

# What are the most important factors for depression among HIV patients?: a study from Bangladesh

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## Abstract

**Introduction:** Depression in human immunodeficiency virus (HIV)-infected patients is a prevalent mental health condition, which can lead to adverse impacts on their quality of life, treatment adherence, and clinical outcomes. This study aimed to investigate the risk factors associated with depression in HIV patients, with a particular focus on demographic, clinical, social, and psycho-social characteristics. Previous research has identified several risk factors for depression, such as age, sex, lower education level, and social isolation; however, these are not well understood. This study aimed to further explore the risk factors and their implications for HIV patients with depression.

**Material and methods:** This cross-sectional study used data of 338 HIV-infected patients on demographic, clinical, and psycho-social factors, including marital status, family type, family size, alcohol consumption, and information on duration of HIV infection and receipt of HIV treatment. Data on 36 variables were collected between July and December 2020 in Bangladesh. Depression outcome was assessed using Beck's depression inventory questionnaire, while ordinal logistic regression model was applied for data analysis.

**Results:** The study showed that occupation ( $p = 0.0267$ ), religion ( $p = 0.0009$ ), type of family ( $p \leq 0.0001$ ), monthly income ( $p = 0.0023$ ), and drug abuse ( $p = 0.0128$ ) were statistically significant risk factors for depression, with other variables adjusted.

**Conclusions:** Certain occupational, religious, and family categories as well as low monthly income and a history of drug abuse are associated with a higher risk of depression. Identifying and understanding these risk factors can help healthcare providers identify patients at higher risk and provide appropriate interventions to manage their mental health effectively.

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**Key words:** HIV, AIDS, depression, ordinal logistic regression.

## Introduction

Depression is a complex mental health disorder that has a significant impact on individuals' overall well-being, leading to negative self-perception, lack of motivation, and with-

drawal from social activities. It has become the most common mental health disorder affecting individuals living with human immunodeficiency virus (HIV) [1]. According to the World Health Organization (WHO), an estimated 3.8%

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of the population worldwide experience depression, including 5% of adults (4% of men and 6% of women), and 5.7% of adults older than 60 years. Approximately 280 million people are affected, and more than 700,000 deaths are attributed to suicide due to depression annually [2]. Depression is particularly prevalent among individuals living with HIV, with approximately 39% of HIV-infected patients reported. This is a pressing issue, as depression in this population can exacerbate disease state and result in poorer health outcomes [3]. As of 2017, there were 36.9 million people living with HIV worldwide, with 1.8 million new infections and 940,000 deaths reported.

Despite the high prevalence of depression among HIV individuals, risk factors for this mental condition are not well understood in this population. Numerous studies have investigated the seriousness of HIV disease; for example, one paper considered pharmacokinetic point of view [4], another study reported the prevention of transplacental transmission of HIV, yet another [5] described a general model setup, emphasizing the effectiveness and importance of early prevention. Several other studies have identified demographic risk factors for depression in HIV patients, showing that depression is more prevalent in females, illiterates, and unemployed individuals. In addition, HIV patients who suffer from depression tend to lead a lower quality life, particularly in the environment and social relationship domains, compared with HIV patients without depression. These findings underscore the importance of identifying and addressing depression in HIV-infected patients, providing support addressing both the physical and mental health needs of this population [6].

In another study, gender, lack of family support, and having an HIV-positive spouse, were identified as the risk factors associated with depression among HIV patients. Similarly, various African studies have identified different risk factors [7]. One study conducted in an African socio-cultural context found that psychological and social aspects were the primary risk factors for major depressive disorders among ambulatory HIV-positive individuals, with no evidence about the role of neurotoxic effects of HIV [8].

These findings suggest that risk factors for depression among HIV patients may vary across different contexts, highlighting the need for tailored interventions, which consider the specific needs of these individuals in different settings. Furthermore, a study demonstrated that several clinical factors were significantly associated with depression among HIV-infected individuals, including being female, non-adherence to treatment, opportunistic infections, six months since HIV diagnosis, previous hospitalization, high baseline viral load, and school discontinuation due to HIV/acquired immune deficiency syndrome (AIDS) [9].

These findings underscore the necessity to identify and address these risk factors to improve the overall quality of life of HIV-infected patients, and offer tailored support that tackles both physical and mental health needs. Therefore, this paper aimed to provide a comprehensive analysis of the potential risk factors associated with depression in HIV patients,

including demographic, clinical, and psycho-social factors. By understanding these risk factors, healthcare providers can identify patients at higher risk of depression, and provide appropriate interventions to manage their mental health effectively. This paper highlighted the importance of addressing depression in HIV-infected individuals, underscoring the need for further research in this area to improve the overall quality of life of individuals living with HIV.

## Material and methods

### Dataset

Dataset used in this study was collected as part of a cross-sectional study among people living with HIV/AIDS (PLWHA) in Bangladesh, conducted between July and December 2020. Sample size of 338 was determined based on a population prevalence of 67.3%, a 5% error, and a 95% confidence interval (CI). The study was conducted at all drop-in centers (DIC) operated by CARE Bangladesh, located in Chankharpul, Swamibag, Dholpur, Hazaribagh, Noya Bajar, and Tongi of Dhaka city. Inclusion and exclusion criteria for the study can be found in the original data source [10]. While for researchers interested in accessing dataset, background information, data dictionary, and data itself, all the information are available at the following link: [https://zenodo.org/record/5808314#.ZDGGA\\_-JKUc](https://zenodo.org/record/5808314#.ZDGGA_-JKUc). This dataset provides valuable information on the risk factors associated with depression among PLWHA in Bangladesh, and can be found useful in future research aiming at improving mental health outcomes of this vulnerable population.

Dataset used in this study contained 36 variables, providing comprehensive information on the study population, including demographic factors, such as age, sex, and social status, which encompass education level, occupation, monthly income, and religion. Other variables were marital status, family type, family size, alcohol consumption, and information on the duration of HIV infection and receipt of HIV treatment. No missing data were found in this dataset. In addition to demographic and social variables, dataset included 21 scores from the Beck's depression inventory questionnaire. These scores were used to calculate the total score, which was then divided into depression levels of the study population. Subsequently, depression levels were categorized into six scales, with scores ranging from 1 to over 40. A score between 1 and 10 indicated emotional fluctuations (ups and downs) considered normal, 11-16 mild mood disturbances, 17-20 borderline clinical depression, and a score of 21-30 indicated moderate depression. A score between 31 and 40 specified severe depression, and a score over 40 extreme depression. These categories were selected to better understand the severity of depression among PLWHA in Bangladesh, and to inform interventions aiming at improving mental health outcomes of this vulnerable population. Statistical programming language R (R version 4.2.2) was used for data analysis.

## Characteristics of participants

Table 1 presents demographic and clinical characteristics of 338 HIV-infected patients with depression, categorized by severity levels. Variables included age, sex, education, occupation, religion, monthly income, marital status, type of family, family size, drug abuse, duration of HIV infection, receiving HIV treatment, smoking, and alcohol consumption. The number of patients for each severity level was given in the columns, and the percentages of patients for each sub-group were shown in parentheses. A *p*-value was reported for each variable, testing for statistical significance of differences between depression sub-groups. Fisher exact test for proportions and Wilcoxon test for continuous variables were used. A *p*-value indicated a significant difference between sub-groups for a variable. For example, if a *p*-value for age was 0.30, no significant difference in age between patients with different depression severity levels was observed. However, for religion, monthly income, marital status, type of family, family size, and drug abuse, all *p*-values < 0.05 indicated significant differences among sub-groups for those variables, which might be potential risk factors when included into multivariate regression analysis.

## Statistical analysis

In this study, ordinal multivariate logistic regression was employed to analyze the relationship between the predictor variables and the outcome variable, i.e., depression. This was because the depression score was an ordinal response, where higher values indicated a more severe condition of depression. By using ordinal logistic regression, we were able to explore the relationship between the predictor variables and the severity of depression. To improve the model fit and reduce the risk of overfitting, a stepwise approach for model selection based on the Akaike information criterion (AIC) was used.

There are multiple approaches for a feature selection. Mainly based on prediction ability of variables, least absolute shrinkage and selection operator method (LASSO) is applied when multiple variables are correlated with each other, and the method selects one of them. However, different criteria may have strengths and limitations in real datasets. In the current study, with only a small number of correlated features, stepwise model selection could work very well. Stepwise approaches have different criteria for including/excluding different regressors. It should not be applied if *p*-values or  $R^2$  are used as selection criteria, mostly because of internal validation bias. However, AIC (Akaike information criterion) or BIC (Bayesian information criterion) are much better metrics used for model selection. Apart from predictive power, data collection and quality are equally important regarding variables. Since the current study goal was focused on statistical information, such as *p*-values, AIC was a convenient and effective choice for feature selection.

AIC is an estimator of in-sample prediction error that effectively penalizes for adding more variables to the model.

Lower AIC scores indicate a more parsimonious model, relative to a model fit with a higher AIC score. Therefore, this approach allowed for identification of the most important predictor variables and develop a model that best explained the relationship between the predictor variables and depression severity. The use of AIC as a model selection criterion provided a more objective measure of the model performance, permitting to assess the relative quality of different statistical models for a given set of data.

## Results

The final selected multivariate model included the following predictors: occupation (unemployed/housewife/others, employed, student), religion (Muslim, Hindu), type of family (nuclear, joint), monthly income ( $\leq 10,000$  BDT, 11,000-20,000 BDT,  $\geq 21000$  BDT), drug abuse (yes, no), and receiving HIV treatment (yes, no). Table 2 shows the coefficients and corresponding *p*-values for the statistical model, examining the relationship between different variables and depression. *P*-values represented the level of statistical significance of the relationship, with *p*-values of less than 0.05 indicating statistically significant relationships. The model identified occupation, religion, type of family, monthly income, and drug abuse, as significant risk/protective factors for depression after controlling for other variables. Coefficients represented the strength and direction of the relationship between the variable and depression, with positive coefficients indicating a positive relationship, and negative coefficients meaning a negative relationship. For example, a coefficient of  $-2.6647$  and a *p*-value of 0.00235 for normal to mild mood disturbance, indicated that the odds of having mild mood disturbance rather than normal depression were decreased by a factor of  $e^{-2.6647} = 0.069$  for each one-unit increase in the predictor variable. Similarly, a coefficient of 2.2007 and a *p*-value of 0.0098 for severe to extreme depression, indicated that the odds of having extreme depression rather than severe depression were increased by a factor of  $e^{2.2007} = 9.035$  for each one-unit increase in the predictor variable.

## Conclusions

Depression is a significant mental health problem in HIV-infected patients, and healthcare providers should be aware of the risk factors for depression in this population. Screening for depression in HIV individuals should be a routine part of clinical care, and appropriate interventions must be provided to those who are at a higher risk of developing depression.

Based on the results, it can be concluded that occupation, religion, type of family, monthly income, and drug abuse, are statistically significant risk factors for depression, with other variables adjusted. Specifically, individuals with certain occupations, religions, family types, low monthly incomes, and a history of drug abuse, are more

**Table 1.** Characteristic data group by depression levels

Depression (N = 338)	Normal (n = 16)	Mild mood disturbance (n = 40)	Borderline clinical depression (n = 40)	Moderate depression (n = 107)	Severe depression (n = 94)	Extreme depression (n = 41)	p-value
Age (years)**	35 (28-42)	36 (29-43)	36 (28-40)	35 (28-44)	35 (27-42)	30 (26-38)	0.300
Sex, n (%)							
Male	15 (94)	34 (85)	34 (85)	95 (89)	84 (89)	35 (85)	0.190
Female	1 (6)	3 (8)	3 (8)	5 (5)	8 (9)	0 (0)	
Transgender	0 (0)	3 (8)	3 (8)	7 (7)	2 (2)	6 (15)	
Education, n (%)							
Illiterate	3 (19)	13 (32)	10 (25)	46 (43)	37 (39)	7 (17)	0.075
Below secondary	8 (50)	20 (50)	24 (60)	49 (46)	46 (49)	26 (63)	
Undergraduate and above	5 (31)	7 (18)	6 (15)	12 (11)	11 (12)	8 (20)	
Occupation, n (%)							
Unemployed/housewife/others	1 (6)	7 (18)	14 (35)	16 (15)	7 (7)	5 (12)	0.031*
Employed	15 (94)	30 (75)	25 (62)	85 (79)	79 (84)	35 (85)	
Student	0 (0)	3 (8)	1 (2)	6 (6)	8 (9)	1 (2)	
Religion, n (%)							
Muslim	16 (100)	40 (100)	38 (95)	100 (93)	91 (97)	31 (76)	0.0007*
Hindu	0 (0)	0 (0)	2 (5)	7 (7)	3 (3)	10 (24)	
Monthly income, n (%)							
≤ 10,000 BDT	8 (50)	22 (55)	24 (60)	85 (79)	73 (78)	29 (71)	0.003*
11,000-20,000 BDT	7 (44)	17 (42)	16 (40)	22 (21)	21 (22)	11 (27)	
≥ 21,000 BDT	1 (6)	1 (2)	0 (0)	0 (0)	0 (0)	1 (2)	
Marital status, n (%)							
Married	12 (75)	27 (68)	22 (55)	63 (59)	58 (62)	13 (32)	0.003*
Unmarried	3 (19)	12 (30)	11 (28)	36 (34)	29 (31)	27 (66)	
Divorced or separated	1 (6)	1 (2)	7 (18)	8 (7)	7 (7)	1 (2)	
Type of family, n (%)							
Nuclear	11 (69)	21 (52)	31 (78)	79 (74)	80 (85)	36 (88)	0.001*
Joint	5 (31)	18 (48)	9 (22)	28 (26)	14 (15)	5 (12)	
Family size, n (%)							
Single	0 (0)	6 (15)	13 (32)	25 (23)	20 (21)	19 (46)	0.003*
2-5 members	16 (100)	30 (75)	27 (68)	72 (67)	67 (71)	20 (49)	
≥ 6	0 (0)	4 (10)	0 (0)	10 (9)	7 (7)	2 (5)	
Drug abuse, n (%)							
Yes	7 (44)	19 (48)	14 (35)	65 (61)	45 (48)	8 (20)	0.0003*
No	9 (56)	21 (52)	26 (65)	42 (39)	49 (52)	33 (80)	
Duration of HIV infection, n (%)							
< 1 year	5 (31)	14 (35)	12 (30)	29 (27)	34 (36)	20 (49)	0.260
1-2 years	7 (44)	15 (38)	15 (38)	33 (31)	29 (31)	14 (34)	
> 2 years	4 (25)	11 (28)	13 (32)	45 (42)	31 (33)	7 (17)	
Receiving HIV treatment, n (%)							
< 1 year	16 (100)	38 (95)	37 (92)	101 (94)	93 (99)	41 (100)	0.180
1-2 years	0 (0)	2 (5)	3 (8)	6 (6)	1 (1)	0 (0)	
> 2 years	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0%)	

Table 1. Cont.

Depression (N = 338)	Normal (n = 16)	Mild mood disturbance (n = 40)	Borderline clinical depression (n = 40)	Moderate depression (n = 107)	Severe depression (n = 94)	Extreme depression (n = 41)	p-value
Smoking, n (%)							
Yes	11 (69)	30 (75)	28 (70)	90 (84)	66 (70)	29 (71)	0.160
No	5 (31)	10 (25)	12 (30)	17(16)	28 (30)	12 (29)	
Alcohol consumption, n (%)							
Yes	5 (31)	19 (48)	13 (32)	60 (56)	41 (44)	15 (37)	0.067
No	11 (69)	21 (52)	26 (68)	47 (44)	53 (56)	26 (63)	

\*p < 0.05. \*\*Age is continuous variable presented as mean (first quantile, third quantile)

Table 2. Ordinal logistical regression results

Variable	Coefficient	p-value
Occupation	0.4798	0.02667
Religion	1.3911	0.000893
Type of family	-0.9834	0.0000385
Monthly income	-0.6541	0.002326
Drug abuse	0.5094	0.01285
Receiving HIV treatment	-0.7055	0.1368
Depression		
Normal/mild mood disturbance	-2.6647	0.00235
Mild mood disturbance/borderline clinical depression	-1.4681	0.0847
Borderline clinical depression/moderate depression	-0.6785	0.4205
Moderate depression/severe depression	0.6886	0.4114
Severe depression/extreme depression	2.2007	0.0098

likely to suffer from depression than those without these risk factors. The coefficients for the different levels of depression also provide insight into the relationship between depression severity and the input variables. These findings can be used to inform depression-oriented interventions and prevention strategies, with a focus on addressing the identified risk factors.

Another note that needs to be emphasized is that our analysis results differ from previous study [11], in which the authors only used logistical regression. In the current analysis, since the depression score is an ordinal response where higher values indicate a more severe condition of depression, the ordinal logistic regression was used to model categorical variables with more than two ordered levels (e.g., mild, moderate, and severe), taking into account the order and spacing of the levels. The main limitation of using logistic regression for ordinal outcomes is that it only provides estimates of the probability of binary outcome (i.e., presence or absence of a particular event or characteristic). It does not provide information about the severity or level of outcome, which is important for ordinal outcomes.

Although this paper highlights the importance of addressing depression risk factors in HIV patients, the data used in the study has several limitations that need to be acknowledged. First, there was only a small number of female and transgender patients included, which limits the generalizability of the findings to these populations. Second, there were only a few subjects in the higher income group, which could affect the conclusions about the impact of socioeconomic status on depression risk. Additionally, religious diversity was also limited, which might not reflect the broader population. Lastly, the dataset only included a limited number of risk factors assessed, as there may be other important factors that should be considered.

To gain a deeper understanding of the relationship between depression and HIV in different populations and to enhance the generalizability of the model results, further studies are needed to address these limitations. Forthcoming research may include more diverse participants, such as female and transgender individuals, persons from different income levels, and a more varied range of religious affiliations. Additionally, researchers could consider a broader range of risk factors,

which may contribute to depression in this population. Factors, such as social support, stigma, and coping mechanisms, might provide further insights into the complex relationship between mental health and HIV. Furthermore, this cross-sectional study does not incorporate time-varying information. To establish causal relationships and explore changes in risk factors, a longitudinal study design can be considered. By addressing these limitations, future studies may provide a more comprehensive understanding of the risk factors and effective interventions for prevention and treatment of depression in HIV-infected patients.

## Disclosures

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