SOCIAL SCIENCE REVIEW ARCHIVES
ISSN Online: 3006-4708
ISSN Print: 3006-4694
https://policyjournalofms.com

Impact of Educational Attainment on Depression Measurement: Insights from Differential Item Functioning

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Abstract
Level of education can impact access to healthcare and health outcomes. Increasing rates of depression are a major public health concern, and vulnerability to depression is compounded for individuals with a lower level of education. Depression screening is important in the management of health and more so, in Primary care and mental health. This paper aims to explore the effects of educational levels on the psychometric properties of depression measures namely BDI-II, CES-D, PHQ-9, and PROMIS Depression items. It is an objective of the proposed research to establish the sources of DIF and make recommendations on modification that can be made to eliminate bias. Specifically, extrapolating results from PROMIS 1, the NIH Toolbox, and the PROsetta Stone panel studies, it weighs the educations of participants and examines DIF values for each measure. Research findings indicate that the DIF values are higher among those with lower education levels, particularly those with high school education or lower. Using the BDI-II and the CES-D yields higher levels of education disparities than when using the PHQ-9. Such adjustments may consist in rewriting particular items to enhance their clarity, and in adapting the organisation of assessments to take into consideration disparities in schooling, in order to ensure fair and valid measurement of mental health in diverse samples.

Keywords: Depression; Differential Item Functioning (DIF); Self-Report; Assessment

Introduction
Depression is a common global public health concern; its lifetime prevalence estimate is 22.5% for adults in the United States (Kessler et al., 2015). This underscores the importance of developing appropriate interventions for the early detection and treatment of depressive symptoms. Scientific evidence shows that people with low literacy level have more likely hood of suffering depression Illness (Miech et al., 1999) this is because education affects economic and health standards of people including income, job status, and health care facilities. Low education level is also a concern as it hinders the needy from receiving quality mental health services and worsens their mental health disorders (Gonzalez et al., 2010). This can result in a vicious cycle of vulnerability where people from the lower strata of society are more prone to being misdiagnosed or receive suboptimal care. Additionally, the assessment tools used could minimize the effect that education will have on the ability of the patient to report symptoms more accurately, leading to inequalities

in diagnoses and treatment outcomes (Smith, 2024). Differential item functioning (DIF) relates to the situation where two individuals with apparently similar status of mental health may show varied responses to certain items because of their difference in education. Such biases can jeopardize both the accuracy and effectiveness of depression questionnaires, as data have demonstrated that years of education may affect the functioning of items (Zumbo et al., 2008). It is pertinent that such issues are addressed, so as to avoid any sort of prejudice and bring about fairness in the testing for mental health conditions. Learning the relation that educational attainment has on depression assessment tools is important to avoid biases in assessments. It can thus be important to understand the relationship between educational achievement and depression measurement so as to construct valid and reliable tools that are capable of measuring the status of people's mental health based on their educational level. Measures of depression differ based on educational attainment: Implications for differential item functioning. The research is therefore also intended to reduce these gaps so that mental health assessments are enhanced and equal treatment provided to patients with different levels of education. This reiterates the call for assessment practices that are able to consider the specificity of the needs of a child, resulting in more precise diagnosis, treatment and mental health management of the condition.

Review of Literature

Educational Attainment, Depression, and Health Outcomes

Level of education has important implications for mental and physical wellbeing (Huppert & Whittington, 1995). People with the least education reported considerably higher depression rates; 28 percent of them (Miech et al., 1999). Health care and mental health services are a major determinant of which educated groups suffer severe depression, due to their limited access (Lantz et al., 2001). It is necessary to make correct and fair evaluations to address the problem of depression and consider the issue of differentiation by education. This paper explores the given variables related to educational attainment of depression and how these have to be addressed differently. Ross and Mirowsky (2010) conducted a study and concluded that education increases mental health, thus reducing depression, as it provides people with knowledge on how to handle their health effectively. Low levels of education present a negative relationship to mental health and higher incidences of depression because of restricted availability of means and coping mechanisms. It is critical, therefore, to examine these dynamics to design interventions aimed at enhancing mental health care for those with varying education levels. Miech et al. (1999) discovered that low levels of education increase the odds of having major depression, mainly because of its effects on other social factors, for instance, coverage of mental health care and financial security. It involved a longitudinal analysis and focused on how lack of education contributed to making depression worse and the importance of addressing the issue of inequality in education to mental health. Gonzalez et al. (2010) discussed comparative analyses of ethnic group depression rates and found education level as one of the primary determinative factors connected with depression rates observed. They observed that educational disparities as well as minority status impose higher risks for poor mental health to receive care and pointed to the need for interventions with focus on improving both access and utilization. In the Stringhini et al.'s (2018) study, the focus was made on the relation between socioeconomic position, including education, and health behaviors and mortality. Rates of depression were higher and self-rated health was worse among participants with lower levels of education, and these findings support the continued importance of education in shaping health choices and resources. Another major factor regarded to the management of chronic conditions is educational attainment. Another study by Lichtenstein, Smith, and McIntyre (2006) showed that education in high and middle income countries help in the management of chronic illnesses such as diabetes through self-care and compliance to medication. In a study by Jorm, Christensen, and Griffiths (2005), the authors

demonstrated that education acts as a buffer between chronic illness and mental health outcomes, decreasing the likelihood of depressive symptoms in people suffering from chronic conditions. In the same manner, limited education increases the probability of mortality from diseases such as cardiovascular diseases and cancer (Cutler & Lleras-Muney, 2010). Koh and others in their scholarly work in 2012 also established the fact that, lesser educated people have poor health literacy that hampers them in comprehending the complexities or health challenges. These results highlight the need for more fair assessments of depression to discuss the interaction between educations, various mental disorders, and the general health state.

Level of Education and Assessment

The results highlighted the importance of education in self-reported mental health measures and depression screening efficiency. Miech and Shanahan (2000) also revealed that there is an inverse relationship between education level and depression rates were higher education levels are associated with better self-management and understanding of mental health. This may help them provide accurate self-report of depressive symptoms as compared to their counterparts with low education level. Another determinant of health literacy is education, which impacts the way people perceive and describe signs of health conditions. Kessler et al., 2011 reflected that people from less education may have difficulties in describing or even identifying their symptoms, thus may do so inaccurately. Berkman, DeWalt, and Pignone (2004) also pointed out that.Syncopal patients with low health literacy, a condition prevalent in people with low education levels, struggled with accurate symptom reporting and assessment. Major assessment tools never consider the academic gaps that exist within students. That is why Paasche-Orlow and Wolf (2007) pointed out that these tools may be misleading and put less educated people at a disadvantage because they fail to address their particular needs. For accurate assessment, it is essential to incorporate such tools to cater for educational preferences that exist between students. The relationship between education, health literacy, and depression requires special attention in enhancing mental health services. Development of probes can minimize biases and implement fair assessments, and help people on how to address the depressive symptoms optimally.

Differential Item Functioning by Education

The general meaning of Differential Item Functioning (DIF) by education is differences in the behaviour of items based on the level of education while comparing the behaviour of the items, the examinees under comparison are presumably of similar characteristics. This can threaten the construct and criterion-related validity of such instruments as depression questionnaires because educational background influences how participants approach items. The study by Zumbo, Gadermann, and Schaffer (2008) supported the previous idea of differential item functioning according to education. For example, patients with low levels of education may have different perceptions of questions, resulting in inconsistency in the assessment of depressive symptoms. Likewise, Geisinger and Kaufman (2002) notes that the differences are educational may cause the variations in the difficulty of items and the patterns of response; hence, less suitable for those with lower education standards. Such variations pose significant consequences to depression assessments. In the absence of procedures to control for differences in education, tools may incorrectly identify or provide an insufficient description of individuals with less education. Ambiguity in the items' language or phrasing can also bias the responses, giving an inaccurate picture of the subject's state of affairs mentally (Schmitt & Stults, 1986).

Measures to deal with DIF include reviewing items for clarity and bias, using statistical means to identify and accommodate FOR DIF and to validate assessment tools on different client groups (Raju, van der Linden, & Fleer, 1995). Applying these changes increases the objectivity and

credibility of evaluations and improves mental health care for the population, regardless of their academic levels.

Objectives

- To examine how educational levels impact the psychometric properties of depression measures (BDI-II, CES-D, PHQ-9, PROMIS).
- To identify Differential Item Functioning (DIF) across educational groups in depression questionnaires.
- To propose adjustments for addressing educational disparities in depression evaluations.

Research questions

- How does education affect the psychometric properties of depression measures (BDI-II, CES-D, PHQ-9, PROMIS)?
- What is the extent of Differential Item Functioning (DIF) across educational groups in depression questionnaires?
- How can we adjust depression assessments to address educational disparities?

Research Gap

Although much effort has been spent on exploring the effect of educational level on health, few studies also examined how education influences DIF of depression. There is limited evidence on the psychometrics of commonly used Depression scales such as the BDI-II, CES-D and the PHQ-9 in this regard. This omission is significant since DIF can bring in sources of bias for assessing depression in people with various educational backgrounds.

Previous research has often associated DIF with health literacy, although there are limited studies on the influence of education on the responses to depression measures. For example, complex language and long items may be alien to those with low education, leading to bias and possible wrong classification.

Future research should focus on exploring the moderation by educational differences in the functioning of the items in the depression measures. This understanding is helpful in enhancing the fairness and validity of the above tools to better assess clients' mental health with varying educational experiences.

Present Study

Specifically, the goal of this paper is to provide an empirical evaluation of DIF across the four parcels of depressive symptoms assessment tools, namely the BDI-II, CES-D, PHQ-9, and PROMIS Depression items. It examines the relationship between educational level and the responses to the items used in assessing depression, which would possibly affect the fairness and accuracy of these instruments. The hypothesis assumes that DIF is likely in the case of the complex items in the traditional depression questionnaires when there could be an issue of difficulty in comprehending complex words or extended description among those with low levels of education. One might expect that such disparities might lead to bias because items cannot necessarily be equally well interpreted as a function of education level. For instance, LT DIF related to health literacy was flagged in a study by Taple, Griffith, and Wolf (2019) which means that due to the low health literacy, the applicability of test items is reduced and same applies in case of educational inequalities. Common screening instruments, such as the BDI-II, CES-D, and PHQ-9, contain many words and sentences with high readability that may confuse the lower education participants. The solution to this problem is to analyse and modify the learned items in a way to make them informative and meaningful among the different levels of education. In this way, the possibility of depression assessments may meet the needs of various populations and offer equally reliable and

valid evaluations. As this investigation constitutes the first one aiming to examine DIF in these measures by educational levels, it provides significant information on how educational achievement influences item performance. They hope to guide future work in fine-tuning these instruments, ensuring equitable and accurate mental health evaluations of clients with differing educational levels.

Research Methodology

Participants and Sampling

The study utilized data from three large internet panel studies: PROMIS, NIH Toolbox, and PROsetta Stone. These two samples were obtained from different agencies, so it can be inferred that the participants are different from each other. The PROMIS 1 sample included 744 adults 18 to 88 years of age enrolled by Polimetrix online. The calibration sample of the NIH Toolbox was made up of 748 individuals covering the age of 18 to 92 years from Greenfield Online (now Toluna). Lastly, the PROsetta Stone sample included 1, 104 participants aged between 18 and 88 years from the Op4G panel. All the samples took different online tests mainly for the sole aim of calibrating IRT and estimating the measurement properties.

Measures

The study analyzed four depression measures: These include the Beck Depression Inventory II (BDI-II), Center for Epidemiologic Studies Depression Scale (CES-D), Patient Health Questionnaire (PHQ-9), and PROMIS Depression items. Each measure was evaluated for Differential Item Functioning (DIF) across three educational levels: Averages the population by the years of education: Less than high school diploma, high school diploma and some college/technical school, and college graduate and above. The reliability of the measures was reported to be greater than 0.9 for the internal consistencies, thus making them reliable for this analysis. In this research, DIF analysis used IRT to ascertain the influence of educational level on item functioning, and to estimate the magnitude of DIF and identify items that significantly differ in their performance for students of different educational levels.

Analytical Strategy

R software was used for data analysis to look at directional and nonlinear relationships between education and psychometric properties of depression measures. The sample PROMIS 1, NIH Toolbox, and PROsetta Stone educational distribution was determined by descriptive statistics. For each item, DIF analysis was conducted based on educational level, and standardized DIF values were computed to assess the degree of DIF. Additional post-hoc readability assessments also elaborated on specifics in how educational background impacted the item understanding. The implications of the study were presented on how the assessment of depression should be made sensitive to education levels while aiming at increasing validity.

Data Analysis and Results

Table 1: Educational Distribution of Participants across Samples

Education Level	PROMIS 1 Sample (%)	NIH Toolbox Sample (%)	PROsetta Stone Sample (%)
High school and below	30	33	32
Some college/technical school	35	36	37
College graduate and above	35	31	31

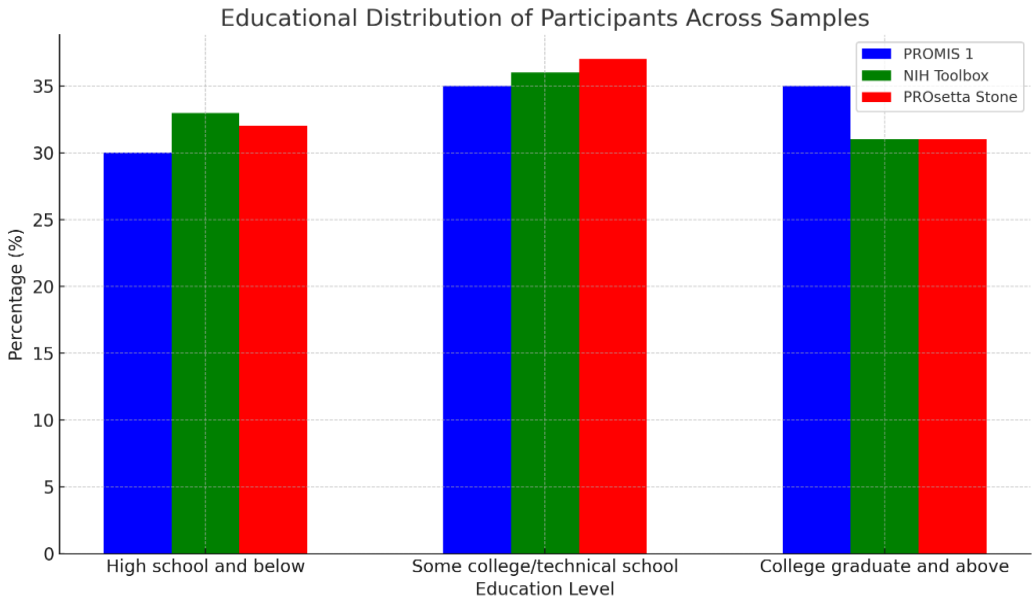

Fig 1: Educational Distribution of Participants across Samples

Table and fig 1 shows that the distribution of the levels of education in the samples was similar in each case. The education level of the PROMIS 1 sample involved 30% having high school education or below, 35% having some college or technical school, and 35% having college education and above. The NIH Toolbox sample was also nearly identical with 33% or less having only high school or less education, 36% stated some college or technical and 31% having college or more. The same was true for the PROsetta Stone sample with 32% among them having education not higher than high school, 37% having some college or technical school, 31% having college and higher education. This distribution puts accent on the importance of the middle level of education and its effect on the evaluation of depression.

Table 2: Differential Item Functioning (DIF) by Education Level and Measure

Measure	High School and Below	Some College/Technical School	College Graduate and Above
BDI-II	0.08	0.06	0.04
CES-D	0.07	0.05	0.04
PHQ-9	0.05	0.04	0.03
PROMIS Depression	0.03	0.02	0.01

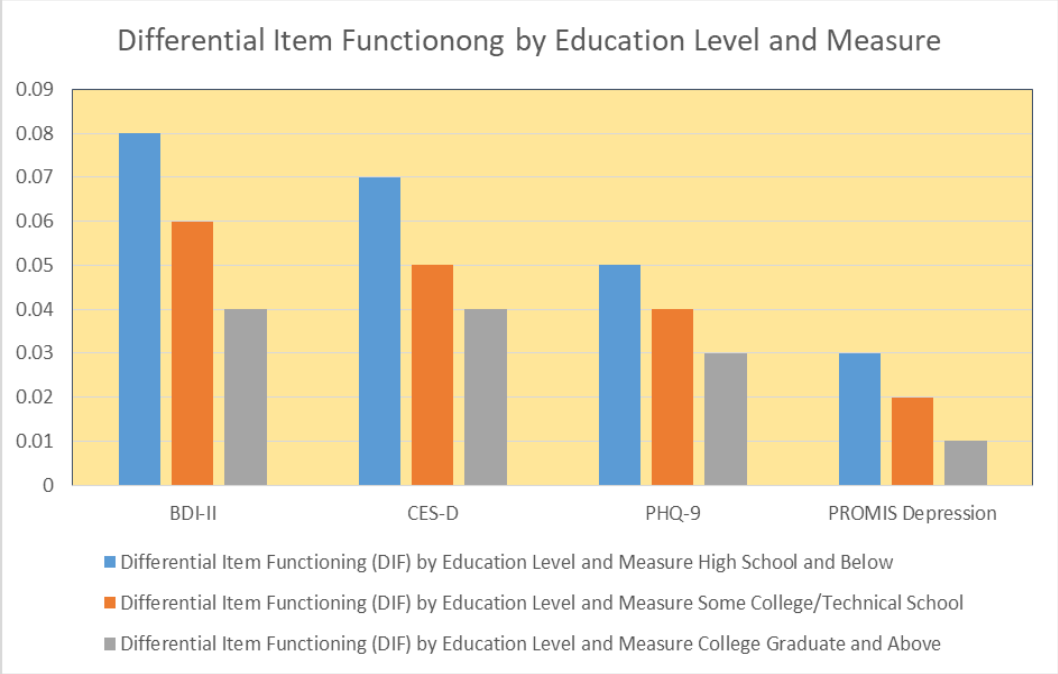

Fig 2: Differential Item Functioning (DIF) by Education Level and Measure

Table and fif 2 shows that as it is discovered in the DIF analysis, there exist differences in the degrees of discrepancy of the depression measures across the educational levels. The BDI-II yielded the highest DIF values where the standardized coefficients were 0.08 for participants with an education level of high school or below, 0.06 for education level some college/ technical school, and 0.04 for education level college graduate and above. Similarly, DIF values with the CES-D were 0.07, 0.05, and 0.04 across these groups. PHQ-9 had comparatively low DIF values, 0.05 for high school or below, 0.04 for some college or technical school, and 0.03 for college graduates. Among all the PROMIS measures, the PROMIS Depression measure had the least impact on DIF and had the value of 0.03 for Age, 0.02 for Gender, and 0.01 for Education. These findings indicate that respondents with less education might have larger differences in their responses to depression measures when using legacy instruments such as BDI-II and CES-D.

Table 3: Effect Sizes for Differential Item Functioning (DIF) by Measure

Measure	Small Effect	Moderate Effect	Large Effect
BDI-II	4	2	1
CES-D	3	3	0
PHQ-9	1	1	0
PROMIS Depression	2	1	1

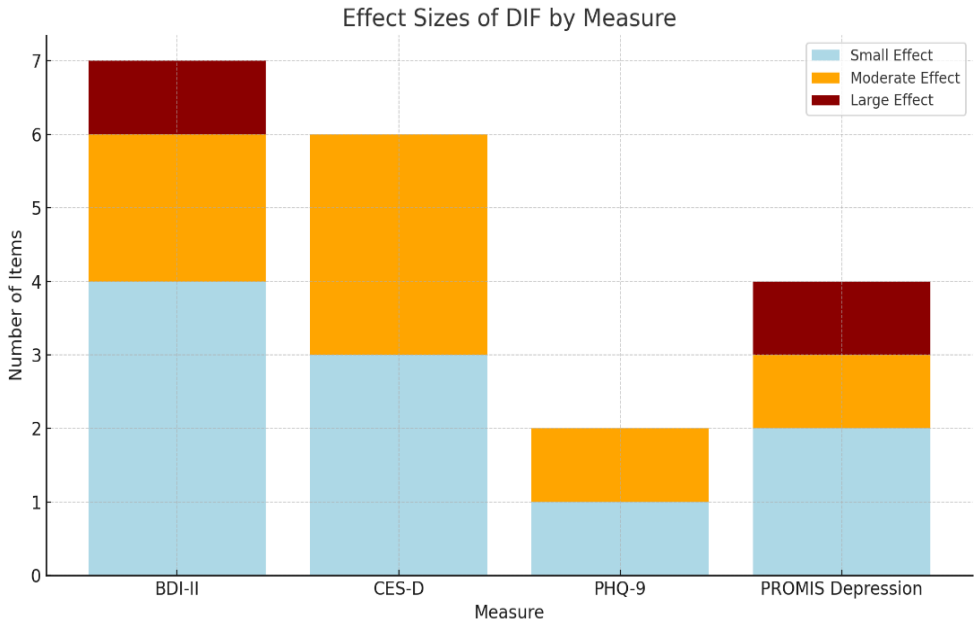

Fig 3: Effect Sizes for Differential Item Functioning (DIF) by Measure

An examination of effect size revealed the differences in the education related outcomes to DIF. Out of all the employed scales, the BDI-II appeared to be the most sensitive, as four of the items were classified as having a small impact, two items were assessed as having moderate impact, while the remaining item was considered to have the largest impact. Concerning test sensitivity, the CES-D again presented a reasonable level of format, featuring three small and three moderate effects but no large effects overall. The results showed that the PHQ-9 has minimal DIF but two were identified as small effect and one as moderate effect. Also, the PROMIS Depression item had two small effects, one moderate effect, and one large effect; therefore, it seemed to be less sensitive to education differences than the BDI-II or CES-D. Such findings clearly imply that more effective and diverse methods of assessment should be employed in order to reduce education prejudice.

The analysis shows moderate to large significant DIF in the legacy depression measures, especially among people with less than 12 years of education. Such a difference could lead to biases; thus, giving incorrect evaluations and even malpractice in diagnosis. Tackling these concerns by improving the measurement instruments can help increase their accuracy and minimize prejudice in the evaluation process. These skills are crucial for fairness and accuracy in measurements of students' mental health.

Discussion

The present research contributes to the understanding of the relationship between education and the psychometric performance of depression measures. The findings indicate the level of education plays a crucial role in determining the biases within depression measures, evidenced by higher levels of DIF among participants with lower levels of education. These differences point towards the need to adapt the tools used in assessment with regard to the different realities provided by varying education backgrounds.

Educational Attainment and DIF

The findings of this analysis indicate that BDI-II and CES-D are more likely to present differential item functioning based on participants' educational level, with elevated DIF indices among those with high school education and below. This sensitivity indicates that respondents with lower education may answer differently due to the inability to understand words relating to health or unfamiliarity with the language used in the assessment. For example, when there is the use of

exclusionary and inferential concepts commonly used in some assessment tool, then, lower-educated persons will give artificially skewed informal responses to questions about their mental condition. On the other hand, the estimates of DIF showed that depression screening tools such as the PHQ-9 and PROMIS demonstrated lower DIF values signifying that these measures are less susceptible to education bias. These tools may be written in plain language, which certainly is easier for people with different levels of education, and may avoid the use of culturally sensitive language. The decline in DIF in these measures provides a good potential for fair assessment of mental health. It is important to note that when educational attainment is not taken into consideration, depression screening may be characterized by inaccurate diagnosis or suboptimal treatment, especially for those with lower educational levels. Higher delta values of DIF means that overall the patient exaggerates or minimizes the symptoms of depression. For example, less educated persons due to inability to understand some words used in the items tend to under report symptoms, while highly educated persons over interpret items hence a tendency to give different responses. Such discrepancies not only affect the equity of mental health assessments but continue to contribute to health disparities as well. In fact, even according to the findings of research, education is one of the social determinates of health which impacts mental health resources and care facilities and systems (Lantz et al., 2001). If such disparities are not considerate while administering the assessments, then DIF may actually aggravate these inequities.

Proposed Interventions

The study emphasizes the need for targeted interventions to mitigate the impact of educational disparities on depression assessments. These include:

Revising Assessment Tools: Items should be worded without the inclusion of concepts and/or phrases that a lay person would not easily understand without losing the essential aspects of the construct that they are trying to assess. Questions should not have j argon or terms that will be arduous for people with low literacy to understand.

Cultural and Educational Sensitivity: Tools should be validated for various age and education levels, as well as cultural backgrounds in order to accurately compare the results. This may involve pre-testing items in focus groups in people who have different levels of education.

Statistical Adjustments: The basic model is that, Techniques like Item Response Theory (IRT) and DIF analysis should be used for identifying the biased items through various statistical tests and then, these items should be eliminated from the test.. This enables assurance that measures are consistent across all groups of the population to improve the validity.

Practitioner Training: The answers to those should be intriguing for mental health professionals to understand how educational inequalities shape assessment and how to read the results within this paradigm. This may result to more accurate assessment and formulation of management plans for the patient.

Conclusion

In conclusion, this study examined the impact of educational levels on the psychometric qualities of depression measures of BDI-II, CES-D, PHQ-9, and PROMIS. The analysis brought to light that respondents with a lesser level of education, those who only completed high school or those with less than a high school education, have elevated DIF values on such measures. This implies differential response biases arising from variations in how they relate to and make sense of the assessment items; a role that education perhaps plays in responding to depression measures. Considering that there are many specific forms of DIF, the analysis pointed to the differences in

DIF effect sizes. It was also revealed that the BDI-II and CES-D are the most affected by educational differences in comparison with other variables: their distribution characterized by more frequent and significant small and moderate DIF effects. The PHQ-9 also evidenced significantly less number of Differential Item Functioning (DIF) meaning that it is less sensitive to educational biases. It was also evident that the PROMIS Depression measure had some element of responsiveness to educational differences but again, to a lesser extent as compared to physical health. The results of this study suggest that there is value in using such approaches but at the same time has shown the importance of assessing these instruments to determine appropriateness across various levels of learning. To minimize disparities in depression assessment due to educational attainment, the study suggests developing items with lower educational requirement, providing tools that are sensitive to educational level, and enhancing practitioners' awareness of educational attainment's impacts on depression measures. These changes are to improve the validity and fairness of the tests to capture depression across the education levels. The findings of the study add to the body of knowledge on how personal and environmental variables including education affect psychological testing and underlines the need for diversity in mental health research and interventions.

Implications for Research and Practice

The implications of the study point towards the importance of the context variables such as education in mental health evaluation. The future study should evaluate the effect of DIF in the long-term mental health status and compare the efficiency of bias adjusted interventions. Moreover, implementing standard procedures for solving the educational differences in assessments could progress equal healthcare management. Adapting the proposed factors into clinical and communal settings could improve mental health care delivery amongst underprivileged groups. Thus, the implementation of the theoretical framework of culturally responsive assessment in practice allows minorities with lower academic achievements, as well as providing equal access to appropriate mental health resources, overall improve the well-being of populations. In light of the above discussion, this paper stresses the importance of addressing education in the evaluation of depression and offer directions on how through which proper and accurate methods in assessing forms can be formulated. These steps are important to ensure that the mental health assessment is equally fair and accurate across the different demographic categories.

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