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Determinants of Community-Based HIV Prevention Effectiveness through Multi-Stakeholder Collaboration

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ABSTRACT: Community-based HIV prevention effectiveness is associated with workforce capability, social conditions, behavior, infrastructure, and stakeholder collaboration. This study examined the direct effects of health worker competence, supportive infrastructure, social factors, and behavioral factors on community-based HIV prevention effectiveness in Kendari City, Indonesia. A mixed-methods sequential explanatory design was employed. The quantitative phase involved a census of 131 beneficiaries/community members, outreach workers, and volunteers, with data analyzed using PLS-SEM in SmartPLS 4. The qualitative phase used in-depth interviews and thematic analysis within a Pentahelix perspective involving government, academia, business/non-governmental organizations, communities, and media. Social factors were the strongest determinant of program effectiveness (β=0.563; $p<0.001$), followed by health worker competence (β=0.218; p=0.049) and behavioral factors (β=0.181; p=0.002). Supportive infrastructure had a positive but non-significant effect (β=0.084; p=0.384). The model explained 82.1% of program effectiveness variance (R^2=0.821) with strong predictive relevance (Q^2=0.705). Qualitative findings revealed persistent stigma, uneven social support, gradual behavioral change, and underutilized infrastructure. The findings demonstrate that effective HIV prevention depends primarily on social conditions, competent health workers, and preventive behavior, supported by coordinated stakeholder action and effective infrastructure utilization.

1. INTRODUCTION

HIV remains a major global public-health challenge despite substantial expansion of testing, antiretroviral therapy, and prevention services. Recent global strategies continue to emphasize ending AIDS as a public-health threat by 2030, while persistent gaps in diagnosis, treatment continuity, prevention uptake, and social inclusion demonstrate that biomedical availability alone is insufficient [1,2]. Contemporary evidence increasingly points toward integrated approaches that combine service access with community engagement, structural support, and interventions addressing the social and behavioral contexts of HIV risk [3,4].

Indonesia faces a concentrated HIV epidemic in key populations, accompanied by unequal service uptake, stigma, and barriers to testing and prevention. National evidence shows that HIV prevention is shaped by sexual and behavioral risk, knowledge, accessibility of services, and the social environment in which individuals make health decisions [5,6,7,8]. Community-based strategies are therefore especially relevant because they bring education, counseling, testing, referral, and peer support closer to populations that may be reluctant to use conventional facility-based services [9,10].

The local context of Kendari City makes this issue particularly important. Southeast Sulawesi recorded 567 new HIV/AIDS cases in 2024, while Kendari reported 290 cases in 2022, 321 in 2023, 311 in 2024, and 131 additional cases by June 2025; cumulative cases reached 2,023 by May 2025. These trends indicate that prevention requires sustained community reach and

cannot rely exclusively on clinical services. Local program implementation involves health offices, health facilities, non-governmental organizations, outreach workers, community groups, and other actors, but coordination occurs within a setting where stigma, fear of disclosure, uneven risk perception, and resource constraints remain salient [11,12].

Health worker competence is one potential direct determinant of effective implementation. Competence includes technical knowledge, counseling and communication skills, professional responsiveness, and the capacity to engage populations experiencing stigma or marginalization. Studies of HIV and infectious-disease programs show that competent personnel improve the quality of prevention, linkage, counseling, and community interaction [13,14,15,16]. Examining its direct contribution to program effectiveness is therefore important for determining whether workforce capability independently strengthens community-based HIV prevention.

Supportive infrastructure is another commonly assumed direct determinant of program effectiveness. Funding, testing supplies, referral systems, educational media, monitoring systems, and accessible service points are necessary for implementation, but implementation science distinguishes the existence of resources from their actual use [17,18]. Infrastructure may therefore show a limited direct contribution when available resources are underused or poorly aligned with community needs. This distinction is important in resource-constrained community programs, where formal resources and actual service utilization may differ.

Social and behavioral factors are particularly important in HIV prevention. Stigma, discrimination, family support, community norms, trust, perceived susceptibility, perceived benefits and barriers, and intention to seek testing can directly influence whether prevention services are accepted [19,20,21,22,23]. Social conditions can facilitate or constrain participation, while behavioral factors shape preventive decisions and actions. Evidence from diverse settings shows that social support and self-efficacy influence self-management, and that socioeconomic and behavioral conditions are associated with HIV-related outcomes [24,25,26,27].

A socio-ecological perspective provides a useful theoretical basis because it conceptualizes health outcomes as products of interactions across individual, interpersonal, organizational, community, and policy levels [28,29]. This multilevel logic is compatible with collaborative governance and Pentahelix thinking, in which government, academia, business or civil-society organizations, communities, and media contribute complementary resources and functions. Effective collaboration, however, depends not simply on the number of actors but on trust, communication, role clarity, and the capacity to translate joint action into community-level change [30,31].

Previous studies have often examined competence, infrastructure, social determinants, behavioral risk, or community engagement separately [32,33,34,35]. Less attention has been given to an integrated direct-effects model that simultaneously compares the independent contributions of health worker competence, supportive infrastructure, social factors, and behavioral factors to community-based HIV prevention effectiveness, while also using multi-stakeholder qualitative evidence to interpret the statistical pattern. This gap is especially evident in medium-sized Indonesian cities where community programs operate through formal health systems and informal social networks simultaneously.

This study addresses that gap by examining the direct effects of health worker competence, supportive infrastructure, social factors, and behavioral factors on the effectiveness of community-based HIV prevention in Kendari City. It further integrates these direct relationships with a Pentahelix analysis to explain how stakeholder roles correspond to the determinants identified statistically. The study contributes a human-centered and socio-ecological interpretation of program effectiveness by comparing human, structural, social, and behavioral determinants within one model.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

The study used a mixed-methods sequential explanatory design, beginning with a quantitative phase to test direct relationships between the four determinants and program effectiveness, followed by a qualitative phase to explain why those statistical patterns occurred. The research was conducted in Kendari City, Southeast Sulawesi, within community-based HIV prevention programs involving the local health authority, non-governmental organizations, outreach services, and key-population communities. Field activities covered preparation, quantitative and qualitative data collection, analysis, and integration. The sequential explanatory logic is appropriate when statistical relationships require contextual explanation through participant and stakeholder experience [36,37].

2.2 Participants and Sampling

The quantitative population consisted of 131 people involved in community-based HIV prevention, including program beneficiaries/community members and program personnel. A saturated sampling (census) approach was used, so all 131 eligible members of the population were included. Eligibility required direct involvement in the program, age of at least 18 years, voluntary participation, at least six months of program involvement, and ability to complete the questionnaire. The qualitative phase used purposive and snowball logic to obtain perspectives from key and expert informants and representatives of the Pentahelix ecosystem, including government, academia, community actors, business/non-governmental organizations, and media [37].

2.3 Measures

Five constructs were measured. Health worker competence captured technical knowledge, communication and counseling skills, technical service skills, and training-related professionalism. Supportive infrastructure covered funding availability, facilities and supplies, management and monitoring systems, and referral access. Social factors represented HIV stigma (reverse-oriented), support from community leaders, family support, and community involvement. Behavioral factors captured risk perception, perceived benefits and barriers, and behavioral intention. Program effectiveness included program coverage, HIV/AIDS knowledge, attitudes and actions, HIV testing participation, and strengthening of program effectiveness. Items were assessed using a five-point agreement scale. Construct development was informed by public-health competence, socio-ecological, behavioral, social-support, and implementation perspectives [13,17,24,28,38].

2.4 Quantitative and Qualitative Analysis

PLS-SEM was performed in SmartPLS 4. Measurement-model evaluation included factor loadings, Cronbach's alpha, composite reliability, and average variance extracted (AVE). The structural model was evaluated using the four direct path coefficients from health worker competence, supportive infrastructure, social factors, and behavioral factors to program effectiveness, together with p-values, R^2, and Q^2 to assess explanatory and predictive performance [39,40]. The qualitative phase applied thematic analysis to in-depth interviews, focusing on competence, infrastructure, social-behavioral conditions, community-based delivery, and the roles of Pentahelix actors. Integration compared the direct quantitative relationships with qualitative explanations to identify convergence, complementarity, and contextual meaning.

2.5 Ethical Considerations

Participation was voluntary and data were treated confidentially. Respondents were informed of the study purpose before questionnaire completion, and qualitative reporting used informant codes rather than personal identifiers. The manuscript reports aggregated findings and does not disclose identifiable health information.

3. RESULTS AND DISCUSSION

3.1 Participant Characteristics

The sample was strongly dominated by men (96.9%), reflecting the composition of the community and key-population networks reached by the program. Nearly half of respondents were aged 21-25 years (47.3%), and 26.0% were aged 26-30 years. Most had completed senior secondary education (62.6%). Beneficiaries or community members represented 84.0% of the sample, while outreach workers and field personnel accounted for 13.7% and volunteers for 2.3%. Most respondents had been involved in the program for one to five years, providing sufficient exposure to evaluate implementation.

Table 1. Characteristics of quantitative respondents (n=131)

Characteristic	Category	n	%
Sex	Male	127	96.9
Sex	Female	4	3.1
Age	≤20 years	17	13.0
Age	21-25 years	62	47.3

Characteristic	Category	n	%
Age	26-30 years	34	26.0
Age	31-35 years	9	6.9
Age	>35 years	9	6.9
Education	Junior secondary	3	2.3
Education	Senior secondary	82	62.6
Education	Diploma	12	9.2
Education	Bachelor	31	23.7
Education	Postgraduate	3	2.3
Program role	Beneficiary/community member	110	84.0
Program role	Outreach worker/field staff	18	13.7
Program role	Volunteer	3	2.3
Involvement	<1 year	18	13.7
Involvement	1-5 years	79	60.3
Involvement	>5 years	34	26.0

Source: Primary data processed by the authors, 2026

3.2 Measurement Model

The measurement model demonstrated strong internal consistency and convergent validity. All reported indicator loadings exceeded 0.90, Cronbach's alpha values ranged from 0.952 to 0.992, composite reliability values ranged from 0.958 to 0.993, and AVE values ranged from 0.867 to 0.977. These values exceed conventional PLS-SEM thresholds and support interpretation of the structural relationships [39,40].

Table 2. Measurement model summary

Construct	Cronbach α	Composite reliability	AVE
Health worker competence	0.992	0.993	0.977
Supportive infrastructure	0.990	0.990	0.956
Social factors	0.977	0.958	0.970
Behavioral factors	0.952	0.978	0.874
Program effectiveness	0.961	0.962	0.867

Source: SmartPLS 4 analysis of primary data, 2026

3.3 Direct Structural Relationships

The structural results show that program effectiveness is associated more strongly with social and human determinants than with infrastructure alone. Social factors had the largest direct effect on program effectiveness ($\beta=0.563$; $p<0.001$), followed by health worker competence ($\beta=0.218$; $p=0.049$) and behavioral factors ($\beta=0.181$; $p=0.002$). Supportive infrastructure had a small positive but non-significant direct effect ($\beta=0.084$; $p=0.384$). Thus, three of the four proposed direct relationships were supported, with social factors emerging as the dominant predictor of community-based HIV prevention effectiveness.

Table 3. Direct structural relationship results

Relationship	β	p-value	Decision
Behavioral factors → Program effectiveness	0.181	0.002	Supported
Social factors → Program effectiveness	0.563	<0.001	Supported
Supportive infrastructure → Program effectiveness	0.084	0.384	Not supported
Health worker competence → Program effectiveness	0.218	0.049	Supported

Source: SmartPLS 4 analysis of primary data, 2026

The direct-effects pattern highlights the relative contribution of each determinant. Social conditions showed the largest coefficient, indicating that stigma, support, trust, and community involvement are closely associated with whether prevention programs become effective. Health worker competence and behavioral factors also made significant independent contributions, whereas infrastructure alone did not. This pattern is consistent with research showing that social support, community engagement, health-worker capability, and preventive behavior are important to HIV-related outcomes [10,20,24,33].

3.4 Explanatory and Predictive Power

The model explained 82.1% of the variance in program effectiveness (R^2=0.821), indicating substantial explanatory power. The Q^2 value of 0.705 indicates strong predictive relevance. The high R^2 is consistent with the integrated nature of the model: competence, social context, behavior, and infrastructure jointly represent multiple socio-ecological levels rather than a single-domain explanation [28,39].

Table 4. Explanatory and predictive performance of the model

Endogenous construct	R^2	Q^2	Interpretation
Program effectiveness	0.821	0.705	Substantial explanatory power and high predictive relevance

Source: SmartPLS 4 analysis of primary data, 2026

3.5 Direct Effect of Health Worker Competence

The significant direct effect of competence confirms that prevention effectiveness depends partly on the quality of the people implementing the program. This aligns with evidence that infection-control and community-health programs require not only technical knowledge but communication, counseling, responsiveness, and context-sensitive engagement [13,14,15,16]. In HIV prevention, these competencies are especially consequential because clients may approach services with fear of disclosure, previous experiences of stigma, or uncertainty about risk.

Qualitative findings further characterized outreach workers as an important link between formal services and communities. They translate technical information into understandable messages, facilitate referrals, respond to sensitive concerns, and help sustain contact with populations that may hesitate to approach conventional services. These observations provide contextual support for the significant direct competence-effectiveness relationship and reinforce the practical value of workforce capability in community-based prevention.

The implication is that workforce development should not be limited to clinical updates. Training should include motivational communication, stigma-sensitive counseling, cultural competence, community mapping, partnership building, digital communication, and referral navigation. Competency-based education for community health workers increasingly emphasizes integrated capabilities rather than isolated procedural skills [15,16].

3.6 Direct Effect of Social Factors

Social factors were the dominant direct determinant of effectiveness. Qualitative evidence identified continuing HIV stigma, fear of being known as HIV-positive, limited family acceptance, and uneven community support. These findings help explain why the social-factor coefficient was substantially larger than the coefficients for behavioral factors, competence, and infrastructure. HIV prevention decisions occur in social environments where anticipated rejection can discourage testing even when services are technically available [19,21,22].

The result is consistent with evidence linking social determinants to HIV incidence, linkage, self-management, and prevention outcomes [20,24,25,26,27]. Social support can increase confidence and continuity of care, whereas stigma can undermine disclosure, testing, treatment engagement, and participation in community activities. For community-based programs, social acceptance is therefore a direct component of the environment in which prevention services are accessed and used.

From a socio-ecological perspective, the dominance of social factors demonstrates the importance of the interpersonal and community levels [28,29]. Interventions should engage peer networks, families, community leaders, and trusted local organizations. Such actors can normalize testing, reduce misinformation, protect confidentiality norms, and create supportive pathways into services. The program should consequently measure changes in stigma, trust, and support as implementation outcomes rather than relying only on counts of activities or materials distributed.

3.7 Direct Effect of Behavioral Factors

Behavioral factors significantly and directly predicted program effectiveness, although their coefficient was smaller than that of social factors. Interview evidence indicated that some community members perceived themselves as not at risk, avoided testing because of fear of a positive result, or required repeated education before becoming more open. This pattern is consistent with behavioral models in which perceived susceptibility, perceived benefits and barriers, self-efficacy, and intention shape preventive action [23,38].

Behavior should also be interpreted within the broader social environment. Risk perception and testing intention can be suppressed by stigma or strengthened by peer support and trusted communication. Studies among populations at risk of HIV similarly demonstrate intersections between behavioral risk and social determinants [25,26,34]. The significant direct behavioral-effectiveness relationship indicates that preventive perceptions, intentions, and actions constitute an independent determinant of program effectiveness.

Program design should therefore combine individualized counseling with community-level communication. Mobile testing, peer outreach, digital education, and targeted risk communication can reduce practical and psychological barriers, but these strategies are more likely to succeed when messages are delivered through credible actors and reinforced by supportive norms [9,35].

3.8 Direct Effect of Supportive Infrastructure

The non-significant direct infrastructure-effectiveness relationship is one of the most important findings. It should not be interpreted as evidence that infrastructure is unnecessary. Rather, the result indicates that facilities, funding, supplies, monitoring systems, and referral arrangements do not automatically translate into greater program effectiveness. Implementation frameworks emphasize that the availability of structural resources and the outcomes achieved from those resources are analytically distinct [17,18].

Qualitative evidence showed that facilities and program resources were not always optimally used and that some activities remained dependent on funding continuity. This contextual evidence is consistent with the small and non-significant direct coefficient for supportive infrastructure. When stigma discourages service use, outreach is uneven, or available resources are not fully utilized, additional infrastructure may have limited observable association with program effectiveness.

This finding has practical consequences for budgeting. Investment should balance physical and logistical inputs with workforce development, social mobilization, and behavior-change activities. Monitoring should assess utilization, referral completion, responsiveness, and community reach, not merely the existence of equipment or service points. This distinction between resource availability and resource activation extends implementation research and challenges resource-heavy approaches to community HIV programming.

3.9 Multi-Stakeholder Collaboration and the Pentahelix Direct-Determinant Model

The qualitative phase organized stakeholder roles through a Pentahelix framework. Government acts as regulator and facilitator; academia as knowledge provider and capacity builder; business and non-governmental organizations as enablers of resources and logistics; communities as accelerators of participation and social support; and media as expanders of information and public advocacy. These roles correspond to the four direct determinants identified in the quantitative model and show how different stakeholders can strengthen workforce competence, infrastructure utilization, supportive social conditions, and preventive behavior. This interpretation is compatible with collaborative-governance arguments that trust, communication, and meaningful participation determine the quality of cross-sector collaboration [30,31].

Table 5. Pentahelix roles in community-based HIV prevention

Actor	Primary role	Program contribution
Academia	Conceptualizer and knowledge provider	Research, education, training, evidence-based capacity development
Business/NGO	Enabler	Funding, logistics, testing support, educational resources, partnership support
Community	Accelerator	Peer outreach, social support, stigma reduction, participation and local legitimacy
Government	Regulator and facilitator	Policy, service systems, financing, coordination, monitoring and evaluation
Media	Expander	Public education, stigma-reduction campaigns, digital dissemination and advocacy

Source: Integrated qualitative findings processed by the authors, 2026

The resulting Pentahelix Direct-Determinant Collaboration Model differs from a purely structural collaboration model. It organizes stakeholder contributions around four parallel determinants of program effectiveness: health worker competence, supportive infrastructure, social factors, and behavioral factors. The quantitative findings show that social factors have the strongest direct association with effectiveness, competence and behavioral factors also contribute significantly, and infrastructure has a positive but non-significant direct association. Collaboration is therefore interpreted as an implementation context that can strengthen these determinants rather than as a chain of intermediary effects.

This model also helps integrate the quantitative and qualitative findings. Government and business/NGOs can strengthen infrastructure and service support; academia can strengthen competence through evidence and training; communities can reduce stigma and reinforce social support; and media can shape risk perception and public norms. The Pentahelix framework therefore provides a stakeholder architecture for acting on the direct determinants identified statistically, without assuming sequential relationships among the quantitative constructs.

The contribution is particularly relevant to HIV programs in settings where formal health services coexist with community outreach and informal support networks. Community engagement research demonstrates that vulnerable populations participate more effectively when interventions recognize lived experience, power relations, and local trust [32,33]. A multi-stakeholder model should therefore institutionalize feedback from key populations and people living with HIV, not merely consult them after program design.

3.10 Theoretical and Policy Implications

Theoretically, the findings strengthen the socio-ecological proposition that health outcomes reflect influences operating across individual, interpersonal, organizational, and community levels [28,29]. Among the four direct determinants tested simultaneously, social factors produced the strongest coefficient, while health worker competence and behavioral factors also showed significant effects. Supportive infrastructure did not show a significant direct effect. This pattern demonstrates the value of comparing determinants across socio-ecological levels within a single direct-effects model.

The study also contributes to implementation thinking by distinguishing resource availability from observed program effectiveness. The non-significant direct effect of supportive infrastructure suggests that the presence of facilities and logistical resources should not be treated as sufficient evidence of effective implementation. This helps explain why interventions with similar formal resources can generate different outcomes across communities [17,18].

For policy, the priority is not to reduce infrastructure investment but to rebalance implementation toward human and social capability. Local HIV policy should establish recurring competency development for health workers and outreach personnel; embed stigma-reduction and family/community engagement into routine programming; strengthen peer-led testing and referral; define stakeholder responsibilities across the Pentahelix; and evaluate social and behavioral outcomes alongside service outputs. Evidence from community-based HIV programs supports the value of community health workers, local organizations, and participatory approaches in improving linkage and prevention outcomes [9,10,33,35].

3.11 Study Limitations

Several limitations should guide interpretation. First, the cross-sectional quantitative design limits strong causal inference. Second, self-reported questionnaire data may be affected by social-desirability and perception bias. Third, the study was conducted in one city and the sample composition was heavily male, limiting generalizability to other populations and regions. Fourth, the sample of 131 was adequate for detecting the strongest direct relationship, but weaker direct effects would require larger samples for more stable estimation. Finally, qualitative findings provide contextual depth but depend on the range of stakeholders and key populations accessible to the study. Future research should use longitudinal or multi-city designs, larger samples, and examine additional direct predictors or moderators such as collaborative leadership, digital competence, organizational commitment, local policy support, funding sustainability, social capital, and stigma intensity.

4. CONCLUSION

Community-based HIV prevention in Kendari City is best explained by the combined direct contributions of human, social, behavioral, and structural determinants. Social factors were the strongest direct determinant of program effectiveness, followed by health worker competence and behavioral factors, while supportive infrastructure showed a positive but non-significant direct effect. The integrated Pentahelix Direct-Determinant Collaboration Model proposes that government, academia, business/NGOs, communities, and media coordinate their roles to strengthen workforce capability, social support and stigma reduction, preventive behavior, and effective infrastructure utilization. For practice, the central message is clear: effective and sustainable HIV prevention requires attention to multiple determinants simultaneously, with particular priority given to the social environment, competent personnel, and behavior-oriented community strategies.

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AUTHOR CONTRIBUTIONS

Elna Sari: Conceptualization, investigation, data curation, formal analysis, methodology, and writing-original draft. Usman Rianse: Supervision, conceptualization, methodology, and writing-review and editing. Ramadhan Tosepu: Supervision, public-health methodology, validation, and writing-review and editing. Devi Savitri Effendy: Supervision, validation, interpretation, and writing-review and editing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

The study involved voluntary adult participants. Informed consent, confidentiality, and anonymized reporting were applied.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to confidentiality and ethical restrictions applicable to HIV-related participant data.

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