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ORIGINAL PAPER

Depressive Symptoms, Disclosure, HIV-Related Stigma, and Coping Following HIV Testing Among Outpatients in Uganda: A Daily Process Analysis

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Abstract As efforts to end the HIV epidemic accelerate there is emphasis on reaching those living with undiagnosed HIV infection. Newly diagnosed individuals face a number of psychosocial challenges, yet we know little about depressive symptoms in the weeks immediately following diagnosis and how disclosure, coping, and other factors may affect short and longer-term depressive symptoms. Purposively sampled Ugandan outpatients completed structured interviews immediately prior to testing for HIV, daily for 28 days after receiving their test results, and at 3 and 6 months post-test. The sample included a total of 244 participants: 20 who tested HIV positive at baseline and who provided 342 daily data points, and 224 who tested HIV negative at baseline and who provided 4388 daily data points. We used linear mixed effects modeling to examine changes in depressive symptom scores over the 28 day daily interview period and predictors of depressive symptom scores and changes over time. Results from the mixed modeling revealed that while those diagnosed with HIV showed initially high depressive symptoms following diagnosis, their symptoms decreased significantly and on average fell below the cutoff for possible depression approximately 15 days after diagnosis. Among those who tested HIV-negative, on average their depressive symptoms were below the cutoff for possible depression and did not change over time. Among those diagnosed with HIV, disclosure, especially to a partner, on a particular day was associated with higher depressive symptoms that day. However, those who disclosed to their partner during the 28 days after diagnosis had significantly lower depression scores by the end of the 28 days as well as lower depression scores 3 and 6 months after diagnosis than did those who did not disclose to their partner during the 28 days after diagnosis. Scoring higher on HIV-related stigma on a particular day was associated with higher depressive symptoms that day and engaging in positive coping on a particular day was associated with lower depressive symptoms that day. Positive coping also accelerated the decrease in depressive symptoms over time. These data underscore the importance of timely disclosure to partners and suggest that regular depression screening after diagnosis and provision of mental health services could improve HIV care engagement and treatment outcomes.

Keywords Depression · HIV · Disclosure · HIV stigma · Coping · HIV testing · sub-Saharan Africa · Daily process

Introduction

As efforts to end the HIV epidemic accelerate, including progress towards the UNAIDS target of 90% of those living with HIV being aware of their status, access to HIV testing has increased and more previously undiagnosed individuals are becoming aware of their HIV infection [1]. Newly diagnosed individuals face a number of psychosocial challenges including disclosure and coping with their diagnosis [2–4]. Depressive symptoms are significantly higher among HIV-positive individuals than among HIV-negative individuals. Findings indicate that depression is twice as high among

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HIV-positive individuals than HIV-negative individuals in the United States [5] with a 1-year depression rate of 36% [6]. Similarly, rates of depression in sub-Saharan Africa are higher among individuals with HIV than among individuals in the general population [7, 8]. Recent studies found that 28–43% of HIV-positive individuals living in Kenya, Tanzania, Namibia, and Ethiopia reported clinically significant depressive symptoms [8, 9]. In Uganda, rates of depression among individuals living with HIV range from 22 to 35%; and in one study, 28% reported feeling "so depressed nothing could cheer them up" [10].

As "test and treat," or antiretroviral therapy (ART) initiation immediately or soon after diagnosis rolls out, as well as WHO recommendations to provide ART to all individuals living with HIV regardless of CD4 count [11], more individuals in resource-limited settings are encouraged to initiate ART immediately or soon after diagnosis. However, with this influx of individuals initiating ART it is important to consider that psychological challenges, specifically depression, negatively affect various aspects of health and well-being among HIV-positive individuals, including HIV care engagement and treatment adherence [12]. For instance, a study in Ethiopia revealed that stigma, discrimination, and depression negatively affect adherence to ART among HIV-positive patients [13]. In Uganda, one study found a significant relationship between severe mental illness and lower retention in HIV care among patients who initiated ART [13]. Depression is also associated with increased mortality among individuals with HIV [14]. Conversely, alleviation of depression can improve ART adherence and care engagement [15].

The need to screen for mild and major depression among HIV-positive individuals in sub-Saharan Africa at the time of diagnosis has been recognized [3]. However, few studies examine the prevalence and correlates of depressive symptoms immediately before or after diagnosis and the time frame when depression was assessed varies [3, 16]; thus few conclusions can be made about the typical course of depression among people newly diagnosed with HIV.

Correlates of Depression Among Individuals Newly Diagnosed with HIV

Identifying beliefs and factors associated with depression among HIV-positive individuals can aid in the development and refinement of interventions to treat depression among individuals living with HIV, which can in turn improve HIV care engagement and ART adherence. One study found that feelings of hopelessness and helplessness were common among HIV-positive individuals in the U.S. who never sought treatment [17]. Many participants associated HIV infection with imminent death and made statements such as, "It's killing me," or "I'm marked for death," or that HIV is a "death sentence." Despite the benefits of identifying cognitions that could be targeted within treatments to reduce depression among HIV-positive individuals, little research on this topic has been conducted to date.

Disclosure

Disclosure of HIV serostatus has benefits for the individual, including early treatment initiation, adherence to treatment, risk-reduction behavior, decreased symptoms of anxiety and depression, and motivation to plan for the future [18–20]. In Uganda, while initial fears of disclosure are common, outcomes of disclosure are predominately positive and disclosure has been associated with increased social support and decreased worry among HIV-positive individuals [20, 21].

However, while disclosure may lead to positive outcomes, the emotional experience of disclosure is complex and not well understood. A body of literature indicates negative outcomes after disclosure, including increased emotional stress and fear of negative outcomes [22, 23]. There is evidence to suggest that some individuals experience depression, blame, abandonment, anger, violence, and stigma after disclosure [23]. These mixed findings highlight the need for further close investigation of the effects of disclosure on depressive symptoms post diagnosis.

Stigma

Previous research, including a meta-analysis of 24 studies of people with HIV/AIDS, demonstrated a moderate correlation between high HIV/AIDS stigma and poor mental health ($r = -0.40$) [24]. Internalized stigma, defined as the acceptance of the devalued status that society attaches to conditions such as HIV, and perceived stigma, or concerns with public attitudes and negative self-image, have been associated with depression among HIV-positive individuals [25–28]. As with depression, stigma negatively affects health-seeking behaviors and treatment adherence [29]. Associations exist between high HIV/AIDS stigma and increased psychological distress, lower well-being, and physical indicators, including lower CD4 count and chronic illness status [30, 31]. Although a correlation between HIV-related stigma and depression has been established, this relationship has not been closely examined immediately after diagnosis.

Coping Style

Some coping styles are associated with positive functioning while others are associated with depression among individuals living with HIV. Disengagement (or avoidance) coping strategies (trying not to think about HIV) are correlated with depressive symptoms and emotional distress [32–34]. In contrast, engagement (or positive) coping strategies, such as making

plans for the future, are related to lower levels of depression and overall distress [35]. However, to our knowledge, no studies have investigated these relationships immediately after diagnosis.

A Daily Process Approach to Studying Depression After Diagnosis of HIV

An important limitation of existing studies on depression among HIV-positive individuals is that depression is typically assessed at one or several time points only, requiring the subject to summarize depressive symptoms over a specified time period [3]. This measurement approach has methodological limitations including recall biases, such as recency and salience effects [36]. Among those diagnosed with HIV, evidence suggests that fluctuations in mood are common [37]. While daily measurements of depression can be valuable to analyze changes in mood over time [38, 39], to our knowledge no studies have utilized a daily process approach to investigate depressive symptoms and correlates of depression immediately after HIV diagnosis. Given that disclosure and initial coping responses may occur soon after the HIV diagnosis, this may be a key time to measure and understand these events and how they affect daily depressive symptoms.

Current Study

The objective of the current study in Uganda was to explore the patterns of daily depressive symptoms in the first month following receiving HIV test results. We compare daily depressive symptoms during this time between those who tested HIV negative and those who tested HIV positive. Among those diagnosed HIV positive, we explore the relationships between daily depressive symptoms and disclosure, coping, stigma, and related factors. We also examine differences in depressive symptom scores 3 and 6 months after diagnosis comparing those who disclosed to their partner during the first 28 days to those who did not. We hypothesized that among those who were diagnosed HIV positive, disclosure and positive coping would be associated with lower depressive symptoms at the day-level—that is that disclosure or positive coping that occurs on a particular day is associated with lower depressive symptoms that same day. We also hypothesized that disclosure would be associated with lower short and longer-term depressive symptoms.

Methods

Setting, Recruitment, and Eligibility Criteria

This study was part of a larger study testing the effect of a brief sexual risk-reduction counseling intervention implemented during outpatient provider-initiated HIV testing and counseling (PITC) in rural Uganda on reducing sexual risk behavior [40]. The study was conducted in the outpatient clinic at Gombe Hospital, a 100 bed public hospital in Butambala District, Uganda. As was standard-of-care, all outpatients regardless of presenting condition were offered PITC which was implemented according to the Ugandan Ministry of Health (MOH) PITC protocol [41]. Specifically, PITC consists of the following components: pretest information about the routine HIV test, rapid HIV testing, provision of results, and post-test counseling. The post-test counseling, which lasts 5–10 min, includes information-based counseling about risk-reduction, disclosure, partner referral for HIV testing, and additionally for those who test HIV positive, HIV care and treatment. If a patient's partner is present the couple is offered couples HIV testing and counseling. At the Gombe Hospital outpatient clinic, as at many outpatient clinics in Uganda, laboratory technicians are among the primary providers of PITC and are trained according to the MOH PITC protocol [41].

Between April 2010 and October 2011 a research assistant recruited participants by non-systematically approaching patients in the outpatient waiting room. Further details about the recruitment can be found in a previous publication from the parent study [40]. The research assistant briefly described the study, verbally determined eligibility from those interested in participating, offered participation to those who were eligible, and obtained written informed consent. Participant inclusion criteria were: attending the outpatient clinic, residing within 20 km of the hospital, age 18 years or older, and sexually active in the prior month. Exclusion criteria were: having had an HIV test within the prior 6 months, attending the clinic specifically for HIV testing, pregnant, and previously tested positive for HIV. There was no inclusion criterion related to HIV risk. Only one member of a couple was allowed to participate.

Institutional review boards at Makerere University School of Public Health and Rhode Island Hospital, as well as the Uganda National Council for Science and Technology, approved the study protocol.

Procedures

Participants completed a structured interviewer-administered computer-assisted personal interview in the local language of Luganda in the onsite study office. The research assistant explained the procedures for the daily structured interviews via phone including that beginning the following day and continuing each day for 28 days, an interviewer would call them on their mobile phone between 2:30 pm and 6 pm each day and ask them a brief set of questions. Participants without mobile phones (n = 102) were provided with one to use for the daily phone interviews. At enrollment participants

were also given appointment dates for 3 and 6 month follow-up interviews, and then received HIV rapid testing according to Ministry of Health guidelines [41]. Interviewers for the daily phone interviews made up to 4 attempts to reach a participant each day during the designated hours. Participants were compensated up to 37,000 Uganda Shillings (~ $12.33 USD) for participating in the daily phone interviews, the amount of which depended on the number of daily interviews completed. Participants were also compensated 3,000 Ugandan Shillings (~ $1 USD) for the baseline interview, 10,000 Ugandan Shillings (~ $3.33 USD) and 15,000 Ugandan Shillings (~ $5 USD) for follow-up interviews at 3 and 6 month respectively, including transportation costs.

Measures

Baseline and follow-up questionnaires included participant socio-demographics (baseline only) and variables relevant to the present study including depressive symptoms and HIV-related stigma. We assessed depressive symptoms with the short version of the Hopkins Symptom Checklist which contains 15 items assessing depression symptoms with responses formatted on a 1 (not at all) to 4 (extremely) scale [42]. This scale has been validated in east African settings [43] and has demonstrated construct validity [44] and good reliability [45] among Ugandan samples of individuals living with HIV. Scores on the items are summed and then a mean is calculated, with a mean score of 1.75 or above indicating clinically significant depressive symptoms [46–49]. Cronbach's alpha in the present sample was 0.86 at baseline, 0.89 at both 3 and 6 month follow-up. We assessed HIV-related stigma (baseline) with 13 items from Kalichman et al's HIV-related stigma scale developed and validated in South Africa [50, 51]; Cronbach's alpha in the present sample was 0.69. Responses were formatted as dichotomous (1) agree (0) disagree and summed to indicate endorsement of HIV-related stigma towards people living with HIV.

In studies which collect daily data from participants, reduced versions of scales are typically used because of the need to keep daily assessments to a short duration [52–59]. Relevant to the present study the daily phone interview questionnaire asked participants to report if, *since yesterday's interview* (*or* 5 pm *yesterday*), they had disclosed their HIV status to anyone and to whom. For individuals who had tested HIV positive, using the same time frame reference, we used three items to assess subjective feelings of experiencing internalized (feeling *embarrassed/ashamed because you have HIV*), enacted (feeling like *people discriminated against you because you have HIV*), and anticipated (feeling *afraid to do or say certain things because you were afraid people would know that you have HIV*) HIV-related stigma. These items were adapted from existing measures of HIV-related stigma [60, 61]. We adapted 8 items from Fleishman and Fogel's coping with HIV scale [62] to assess HIV-positive participants' engagement in strategies to cope with the HIV diagnosis *since yesterday's interview* (*or* 5 pm *yesterday*) with yes/no response options: positive coping (2-items, e.g., "in regards to knowing that you have HIV have you made plans for the future"), seeking social support coping (2 items, e.g., "talked to someone about how you are feeling about having HIV") and avoidance coping (4 items, e.g., "have you tried to act as though it hasn't even happened").

We assessed participants' depression symptoms *since waking up today* with 7 items from the Hopkins Symptom Checklist, which, in a factor analysis based on previously collected data at the same research site, loaded most strongly on a single depression factor. The mean of these 7 items was the daily depression symptom score, possible range 1–4, with a cutoff of 1.75 indicating possible depression [46–49] as noted above. Similarly, we assessed concern about HIV relative to other concerns for the time frame of *since waking up today* with a single constructed item using a 0 (worried about other things much more than about HIV) to 4 (worried about HIV much more than about other things) scale.

Statistical Analyses

We used linear mixed modeling, also called random coefficient, multi-level, or hierarchical regression modeling in SPSS version 24 to examine changes in depressive symptom scores over the 28 day daily interview period and predictors of these depressive symptom scores and changes over time. Mixed modeling is appropriate to analyze daily diary data since daily data points are nested within participants. Our outcome is the daily depressive symptoms score and our models contain time varying variables which were measured in the daily interviews (disclosure of HIV test results to partner, other person, or neither; engaged in positive coping (y/n); concern about HIV relative to other life concerns; and HIV-related stigma) as well as time invariant variables which were measured at baseline (baseline depression, baseline HIV-related stigma, gender). We also included study arm (control or intervention) as a time invariant variable to control for any differences by study condition. Baseline depression and HIV-related stigma were centered at the grand mean. Daily measures of concern about HIV relative to other life concerns and HIV-related stigma were also grand mean centered.

We first examined between- and within-person variance in our outcome of daily depression scores and daily predictor variables using an unconditional mean model. Next we identified the most appropriate slope (e.g., linear, quadratic) by fitting an unconditional linear growth model to examine individual variation in the rates of change over time and in two subsequent models we added quadratic and cubic time effects respectively to determine if the rates of

change decelerated or accelerated over time. We compared the model fit to the data using Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Next in a model adding our predictor variables we explored different covariance structures: unstructured, compound symmetry, and first-order autoregressive (AR1), to determine the best fit to the data.

Having established the most appropriate slope shape for the rates of change over time and the most appropriate covariance structure, in a mixed model with a random slope, we then examined changes in daily depressive symptom scores over time separately for individuals who tested HIV positive and HIV-negative and investigated whether the baseline depression score predicted daily depression scores and changes in these scores over time. We conducted further analyses focusing only on the HIV-positive participants to see if the daily depression score slope differed based on having disclosed the test results to the partner and identifying other time-varying and time-invariant predictors of daily depression scores and changes during the 28 day daily diary. Lastly, we explored differences in 3 and 6-month follow-up depression symptom scores between those who did and did not disclose their results to their partner during the first 28 days after diagnosis (interaction between time and disclosure). We used linear mixed modeling with a compound symmetry covariance structure for this analysis, which included depression symptom scores assessed at the following 4 time frames: baseline, mean of scores from 28 day diary, 3 and 6 months.

Results

Of the possible 6832 daily diary interview days during the 28-day study, the 244 participants completed 4730 (69.23%) of the possible days. A number of the missed days (285) were due to cellular network outages. Taking this into account, participants completed interviews on 72.24% of the 6547 days during which the interview calls were technically possible. The mean number of days completed was 19.39 (SD = 5.78), and the range was 4–28. Three participants who tested HIV positive and 23 participants who tested HIV negative were excluded because they provided fewer than 4 days of data. Therefore, the analytic sample consisted of a total of 244 participants. Of these, 20 tested HIV positive at baseline; they provided 342 data points and 224 tested HIV negative at baseline; they provided 4,388 data points.

Descriptive Statistics and Between-Person Findings

We calculated individual mean scores across the 28 day daily interview for variables measured daily and, using those individual means, calculated sample means. Among those who tested HIV positive the mean of daily depression symptom scores was 1.88 (SD 0.45) and 50% of participants had means above the possible depression symptom cutoff of 1.75. Among those who tested HIV negative the mean of daily depression symptom scores was 1.57 (SD 0.36) and 25% of participants had means above the possible depression symptom cutoff. Forty percent of participants who tested HIV positive engaged in positive coping on one or more day during the 28 day daily diary and the mean HIV-related stigma score was 0.94 (SD 1.86). The mean of daily scores on concern about HIV among those HIV-positive was 1.61 (SD 1.04). We present the baseline sample characteristics and descriptive statistics for time invariant variables in Table 1.

Between- and Within-Person Variability and Determining the Shape of the Growth Curve Model

First, we fitted an unconditional mean model to explore what proportion of the variance in our outcome, depressive symptoms score, was due to within-individual differences. For individuals who tested HIV positive the ICC was 0.32, reflecting that 32% of the variance in daily depressive symptom scores were due to between-person differences, and thus 68% of the variance was due to within-person variability. For those who tested HIV negative the ICC was 0.44, suggesting that 44% of the variance in daily depressive symptom scores were due to between-person differences. We also examined between person variability in continuous predictor variables; the ICC for HIV-related stigma among those who were HIV positive was 0.19. The ICC for concern about HIV was 0.32 for those who were HIV positive.

Next, we fitted an unconditional linear growth model to examine individual variation in the growth rates (change over time). There was a significant decrease over time in depressive symptom scores for those who tested negative ($\beta = -0.003$, $t = -3.19$, $p = 0.002$) and those who tested positive ($\beta = -0.024$, $t = -4.338$, $p < 0.001$). The estimated depression score on day 1 was 1.61 for those who tested negative and 2.19 for those who tested positive. For those who tested negative the correlation between the intercept and linear growth parameter was negative ($\beta = 0.001$, $t = -2.784$, $p = 0.005$) which suggests that among those who tested HIV negative and had higher initial depression scores they had a slower linear decrease.

Finally, we fitted a quadratic growth cure model, which tests whether changes in the rate of linear growth changed over time. The negative linear time effect remained for those who tested negative ($\beta = -0.012$, $t = -4.02$, $p < 0.001$) and those who tested positive ($\beta = -0.070$, $t = -4.56$, $p < 0.001$) showing that the rate of linear growth decreased over time. There was also a quadratic effect of time for those who tested negative ($\beta = 0.0003$,

Table 1 Baseline sample characteristics and descriptive statistics

	HIV positive (n = 20) % (n); mean (SD)	HIV negative (n = 224) % (n); mean (SD)
Male	25.0% (5)	52.2% (117)
Female	75.0% (15)	47.8% (107)
Age	34.60 (9.03)	33.28 (10.12)
Marital status		
Married or living with a partner	95.5% (19)	88.4% (199)
Education		
None	5.0% (1)	4.0% (9)
Primary	60.0% (12)	58.5% (131)
Secondary	30.0% (6)	28.6% (64)
Tertiary or greater	5.0% (1)	8.9% (20)
Baseline depression symptoms	1.67 (0.59)	1.37 (0.49)
Baseline depression, % scoring > 1.75	25.0% (5)	15.6% (35)
Baseline HIV-related stigma	2.73 (2.11)	2.94 (2.19)

t = 3.14, $p = 0.002$) and for those who tested positive (β = 0.002, t = 3.21, $p = 0.001$) showing that the rate of decrease in depression scores decreased over time. Depression scores decreased the most at the beginning and then the rate of decrease slowed down. The quadratic model improved the fit of the model over the linear model: HIV negative: $\chi^2(1)$: 4901.01–4891.18 = 9.83, $p < 0.005$ AIC: 4913.01–4905.18 = 7.83, BIC: 4951.34–4949.89 = 1.45; HIV positive: χ^2 (1): 628.46–618.44 = 10.02, $p < 0.005$, AIC: 640.46–632.44 = 8.02, BIC: 663.45–659.27 = 4.18.

We also fitted a cubic growth curve model to determine if that was a better fit for the data. It did not improve model fit above improvements seen with the quadratic growth curve model. Therefore, in the models testing relationships between predictor variables and the outcome of daily depressive symptoms we use the quadratic growth curve model.

Patterns of Depressive Symptom Scores in the First 28 Days After Receiving HIV Test

Modeling the change over time while controlling for covariates of gender, study arm, and baseline depression, there were significant time effects both linear (HIV positive: β = − 0.069, t = − 3.71, df = 93.12, $p < 0.001$; HIV negative: β = − 0.012, t = − 3.63, df = 1433.11, $p < 0.001$) and quadratic (HIV positive: β = 0.002, t = 2.45, df = 96.26, $p = 0.016$; HIV negative: β = 0.0003, t = 2.70, df = 1437.26, $p = 0.007$). As shown in Fig. 1, we observed that depression started out initially high (2.4) on the day after diagnosis for those who tested positive but decreased to below the cutoff for possible depression of 1.75 by approximately day 15 and remained below the cutoff through day 28 but did not show further large decreases. Individuals who tested HIV negative had scores below the cutoff at day one and remained below

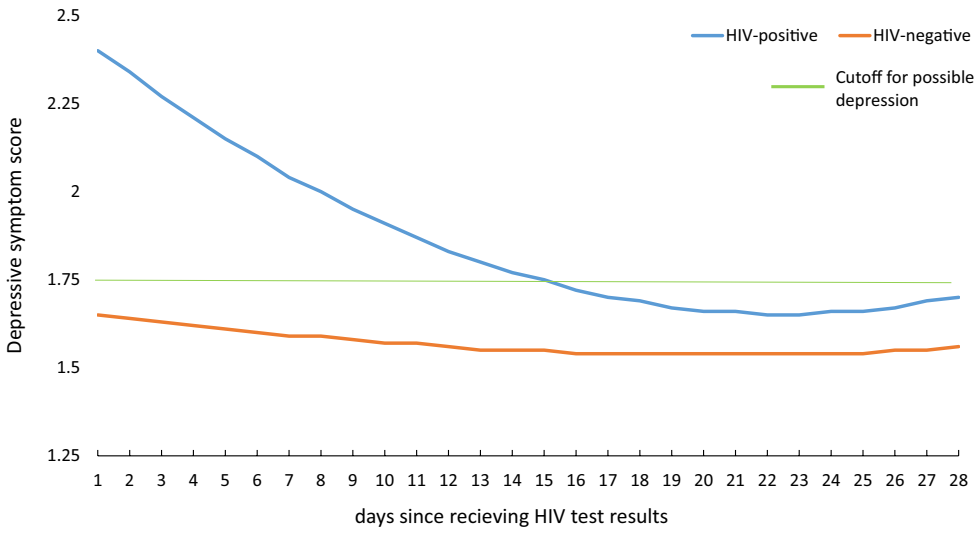

Fig. 1 Daily depressive symptoms score by HIV test results in the 28 days following HIV testing

the cutoff through day 28. We examined if the patterns of change over time differed between those who scored above and below the cutoff for possible depression (1.75) at baseline. For both those who tested HIV negative and those who tested HIV positive there was no difference in the time effect based on baseline depression symptoms (time x baseline depression interaction: HIV positive: $\beta = 0.0024$, $t = 0.15$, $df = 79.16$, $p = 0.88$; HIV negative: $\beta = 0.0021$, $t = 0.51$, $df = 975.58$, $p = 0.61$).

For those who tested HIV positive, we also compared daily depressive symptom scores between those who disclosed their results to their partner within the first 28 days after receiving the HIV positive test results to those who did not disclose to their partner during this time period. The pattern of change in daily depression symptom scores differed between those who reported disclosing their status to their partner during that time and those who did not disclose (disclosure to partner during first 28 days (y/n) × time $\beta = -0.29$, $t = -2.88$, $p = 0.005$). As Fig. 2 illustrates, using the model predicted values and standard errors, those who disclosed had higher depressive symptom scores in the first few days, likely because most disclosures occurred then, but then significantly lower depressive symptom scores towards the end of the 28 days.

Predictors of Daily Depression Scores and Changes in Daily Depression Scores Over Time Among Those Who Tested HIV Positive

Results of the model predicting daily depression scores from time varying and time invariant variables, using a first-order autoregressive correlation structure, are reported in Table 2 and described below. For those who tested HIV positive, at the day-level, disclosure to a partner increased depressive symptoms that day by about 0.89 points ($t = 3.74$, $df = 287.9$, $p < 0.001$. Disclosure to someone else increased depressive symptoms by about 0.33 points ($t = 2.15$, $df = 300.1$, $p = 0.033$). This effect decreased over time for disclosure to others ($t = 2.25$, $df = 292.0$, $p = 0.025$) but did not significantly decrease over time for disclosure to a partner ($t = -1.05$, $df = 295.8$, $p = 0.29$). Engaging in positive coping on a particular day decreased that day's depressive symptoms by 0.43 points ($t = -2.38$, $df = 289.6$, $p = 0.018$) and the effect of positive coping on decreasing daily depressive symptoms increased over time ($t = 2.07$, $df = 246.5$, $p = 0.04$). Scoring higher on the daily measure of HIV stigma ($t = 4.56$, $df = 304.4$, $p < 0.001$) and feeling that HIV was of more concern to them than other things ($t = 4.16$, $df = 300.94$, $p < 0.001$) were both associated with higher daily depressive symptoms. We controlled for baseline depression score and it was not significantly related to daily depression scores after diagnosis nor did it interact with any of the predictors of daily depression scores. There was no significant effect for baseline HIV-related stigma. Also there was no main effect or moderating effects of gender, study arm, age, marital status, or education; all of these except gender and study arm were removed from the final model presented in Table 2.

We also explored adding disclosure from the prior day to the model (lagged disclosure); it did not yield any differences, meaning that controlling for today's disclosure, yesterday's disclosure did not affect depressive symptoms. This suggests that the day-of increase in depressive symptoms from disclosure dissipated by the next day.

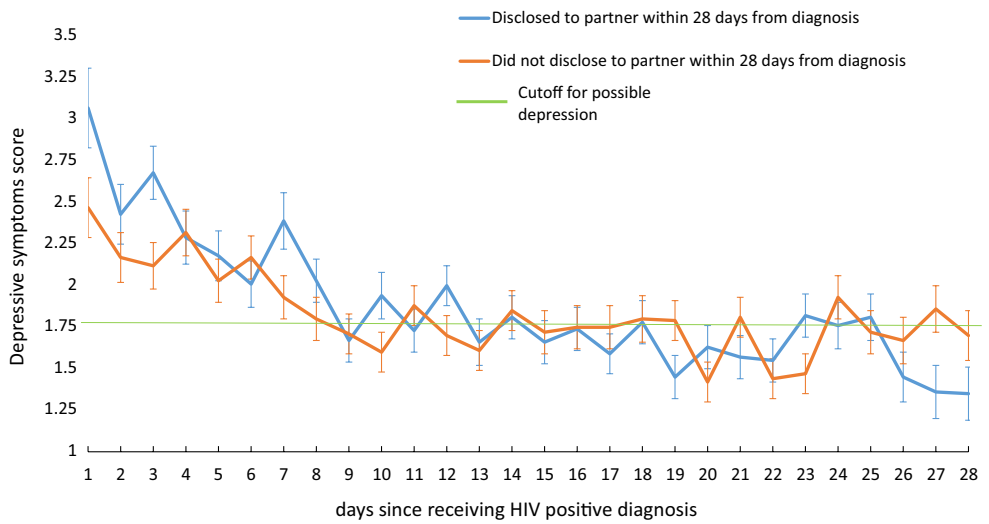

Fig. 2 Model predicted daily depressive symptoms score by disclosure to partner during the first 28 days following the HIV positive diagnosis

Table 2 Mixed model predicting daily depression scores from time-varying and time invariant variables

	Estimate	*t* (df)	*p* value
Intercept	2.40	9.86 (73.6)	$p < 0.001$
Time-varying variables			
Day (days since diagnosis)	− 0.038	− 1.94 (121.3)	$p = 0.055$
Day^2 (days since diagnosis^2)	0.0003	0.38 (96.6)	$p = 0.705$
Disclosed			
Partner	0.89	3.74 (287.9)	$p < 0.001$
Other person	0.33	2.15 (300.1)	$p = 0.033$
Neither (ref.)	–	–	–
Engaged in positive coping (Y/N)	− 0.43	− 2.38 (289.6)	$p = 0.018$
Concern about HIV	0.09	4.16 (300.94)	$p < 0.001$
HIV-related stigma	0.09	4.56 (304.4)	$p < 0.001$
Disclosure by day interaction			
Partner × day	− 0.018	− 1.05 (295.8)	$p = 0.297$
Other person × day	− 0.024	2.25 (292.0)	$p = 0.025$
Positive coping × day	0.024	2.07 (246.5)	$p = 0.038$
Time-invariant variables			
Study arm			
Control	0.21	1.32 (17.7)	$p = 0.204$
Intervention (ref.)			
Female gender	− 0.08	− 0.45 (17.9)	$p = 0.665$
Baseline depression	0.11	0.80 (16.5)	$p = 0.437$
Baseline HIV-related stigma	− 0.08	− 1.44 (17.2)	$p = 0.174$
Random effects			
Intercept variance	0.074	z = 2.02	$p = 0.043$

Longer-Term Patterns of Change in Depressive Symptoms as a Function of Disclosing to the Partner During the First 28 Days After Diagnosis

There was a significant interaction between time and the timing of disclosure of HIV-positive results to the partner ($F_{[3,25]} = 3.95$, $p = 0.02$) on predicting depressive symptoms. As shown in Fig. 3, those who disclosed during the first 28 days had slightly, but not significantly, lower depressive symptom scores at baseline and had slightly higher mean depressive symptom scores during the 28 days after diagnosis. Most notably, however, those who disclosed to their partner during the first 28 days after diagnosis had significantly lower depressive symptom scores at both 3 and 6 month follow up compared with those who did not disclose to their partner during the first 28 days after diagnosis.

Discussion

Relatively little research has closely examined depressive symptoms in the initial days and weeks after being diagnosed HIV-positive, how depressive symptoms may change during this time, and what factors may be associated with changes in depressive symptoms over time. The daily diary methodology used in this study in rural Uganda allowed us to more adequately assess the directions and patterns of depressive symptom change within subjects over time and the effects of events (i.e., disclosure) and constructs (i.e., HIV-related stigma, positive coping) on depressive symptoms. Our data showed that there was meaningful and significant day-to-day within-person variability in depressive

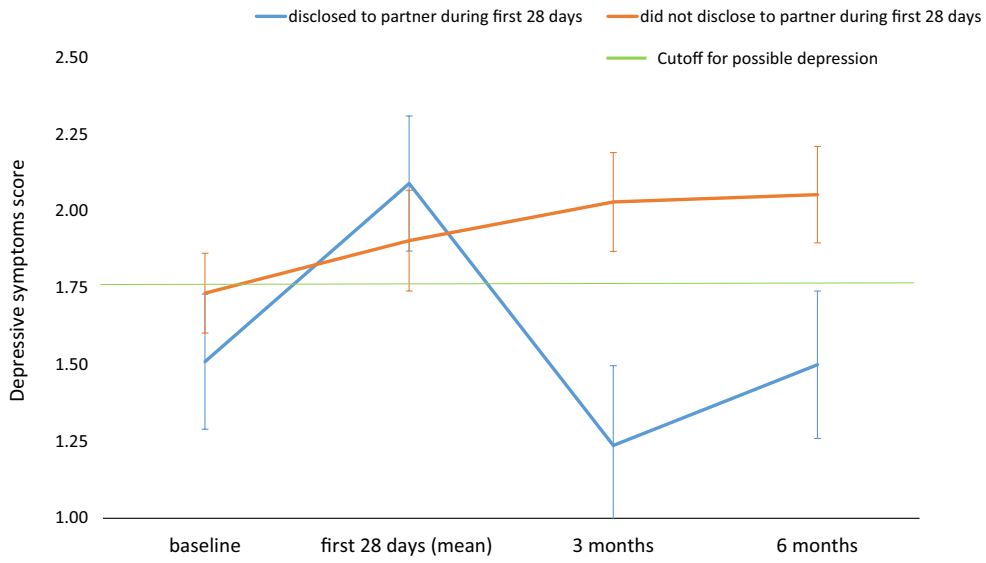

Fig. 3 Model predicted depressive symptoms among individuals diagnosed with HIV from pre-diagnosis (baseline) through 6 months post-diagnosis by disclosure of HIV positive test results to partner during first 28 days

symptoms, particularly after disclosure to a partner. Other factors that we measured daily, including positive coping and HIV-related stigma, also predicted daily depressive symptoms.

We found that while those diagnosed with HIV showed initially high depressive symptoms in the first few days following their diagnosis, their symptoms decreased significantly over the course of the first month after diagnosis—falling below the cutoff for possible depression approximately 15 days after diagnosis (Fig. 1). By comparison, those who tested HIV negative showed slight decreases in depressive symptoms during the month following receiving their negative test results but their depressive symptoms started at and remained below the cutoff for possible depression. Although high depressive symptoms following being diagnosed with HIV makes intuitive sense and is supported by prior findings that individuals living with HIV have higher rates of depression than the general population, [10, 63], the rapid decrease in depressive symptoms which we observed in the first 15 days was surprising. This initial rapid decrease was irrespective of disclosure, which suggests an individual's coping approaches or other personal factors may have played a large role in early decreases in depressive symptoms. The overall decrease in depressive symptoms from diagnosis to 28 days later, however, did show advantages for disclosure. By day 28 those who had disclosed to their partner had significantly lower depressive symptoms and showed a larger change in depressive symptoms between diagnosis and 28 days post-diagnosis than those who did not disclose.

Several of the associations found with related psychosocial constructs, namely HIV-related stigma and coping, demonstrated expected associations based on previous research such that scoring higher on daily HIV-related stigma and feeling that HIV was of more concern than other things were both associated with higher daily depressive symptoms. Increased felt stigma and methods of coping with stigma (by disengaging from or engaging with the stigma stressor) have predicted self-reported depression [28, 64]. Consistent with our hypotheses, in our study, at the day-level engaging in positive coping was associated with lower daily depressive symptoms and it also accelerated the decrease in depressive symptoms over time. Positive coping strategies such as problem-solving coping, in which individuals take action to change their environment and/or within themselves to reduce stress, has been associated with decreases in depressive symptoms [28]. In general, positive coping is related to the theoretical underpinnings of Behavioral Activation, an empirically validated treatment for depression. Behavioral Activation (BA) seeks to increase the patient's contact with sources of reward by increasing action and, in so doing, decreasing depressive symptoms. In BA, individuals identify relationships between their actions and emotions, with actions being seen as the cause of emotions. The goal is for individuals to schedule activities that lead to environmental reinforcement. Similarly, problem-solving coping strategies are specific actions initiated by the individual to increase internal or external reinforcement and often lead to an improvement in feelings and thoughts [65, 66]. Given our findings, BA may be an effective therapeutic approach for treating depression among individuals diagnosed with HIV.

Contrary to our hypothesis, among newly diagnosed HIV-positive individuals, at the day-level, disclosure, especially disclosure to a partner, was associated with higher depressive symptoms. However, consistent with our hypothesis, those who disclosed to their partner during the 28 days after diagnosis had significantly lower depression scores by the end of the 28 days (Fig. 2) as well as significantly lower depression scores 3 and 6 months after diagnosis (Fig. 3). Those who did not disclose to their partner during the first 28 days had depression scores above the cutoff for possible clinically significant depression at the 3 and 6-month follow-up, illustrating the longer term benefits of disclosure to a partner soon after diagnosis. From a public health perspective, disclosing HIV-positive results to partners is crucial to help facilitate risk-reduction by, for example, getting the partner tested for HIV and, if HIV negative, initiating pre-exposure prophylaxis (PrEP). Disclosure also benefits the individual, in most cases making HIV care engagement and treatment adherence easier [22, 67] and consequently improving treatment outcomes [68, 69].

Since depression is a debilitating illness that negatively affects HIV care and treatment engagement [19, 70], it is critical to understand the effects of disclosure on depression. Prior research on the psychological effects of disclosure of HIV serostatus is mixed; some findings indicate that disclosure induces a negative mood and increases in anxiety [71–73]. However, a significant body of literature suggests that disclosure is associated with significantly more positive than negative psychological outcomes, including in Uganda and Tanzania [18, 22, 74]. For instance, findings indicate that disclosure to a partner is associated with decreases in psychological distress, including anxiety, and with greater perceived acceptance and kindness [68]. Our findings showing short-term negative effects of disclosure on depressive symptoms but longer-term positive effects are consistent with both bodies of literature. Also noteworthy, was that according to our data, day-level increases in depressive symptoms from disclosure appeared to dissipate by the next day. Specifically, our data showed that, for example, if disclosure occurred yesterday, it did not affect today's depressive symptoms. These results are also somewhat consistent with Kelley et al.'s finding that verbal disclosure of feelings and emotional processing of stressful life events among patients with a chronic illness induces an immediate negative mood followed by improved psychological functioning

[75]. This may also help to explain the large decrease in depressive symptoms in the first month since most disclosure to partners occurred soon after diagnosis and all but one HIV-positive participants disclosed to someone (another person or their partner) during the first 28 days.

The costly impact of depression on HIV-positive individuals' physical health and wellbeing demands innovation in assessment strategies and psychological treatment approaches to better understand factors and influences on depression. While depression could be conceptualized as a broad disposition that is stable across time and situations, emerging evidence suggests that major depressive disorder (MDD) is characterized by high levels of emotional variability on a day-to-day basis among depressive symptoms (for a review, see Houben et al. [76]). An investigation by Thompson et al. [77] found that individuals with MDD had higher levels of emotional variability than healthy controls, even after excluding individuals with MDD with co-occurring anxiety disorders. Thus, the application of daily diary techniques in the present study illustrates the power of this approach in identifying temporal processes, which are unable to be assessed with cross-sectional or longitudinal designs, and adds to the extant literature on the HIV diagnosis-depression relationship.

It was also notable that depressive symptoms measured at baseline immediately before HIV testing did not predict daily depressive symptoms in the 28 days following receiving HIV-positive test results nor the change in depressive symptoms over time. Furthermore, it did not moderate any of the observed associations between daily depressive symptoms and disclosure, positive coping, or HIV-related stigma. This suggests that depression screening prior to HIV testing may have less utility as a screener for risk of post-diagnosis depression and that depression screening should instead be conducted after receiving HIV test results. Our data also suggests that depression screening should be repeated regularly during the 6 months following diagnosis, especially for those who have not disclosed their status to their partner. Specifically, optimal screening times for identifying those at risk of experiencing continued longer-term depressive symptoms may be: immediately after diagnosis, between 2 and 4 weeks, and again between 4 weeks and 6 months.

Limitations

Limitations of the present study include a small participant sample size, particularly of those diagnosed HIV-positive, although with the daily diary methodology the large number of data points per person provides a larger overall analytical sample size. There were more females than males, which is common in samples recruited from health care settings in Uganda and similar settings, but limited our power to detect gender differences. While some findings indicate no differences in the prevalence of depression by gender or a higher prevalence of depression among women [26, 78], some evidence exists for higher rates among men in sub-Saharan Africa [79]. We non-randomly sampled individuals presenting to the outpatient clinic and limited enrollment to those meeting the eligibility criteria for participation, which limits the generalizability of our findings outside of our study context. In addition, all data was self-reported.

Implications and Conclusions

The inherently idiographic nature of depression following a stressful life event such as an HIV-positive diagnosis is exceptionally well suited to study through daily process designs. Inclusion of the dimension of day-to-day changes in depressive symptoms and related constructs requires that we adjust our conceptualization of the experience of depression among this population. Further analysis of daily depressive symptoms post-diagnosis could provide a template for exploring additional factors that interact with depression to elucidate moderators of depression; this could perhaps be done by measuring relevant constructs such as anxiety, to understand psychological symptoms and how they affect HIV care engagement, treatment initiation, and adherence.

Our findings have a number of implications for clinical interventions. Considering high rates of depression in persons diagnosed with HIV and consistent evidence that chronic depression and stressful events may negatively affect HIV disease progression in terms of decreases in CD4 count, increases in viral load, and greater risk for clinical decline and mortality, [80] it is important for health care workers to be informed about how to screen for depression and to refer newly diagnosed individuals for depression treatment as part of HIV care in Uganda.

Our results support current recommendations to promote and assist with HIV status disclosure to a partner soon after diagnosis. Post-test counseling and HIV care services for HIV-positive individuals should include clear messages regarding the patterns of depressive symptoms and the impact of disclosure on depressive symptoms. However, counselors could ideally inform patients of both the short and long-term effects of disclosure so patients recognize that temporary increases in depression are expected yet a significant reduction in symptoms typically occurs within weeks and is maintained long-term. Furthermore, encouraging individuals to engage in positive coping strategies, and providing examples of such strategies, could help alleviate depressive symptoms and speed the decrease in symptoms post-diagnosis. Regular depression screening after diagnosis, perhaps integrated into HIV testing post-test counseling as well as into HIV care services, could help newly diagnosed individuals access mental health treatment, which

in turn may improve HIV care engagement at treatment outcomes.

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Compliance with Ethical Standards

Conflict of interest The authors declare no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional (Makerere University School of Public Health and Rhode Island Hospital) and national research committee (Uganda National Council for Science and Technology) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All participants provided written informed consent. This article does not contain any studies with animals performed by any of the authors.

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