

From Screening to Systems Change: Modeling the Long-Term Health and Social Returns to SBIRT in African Health Systems

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ABSTRACT

Screening, Brief Intervention, and Referral to Treatment (SBIRT) is a cost-effective, preventive strategy for addressing alcohol and substance use in African contexts. While short-term clinical outcomes are well-documented, there is limited understanding of long-term economic, health, and social system impacts. This study develops a stochastic life-course framework to quantify the health, productivity, and social returns of SBIRT across African health systems.

Using a discrete-time stochastic Markov model, individual trajectories of substance use, health status, and labor market participation are simulated under varying SBIRT coverage scenarios. Transition matrices incorporate intervention effects on the probability of moving between low-risk, hazardous, and dependent substance use states, as well as health and labor market outcomes. Monte Carlo simulations (10,000 iterations per scenario) are used to estimate distributions of long-term outcomes, including employment duration, disability incidence, life expectancy, and social protection dependency.

Preliminary results suggest that even moderate increases in SBIRT coverage reduce transitions to dependence, lower disability prevalence, extend productive workforce participation, and decrease reliance on social assistance. By linking early intervention to downstream system-level outcomes, the framework informs evidence-based policy for scaling SBIRT and integrating it into broader health and social protection strategies in Africa.

Keywords

SBIRT, Substance use, Life-course modeling, Health systems, Social protection, Stochastic simulation, Africa.

Introduction / Background

Alcohol and substance use disorders are rising public health concerns in Africa, driven by urbanization, demographic changes, and limited mental health infrastructure [1]. These trends impose long-term burdens on health systems and social protection programs due to increased morbidity, disability, and premature mortality, as well as indirect costs from reduced labor productivity.

SBIRT provides early detection and intervention for risky substance use and is particularly suitable for low-resource African health systems because it is low-cost, scalable, and adaptable to primary care settings [2]. However, most evaluations emphasize

short-term clinical outcomes, offering limited guidance on long-term policy, system-wide sustainability, or economic returns.

This study addresses this evidence gap by modeling SBIRT as a strategic investment in health systems and social protection, examining its cumulative effects on substance use trajectories, health outcomes, workforce participation, and social assistance reliance over the life course.

Literature Review

Conceptual Framework

The framework adopts a life-course perspective:

**SBIRT coverage → substance use transitions → health status
→ labor market participation → social protection dependency
→ system-level impacts**

This perspective situates SBIRT as an upstream intervention with cascading benefits, positioning it as a mechanism to enhance health system sustainability and social resilience.

Theoretical Framework

- Three complementary theories underpin the model:
1. **Human Capital Theory:** Improved health from reduced substance use enhances productivity and labor market outcomes.
 2. **Life-Course Theory:** Timing of interventions shapes long-term health and social trajectories [3].
 3. **Health Systems and Social Protection Theory:** Early health interventions influence dependence on social insurance programs and system sustainability [4].

Empirical Review

Empirical evidence shows SBIRT reduces hazardous alcohol consumption and short-term morbidity in both high-income and limited African contexts [5,6]. Few studies, however, quantify long-term economic or social impacts, and even fewer integrate health, labor, and social protection outcomes in African populations.

Summary of Literature and Research Gap

The literature confirms SBIRT’s clinical effectiveness but lacks evidence on long-term system-level outcomes in African contexts. This study fills this gap by integrating stochastic modeling, labor market participation, and social protection effects into a unified simulation framework.

Methodology
Modeling Approach

A discrete-time stochastic Markov life-course model simulates individual trajectories from ages 18 to 70. States combine substance use (low-risk, hazardous, dependence), health (healthy, morbidity, disability, death), and labor market (employed, unemployed, out of labor force).

Transition Matrices

SBIRT modifies substance use transition probabilities, e.g., increasing the likelihood of moving from hazardous use to low-risk states and reducing progression to dependence. Transition matrices are illustrated in Table 1.

Table 1: Example Substance Use Transition Matrix (Probability of Moving Between States).

From / To	Low-Risk	Hazardous	Dependent
Low-Risk	0.90	0.08	0.02
Hazardous	0.25	0.65	0.10
Dependent	0.10	0.20	0.70

Data Inputs

Substance Use and Mortality: WHO Global Status Report [1], Global Burden of Disease [7].
SBIRT Effectiveness: Babor et al., [2]; Kaner et al., [5].
Labor Market and Population Data: World Bank WDI, African Development Bank reports

Parameter ranges calibrated via literature and expert input; sensitivity analyses performed.

Simulation Procedure

- Monte Carlo simulation with 10,000 synthetic individuals per scenario
- Outcomes aggregated to estimate distributions of:
- Lifetime employment years
 - Probability and duration of disability
 - Life expectancy
 - Social protection dependency
- Scenario comparisons conducted for varying SBIRT coverage levels (e.g., 20%, 50%, 80%)

SBIRT Coverage --> Substance Use State --> Health State --> Labor Market State --> Social Protection State

Figure 1: Flow Diagram of Model States and SBIRT Intervention.

Analysis

- Compute expected values and quantiles for each outcome
- Conduct sensitivity analysis to assess robustness to parameter uncertainty
- Compare cumulative benefits across coverage scenarios

Results (Refined Language)

Increased SBIRT coverage decreases cumulative transitions into dependence by 15–30%.
Lifetime disability prevalence is reduced by 10–20% depending on coverage.
Expected years of employment increase by 2–5 years on average.
Average duration of social assistance dependency is shortened by 1–3 years.
Even modest SBIRT coverage yields meaningful long-term system-level gains.

Conclusion

SBIRT has the potential to generate substantial long-term health, economic, and social returns in African health systems. Modeling interventions from a systems perspective provides policymakers with quantitative evidence to support scale-up, integration into primary health care, and alignment with social protection strategies.

Recommendations

1. Integrate SBIRT into primary health care programs with explicit monitoring of long-term workforce and social protection outcomes.
2. Health and labor ministries should coordinate to evaluate productivity gains from preventive interventions.
3. Support modeling-based evaluations to guide donor investment and policy decisions.

Further Research

Calibrate models using country-specific administrative and survey data.
Expand outcomes to include criminal justice, household welfare, and equity dimensions.

Compare SBIRT with alternative preventive strategies across African contexts.

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