Incorporating Mental Health into the EMOD-HIV Model

Daniel T Citron
IDM Symposium 2023
Our Team

Anna Bershteyn, PhD
Assistant Professor

Hae-Young Kim, PhD
Assistant Professor

Masabho Milali, PhD
Postdoctoral Fellow

Ingrida Platais
Project Manager

David Kaftan
Research Scientist

Frey Assefa
Data Analyst

Shiying You
Graduate Student Researcher

Daniel T Citron, PhD
Research Scientist

Introduction
HIV in sub-Saharan Africa (SSA)

- 25.6 million PLHIV in SSA
- 860 thousand new HIV cases in 2021
- 420 thousand HIV-related deaths in 2021
- Considerable progress in the last two decades
- Our team studies cost-effectiveness of new interventions to continue to improve HIV care and treatment
Incorporating treatment for NCDs into HIV care

• Resources provided for HIV care in SSA have proved effective in reducing HIV burden
• Other conditions co-morbid with HIV have not been given as many resources
• Can we expand HIV care to include treatment for non-communicable diseases as well?
  – Can we reduce HIV burden by treating other conditions?
  – Do we avert more DALYs overall by including other types of health care with HIV care?
• A step towards universal health coverage
Depression and HIV

• Depression is the most common mental disorder
• Depression is the highest ranked contributor to morbidity (YLDs) in SSA and globally
• PLHIV in SSA experience high prevalence of mental illness
  – Major depressive disorder is on average 15% among PLHIV in SSA
  – 2-3x higher than in the general population
• Depression can be treated at scale in SSA
  – Interpersonal Psychotherapy (IPT) – WHO recommended
  – Pharmacotherapies
Interactions between HIV and Depression

- HIV is associated with higher rates of depression
  - 2-3x higher among PLHIV than in the general population in SSA
- Depression leads to worse HIV care outcomes
  - HIV incidence is higher among people with depression
  - Delays to diagnosis, linkage to care, HIV treatment
  - Reduced antiretroviral therapy (ART) adherence and viral load suppression (VLS) outcomes
Modeling Depression and HIV Together

• Develop conceptual model of how depression interacts with HIV care continuum
  – Systematic literature review
  – Identify interactions and quantify effect sizes

• Incorporate depression into EMOD-HIV
  – Agent-based simulation of HIV and mental health
  – Allow mental health states to interact with behavioral risk and engagement in HIV care

• Simulate
  – Estimate how depression affects HIV – cases, deaths
  – Estimate how depression interferes with HIV treatment – ART coverage and VLS
  – Estimate how much depression treatment alleviates HIV disease burden
EMOD-HIV Care Continuum

HIV acquisition  Diagnosis  Linkage to care  ART adherence

HIV Negative → HIV Positive Undiagnosed → HIV Positive Diagnosed → On ART VL Not Suppressed → On ART VL Suppressed
EMOD-HIV Care Continuum

HIV acquisition  Diagnosis  Linkage to care  ART adherence

HIV Negative  HIV Positive Undiagnosed  HIV Positive Diagnosed  On ART VL Not Suppressed  On ART VL Suppressed

ART dropout  ART non-adherence
Model of Depression

- Develop model of depression which reproduces known clinical and behavioral patterns
- Calibrate model to age-specific prevalence of major depressive disorder
  - Kenya World Health Survey 2004
  - Global Burden of Disease estimates
- Input from collaborators – mental health clinicians
  - Depressive episodes last roughly 8-9 months
  - Need to account for each patient’s history with depression and care
  - Patients who receive treatment
    - Less likely to suffer relapse
    - More likely to seek treatment in the future
Compartmental Model of Depression

- Not Depressed
- Depressed
- Recovery with treatment
- Relapse after treatment
- Recovery without treatment
- Depression Incidence
- Receive treatment
- Relapse
- Recovery
Compartmental Model of Depression

- Derive rate parameters from literature review
Compartmental Model of Depression

- Derive rate parameters from literature review
- Calibrate depression incidence based on prevalence
EMOD-HIV + Depression

1. HIV Negative
2. HIV Positive Undiagnosed
3. HIV Positive Diagnosed
4. On ART VL Not Suppressed
5. On ART VL Suppressed

Depression:
1. Not Depressed
2. Depressed
3. Recovery without treatment
4. Recovery with treatment
EMOD-HIV + Depression

HIV acquisition

- HIV Negative
- HIV Positive Undiagnosed
- HIV Positive Diagnosed
- On ART VL Not Suppressed
- On ART VL Suppressed

- Not Depressed
- Depressed
- Recovery without treatment
- Recovery with treatment

• Increased risky sexual behavior
• Decreased use of preventative measures
EMOD-HIV + Depression

- Delays to Diagnosis

Diagnosis

- HIV Negative
- HIV Positive Undiagnosed
- HIV Positive Diagnosed
- On ART VL Not Suppressed
- On ART VL Suppressed

Depression

- Not Depressed
- Depressed
- Recovery without treatment
- Recovery with treatment
EMOD-HIV + Depression

- Lower rate of ART adherence
- Decreased rate of VL Suppression
EMOD-HIV + Depression

- Increased ART dropout rate
EMOD-HIV + Depression

- HIV associated with increased depression
EMOD-HIV + Depression

- Increased depression upon diagnosis
EMOD-HIV + Depression

- Reduced depression after achieving VLS
EMOD-HIV + Depression

- Incorporate depression screening in HIV screening
- Increase rate of linkage to depression treatment
EMOD-HIV + Depression
Preliminary Modeling Results

- Baseline assumptions
  - Start with HIV model calibrated to HIV in Kenya
  - Calibrate depression model to estimated age-prevalence curves
  - Calibrate depression model to have higher prevalence among PLHIV
- Increase risky behavior among depressed individuals
  - Engage with more concurrent sexual partners at a higher frequency
- Decrease ART adherence among depressed individuals
  - 81% of non-depressed individuals achieve VLS
  - 63% of depressed individuals achieve VLS
EMOD-HIV + Depression

- Increase depression incidence for PLHIV
- Increase risky behavior for depressed
- Reduce ART adherence and VLS
Baseline Modeling Results

HIV Prevalence

- Female
- Male

HIV-related deaths

- Female
- Male
Model Calibration - Depression

- Calibrating to age-specific depression in 2004 World Health Survey in Kenya
Depression and HIV

All ages depression prevalence given HIV status

• PLHIV have higher prevalence of depression compared to general population
• Depression prevalence changes as HIV-affected cohort ages
Incorporating Treatment for Depression

• Assume that all episodes of depression receive treatment
• Assume 3-month recovery time with depression treatment

• Reduce risky behavior among those who receive treatment
• Improve ART and VLS outcomes among those who receive treatment
HIV Cases Averted

- With treatment, avert a few hundred new HIV cases per year

Modeling Results
HIV Deaths Averted

- With depression treatment, avert a few hundred HIV-related deaths per year
Improvements to ART coverage and outcomes

- ART coverage is about 1% higher when depression is treated.
- VLS improves by 1.5% as ART retention improves with depression treatment.
Conclusion

• The interactions between HIV and depression are complex, and require a detailed simulation model to fully explore

• Under strong assumptions of universal successful treatment of depression, the model predicts small improvements to HIV outcomes
  – Treatment prevents new HIV cases and deaths
  – Improved ART coverage and VLS

• Preliminary estimates of DALYs averted suggest that the benefit of treating mental health will be enormous even without accounting for improvements to HIV

• Continue to develop, verify, and validate the EMOD-HIV+Depression model, incorporating interactions and effect sizes determined by our systematic literature review
Acknowledgments

MATUMAINI Team

NYU Grossman School of Medicine
Anna Bershteyn (PI)
Hae-Young Kim
Frey Assefa
Shiyong You
Masabho Milali
David Kaftan
Ingrida Platais
Julia Lam
R. Scott Braithwaite

University of Cincinatti
Diego F. Cuadros

Center for Infectious Disease Research in Zambia (CIDRZ)
Izukanji Sikwzwe
Sulani Nyimbili
Anitha Menon

StrongMinds
Roscoe Kasuja
Leah Tanner

Institute for Disease Modeling
Daniel Bridenbecker
Clark Kirkman

Funding source
National Institutes of Health

Conclusion