AI and Poverty

Harnessing Data to Understand Health Risks and Inequities

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Health Needs More Than Medicine

- Will a person utilize health services?
- Will they avoid substance abuse?
- Will they adhere to therapy?

- Depend not only on medical factors, but also on **socioeconomic** conditions.

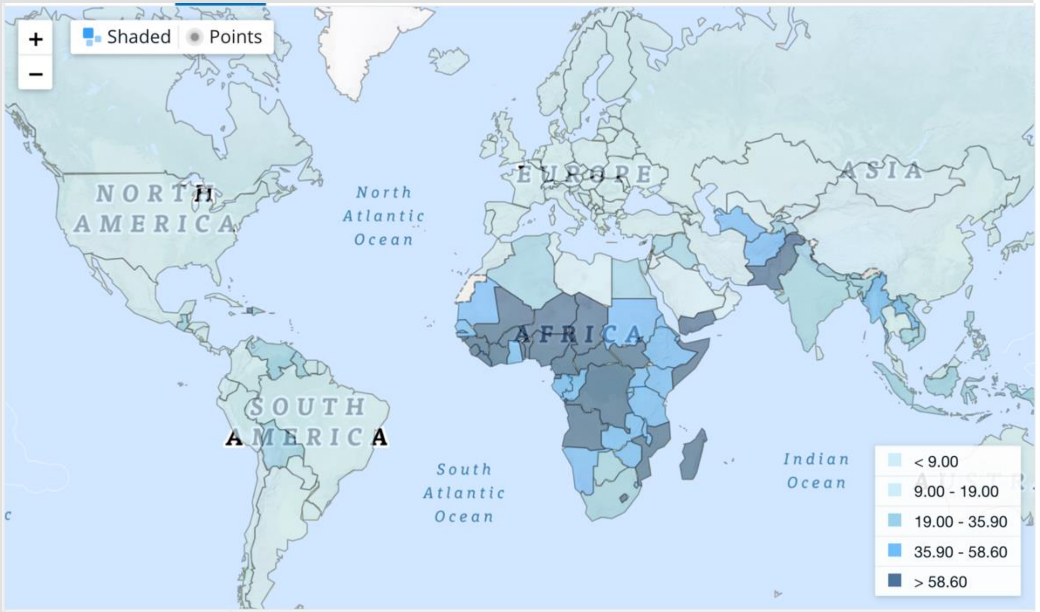
How can we harness **AI** to understand socioeconomic determinants and enhance health?

AI for Public Health

- **Understand access to care**
  - Who utilizes maternal and child health services?
- **Predict health risks and outcomes**
  - Who is at risk of substance use?
- **Predict treatment adherence**
  - Who is likely to stay on antiretroviral therapy?

Who utilizes maternal and child health services?

- Sub-Saharan Africa (SSA) accounts for >80% of global **Under-Five Mortality (U5M)** rates.
- **Maternal and child health services** are critical in reducing U5M rates.
- Goal: Identify **distinct patterns** of maternal and child health services and associated **socioeconomic disparities**.



WHO estimates of global U5M rates in 2021

Work with Claire Najjuuko, Ziqi Xu, Samuel Kizito, Fred M. Ssewamala

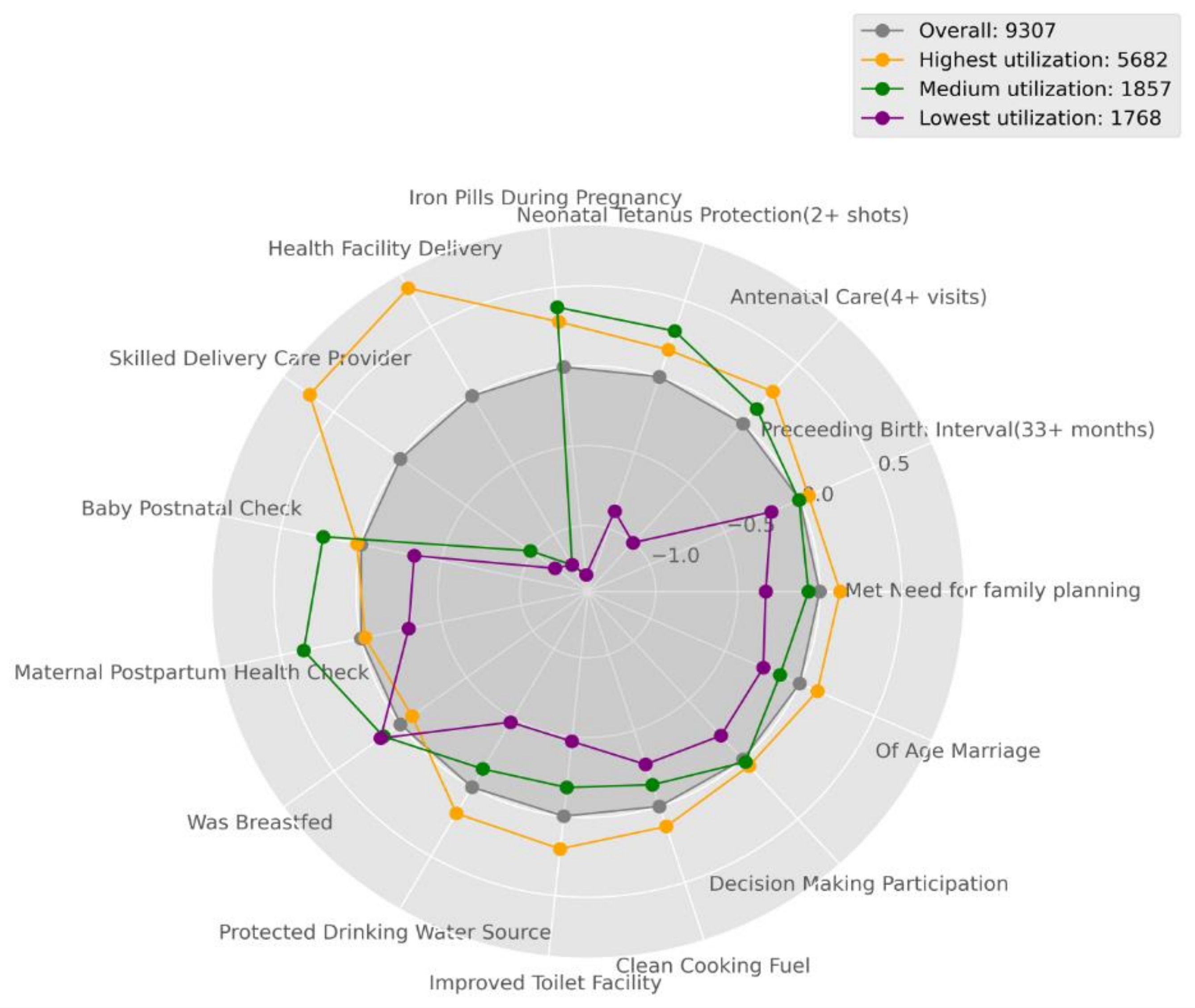
Data

- Nationally representative demographic and health surveys (DHS)
- Latest survey from **31 Sub-Saharan Africa (SSA) countries** (2014 – 2024)
- **9307 mother-reported births** that ended in U5M

Maternal and child health services and protective practices indicators

#	Utilization Indicator	#	Utilization Indicator
1	Met Need for family planning	9	Clean fuels for cooking
2	Antenatal care (4+ visits)	10	Improved sanitation facility
3	Iron pills during pregnancy	11	Piped water / Protected water source
4	Neonatal tetanus protection (2+ shots)	12	Non-tobacco user
5	Health facility delivery	13	Married at mature age
6	Skilled provider delivery	14	Decision making participation
7	Post-partum visits for women	15	Child was breastfed
8	Post-natal visit for babies	16	Child spacing (33+ months)

Service Utilization Patterns



16 utilization indicators of maternal and child health services

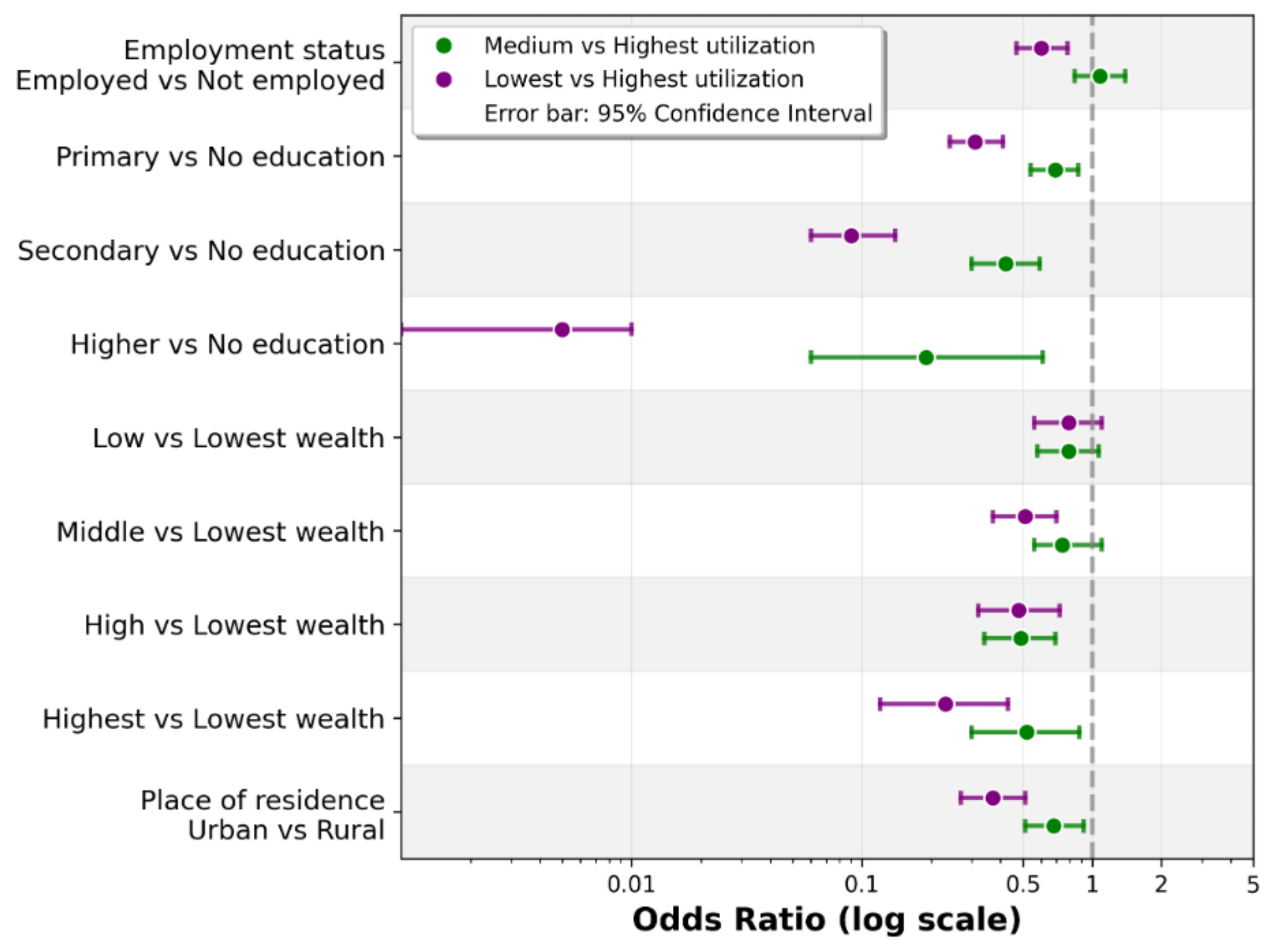
Latent Class Analysis

Three distinct utilization groups: **high, medium, low**

Utilization Patterns vs. Socio-economic Status

In comparison to the high utilization group, the lower utilization groups have lower odds of

- **mother's education**
- **employment**
- **high wealth tier**
- **residing in urban areas**



Inequality in Service Utilization

Measures of inequality in service utilization

Ranking variable	Slope Index of Inequality (95% CI)	Relative Concentration Index (95% CI)
Wealth quintile	0.525 (0.474 - 0.576)	0.155 (0.138 - 0.171)
Mother's education level	0.679 (0.634 - 0.720)	0.197 (0.182 - 0.211)
Place of residence	0.599 (0.545 - 0.653)	0.120 (0.108 - 0.133)
Mother's employment status	0.128 (0.059 - 0.197)	0.028 (0.013 - 0.043)

95% CI – 95% confidence interval.

Health service utilization is disproportionately concentrated among more **affluent**, **educated**, **urban**, and **employed** populations.

Implications

- Our findings show a **strong link** between socioeconomic status and maternal and child health services utilization.
- **Targeted strategies** are needed to improve access and uptake of essential health services among socioeconomically disadvantaged groups.
- **Multi-level latent analysis** enables precise, service-specific policy design, empowering stakeholders to target barriers at different levels.

Najjuuko C, Xu Z, Kizito S, Lu C, Ssewamala FM. Patterns of maternal and child health services utilization and associated socioeconomic disparities in sub-Saharan Africa. *Nature Communications*. 2025; 16:7840.

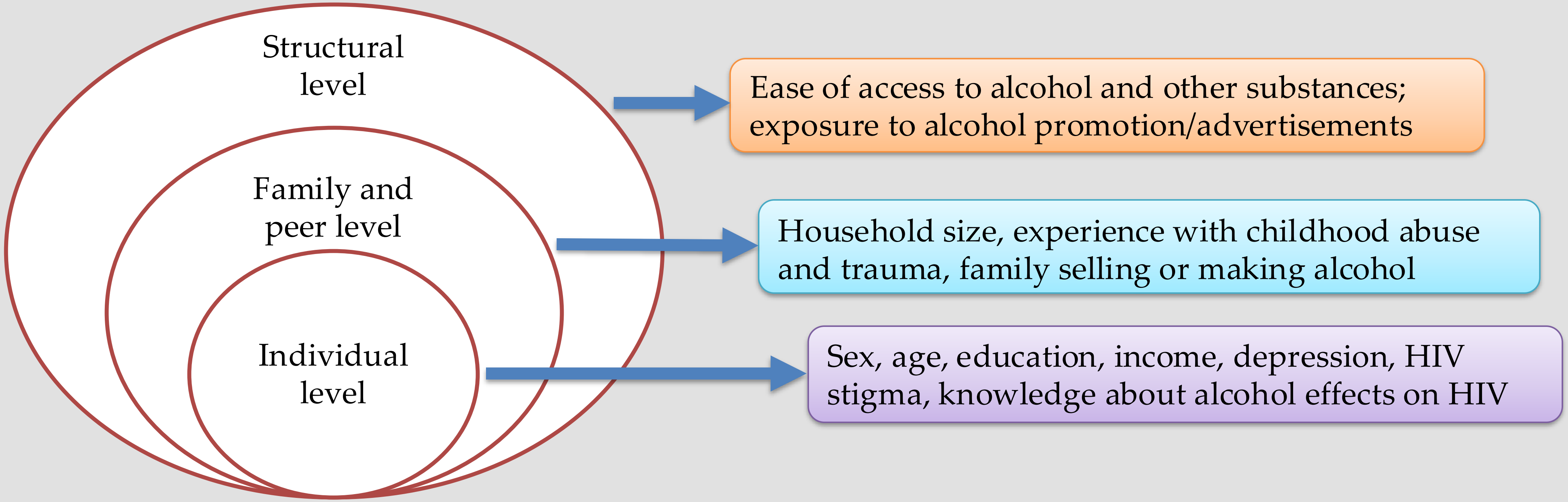
Predicting Substance Use

- **39.9 million** people living with HIV globally, with **67%** in SSA (UNAIDS, 2023).
- Substance use and HIV/AIDS are co-occurring epidemics in Uganda's fishing villages.
  - HIV rate: Uganda (5.8%) vs. fishing villages (**26%**)
  - Alcohol use: Uganda (26.8%) vs. fishing villages (**44-61%**)
- Early detection of problematic substance use is critical for youth.
- **Goal**: Predict substance use among youth living with HIV (YLWHIV).

Work with Claire Najjuuko, Rachel Brathwaite, Massy Mutumba, Saltanat Childress, Sylivia Nannono, Phionah Namatovu, Fred Ssewamala

Data

- Participants: 200 YLWHIV in six HIV clinics located in fishing villages in Uganda
- Outcome: **Substance Use** measures including biological assay of urine and alcohol drug test and self reported substance involvement score (ASSIST)
- Predictors: multi-level risk factors in the **Social-Ecological Model (SEM)**



Model

Data pre-processing

- Considered 50 variables based on SEM
- Lasso-based feature selection (7-14 features retained across iterations)

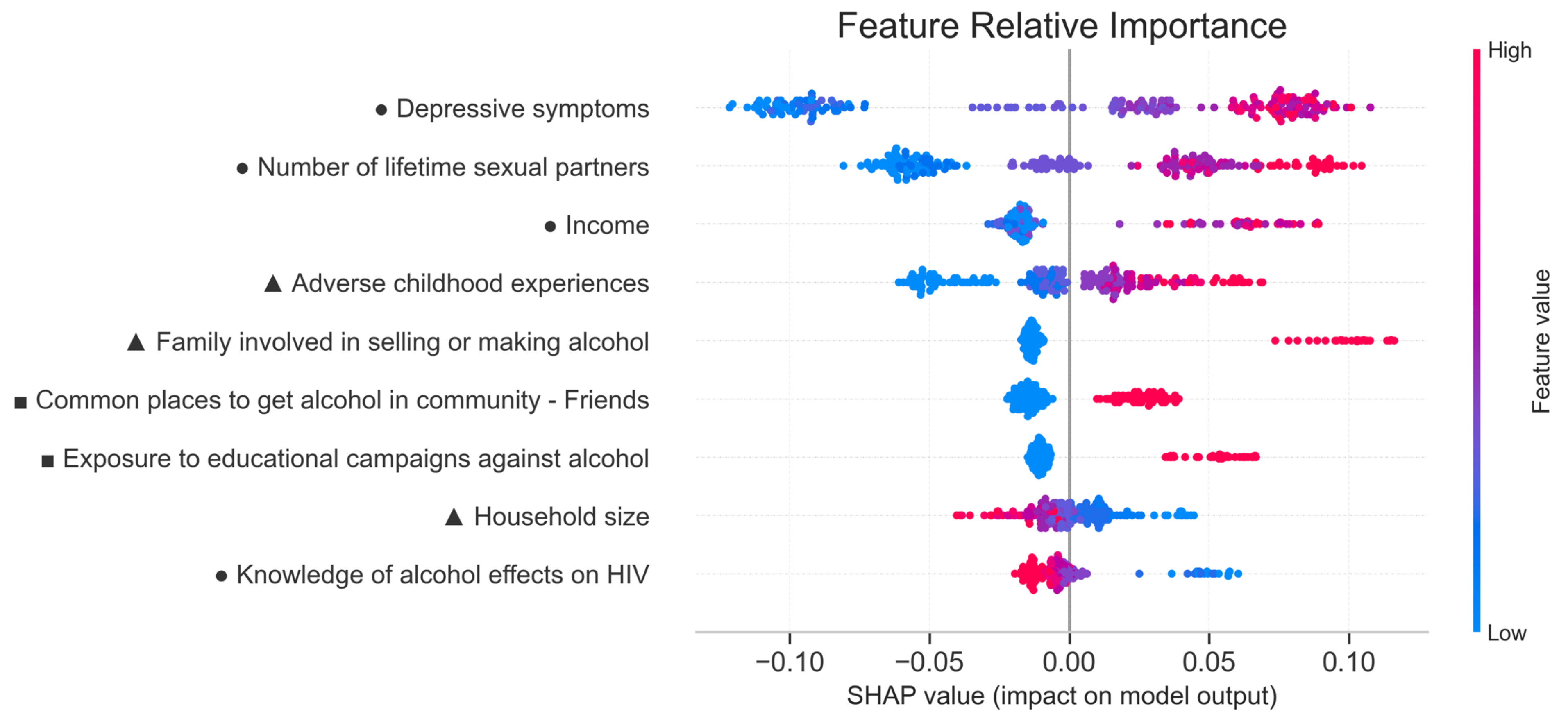
Model Development

- Stratified 10-fold cross-validation.
- Fixed sensitivity (80%) for identifying high-risk cases

Model	AUROC	AUPRC	Specificity	Sensitivity	F1-Score	Brier Score	Log Loss
Random forest	0.78 (0.01)	0.75 (0.02)	0.59 (0.02)	0.80 (0.00)	0.68 (0.08)	0.19 (0.00)	0.56 (0.00)
XGBoost	0.77 (0.01)	0.73 (0.02)	0.57 (0.04)	0.80 (0.00)	0.68 (0.01)	0.19 (0.00)	0.58 (0.02)
Logistic regression	0.76 (0.01)	0.72 (0.02)	0.56 (0.03)	0.80 (0.00)	0.67 (0.01)	0.20 (0.00)	0.60 (0.03)
Gradient Boosting	0.76 (0.01)	0.70 (0.02)	0.55 (0.03)	0.80 (0.00)	0.67 (0.01)	0.20 (0.00)	0.62 (0.03)
Support vector machine	0.75 (0.00)	0.70 (0.02)	0.55 (0.03)	0.80 (0.00)	0.67 (0.01)	0.20 (0.00)	0.65 (0.06)
Ada Boost	0.75 (0.01)	0.69 (0.02)	0.53 (0.04)	0.80 (0.00)	0.66 (0.01)	0.26 (0.02)	1.66 (0.24)

Random forest achieved **specificity of 0.59 at 0.80 sensitivity.**

Important Predictors



- SHapley Additive exPlanations (SHAP) → **contributions of predictors to the predictions**.
- Important predictors included **individual (●)**, **interpersonal (▲)**, and **community (■)** levels.
- **Depression**, **sexual risk-taking behaviors**, and **income** were the strongest predictors.

Implications

- **Practice**
  - Support **screening** and **personalized intervention** at HIV care clinics to prevent substance use

- **Programming**
  - Identify **modifiable risks** or **protective factors** across ecological levels
  - Inform **prevention strategies** and optimize **resource allocation**

Najjuuko C, Brathwaite R, Mutumba M, Childress S, Nannono S, Namatovu P, Lu C, Ssewamala FM. Identifying predictors of problematic substance use among youth living with HIV in Uganda: A machine learning approach. *AIDS and Behavior*. 2025;29:4051-4062.

Advancing Public Health with AI

- AI as a transformative tool for public health
  - **Profile** services → **Targeted** policies and programming
  - **Predict** outcomes → **Personalized** care strategies
  - **Interpret** models → **Actionable** health insights

- AI models must incorporate socioeconomic data to understand health risks and inequities

- Unlocking AI's potential in health through interdisciplinary **collaboration**

https://aihealth.wustl.edu/