].

C) Minnesota MultiPhasic Personality Inventory (MMPI): includes 71 items with scores 0 and 1 for each item and nine subscale [11, 16, and 17]. It is one of the most popular psychopathological instrument for measuring of personality pathology, which was built by Kingly in 1943 with validity range of 0.7 - 0.8 and cut-off point of 65 [16].

Data analysis: Participants based on their clinical interview were grouped in healthy and patient groups. Next, Discriminant analysis and Lambda Wilk's criteria were used alone or in combination. Finally, normal range was determined for each function and sensitivity, specificity, corrected classification and canonical coefficient correlation were calculated.

3.Results

Based on clinical interview of 145 volunteer students, 62(42.8%) had pathological problem. Twelve cases had dysthiymic disorder, 10 cases GAD and 18 cases had co- morbidity. Mean and standard deviation of age in pathological and healthy groups were 20.9 ± 1.6 and 20.5 ± 1.6 years respectively. There was no significant difference between two groups of study regarding age and gender (p>0.05), but statistically significant difference was found between two groups regarding marital status (p=0.011).

Table 2 presents the results obtained from the ROC curve that shows sensitivity and specificity of each tool. These quantities for GHQ-28 were 69.4% and 68.7%, for BSI, 75.8% and 67.5% and for MMPI were 75.8% and 67.5% respectively. Corrected classification of each test was 69, 72.4 and 71 percent, respectively.

Table 1) Demographic characteristic of participants

Variables	Mental disorder group	Healthy group	p.value
Sex(female)	68(81.9)	49(79)	0.662
Age(≤22)	64(77.1)	45(72.6)	0.532
$\bar{X} \pm$SD(years)	20.87 ± 1.6	20.5 ± 1.9	0.263
Marital status(single)	75(90.4)	62(100)	0.011

Table 2) Frequency of participants based on psychiatric instruments and clinical interviewExtracted from the article author **(*The validity of GHQ-28, BSI and MMPI tests in mental health status of students*. life science journal, 2013. **10**: p. 314-319)[3]**

Instruments	STATUS	Clinical interview		Corrected classification	p.value
		Normal (n=83)	Mental disorder (n=62)		
GHQ-28	Negative(<22)	57(68.7)	19(30.6)	69	<0.001
	Positive(≥22)	26(31.3)	43(69.4)		
	$\bar{X} \pm$SD	19.2±9.5	28.8±14		
BSI	Negative(<41)	58(69.9)	15(24.2)	72.4	<0.001
	Positive(≥41)	25(30.1)	47(75.8)		
	$\bar{X} \pm$SD	40.2±30.4	69±40.9		
MMPI	Negative(<50)	56(67.5)	15(24.2)	71	<0.001
	Positive(≥50)	27(32.5)	47(75.8)		
	$\bar{X} \pm$SD	46.2±13.1	59±16.1		

Table 3) Results of DISCRIMINAN functions for psychiatric Instruments separately and in combinations

MODEL (Indep. Var.)	Predicted Group membership	Cross-validated		Correctly Classified For cross-validated group
		normal	disease	
GHQ-28	Normal	71(85.5)	26(41.9)	73.8%
	disease	12(14.5)	36(58.1)	
BSI	Normal	76(91.6)	25(40.3)	77.9%
	disease	7(8.4)	37(59.7)	
MMPI	Normal	71(85.5)	18(29)	79.3%
	disease	12(14.5)	44(71)	
GHQ BSI	Normal	78(94)	20(32.3)	82.8%
	disease	5(6)	42(67.7)	
GHQ MMPI	Normal	81(97.6)	16(25.8)	87.6%
	disease	2(2.4)	46(74.2)	
BSI MMPI	Normal	79(95.2)	22(35.5)	82.1%
	disease	4(4.8)	40(64.5)	
GHQ BSI MMPI	Normal	81(97.6)	18(29)	86.2%
	disease	2(2.4)	44(71)	

Table4) Frequency of participants based on interview and prediction in various DIS

Model	Wilk's lambda	Eigen value	Canonical correlation	Explained error	Canon. Disc. Fun. coef. (B)	Func. Of group centroid	
						Normal	disease
GHQ-28 CONS	0.644	0.553	0.597	35.6%	0.11 -2.5	-0.638	0.855
BSI CONS	0.652	0.533	0.59	34.8%	0.036 -1.737	-0.627	0.839
MMPI CONS	0.593	0.688	0.638	40.7%	0.086 -3.437	-0.712	0.953
GHQ BSI CONS	0.644 0.652	0.718	0.647	41.9%	0.065 0.02 -2.448	-0.728	0.974
GHQ MMPI CONS	0.644 0.593	0.941	0.696	48.4%	0.06 0.059 -5.056	-0.832	1.114
BSI MMPI CONS	0.652 0.593	0.904	0.689	47.5%	0.019 0.059 -4.636	-0.816	1.092
GHQ BSI MMPI CONS	0.644 0.652 0.593	1.012	0.709	50.3%	0.043 0.012 0.051 -4.704	-0.863	1.156

CRIMINAN functions

In the next section, Discriminant function of each instrument was built either alone or in combinations of two or three instrument. (Totally 7 models). Then model's coefficients, canonical correlation coefficient and normal range of each of instruments were determined. DISCRIMINAN function analysis, Wilks' Lambda criteria and canonical correlation coefficient was showed a model that had only used of GHQ-28 test had canonical correlation coefficient and explained error of 0.597 and 35.6% respectively. (Table 3) It was observed whenever each tool was used separately in a model, the model included MMPI test had the highest canonical correlation coefficient (r=0.638). In double combination state (using two test s in combination) a

222

Discriminant function including GHQ-28 and MMPI tests had the highest coefficient correlation (r=0.696). When BSI tests' results was added to GHQ-28 and MMPI tests (full model) canonical correlation coefficient was increased to 0.709 and power of explained error of function was increased from 48.4% to 50.3% (1.9% increase) and in this situation function was Y = -4.704 +0.043 GHQ +0.012 BSI +0.051 MMPI and it's normal range was between 0.863 and 1.114**.**

The sensitivity and specificity of model including GHQ-28 were 58.1%, 85.5% respectively. Also its corrected classification was 73.8%, while the mentioned index in a function with MMPI test alone was 79.3%. In double combination state, MMPI and GHQ-28 tests, corrected classification had the highest rate (87.6%) but in full model state, it was 86.2%.In addition, sensitivity in double combination state was 74.2% and in triple combination reduced to 71%. Therefore, accuracy was reduced when BSI score was added to MMPI and GHQ-28.

4.Discussion

The results of this study showed that sensitivity, specificity and corrected classification of the model including only GHQ-28 score, were 58.1%, 85.8% and 73.8%, respectively. Sensitivity, specificity and corrected classification of GHQ-28 were calculated using ROC method in another study that those quantities were 68.7%, 69.4% and 69% respectively[3]. Spanish version of GHQ-28 questionnaire had been measured using AUC. In this method, sensitivity was calculated between 76.9% and 84.6%, specificity between 82% and 90.2% and corrected classification between 83% and 85%.[17] In another study sensitivity, specificity and corrected classification of GHQ-28 has been reported by Mitchell and Roa 80.2%[18]. However, in several studies sensitivity of GHQ-28 were reported between 35.7% and 91% and specificity between 10% and 89% [18-21]. Of Course in some studies for GHQ-12 sensitivity and specificity has been measured 81% and 58.2% respectively[21, 22].In the current study, when BSI score was used in a model alone, sensitivity, specificity and corrected classification of model were calculated 59.7%, 91.6%, and 77.9% respectively.In another study that BSI validity was measured by ROC method those indices were 75.8%,69.9%, and 72.4% [3]. Sensitivity and specificity of SCL-90-R has been reported also 55.6% and 80.7% in the another study[8].However, different results have been reported in various studies[23, 24]. In this study, sensitivity and specificity and corrected classification of a model including only MMPI test was determined 71%, 85.5% and 79.3%, respectively. In a study using ROC method, sensitivity, specificity and corrected classification of the MMPI test were reported 75.8%, 67.5% and 71% respectively[3]. Corrected classification of MMPI test has been reported 83.4% in the Name's study [25], although in the Name's study, sensitivity, specificity and corrected classification of MMPI 86%, 100% and 86% has been measured[26].In different studies the difference in validity of psychological tests can be related to the homogeneity of samples, the prevalence of mental disorders in sample size, the measure was used as criterion (e.g. structured or interview), the nature of the mental disorder, the method of using instruments and finally the target community[5].

In our study, in contrast to earlier studies that generally calculated accuracy and validity of a test alone, part of the present study deals with consideration of MMPI, BSI and GHQ-28 tests in double or triple combination. It is interesting to note that as mentioned earlier in the results part, when the GHQ-28 was used alone, corrected classification was 73.8%, while we added MMPI score to model it was increased to 87.6% and after adding BSI to GHQ-28 it was increased to 82.8%. MMPI alone had corrected classification rate of 79.3%, while combined with GHQ-28, it showed an increase of 7.9% in corrected classification. The addition of BSI score to MMPI resulted in just 2.8% increase of corrected classification. The highest accuracy and validity in discrimination function was observed when both MMPI and GHQ-28 were accounted inside the model. Canonical correlation coefficient reached 0.709 along with a corrected classification of 87.6%. The results of the present study show a higher synergistic effect between MMPI and GHQ-28 than otherwise observed in BSI. The highest sensitivity and specificity of all models was observed in a combination of MMPI and GHQ-28 with amounts of 74.2% and 97.6% respectively. According to Discriminant analysis of Dissociative Experiences Scale in screening for multiple personality disorder the sensitivity was 76% and its specificity was 85%[26]. In another study the ability of the MMPI to classify five well-defined patient groups was investigated. That Discriminant function analysis correctly was classified the groups with overall accuracy of 78%. Also Results indicate that complex statistical analysis of the MMPI is potentially useful in diagnosis and decision making[27].In another study in screening of mental health and the risk factors associated with the pathogenesis of mental disorders, the function of Discriminant analysis in control group and patient group was compared and total misjudgment rate was 10.5%[28].

5.Conclusion

The results of this study along with some other studies showed that ROC method alone will increase the sensitivity and specificity of screening tests. But the major problem of this approach is impossibility of integration of two or more independent variables, while by Discriminant analysis we can measure both combination effects of independent variables in enhancing of their validity and also effects of distracted factors in calculation of test validity indices. Thus, it is suggested if, in a study, there is more than one screening test; it is recommended to accompany Discriminant method with ROC technique.

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