ORIGINALS

Psychometric validation of a scale to measure vulnerability to HIV in school-attending adolescents

Validación psicométrica de una escala para medir la vulnerabilidad al VIH en adolescentes escolarizados

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ABSTRACT:
Introduction: This study validates a scale to measure vulnerability to HIV in school-attending adolescents. The results show a solid factorial structure and high reliability, supporting its use in research and prevention.
Objective: This study aimed to determine the validity and reliability of the Scale for Vulnerability to HIV in School-Aged Adolescents.
Methodology: A cross-sectional, instrumental, descriptive study was conducted with a random sample of 890 adolescents aged 14 to 21 years, enrolled in public schools in Bogotá, Colombia. Construct validity was assessed using Exploratory Factor Analysis (EFA), and reliability was evaluated through Cronbach's alpha coefficient.
Results: The EFA identified ten factors related to HIV vulnerability, such as school-based sexual education, partner maltreatment, risky sexual behaviors, and self-image, explaining 57% of the total variance. Factor loadings ranged from 0.49 to 0.93, and reliability coefficients (Cronbach's alpha) ranged from 0.71 to 0.93. These results enabled the development of the EVA scale, designed to measure HIV vulnerability in school-aged adolescents.
Conclusion: The EVA scale demonstrated strong psychometric properties, and its use is recommended to identify HIV vulnerability in adolescents with characteristics similar to the studied population.

Keywords: Vulnerability, HIV, Adolescent, Factor Analysis, Psychometrics.

RESUMEN:

Introducción: Este estudio valida una escala para medir la vulnerabilidad al VIH en adolescentes escolarizados. Los resultados muestran una estructura factorial sólida y alta fiabilidad, respaldando su uso en investigación y prevención.

Objetivo: Este estudio tuvo como objetivo determinar la validez y fiabilidad de la Escala para Vulnerabilidad al VIH en Adolescentes Escolarizados.

Metodología: Se realizó un estudio instrumental, descriptivo transversal con una muestra aleatoria de 890 adolescentes, de 14 a 21 años, provenientes de colegios públicos de Bogotá, Colombia. La validez de constructo se determinó mediante Análisis Factorial Exploratorio (AFE) y la fiabilidad se evaluó con el coeficiente alfa de Cronbach.

Resultados: El AFE identificó diez factores relacionados con la vulnerabilidad al VIH, tales como educación sexual escolar, maltrato de pareja, comportamientos sexuales de riesgo y autoimagen, que explicaron el 57% de la varianza total. Las cargas factoriales oscilaron entre 0.49 y 0.93, y los coeficientes de fiabilidad (alfa de Cronbach) estuvieron entre 0.71 y 0.93. Estos resultados permitieron la construcción de la escala EVA, diseñada para medir la vulnerabilidad al VIH en adolescentes escolarizados.

Conclusiones: La escala EVA demostró tener propiedades psicométricas sólidas, por lo que se recomienda su uso para identificar la vulnerabilidad al VIH en adolescentes de características similares a la población estudiada.

Palabras clave: Vulnerabilidad, VIH, Adolescente, Análisis Factorial, Psicometría.

INTRODUCTION

HIV/AIDS continues to be one of the main challenges for global public health, disproportionately affecting young and vulnerable populations. According to UNAIDS, in 2023 approximately 39 million people were living with HIV, and more than 630,000 died from AIDS-related causes. Among these, 1.5 million were under the age of 18, highlighting the persistent vulnerability of adolescents to this epidemic. In sub-Saharan Africa, adolescent girls and young women accounted for over 77% of new infections among youth aged 15 to 24, underscoring that adolescents remain one of the most affected populations[1].

Globally, despite advances in HIV prevention and treatment, significant disparities persist in access to these interventions, particularly among vulnerable populations[2]. In Colombia, the situation is alarming, with an increase in HIV incidence among youth. During the first half of 2023, the National Institute of Health reported that 23.57% of confirmed HIV cases in the country corresponded to individuals aged 15 to 24, with Bogotá being the city with the highest incidence[3].

Adolescent vulnerability to HIV has been addressed from multiple theoretical perspectives. One of the most widely recognized is that of Mann and Tarantola, who define vulnerability as a multidimensional phenomenon involving individual, social, and programmatic factors[4]. However, the measurement of these factors has been limited, and there are not enough validated scales to assess this vulnerability in adolescents. In this context, the present study aims to determine the validity and reliability of the Scale for Vulnerability to HIV in School-Attending Adolescents (EVA), thereby contributing to the assessment and mitigation of factors that increase the risk of infection in this critically affected population.

MATERIAL AND METHOD

Participants

The study was conducted in a district located in the southeastern area of Bogotá, Colombia, with the voluntary participation of three public schools. Data collection took place between 2018 and 2019 by administering the scale to the entire population that met the inclusion criteria: students enrolled in grades 9, 10, and 11, aged between 14 and 21 years, and without any medical conditions affecting their cognitive abilities. Adolescents over the age of 18 signed an informed consent form, while for those under 18, both assent from the adolescent and written consent from their parents or legal guardians were obtained.

Initially, the study considered a population of 972 adolescents. However, surveys with more than 10% missing data were excluded, resulting in a final population of 966 participants. From this population, a random and stratified sample was selected according to academic grade, yielding a total of 890 adolescents (n = 338 from 9th grade, n = 292 from 10th grade, and n = 260 from 11th grade). This sample size was determined based on the recommendations of Hair et al., which suggest including 10 participants per item evaluated in an Exploratory Factor Analysis (EFA), making it appropriate for the 89 items of the scale[5].

Procedure

The study was approved by the Ethics Committee of the Faculty of Nursing at the National University of Colombia, Bogotá campus (AVAL-011-17), and received authorization from the Local Education Authority of the district (E2016.169734) as well as from the participating schools. Multiple meetings were held with school administrators, teachers, and students to present the project and explain its purpose. During these sessions, participants' questions were addressed, and emphasis was placed on the importance of anonymity and the confidentiality of the information, assigning a unique code to each completed scale. It was also emphasized that students' participation was entirely voluntary.

Data collection was carried out in classrooms according to each school's logistical conditions. Students were seated in a way that ensured physical separation from one another, thereby guaranteeing privacy during the administration of the scale.

Instruments

The Scale for Vulnerability to HIV in School-Attending Adolescents (EVA) was used, comprising 18 constructs and 89 items. The assessed constructs included: School environment (3 items), Family relationships (7 items), Risky sexual behaviors (8 items), Media (3 items), Love and sexual relationships (7 items), Sexually transmitted infections (5 items), Self-regulation (3 items), School-based sexual education (12 items), Self-esteem (5 items), Knowledge about HIV/AIDS (5 items), Power in sexual relationships (4 items), Risk perception (4 items), Condom use (5 items), Depression (3 items), Use of psychoactive substances (3 items), Cultural beliefs about HIV (3 items), Partner maltreatment (5 items), and Health-based sexual education (4 items).

The scale assesses both the level of agreement and the frequency of behaviors related to HIV vulnerability in adolescents, using a 5-point Likert scale with frequency ranges from "never" to "very frequently."

Linguistic validity was ensured through expert review, and a pilot test conducted with 90 adolescents allowed for refinement of the instrument. Content validity was confirmed using the modified Lawshe method[6], yielding a global content validity index of 0.78, exceeding the minimum threshold of 0.58[7].

Data Analysis

The data analysis was aligned with the nature of the study, which was instrumental, descriptive, and cross-sectional. An Exploratory Factor Analysis (EFA) was conducted following the criteria established by Hair et al.[5] For the analysis, SPSS software version 25 was used. A preliminary analysis was performed to verify normality, linearity, and the absence of outliers. Sample adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) index and Bartlett's test of sphericity. Factors were extracted using the maximum likelihood method, selecting those with eigenvalues > 1 and based on the scree plots.

An oblique Promax rotation with Kaiser normalization was applied to facilitate interpretation. Factors were interpreted based on variables with factor loadings > 0.3, given the sample size. Finally, internal reliability was assessed using Cronbach's alpha (with values > 0.7 considered acceptable), and convergent validity was examined through correlations among the variables within each factor[5].

RESULTS

Descriptive Statistics

The total sample consisted of 890 adolescents, of whom 48.7% were male (n = 433) and 51.3% were female (n = 457). The average age of participants was 15 years, with a standard deviation of 1.28 for males and 1.30 for females. The age distribution showed that 31.7% of the adolescents were 16 years old, making it the most represented age, followed by those aged 15 (25.5%) and 17 (17.1%). Younger adolescents (aged 14) accounted for 15.2% of the sample, while those aged 18 made up 7.5%, and those aged 19 to 21 represented a minority, with proportions ranging between 0.7% and 0.1%. Regarding school distribution, School 2 had the highest proportion of participants, comprising 38.2% of the total sample, with a higher percentage of females (40.5%) than males (35.8%). In terms of academic grade, most students were in the ninth grade (38%), followed by tenth grade (32.8%), with eleventh grade being the least represented (29.2%).

Among the 890 adolescent participants, three sociodemographic variables were initially considered: age, sex, and socioeconomic status, along with the 89 items of the scale. However, due to more than 10% missing data, the socioeconomic status variable was excluded prior to subsequent analyses.

Data normality was assessed using kurtosis and skewness, following the recommendations of Bentler and Hair et al., who suggest that kurtosis values between +3 and –3 and skewness values between +2 and –2 are indicative of normality in large

samples[5,8]. Of the 89 items analyzed, 10 were outside of this range and were therefore excluded from further analyses. The remaining 79 items showed skewness values ranging from –1.41 to 1.87 (standard error of skewness = 0.08), and kurtosis values ranging from –1.42 to 2.56 (standard error of kurtosis = 0.16).

Factor Analysis: Determination of Factors for Construct Validity

The data were deemed suitable for conducting an Exploratory Factor Analysis (EFA). Of the initial 89 items on the scale, 10 were eliminated for falling outside the acceptable range of normality. Subsequently, 46 items were selected (see Table 1), with extraction communalities ranging from 0.37 to 0.84. The set of items achieved a Kaiser-Meyer-Olkin (KMO) index value of 0.87, indicating adequate sampling adequacy, and Bartlett's test of sphericity was significant ($p < 0.05$), suggesting that the items were sufficiently correlated to conduct a meaningful EFA.

Regarding the explained variance, although no absolute threshold was established, a solution accounting for at least 60% of the total variance is generally considered satisfactory in the social sciences. In this case, the ten retained factors explained 57.116% of the total variance, with factors one and two accounting for the largest proportion, approximately 24% each.

Factor Validity

The face validity of the ten factors was demonstrated by their ease of labeling, and the factor loadings of the items were consistent with the theoretical dimensions underlying the instrument. Discriminant validity was also confirmed, as the items showed stronger associations with their corresponding factor than with others, as seen in the pattern matrix, where item loadings were significant on a single factor with no cross-loadings (Table 1). Upon examining the factor correlation matrix, it was observed that the inter-factor correlations did not exceed 0.7, indicating low shared variance among the factors[5].

Table 1: Pattern Matrix Extracted in the Exploratory Factor Analysis (EFA).

Items	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
ESEs_V65	0.85									
ESEs_V61	0.83									
ESEs_V63	0.82									
ESEs_V62	0.81									
ESEs_V64	0.79									
ESEs_V60	0.78									
ESEs_V68	0.72									
ESEs_V66	0.67									
ESEs_V67	0.64									
ESEs_V69	0.54									
RelSC_V24		0.86								
RelSC_V28		0.82								
RelSC_V26		0.81								
RelSC_V25		0.72								
RelSC_V22		0.64								
RelSC_V23		0.62								

Items	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
MalP_V52			0.88							
MalP_V54			0.83							
MalP_V53			0.79							
MalP_V51			0.73							
MalP_V55			0.71							
ESSa_V72				0.93						
ESSa_V71				0.85						
ESSa_V73				0.83						
ESSa_V74				0.78						
RelSR_V36					0.75					
RelSR_V33					0.74					
RelSR_V37					0.66					
RelSR_V34					0.65					
RelSR_V38					0.65					
RelSR_V35					0.49					
AutI_V2						0.92				
AutI_V1						0.86				
AutI_V3						0.57				
Cono_V76							0.76			
Cono_V79							0.64			
Cono_V77							0.57			
Cono_V75							0.54			
ApoF_V15								0.86		
ApoF_V16								0.68		
ApoF_V14								0.64		
Depr_V6									0.74	
Depr_V7									0.66	
Depr_V8									0.62	
RelE_V11										0.83
RelE_V10										0.81

Note: Extraction method: Maximum likelihood. Rotation method: Promax with Kaiser normalization. F1-School-based sexual education; F2-Sexual relations driven by love; F3-Partner maltreatment; F4-Health-based sexual education; F5-Risky sexual behaviors; F6-Self-image; F7-Knowledge about HIV/AIDS; F8-Family support; F9-Depression; and F10-Emotional expression at school.

Convergent validity was observed in the scale, as the items within each factor showed strong correlations, with factor loadings ranging from 0.49 to 0.93. These loadings were both significant and representative, particularly considering the sample size of 890 adolescents. This indicates that the scale demonstrates adequate convergent validity (see Table 1).

The EFA identified ten correlated and reliable factors, with factor loadings ranging from 0.49 to 0.93, and reliability coefficients (Cronbach's alpha) ranging from 0.71 to 0.93. A clear and coherent factorial structure was observed, with evidence of both convergent and discriminant validity, and no significant cross-loadings between factors. The reliability of each factor was evaluated using Cronbach's alpha coefficient, with a lower acceptable threshold set at 0.7. Additionally, one factor consisting of only two ítems "emotional expression at school" was retained due to its high reliability (0.800) and

strong factor loadings (0.81 and 0.83) (Table 2). The names and definitions of the factors were refined based on the items retained in the analysis.

Table 2: Factor Structure and Reliability of the Factors.

Factors	Retained Items	Range of Factor Loadings	Cronbach's Alpha for the Factor
F1	10 Items	0.54 - 0.85	0.93
F2	6 Items	0.62 - 0.86	0.88
F3	5 Items	0.71 - 0.88	0.89
F4	4 Items	0.78 - 0.93	0.92
F5	6 Items	0.49 – 0.75	0.83
F6	3 Items	0.57 – 0.92	0.83
F7	4 Items	0.54 – 0.76	0.73
F8	3 Items	0.64 – 0.86	0.76
F9	3 Items	0.62 – 0.74	0.71
F10	2 Items	0.81 – 0.83	0.80

Note: F1-School-based sexual education; F2-Sexual relations motivated by love for a partner; F3-Partner maltreatment; F4-Health-based sexual education; F5-Risky sexual behaviors; F6-Self-image; F7-Knowledge about HIV/AIDS; F8-Family support; F9-Depression; and F10-Emotional expression at school.

DISCUSSION

In psychometric research, normality tests such as the Kolmogorov–Smirnov test, and measures like kurtosis, are commonly used to assess the distribution of data. However, the relevance of these tests has been questioned in the context of psychometric scales. Micceri found that most data distributions in psychometric studies deviate significantly from normality, suggesting that traditional methods for assessing normality may not be appropriate in such contexts[9]. This finding highlights the need to consider the underlying nature of psychometric distributions rather than applying these tests automatically.

Moreover, Bentler suggests that in large samples, kurtosis levels should remain within certain limits to be considered normal, as extreme values may distort statistical inferences. This recommendation is particularly relevant in the analysis of psychometric scales, where data rarely follow a normal distribution, making it necessary to apply more flexible criteria for interpreting results[10]. In the present study, this perspective was adopted to ensure that deviations from normality would not compromise the validity of the conclusions, thereby providing a solid foundation for interpreting the EFA results.

In the EFA, items with extraction communalities greater than 0.30 were selected, a result consistent with the recommendations of Hair et al., who state that such values can be acceptable in large samples, as is the case in this study[5].

Although the explained variance (57.1%) is slightly below the ideal threshold of 60%, it is considered acceptable in social science studies involving multiple interrelated factors[5]. This analysis contrasts with two studies that emphasize the importance of establishing appropriate thresholds in EFA. The first advocates for basing thresholds on empirical evidence and theoretical reasoning rather than strictly adhering to a fixed

criterion[11], while the second suggests that the quality of the factors may be more important than the proportion of variance explained, justifying lower thresholds if the factors are meaningful and contribute to the understanding of the studied constructs[12].

The scale demonstrated construct validity, as items with similar characteristics were correctly grouped into the expected factors, facilitating their interpretation and labeling. This result suggests that the identified factors clearly reflect the underlying constructs, thus providing conceptual coherence. Discriminant validity was also confirmed, as the factors did not exhibit cross-loadings, indicating that the items belonged exclusively to a single factor. Additionally, inter-factor correlations remained within acceptable limits, ensuring that the constructs were distinguishable from one another, results consistent with the criteria established in previous research[5,13].

Moreover, the factor loadings indicated that the items within each factor were highly correlated, demonstrating that they consistently measured the associated constructs. This confirms that the items contributed significantly to the factorial structure. Regarding reliability, the Cronbach's alpha coefficients were high, indicating excellent internal consistency and ensuring that the measured factors are stable and reproducible, findings aligned with established psychometric reliability standards[14].

The factors retained in the EFA included key dimensions such as self-image, knowledge about HIV/AIDS, depression, sexual relations motivated by love for a partner, partner maltreatment, risky sexual behaviors, family support, emotional expression at school, school-based sexual education, and health-based sexual education. These factors encompass emotional, behavioral, and psychosocial aspects, providing a comprehensive understanding of the elements that influence HIV vulnerability in adolescents.

It is important to highlight that, although the factor *emotional expression at school* consisted of only two items, it was retained due to its high reliability and strong factor loadings. According to Hair's criteria, a factor composed of two items can be considered valid if it demonstrates adequate reliability and if the items are conceptually well-defined and highly correlated[5,13]. In this case, both items clearly and concisely reflect the construct of emotional expression, which justifies their inclusion despite the reduced size. Moreover, this factor is easily interpretable and provides relevant information in the school context a setting that plays a crucial role in adolescents' emotional well-being.

The identified factors reflect various dimensions of HIV vulnerability in adolescents. For example, the fact that risky sexual behaviors and school-based sexual education emerged as independent factors suggests that, although they are related, formal education and individual decisions regarding sexuality have distinct impacts on HIV vulnerability. As noted in the study by Rudgard et al.,[15] on protective factors against HIV-related risky sexual behaviors, sexual education has been highlighted as a key intervention to reduce the risk of HIV transmission. This finding is consistent with the present study, since this perspective also reveals that other factors, such as partner maltreatment and depression, have a significant impact on adolescent vulnerability.

This study has several limitations inherent to its cross-sectional design and reliance on self-report, which constrain causal inference and may introduce social desirability bias.

Psychometric evidence rests primarily on exploratory factor analysis, without independent confirmation or tests of measurement invariance; thus, the latent structure requires further verification. The sample, confined to a specific educational context, limits generalizability across populations and time. Moreover, data-cleaning decisions—including handling of missingness and item removal based on statistical assumptions—may have influenced the factorial configuration. These considerations warrant multicenter replications, confirmatory analyses, and complementary reliability estimates.

In the literature, sexual education has been identified as a key intervention to reduce the risk of HIV transmission, but this study provides an additional perspective by showing that factors such as partner maltreatment and depression also play a significant role in adolescent vulnerability[15]. It is important to highlight that some factors less frequently discussed in the literature, such as self-image and emotional expression at school, suggest that mental health and the social environment in which adolescents develop are critical components that should be addressed in preventive interventions. These findings also emphasize the importance of comprehensive education that not only focuses on technical knowledge about HIV, but also fosters the emotional and social development of adolescents[15].

Therefore, the results suggest that an effective educational intervention should include not only information on HIV prevention, but also strategies to improve self-image and address partner maltreatment and depression, factors that are highly correlated with HIV vulnerability in this population[16].

CONCLUSIONS

The validation of the Scale for Vulnerability to HIV in Adolescents (EVA) confirmed that this instrument possesses strong psychometric properties, making it a fundamental tool for assessing the psychosocial and behavioral factors that influence HIV vulnerability in adolescents. The EFA identified ten main factors, which explained a significant percentage of the total variance. The reliability of the factors was confirmed through Cronbach's alpha coefficients, indicating excellent internal consistency. These factors, such as self-image, partner maltreatment, depression, risky sexual behaviors, and sexual education, highlight the need to consider HIV vulnerability as a multidimensional phenomenon involving emotional, behavioral, and social aspects.

These findings suggest that any educational intervention aimed at this population should be comprehensive, not only focusing on technical aspects of HIV prevention, but also addressing adolescents' emotional and psychosocial well-being. Specifically, the retention of the factor emotional expression at school, composed of only two items, underscores the relevance of the school environment in adolescent emotional health and highlights the need to include components that promote this well-being in educational programs.

Based on the results obtained, it is recommended that educational interventions include not only HIV prevention strategies, but also approaches that strengthen self-image, address partner maltreatment and depression, and reinforce sexual education. In addition, it would be advisable to conduct further studies in other geographic and cultural contexts to validate the instrument and enhance its applicability. Likewise, a

Confirmatory Factor Analysis (CFA) in future research would help validate the structure identified through the EFA and strengthen the stability of the factors. In this way, the EVA scale could become an effective tool for implementation in educational settings, facilitating the identification of vulnerable adolescents and the development of appropriate preventive programs. The combination of technical and psychosocial approaches in interventions could be key to reducing HIV vulnerability and improving the well-being of adolescents at risk.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. ONUSIDA. Día Mundial del Sida 2023: hoja informativa — últimas estadísticas sobre el estado de la epidemia de sida [Internet]. Ginebra: ONUSIDA; 2023 [citado 2024 abr 16]. Disponible en: https://www.unaids.org/es/resources/fact-sheet
2. Mody A, Sohn AH, Iwuji C, Tan RKJ, Venter F, Geng EH. HIV epidemiology, prevention, treatment, and implementation strategies for public health. *Lancet*. 2024 Feb 3;403(10425):471–92. Available from: https://doi.org/10.1016/S0140-6736(23)01381-8
3. Instituto Nacional de Salud (INS). Informe de evento: primer semestre VIH, sida y muerte por sida, 2023 [Internet]. Bogotá D.C.: Instituto Nacional de Salud; 2023 [citado 2024 abr 16]. Disponible en: https://www.ins.gov.co/buscador-eventos/Informesdeevento/VIH
4. Mann J, Tarantola D. *AIDS in the world*. New York: Oxford University Press; 1996.
5. Hair JF, Black WC, Babin BJ, Anderson RE. *Multivariate data analysis*. 7th ed. Harlow, Essex: Pearson Education Limited; 2014.
6. Tristán-López A. Modificación al modelo de Lawshe para el dictamen cuantitativo de la validez de contenido de un instrumento objetivo. *Av Medición* [Internet]. 2008;6(1):37–48 [citado 2025 jun 19]. Disponible en: https://www.humanas.unal.edu.co/lab_psicometria/application/files/9716/0463/3548/VOL_6._Articulo4_Indice_de_validez_de_contenido_37-48.pdf
7. Telpiz-De La Cruz SG. Diseño y validación de un instrumento para medir la vulnerabilidad al VIH en adolescentes escolarizados en colegios [tesis doctoral en Internet]. Bogotá: Universidad Nacional de Colombia; 2021 [citado 2025 jun 19]. Disponible en: https://repositorio.unal.edu.co/handle/unal/79612
8. Sposito VA, Hand ML, Skarpness B. On the efficiency of using the sample kurtosis in selecting optimal LP estimators. *Commun Stat – Simul Comput*. 1983;12(3):265–72. Available from: https://doi.org/10.1080/03610918308812318

9. Micceri T. The unicorn, the normal curve, and other improbable creatures. *Psychol Bull*. 1989;105(1):156–66. Available from: https://doi.org/10.1037/0033-2909.105.1.156

10. Bentler PM. *EQS 6 structural equations program manual*. Encino, CA: Multivariate Software, Inc.; 2006.

11. Kraal AZ, Massimo L, Fletcher E, Carrión CI, Medina LD, Mungas D, et al. Functional reserve: the residual variance in instrumental activities of daily living not explained by brain structure, cognition, and demographics. *Neuropsychology*. 2021 Jan;35(1):19–32. Available from: https://doi.org/10.1037/neu0000705

12. Savahl S, Casas F, Adams S. Considering a bifactor model of children's subjective well-being using a multinational sample. *Child Indic Res* [Internet]. 2023; 16: 2253–78. Available from: https://doi.org/10.1007/s12187-023-10058-6

13. Goretzko D, Pham TTH, Bühner M. Exploratory factor analysis: current use, methodological developments and recommendations for good practice. *Curr Psychol* [Internet]. 2021;40(7):3510–21. Available from: https://doi.org/10.1007/s12144-019-00300-2

14. Geisinger KF, Bracken BA, Carlson JF, Hansen JI, Kuncel NR, Reise SP, Rodríguez MC, eds. *APA Handbook of Testing and Assessment in Psychology*. Vol. 1. Washington, DC: American Psychological Association; 2013.

15. Rudgard WE, Saminathen MG, Orkin M, Banougnin BH, Shenderovich Y, Toska E, et al. Protective factors for adolescent sexual risk behaviours and experiences linked to HIV infection in South Africa: a three-wave longitudinal analysis of caregiving, education, food security, and social protection. *BMC Public Health* [Internet]. 2023; 23: 408. Available from: https://doi.org/10.1186/s12889-023-16373-5

16. Howes A, Risher KA, Nguyen VK, Stevens O, Jia KM, Wolock TM, et al. Spatio-temporal estimates of HIV risk group proportions for adolescent girls and young women across 13 priority countries in sub-Saharan Africa. *PLOS Glob Public Health* [Internet]. 2023 Apr;3(4): e0001731. Available from: https://doi.org/10.1371/journal.pgph.0001731