

## Adolescents' HIV Preventive Behavior: The Roles of HIV Literacy, HIV Sensitivity, AI Openness, and Chatbot Engagement

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HIV Prevention;  
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### ABSTRACT

**Introduction:** Adolescents remain vulnerable to HIV due to gaps in knowledge, attitudes, and digital health engagement. Cognitive, attitudinal, and digital factors may influence preventive behaviors, yet their combined effects remain underexplored, particularly as adolescents increasingly interact with AI-driven platforms that shape health information access. This study aimed to examine the associations of HIV literacy, HIV sensitivity, AI openness, and chatbot choice with HIV preventive behaviors among adolescents.

**Methods:** A cross-sectional study was conducted among 910 senior high school and vocational students in Sleman Regency, Indonesia. Participants completed a validated questionnaire assessing HIV preventive behavior (low vs. high) and four predictors: HIV literacy, chatbot choice, AI openness, and HIV sensitivity. Chi-square tests were used to assess bivariate associations. Multivariate logistic regression identified independent predictors, with odds ratios (ORs) and 95% confidence intervals (CIs) reported.

**Results:** Bivariate analyses showed that higher HIV literacy, greater HIV sensitivity, increased AI openness, and active chatbot choice were significantly associated with high-level HIV preventive behavior (all  $p < 0.001$ ). Multivariate logistic regression confirmed all variables as significant independent predictors: HIV literacy (OR = 1.18, 95% CI: 1.12–1.24), chatbot choice (OR = 1.10, 95% CI: 1.05–1.16), AI openness (OR = 1.08, 95% CI: 1.02–1.14), and HIV sensitivity (OR = 1.10, 95% CI: 1.04–1.16). The model explained a meaningful proportion of variance in preventive behavior (Nagelkerke  $R^2 = 0.234$ ).

**Conclusion:** HIV literacy, HIV sensitivity, and engagement with AI-based digital tools significantly predict adolescents' HIV preventive behaviors. Interventions that enhance knowledge, strengthen attitudes, and promote informed digital decision-making may reinforce HIV prevention efforts among adolescents.

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## INTRODUCTION

Human Immunodeficiency Virus (HIV) remains one of the most urgent global public health concerns, with adolescents identified as a particularly vulnerable population (1,2). Data from UNAIDS in 2023 estimated that around 1.7 million adolescents aged between 10 and 19 years were living with HIV, emphasizing the continuing necessity for comprehensive and effective prevention strategies (3). The vulnerability of this group is closely linked to limited health literacy, involvement in unsafe sexual practices, and exposure to social as well as digital environments that shape health-related decisions (4,5). Research has shown that limited understanding of HIV transmission and prevention often delays the adoption of protective actions, increasing susceptibility to infection.

HIV literacy refers to the ability to understand modes of transmission, preventive measures, and access to relevant health resources. Adolescents with higher literacy levels tend to identify potential risks more accurately, demonstrate safer behavioral choices, and seek appropriate health services when needed (6). Previous studies have revealed a consistent relationship between literacy and preventive behavior, yet knowledge alone rarely guarantees behavioral transformation (7,8). The gap between what adolescents know and how they act indicates the importance of incorporating motivational, attitudinal, and technological aspects into health education programs (9).

The growing presence of digital technology has transformed approaches to adolescent health education. Interactive digital platforms such as chatbots now provide tailored information, real-time responses, and repeated exposure to preventive messages, which reinforce both understanding and behavioral change (10,11). The willingness of adolescents to interact with these tools often reflects their comfort and trust in technology, and this engagement contributes to stronger knowledge retention and the application of preventive behavior in daily life (12). Digital interaction therefore serves as a bridge between understanding and action in health promotion.

Openness to new forms of technology also enhances the effectiveness of health communication (13). A positive attitude toward artificial intelligence in educational or decision-support systems can increase receptivity to information and encourage informed decision-making (14). Adolescents who are more open to using AI-based resources are typically more active in integrating digital insights into concrete preventive actions. Technology acceptance thus complements cognitive and motivational dimensions in shaping adolescent health behavior (15).

Motivation remains a decisive factor influencing the adoption of preventive measures. Awareness of the personal and social consequences of HIV infection encourages individuals to view prevention as a personal responsibility. Adolescents who internalize the seriousness of HIV tend to demonstrate a stronger commitment to protective behavior. However, existing studies often explore knowledge, technology engagement, and motivational sensitivity separately, resulting in a fragmented understanding of the broader behavioral mechanisms involved.

The Information Motivation Behavioral Skills (IMB) model provides a relevant theoretical foundation to explain this interaction. The model emphasizes that accurate information must be accompanied by motivation and practical behavioral skills to achieve consistent preventive outcomes (16). Within the context of adolescent HIV prevention, cognitive understanding in the form of literacy, motivational readiness represented by sensitivity, and technological engagement through chatbot use and openness to AI together shape preventive behavior (17). In this framework, literacy aligns with the information component, sensitivity reflects motivation, and engagement with chatbots and AI supports the development of behavioral skills, demonstrating how these determinants interact according to the IMB model. This integrated perspective allows a more comprehensive understanding of how adolescents transform information into sustained action.

Although theoretical developments and empirical findings related to HIV prevention have grown substantially, the current body of research still provides limited understanding of how cognitive, motivational, and technological factors operate together in shaping preventive behavior among adolescents (12). Many studies examine these dimensions separately, for instance focusing solely on knowledge improvement or evaluating the use of digital tools without considering the motivational readiness of the target group (18–20). However, research explicitly integrating HIV literacy, engagement with chatbot-based information services, openness to artificial intelligence, and sensitivity to HIV risk remains limited. Such segmented analytical approaches tend to produce partial explanations of adolescent decision-making processes, particularly in digitally mediated HIV prevention contexts. Consequently, existing evidence does not yet fully capture how adolescents integrate information, motivation, and technology when translating awareness into sustained preventive action.

Building on this conceptual context, a comprehensive understanding of the predictors of preventive behavior is essential for developing health promotion strategies that remain relevant and effective over time. Clarifying how informational, motivational, and technology-related factors function jointly enables educators and policymakers to design interventions that convey information clearly, evoke meaningful personal awareness, and align with adolescents' digital engagement patterns. Accordingly, the present study examines the combined influence of HIV literacy, engagement with chatbot-based information services, openness to artificial intelligence, and sensitivity to HIV risk on preventive behavior among adolescents. This approach offers a holistic perspective on adolescent health behavior and strengthens the foundation for technology-supported and motivation-oriented interventions that promote sustained HIV prevention practices.

## **METHOD**

### **Research Type**

This study employed a cross-sectional design conducted in August 2025 to examine factors influencing HIV preventive behavior among adolescents. The cross-sectional approach allowed assessment of the relationships between multiple predictor variables and preventive behaviors at a single point in time.

### **Research Location**

The study was carried out in Sleman Regency, Special Region of Yogyakarta, Indonesia, chosen due to its substantial adolescent population and limited data on HIV/AIDS preventive behaviors. Sleman has been identified as one of the regencies with a consistently high number of HIV cases in the province, indicating the need for stronger adolescent-focused preventive efforts. Local reports also show that knowledge and attitudes toward HIV prevention among students vary considerably, suggesting gaps that require further empirical examination (21,22).

### **Population and Sample**

The population comprised students aged 16–19 years enrolled in senior high schools (SMA) and vocational high schools (SMK) in Sleman Regency. The sample consisted of 910 adolescents who met the inclusion criteria and provided consent to participate. A stratified random sampling procedure was employed, with strata defined by school type (SMA and SMK). Within each stratum, a comprehensive list of enrolled students served as the sampling frame, and participants were randomly selected proportionally to the size of each stratum to ensure representativeness. Allocation procedures ensured that both school types were adequately represented, minimizing potential selection bias. Students unable to understand the questionnaire were excluded, and the final sample size met the statistical power requirement based on Isaac and Michael's table at a 95% confidence level.

### **Instrumentation**

Data were collected using a structured, self-administered questionnaire measuring the outcome variable, HIV preventive behavior, categorized as low and high, and four predictor variables: HIV literacy, chatbot choice, AI openness, and HIV sensitivity. The questionnaire was adapted from validated instruments (e.g., HKQ-18 for HIV literacy; AI Literacy Questionnaire; AI Openness Scale; Trust in Automation Scale) and pilot-tested with 30 students to ensure clarity, reliability, and internal consistency (Cronbach's  $\alpha > 0.8$ ). The survey was delivered digitally via QR code, and participants completed it on smartphones under the guidance of trained research assistants, requiring approximately 15–20 minutes. Each questionnaire item, its response scale, and scoring methodology are explicitly documented, and construct validity was assessed through expert review and pilot testing to ensure alignment with the theoretical constructs.

### **Data Analysis**

Data were coded and analyzed using IBM SPSS Statistics version 25. Descriptive statistics were used to summarize demographic characteristics and HIV preventive behavior. The dependent variable, HIV preventive behavior, was dichotomized into low and high categories based on a conceptual emphasis on behavioral adequacy in HIV prevention. Similarly, all variables were dichotomized using median splits to create categorical groups, which ensured analytic consistency and interpretability. Predictor variables (HIV literacy, chatbot choice, AI openness, and

HIV sensitivity) were also dichotomized to maintain analytical consistency and facilitate interpretation within the logistic regression framework. Bivariate associations were examined using Chi-square tests, and multivariable logistic regression analysis was conducted to identify predictors of high HIV preventive behavior, with odds ratios (ORs) and 95% confidence intervals (CIs) reported. Statistical significance was set at  $p < 0.05$ .

### Ethical Approval

Ethical approval was obtained from the Institutional Ethics Committee of Poltekkes Kemenkes Semarang (No. 1049/EA/F.XXIII.38/2025, 1 August 2025). Participants aged 18 and above provided written consent, whereas those under 18 gave assent with parental consent facilitated by school authorities. Participation was voluntary, and confidentiality was maintained by removing personal identifiers.

## RESULTS

The study involved a total of 910 adolescent participants. Their demographic and educational characteristics are summarized in Table 1. The sample included students from senior high schools and vocational high schools, with representation across different age groups, gender, school types, and class levels. Most participants had access to the internet, which facilitated their participation in the digital survey. Presenting these descriptive data provides a clear overview of the study population and establishes the context for subsequent analyses of HIV preventive behavior.

**Table 1.** The characteristics of respondents (n=910)

Variable	Category	Frequency	Percent (%)
Age	≤15	303	33.3
	16–17	569	62.5
	≥18	38	4.2
Gender	Male	272	29.9
	Female	638	70.1
School Type	SMA	461	50.7
	SMK	449	49.3
Grade Level	10	426	46.8
	11	378	41.5
	12	106	11.6
Internet Access	None	63	6.9
	Available	847	93.1

The demographic and educational characteristics of the participants are presented in Table 1. The majority of adolescents were between 16 and 17 years old, representing over 60 percent of the sample. Female students constituted a substantial majority at 70 percent. The distribution across school types and grade levels was relatively balanced, with the largest proportion in the 10th grade. Most participants reported having access to the internet, highlighting a digitally connected population. These characteristics provide a representative context for interpreting the subsequent analyses of HIV preventive behavior.

The demographic and educational characteristics of the participants provide context for understanding variations in HIV preventive behavior. To explore how cognitive, attitudinal, and digital engagement factors relate to preventive practices, bivariate analyses were conducted. The results of these analyses, presented in Table 2, highlight the associations between key predictors and the likelihood of adopting high-level HIV preventive behaviors.

**Table 2.** Factors Associated with HIV/AIDS Prevention in Adolescents

Variable	Category*	HIV Prevention		Total	$\chi^2$	p-value	OR (95% CI)
		Low	High				
HIV Literacy	Poor	300 (75.4%)	98 (24.6%)	398	100.47	<0.001	4.195 (3.146–5.593)
	Good	216 (42.2%)	296 (57.8%)	512			
HIV Sensitivity	Low	328 (67.2%)	160 (32.8%)	488	46.23	<0.001	2.552 (1.949–3.340)
	High	188 (44.5%)	234 (55.5%)	422			
AI Openness	Low	329 (71.1%)	134 (28.9%)	463	50.88	<0.001	3.414 (2.593–4.495)
	High	187 (41.8%)	260 (58.2%)	447			
Chatbot Choice	Low	275 (70.2%)	117 (29.8%)	392	21.15	<0.0001	2.702 (2.048–3.563)
	High	241 (46.5%)	277 (53.5%)	518			

\*Categorical variables were created using median splits

The bivariate analysis of predictors and HIV preventive behavior is presented in Table 2. Adolescents with higher HIV literacy were significantly more likely to report high-level preventive behaviors, with an odds ratio of 4.20 (95% CI: 3.15–5.59). Similarly, participants with greater sensitivity to HIV demonstrated higher likelihood of engaging in preventive actions, showing an odds ratio of 2.55 (95% CI: 1.95–3.34). Openness to artificial intelligence also appeared to influence behavior, as adolescents with higher AI openness were more likely to adopt preventive measures, with an odds ratio of 3.41 (95% CI: 2.59–4.50). Engagement in digital health decision-making, reflected by chatbot choice, was associated with increased preventive behaviors, yielding an odds ratio of 2.70 (95% CI: 2.05–3.56). All associations were statistically significant ( $p < 0.001$ ), indicating that cognitive, attitudinal, and digital engagement factors are meaningfully related to HIV preventive behavior among adolescents.

The significant associations observed in the bivariate analyses suggest that HIV literacy, HIV sensitivity, AI openness, and chatbot choice are meaningfully related to adolescents’ preventive behaviors. To determine the independent contribution of each factor while controlling for the others, a multivariate logistic regression analysis was conducted. The results of this model, presented in Table 3, provide a clearer understanding of which predictors exert the strongest influence on high-level HIV preventive behavior.

**Table 3.** Multivariate Predictors of HIV/AIDS Preventive behavior Among Adolescents

Predictor	B	SE	Wald	df	p-value	Exp(B)	95% CI for Exp(B)
HIV Literacy	0.162	0.027	36.520	1	<0.001	1.176	1.116 – 1.240
Chatbot Choice	0.097	0.027	12.865	1	<0.001	1.101	1.045 – 1.161
AI Openness	0.074	0.030	6.172	1	0.013	1.077	1.016 – 1.142
HIV Sensitivity	0.093	0.030	9.639	1	0.002	1.097	1.035 – 1.163
Constant	-7.265	0.644	127.438	1	<0.001	0.001	—

The multivariate logistic regression analysis revealed that all four predictors, HIV literacy, chatbot choice, AI openness, and HIV sensitivity, were significantly associated with adolescents’ engagement in high-level HIV preventive behaviors. HIV literacy emerged as the predominant predictor, highlighting the critical role of cognitive understanding. Digital engagement, represented by chatbot choice and AI openness, and motivational readiness, indicated by HIV sensitivity, also contributed meaningfully. The model demonstrated acceptable explanatory power, with Cox and Snell  $R^2 = 0.174$  and Nagelkerke  $R^2 = 0.234$ , indicating that the combination of cognitive, motivational, and technological factors accounted for a substantial proportion of the variance in preventive behavior.

## DISCUSSION

The present study examined the determinants of HIV preventive behavior among adolescents by analyzing the roles of HIV literacy, HIV sensitivity, AI openness, and chatbot choice. The results indicate that each factor contributed significantly to the prediction of preventive behaviors, reflecting the multifaceted nature of health-related decision-making during adolescence. The findings demonstrate that cognitive, motivational, and technological

components are interwoven within adolescents' behavioral frameworks, suggesting that preventive behavior is shaped by the dynamic interaction of knowledge, awareness, and engagement (7,23). Within the conceptual foundation of the Information Motivation Behavioral Skills model, these results reaffirm the necessity of integrating multiple psychological and contextual dimensions when explaining variations in health actions among youth (24,25). While the IMB model provides a relevant foundation for interpreting these findings, behavioral skills were not measured as a distinct construct in the present study and were instead indirectly reflected through digital engagement indicators, particularly AI openness and chatbot choice. These findings further extend the theoretical implications of the IMB model by illustrating how digital engagement can function as a practical and reinforcing component of behavioral skills, suggesting that technology acceptance and interactive learning platforms may serve as critical mechanisms linking knowledge and motivation to actual preventive behavior.

HIV literacy emerged as the strongest predictor, underscoring the central role of knowledge in forming behavioral intentions. Adolescents who possess comprehensive understanding of HIV transmission, preventive mechanisms, and potential health outcomes show a greater likelihood of engaging in consistent protective practices (26). The association between literacy and preventive behavior reflects the principle that information serves as the cognitive infrastructure upon which behavioral decisions are constructed. When adolescents are aware of the scientific basis of transmission routes and recognize effective preventive measures, they are more capable of interpreting risk situations and choosing appropriate responses. This pattern aligns with prior research emphasizing that accurate and accessible knowledge is critical for establishing awareness and guiding individual choices in health-related contexts. Several studies have demonstrated that adolescents with high HIV knowledge exhibit more frequent use of condoms, greater willingness to undergo testing, and stronger commitment to safe sexual conduct, which collectively reinforce the significance of literacy in behavioral regulation (27,28).

The findings related to HIV sensitivity highlight the motivational dimension of the behavioral process. HIV sensitivity encompasses emotional awareness, perceived personal vulnerability, and cognitive appraisal of the consequences of infection (29). Adolescents who report higher levels of sensitivity tend to evaluate their health decisions more carefully, internalizing HIV prevention as a personal and social responsibility. This heightened awareness operates as a motivational force that transforms cognitive understanding into behavioral initiative (30). The observed relationship between sensitivity and preventive behavior is consistent with the motivational assumptions of the Information Motivation Behavioral Skills model, which posits that attitudes, perceived risks, and social expectations influence the willingness to engage in health-promoting actions (31). Studies examining adolescent populations have shown that those who perceive themselves as vulnerable to infection are more inclined to maintain safer sexual relationships and to communicate openly about health issues (32). Emotional and normative factors such as empathy, social accountability, and fear of stigmatization have also been identified as mechanisms that sustain motivation over time (33).

The contribution of digital engagement, represented by AI openness and chatbot choice, provides a contemporary understanding of how adolescents interact with emerging technologies in the context of health education. Adolescents who are receptive to AI-based tools and who actively participate in chatbot-mediated learning demonstrate greater consistency in applying preventive behaviors. This association indicates that digital engagement functions both as a source of information and as a means of practicing behavioral skills (12). Through interactive features and personalized content delivery, AI-driven platforms facilitate learning experiences that are adaptive, responsive, and repetitive, which enhances comprehension and retention (30,34). These characteristics allow adolescents to receive feedback, clarify misconceptions, and simulate real-life decision-making scenarios related to HIV prevention (35). Previous empirical work has identified similar patterns, showing that digital interventions designed with interactive interfaces increase motivation, strengthen self-efficacy, and foster more active participation in health management. By emphasizing these mechanisms, the study underscores that digital engagement is not merely a technological addition but a theoretically meaningful extension of the IMB framework, enhancing the model's explanatory power for adolescent preventive behavior.

The variable of AI openness represents a significant psychological factor that shapes the way adolescents approach technology-assisted learning. Openness to digital innovations indicates curiosity, adaptability, and confidence in using emerging tools as trusted sources of information. Adolescents who demonstrate such openness tend to perceive technology as supportive rather than intimidating, which encourages deeper exploration and repeated

engagement with educational content (34,36). In the present context, this openness enables individuals to process HIV-related information more effectively and to integrate technological resources into their behavioral routines. The relationship between AI openness and preventive behavior suggests that technology acceptance enhances both informational access and behavioral reinforcement, making digital engagement a practical extension of the cognitive and motivational components of the IMB model.

Chatbot choice, as another indicator of digital interaction, further enriches the interpretation of adolescent behavior. Chatbots provide accessible, conversational, and non-judgmental spaces for adolescents to inquire about sensitive issues, reducing the social barriers that often hinder open discussion about sexuality and HIV prevention. When adolescents choose to interact with chatbot systems, they are effectively engaging in self-directed learning that promotes autonomy and responsibility. Such engagement facilitates repeated exposure to preventive messages and encourages reflection on personal risk perceptions (37,38). Evidence from digital health interventions supports the idea that adolescents are more responsive to conversational formats that simulate interpersonal dialogue, as these interactions promote emotional comfort and sustained participation (39). The ability of chatbots to adapt responses based on user input also enhances their role as behavioral facilitators, providing context-specific guidance aligned with the user's level of understanding.

The combined influence of HIV literacy, HIV sensitivity, AI openness, and chatbot choice illustrates the complex structure of adolescent HIV preventive behavior. Each variable contributes distinct yet interconnected functions within the behavioral process. Literacy provides the factual basis for risk recognition, sensitivity infuses personal and emotional relevance, and digital engagement enables the practical translation of knowledge and motivation into behavioral execution (40). The statistical relationships identified in this study reveal that these dimensions operate synergistically rather than independently, producing cumulative effects that explain meaningful variations in preventive outcomes (7). This pattern suggests that the behavioral process among adolescents is shaped by the interaction of cognitive, affective, and technological systems that reinforce one another through feedback mechanisms (41).

The observed Nagelkerke  $R^2$  value of 0.234 reflects that these predictors collectively account for a considerable portion of variance in preventive behavior. Although this proportion indicates strong predictive value, it also implies that other contextual influences play a role in shaping adolescents' responses to HIV-related risks (42). Factors such as peer norms, family communication patterns, access to reproductive health services, and cultural expectations regarding sexuality may interact with individual-level predictors to produce diverse behavioral expressions (43). These contextual dimensions are likely to modulate how adolescents interpret risk, negotiate social pressures, and apply preventive strategies in daily life (8). Further examination of these social determinants would provide a more comprehensive view of the behavioral ecology surrounding HIV prevention.

The results also highlight the necessity of reexamining how digital health interventions are designed and implemented within adolescent populations. Technological innovations must not only disseminate information but also cultivate motivation and reinforce behavioral competencies (44). Incorporating elements of empathy, interactivity, and user-centered design can increase adolescents' engagement with digital health programs (45). Moreover, attention should be directed toward inclusivity, ensuring that interventions are accessible to diverse groups regardless of socioeconomic background, digital literacy, or geographic location. Understanding how adolescents navigate the intersection of information, emotion, and technology is crucial for improving the design of digital learning environments that encourage preventive practices (46).

This study contributes to a broader understanding of adolescent behavior by identifying how informational, motivational, and technological determinants interact within a single analytical framework. The patterns observed emphasize that health-related behaviors are best understood through an integrative perspective that captures the simultaneous operation of knowledge acquisition, emotional processing, and technology-mediated engagement. These findings advance theoretical understanding by demonstrating how digital engagement complements cognitive and motivational factors, thereby extending the explanatory scope of the IMB model for adolescent HIV preventive behavior, and they highlight the novelty of examining cognitive, motivational, and technological determinants together in a single framework. Moreover, these insights can inform public health strategies by guiding the design of interventions that effectively integrate information, motivation, and technology to promote sustained preventive behaviors among adolescents. The multidimensional relationships revealed in this research invite further exploration

into how each domain reinforces or moderates the others in different social and cultural contexts. Continued investigation into these dynamics will deepen comprehension of the psychological and structural conditions that support sustained HIV preventive behavior among adolescents.

At the same time, the study acknowledges several limitations that should be considered when interpreting the findings. These include potential measurement bias, reliance on self-reported data, contextual heterogeneity, omitted variable bias, and concerns regarding external validity. While these constraints do not diminish the significance of the observed relationships, they highlight opportunities for future research to further refine and expand understanding of adolescent HIV preventive behavior, including the exploration of additional psychosocial and contextual factors that may influence outcomes.

## **CONCLUSION**

This study investigated factors influencing HIV preventive behavior among adolescents and aimed to examine the roles of HIV literacy, HIV sensitivity, AI openness, and chatbot choice in predicting high-level preventive behaviors. The findings demonstrated that all four predictors were significantly associated with adolescents' engagement in preventive actions, highlighting the combined influence of cognitive, motivational, and digital engagement factors. Notably, HIV literacy emerged as the strongest predictor, while AI openness and chatbot choice emphasized the growing relevance of technology-mediated interventions in promoting health behavior. These results underscore the importance of integrating informational, motivational, and skills-based approaches, suggesting that health education programs should leverage both traditional literacy and digital engagement strategies to enhance HIV preventive practices.

While this study provides valuable insights into adolescent HIV preventive behavior, certain limitations should be noted, such as the cross-sectional design limiting causal inference, reliance on self-reported data, and the focus on a single geographic region, which may restrict generalizability. Future research should focus on longitudinal studies, exploring the causal pathways among IMB components, evaluating the long-term effectiveness of AI-mediated interventions, and examining contextual and sociocultural factors influencing behavior. Such efforts could enhance our understanding of adolescent preventive behaviors and inform the development of more effective, scalable, and context-sensitive HIV prevention strategies.

## **AUTHOR'S CONTRIBUTION STATEMENT**

MM formulated the overall research design, directed the project, validated the research procedures, supervised all stages of the study, and led the preparation of the manuscript. AS supported the development of the methodological framework and participated in data analysis and interpretation. HNW contributed to data collection and ensured that field implementation followed the established research procedures. MM also carried out the critical revision of the manuscript and confirmed the coherence of the final document. All authors have read and approved the final version of the manuscript prior to submission.

## **CONFLICTS OF INTEREST**

The author(s) affirm that no conflicts of interest were present in relation to the conduct of the research, the preparation of the manuscript, or the publication of this article.

## **DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS**

Generative AI and AI-assisted tools were used exclusively for linguistic refinement and structural clarity during manuscript preparation. All ideas, analyses, and interpretations originate from the authors, and the use of such technologies was confined to editorial support in line with ethical publishing guidelines.

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