AGILE: GIScience Series, 6, 45, 2025. https://doi.org/10.5194/agile-giss-6-45-2025
Proceedings of the 28th AGILE Conference on Geographic Information Science, 10–13 June 2025.
Eds.: Auriol Degbelo, Serena Coetzee, Carsten Keßler, Monika Sester, Sabine Timpf, Lars Bernard
This contribution underwent peer review based on a full paper submission.

Mapping the geography of violence against children in Namibia: A Geographically Weighted Regression Approach

Tobias Willem Shinyemba [1,2,3], Shino Shiode [1], and Karen Devries [2]

[1] Department of Geography, Birkbeck, University of London, London, UK
[2] Department of Population Health, London School of Hygiene and Tropical Medicine, London, UK
[3] Department of Computing, Mathematical and Statistical Sciences, University of Namibia, Windhoek, Namibia

Correspondence: Tobias Willem Shinyemba (tshiny01@student.bbk.ac.uk)

Abstract. This study investigated the geospatial patterns and determinants of violence against children and young people in Namibia using data from 5,191 individuals aged 13-24 years, interviewed across 79 constituencies in the 2019 Violence Against Children and Youth Survey. We employed Global Moran's *I* and Local Indicators of Spatial Autocorrelation to identify global spatial autocorrelation and hotspots. Ordinary least squares regression was used to identify significant area-level risk factors, whereas Geographically Weighted Regression was used to model local variations. We found significant regional variations in the prevalence of past-year sexual (SV), physical (PV), and emotional violence (EV), with the highest rates observed in constituencies in central and northern Namibia. Global spatial autocorrelation was evident for SV and EV but not for PV, suggesting distinct spatial patterns for each form of violence in the study area. Our findings also revealed notable spatial variations in risk factors, with area-level factors showing strong influences in certain areas, while being less impactful or negligible in others. These findings emphasise the need for geographically targeted interventions and policies to address localised risk factors and reduce violence against children and young people in Namibia.

Submission Type. Analysis

BoK Concepts. [AM7] Spatial Statistics or [AM9] Spatial regression and econometrics

Keywords. Violence against children, young people, Namibia, geospatial patterns, area-level data

1 Introduction

Violence against children (VAC) remains a major global public health concern, affecting nearly one billion children under the age of 18 each year through sexual (SV), physical (PV), and emotional violence (EV) (Hillis et al., 2016). Despite concerted global interventions, VAC persists and is often rooted in cultural norms and beliefs that endorse the use of physical or psychological punishment as part of child-rearing practices (Akmatov, 2011;Lev-Wiesel et al., 2018). If left unaddressed, VAC can have profound developmental outcomes for victims, with adverse effects that frequently extend into adulthood (Farrar et al., 2020;Hillis et al., 2017).

The prevalence of VAC exhibits notable spatial variation, with higher rates observed in low- and middle-income countries (LMICs) than in high-income countries (Akmatov, 2011;Stoltenborgh et al., 2015). Recent studies have explored the geospatial patterns of VAC in regions such as the Americas, Spain, France, and the UK. However, much of this research depends on administrative data, which often underestimate VAC prevalence compared with self-reported survey data (Shinyemba et al., 2024). Despite the increased recognition of spatial variations in VAC, research remains limited in LMICs, particularly in sub-Saharan Africa, where VAC continues to be pervasive and inadequately understood.

Understanding the spatial variability of VAC is crucial for identifying high-risk areas and guiding geographically targeted interventions and resource allocation (Bhunia and Shit, 2019;Bergquist and Manda, 2019). Building on this global context, our study focuses on Namibia, where patriarchal norms, cultural beliefs, and social issues such as poverty, crime, and alcoholism present unique challenges in tackling VAC (Brown, 2011;Jewkes et al., 2005;De Klerk, 2009). Police data reveal that children constitute 10 percent of murder victims and 32 percent of rape cases, while the 2019 Violence Against Children and Youth Survey (VACS) reported that 40 percent of girls and 45 percent of boys experienced SV, PV, or EV before the age of 18 (MGEPESW et al., 2020). Despite evidence of spatial disparities in VAC within Namibia (MGEPESW et al., 2020;Gentz et al., 2021), no studies have accurately analysed its geographic distribution or determinants.

This study examined the spatial distribution of SV, PV, and EV against children and young people (CYP) in Namibia. The specific objectives of this study were to 1) map the area-level prevalence of SV, PV, and EV; 2) assess spatial autocorrelation; 3) identify area-level risk factors influencing prevalence; and 4) determine whether the spatial variations in the impact of these risk factors vary across the country.

2 Methods

2.1 Data and sample

Our study employed a cross-sectional ecological design using secondary data from the 2019 Namibia VACS, a nationally representative household survey of children and young people aged 13-24 years. The survey provides data on SV, PV, and EV before the age of 18 years, lifetime childhood violence among adolescents aged 13-17, and past-year violence.

VACS used a three-stage cluster sampling method. The first phase involved the random selection of 274 primary sampling units (PSUs) out of 3,472 based on the 2011 Population and Housing Census, with 220 allocated to females and 54 to males. The second phase entailed the selection of 25 households within each PSU. In the final phase, a participant was randomly selected from each household. The resulting sample consisted of 4,211 females and 980 males, with response rates of 89 percent and 84 percent, respectively. Data were collected from 4,839 households for females and 1,203 households for males.

The Research and Ethics Committee of the Ministry of Health approved the VACS, and all participants provided their written informed consent. Permission to use the data was granted by the US Centers for Disease Control and Prevention and Together for Girls.

2.2 Geoprocessing

We used IBM SPSS v.20 to clean and code the data, and later exported it to R for georeferencing. VACS covered 67 percent of constituencies and 4 percent of enumeration areas (EAs). To mitigate data loss, generate stable patterns, and address modifiable areal unit problem (MAUP) issues at the regional level, we aggregated responses at the constituency level due to limited EAs coverage and the absence of geo-points in VACS. To enhance reliability, constituencies with fewer than ten respondents were omitted from the analysis, resulting in a final dataset comprising 79 constituencies. The current study presents combined weighted area-level responses from 4,199 females and 980 males.

2.3 Measures

Dependent variables: In this study, we defined past-year SV, PV, and EV as specific acts experienced within the 12 months preceding the survey. SV encompasses non-consensual sexual touching, attempted or forced sex, and coerced sex. PV includes slapping, strangling, and being threatened with a weapon. EV comprise belittling by parents, intimate partner humiliation, and peer-inflicted verbal abuse or social exclusion.

Independent variables: We analysed area-level risk factors as aggregated percentages, guided by the socio-ecological framework and a comprehensive literature

Table 1. Variables summary

Area-level rates	Mean	SD	CV
Types of violence			
Past year SV (%)	7.58	6.68	0.88
Past year PV (%)	21.47	10.44	0.49
Past year EV (%)	25.21	13.23	0.52
Explanatory variables			
Currently schooling (%)	61.66	20.54	0.33
Paid/Self-employment (%)	24.51	16.24	0.66
Romantic partner (%)	50.60	12.85	0.25
Tolerate violence (%)	14.57	10.70	0.73
Fear of violence (%)	7.90	6.76	0.86
Domestic violence (%)	15.75	9.00	0.57
Abuse of siblings (%)	25.42	12.90	0.51
Community violence (%)	44.87	19.15	0.43
HHs single (%)	42.75	16.69	0.39
HHs government aid (%)	42.91	22.39	0.52

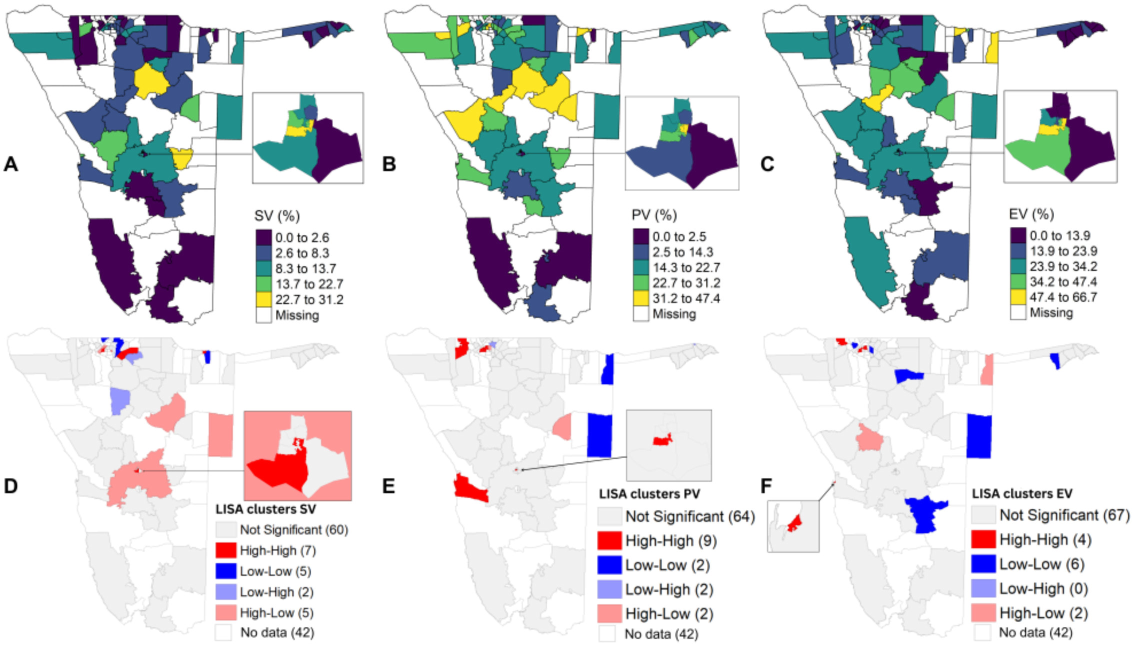

Figure 1. Area-level rates of past year: (A) SV, (B) PV, and (C) SV; and LISA clusters: (D) SV, (E) PV, and (F) EV

review, which underscores individual-, household-, and community-level influences on violence risk (Belsky, 1980;Shinyemba et al., 2024). Short and full variable names are provided in the data dictionary in the appendix (Tab. 4).

2.4 Geospatial analysis

We used choropleth maps to visualise the spatial patterns of violence. Pearson's correlation was used to evaluate the relationships between the different forms of violence. Global Moran's *I* was applied to assess global spatial autocorrelation and Local Indicators of Spatial Autocorrelation (LISA) to identify local hotspots and cold spots based on four-nearest neighbour spatial weights.

We used ordinary least squares (OLS) regression with stepwise selection to identify statistically significant risk factors and applied Geographically Weighted Regression (GWR) to assess local variations. Statistical significance was set at $p < 0.05$.

2.5. Data and Software Availability Section

The original data cannot be made available because of ethical restrictions. Analyses were performed using R and GeoDa. We used *sf, tmap, lmtest, and GWmodel* R packages in our analyses. The code will be published with final outputs.

3 Results

3.1. Exploratory analysis

The mean prevalence rates for past-year SV, PV, and EV were 7.6 percent, 21.5 percent, and 25.2 percent, respectively (Tab. 1). We observed considerable variations in the prevalence of each form of violence and its associated explanatory variables, with significant deviations from the mean across Namibia.

Our findings revealed significant spatial variations in the prevalence of past-year SV, PV, and EV across Namibia, with the highest rates observed in the central, northern, and northeastern regions (Fig. 1A–C). The results showed no discernible pattern for high prevalence areas for SV compared to PV and EV, which showed evidence of high prevalence areas adjacent to other high prevalence areas (Fig. 1A–C). Pearson's correlation analysis identified moderate positive correlations between SV and PV (r = 0.41, $p < 0.01$), SV and EV (r = 0.47, $p < 0.01$), and PV and EV (r = 0.52, $p < 0.01$), suggesting that areas with a high prevalence of one form of violence tended to co-locate with areas of similar prevalence for other forms. The high correlation between PV and EV, compared to other combinations of violence, suggests that the patterns for PV and EV are more similar.

Moran's *I* results indicated global spatial autocorrelation, with a tendency to cluster observed in SV (I = 0.21, p = 0.003) and EV (I = 0.18, p = 0.006). However, PV (I = 0.10, p = 0.067) exhibited a weaker global spatial

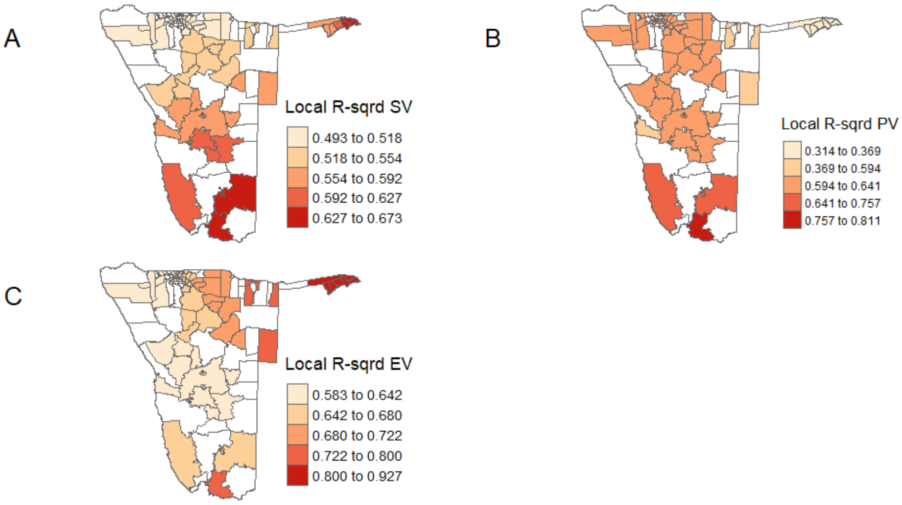

Figure 2. Local GWR R^2 values for violence types

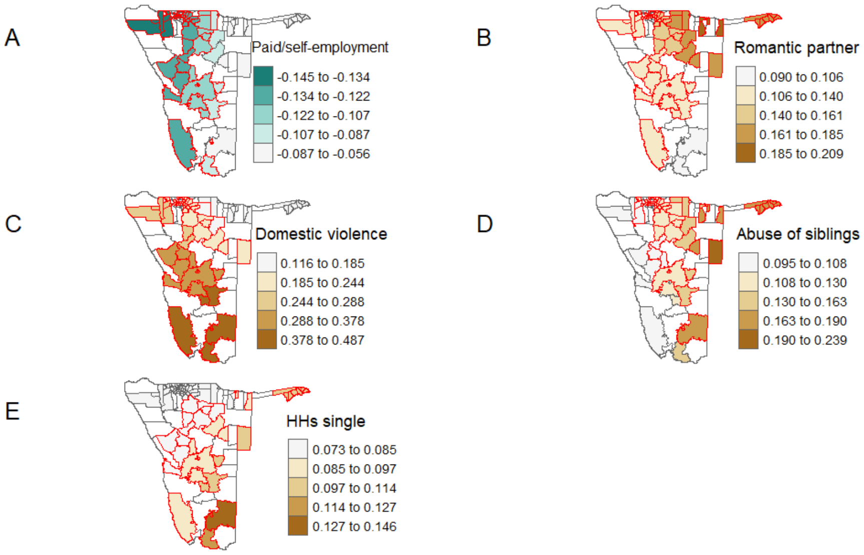

Figure 3. Predictors of SV with significant *t*-values highlighted with red borders

autocorrelation, indicating no significant global spatial autocorrelation. Using LISA, we identified seven hotspots of SV in central and northern Namibia, nine hotspots of PV in central, northern, and western regions, and four EV hotspots in northern and western Namibia (Fig. 1D–F). Additionally, the results show that PV and EV hotspots overlap in constituencies in northern and western Namibia.

2.4 Geographically Weighted Regression

Tables 2 and 3 (in the appendix) present the OLS and GWR model results. The GWR model showed lower AIC and AIC_c values for all forms of violence than the OLS, suggesting that the GWR model provided a better fit and explained a significantly larger proportion of the variance in the risk of violence (Tab. 3).

To demonstrate the inherent spatial heterogeneity in violence risk, we mapped the local coefficient of determination for each violence outcome and the coefficients for each significant risk factor and their associated *t*-values (represented by red borders to show local statistical significance).

We observed an inverse relationship between GWR model performance and violence prevalence, with lower local R^2 values in high-prevalence areas, indicating that unaccounted factors may play a role in these areas (Fig. 2).

Examining the statistical significance of the spatial distribution of coefficients showed that the influence of risk factors varied across the study area, as indicated by the spatially varying local coefficients, with some constituencies having stronger influences and others demonstrating weaker effects (Fig. 3, 4, 5). For example,

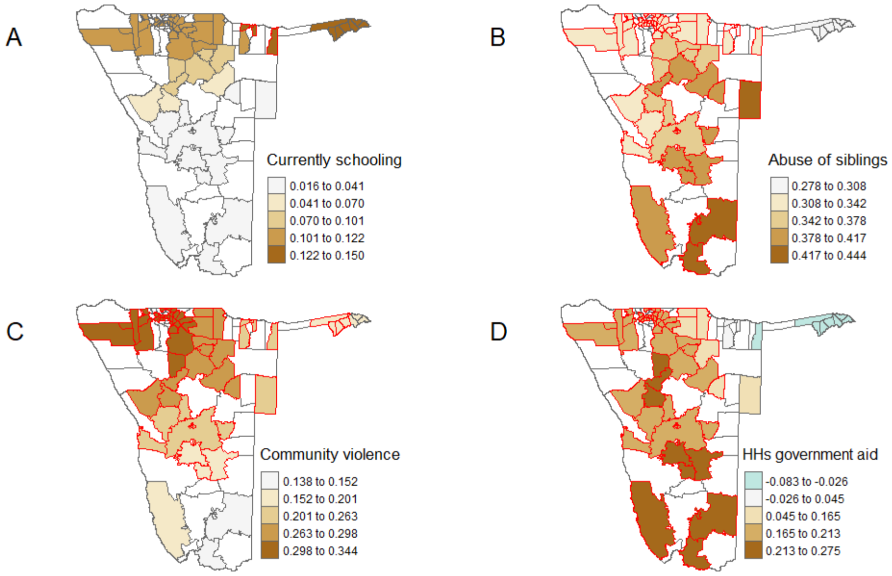

Figure 4. Predictors of PV with significant *t*-values highlighted with red borders

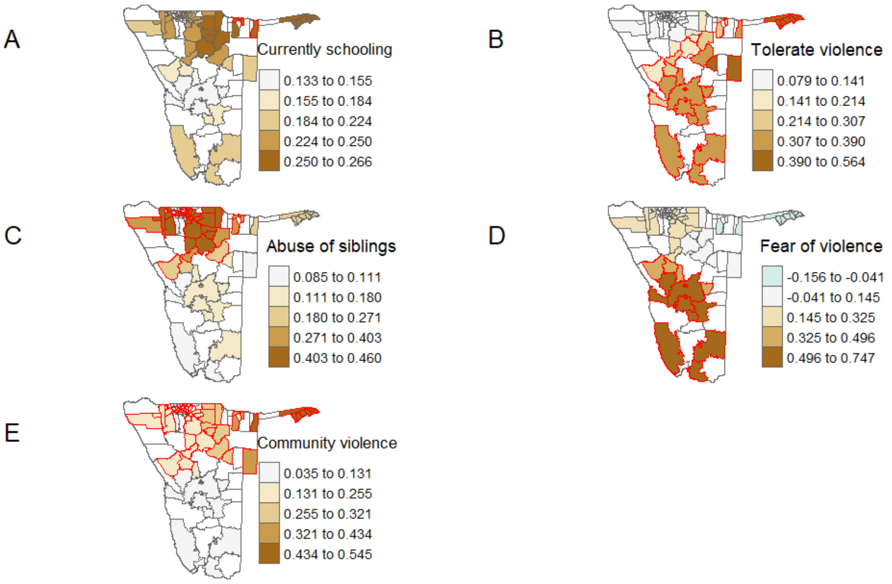

Figure 5. Predictors of EV with significant *t*-values highlighted with red borders

in southern Namibia, SV was related to factors such as residing in a '*single-parent household (HHs single)*', witnessing '*domestic violence*', and having a '*romantic partner*', whereas in regions in the northeast, witnessing '*domestic violence*' was not associated with SV (Fig. 3). Similarly, for PV in northeastern Namibia, factors such as '*currently schooling*', witnessing '*community violence*', and witnessing parental '*abuse of siblings*' were related to PV but not to residing in a '*household receiving government aid (HHs government aid)*' which was significant in other parts of the country (Fig. 4). For EV, witnessing parental '*abuse of siblings*' and witnessing '*community violence*' were associated with EV in northern Namibia, but in central Namibia, EV was related to 'fear of violence' and the belief that women should '*tolerate violence*' to keep the family together. We also observed geographical variations in the importance of shared risk factors. For instance, witnessing parental '*abuse of siblings*' was a significant risk factor for all three types of violence, but its association with SV was not important in western Namibia (Fig. 3), while it was significant countrywide for PV, except in the northeast-most region (Fig. 4), which was only significant in some northern regions for EV (Fig. 5).

4 Discussion

This study leveraged nationally representative survey data to model the geospatial patterns and determinants of the area-level prevalence of SV, PV, and EV against CYP in Namibia. The findings showed significant regional disparities, with the highest prevalence rates observed in central and northern Namibia, regions characterised by high population density, poverty, and other social challenges (NSA, 2021). Additionally, we found moderate co-location between SV and PV, SV and EV, and PV and EV.

Spatial autocorrelation analysis demonstrated statistically significant global clustering for SV and EV, consistent with findings from Peru (Arhuis-Inca et al., 2022) and Brazil (Stocco et al., 2024). However, no global spatial autocorrelation was observed for PV, suggesting that geographically targeted interventions may be more effective for SV and EV, whereas broader strategies may be required for PV intervention. At the local level, SV hotspots were concentrated in urban constituencies in central Namibia, including the capital city, and in a mix of rural and urban constituencies in the northern regions. For PV and EV, hotspots were identified in both rural and urban constituencies in the northern and urban areas of central and western Namibia, respectively. Notably, overlapping hotspots for PV and EV in the northern and western regions suggest shared spatial patterns that are potentially linked to common underlying risk factors.

Our findings also highlight notable spatial variations in the influence of area-level risk factors on the three forms of violence. This spatial variation highlights that while certain risk factors exerted a strong influence on specific constituencies for one form of violence, their impact was minimal or negligible for others for the same form of violence. These nuanced relationships, revealed through GWR, would have been obscured by the OLS model. The spatial heterogeneity in area-level violence and its associated risks likely arise from complex interactions between social and physical environments, traditional child-rearing practices, and cultural misconceptions about violence against CYP (Jewkes et al., 2005;Gentz et al., 2021).

Additionally, we found that the GWR model exhibited lower R^2 values in some constituencies, indicating that unaccounted factors may contribute to violence against CYP in these areas. Therefore, there is a need to explore additional predictors unique to these constituencies and employ multilevel models that account for the nested data structure.

We found several area-level factors that increased the likelihood of violence, including school attendance, witnessing domestic violence, parental abuse of siblings, exposure to community violence, living in single-parent households, and residing in households that received government aid. These findings highlight the need for localised interventions that create safe environments for children by modifying social and physical contexts, implementing programs to address violence in households and schools, and challenging harmful gender norms and cultural beliefs (WHO, 2016).

This study has several strengths. First, it used nationally representative data, enhancing the generalisability of the findings. Second, the VACS provides rigorous and validated measures of violence, ensuring the validity and reliability of the results. Third, this study offers location-specific insights that can guide policymakers in targeting interventions where they are most needed. However, this study has some limitations. The lack of estimates in some constituencies reduced statistical power and limited the scope of the analysis. The cross-sectional nature of the data precluded causal inference, and self-reported data may have been affected by recall and social desirability biases. Finally, challenges such as ecological fallacy and the modifiable areal unit problem may complicate the interpretation of the findings.

These findings emphasise the importance of designing geographically tailored and context-specific interventions to address violence against CYP in Namibia

5 Conclusion

This study is the first to examine the geospatial patterns and determinants of violence against CYP in Namibia, revealing significant regional disparities in the rates of SV, PV, and EV, which are influenced by area-specific factors. The findings underscore the need for tailored interventions that focus on improving school safety, addressing harmful cultural norms, and targeting other structural drivers of violence, as broader generalised approaches may prove ineffective. GWR analysis revealed spatial variations in the influence of risk factors, emphasising the importance of disaggregating investigations by form of violence to capture these nuances. By leveraging geospatial modelling, policymakers can gain valuable insights into the design of geographically targeted interventions, allocate resources effectively to high-risk areas, and ultimately reduce violence and improve the well-being of CYP in Namibia.

CRediT authorship contribution statement

Tobias Shinyemba: Writing – original draft, Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Shino Shiode:** Writing – review & editing, Validation, Supervision, Methodology. **Karen Devries:** Writing – review & editing, Validation, Supervision, Methodology.

Declaration of Generative AI in writing

The authors declare that they have not used Generative AI tools in the preparation of this manuscript. All intellectual and creative work, including the analysis and interpretation of data, is original and has been conducted by the authors without AI assistance.

Acknowledgements.

The authors thank Birkbeck, University of London, for funding Tobias Willem Shinyemba through the Mark James Studentship, and the Government of Republic of Namibia, the US CDC, and Together for Girls for granting access to the VACS data.

Appendix A. Supplemental tables

References

Akmatov, M. K.: Child abuse in 28 developing and transitional countries—results from the Multiple Indicator Cluster Surveys, International Journal of Epidemiology, 40, 219-227, https://doi.org/10.1093/ije/dyq168, 2011.

Arhuis-Inca, W., Ipanaqué-Zapata, M., Bazalar-Palacios, J., and Gaete, J.: Space Analysis of School Violence in the Educational Setting of Peru, 2019, International Journal of Environmental Research and Public Health, 19, 16044, https://doi.org/10.3390/ijerph192316044, 2022.

Belsky, J.: Child maltreatment: an ecolog ical integration, American Psychologist, 35, 320-335, https://doi.org/10.1037/0003-066X.35.4.320, 1980.

Bergquist, R., and Manda, S.: The world in your hands: GeoHealth then and now, Geospatial Health, 14, https://doi.org/10.4081/gh.2019.779, 2019.

Bhunia, G. S., and Shit, P. K.: Geospatial Analysis of Public Health, Springer, https://doi.org/10.1007/978-3-030-01680-7, 2019.

Brown, J.: Child fostering chains among Ovambo families in Namibia, Southern Africa, Journal of Southern African Studies, 37, 155-176, https://doi.org/10.1080/03057070.2011.555156, 2011.

De Klerk, V. C.: Understanding the perpetrators of violent crimes against children, in: Children's rights in Namibia, edited by: Ruppel, O. C., Konrad Adenauer Stiftung, Windhoek, Namibia, 2009.

Farrar, J., Thomson, D., and Betancourt, T. S.: Children and Violence across the Life Span: A Global and Socioecological Perspective, in: The Cambridge Handbook of Psychology and Human Rights, edited by: Rubin, N. S., and Flores, R. L., Cambridge Handbooks in Psychology, Cambridge University Press, Cambridge, 389-403, 2020.

Gentz, S., Zeng, C., and Ruiz-Casares, M.: The role of individual-, family-, and school-level resilience in the subjective well-being of children exposed to violence in Namibia, Child Abuse & Neglect, 119, 105087, https://doi.org/10.1016/j.chiabu.2021.105087, 2021.

Hillis, S., Mercy, J., Amobi, A., and Kress, H.: Global Prevalence of Past-year Violence Against Children: A Systematic Review and Minimum Estimates, Pediatrics, 137, e20154079, https://doi.org/10.1542/peds.2015-4079, 2016.

Hillis, S. D., Mercy, J. A., and Saul, J. R.: The enduring impact of violence against children, Psychol Health Med, 22, 393-405, https://doi.org/10.1080/13548506.2016.1153679, 2017.

Jewkes, R., Penn-Kekana, L., and Rose-Junius, H.: "If they rape me, I can't blame them": Reflections on gender in the social context of child rape in South Africa and Namibia, Social Science & Medicine, 61, 1809-1820, https://doi.org/10.1016/j.socscimed.2005.03.022, 2005.

Lev-Wiesel, R., Eisikovits, Z., First, M., Gottfried, R., and Mehlhausen, D.: Prevalence of Child Maltreatment in Israel: A National Epidemiological Study, Journal of Child & Adolescent Trauma, 11, 141-150, https://doi.org/10.1007/s40653-016-0118-8, 2018.

MGEPESW, NSA, and I-TECH: Violence Against Children and Youth in Namibia: Findings from the Violence Against Children and Youth Survey, 2019 Government Republic of Namibia, Windhoek, Namibia, 2020.

NSA: Namibia Multidimensional Poverty Index (MPI) Report 2021, Namibia Statistics Agency, Windhoek, Namibia, 2021.

Shinyemba, T. W., Shiode, S., and Devries, K.: Application of geospatial analysis in health research: A systematic review of methodological aspects of studies on violence against children and young people, Child Abuse & Neglect, 151, 106730, https://doi.org/10.1016/j.chiabu.2024.106730, 2024.

Stocco, C. S., Zubiolo, T. F. M., Beltrame, M. H. A., and Dell'Agnolo, C. M.: Sexual violence against children and adolescents in Paraná State: geospatial analysis and main socioeconomic indicators, Jornal de Pediatria, 100, 498-504, https://doi.org/10.1016/j.jped.2024.03.014, 2024.

Stoltenborgh, M., Bakermans-Kranenburg, M. J., Alink, L. R. A., and van Ijzendoorn, M. H.: The Prevalence of Child Maltreatment across the Globe: Review of a Series of Meta-Analyses, Child Abuse Review, 24, 37-50, https://doi.org/10.1002/car.2353, 2015.

WHO: INSPIRE: Seven strategies for ending violence against children, World Health Organization, Geneva 27, Switzerland, 2016.

Appendix A. Supplemental tables

Table 2. OLS regression estimates.

	SV			PV			EV		
	Coef.	**SE**	**VIF**	**Coef.**	**SE**	**VIF**	**Coef.**	**SE**	**VIF**
Intercept	-7.49**	2.46	-	-11.55**	4.04	-	-13.21**	4.65	-
Paid work (%)	-0.13***	0.04	1.15						
Romantic partner (%)	0.13*	0.05	1.33						
Domestic violence (%)	0.29***	0.07	1.25						
Abuse of siblings (%)	0.11*	0.05	1.43	0.36***	0.08	1.64	0.29**	0.10	1.52
HHs single (%)	0.10**	0.04	1.25						
Currently schooling (%)				0.07.	0.05	1.23	0.23***	0.05	1.05
Community violence (%)				0.24***	0.05	1.49	0.25***	0.07	1.53
HHs government aid (%)				0.19***	0.05	1.53			
Tolerate violence (%)							0.19.	0.10	1.06
Fear of violence (%)							0.29.	0.16	1.13
R^2	0.494			0.526			0.541		
Adjusted-R^2	0.459			0.500			0.510		
AIC	483.446			546.749			583.715		
AIC_c	485.838			552.163			585.292		

Note: AIC – Akaike information criterion; AIC_c – corrected Akaike information criterion; VIF – variance inflation factor; SE – standard error; and Coef. – coefficient; *** *p < 0.001*, ** *p < 0.01*, * *p < 0.05*, . *p < 0.1*

Table 3. GWR estimates

	SV			PV			EV		
	Min.	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**
Paid work (%)	-0.15	-0.11	-0.06						
Romantic partner (%)	0.09	0.15	0.21						
Domestic violence (%)	0.12	0.26	0.49						
Abuse of siblings (%)	0.10	0.13	0.24	0.28	0.35	0.44	0.09	0.30	0.46
HHs single (%)	0.07	0.09	0.15						
Currently schooling (%)				0.02	0.09	0.15	0.13	0.22	0.27
Community violence (%)				0.14	0.27	0.34	0.03	0.24	0.55
HHs government aid (%)				-0.08	0.15	0.27			
Tolerate violence (%)							0.08	0.25	0.56
Fear of violence (%)							-0.16	0.29	0.75
R^2	0.569			0.612			0.711		
Adjusted-R^2	0.477			0.519			0.621		
AIC	467.911			531.467			547.995		
AIC_c	485.023			547.916			573.703		

Note: AIC – Akaike information criterion; AIC_c – corrected Akaike information criterion; VIF – variance inflation factor; Min. – minimum; and Max. – maximum.

Table 4. Data dictionary.

Short name	**Full variable name**
Aggregated violence of measures	
SV	Sexual violence
PV	Physical violence
EV	Emotional violence
Aggregated household indicators	
HHs government aid	Household receiving government aid
HHs single	Single-parent household
Aggregated individual's indicators	
Currently schooling	Currently attending school
Paid/Self-employment	Engaged in any paid employment
Romantic partner	Having a romantic partner
Tolerate violence	Belief women should tolerate violence to keep family together
Fear of violence	Missed school or stayed home on some days due to feeling unsafe for any reason
Domestic violence	Witnessing domestic violence
Abuse of siblings	Witnessing parent abuse of siblings
Community violence	Witnessing community violence