Capture and Recapture Approach for Estimating the Number of Victims of Domestic Violence in Kunini, Lau Local Government Area of Taraba State

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Abstract

Domestic violence is a global threat to peaceful human co-existence. The purpose of this study is to estimate the number of victims of domestic violence using capture-recapture method in Kunini, Lau Local government area in Taraba State. Data cases of domestic violence was collected from 3 different facilities; General Hospital, Kunini (GH), Magistrate court, Kunini (MC), and Nigerian Police Force, Kunini (NPF). The data was matched by comparing the lists of domestic violence victims that were documented in these three data sources. The data was analyzed using a three (3) way log-linear model, R version 4.2.2, a statistical tool in public domain, was used to conduct the analysis. 1,279 victims were found to be registered in the data sources; 1136 victims of domestic abuse were discovered in the three (3) registers. AIC and the principle of parsimony were employed to select the best fit model which is model 3 that reveals the estimated population of victims of domestic violence is 5933, unreported cases at (5933-1136) =4797 and total coverage at 19.15%.

Keywords: Capture Recapture, Domestics Violence, Victims

Introduction

Domestic violence is a global threat to peaceful human co-existence, with significant public health impacts and a violation of human rights across various conditions (Oguntayo, et. al., 2020). It involves coercive behaviors by one competent adult or adolescent to control another, often within intimate relationships, including heterosexual and divorced partners (Oguntayo, et. al., 2020). Forms of domestic violence include physical, verbal, emotional, economic, reproductive, and sexual abuse, ranging from subtle coercion to physical abuse like beating and female genital mutilation (Umana & Willie, 2020). Vulnerable individuals often face danger within their families, suffering physically, sexually, psychologically, and economically (Umana & Willie, 2020). In Nigeria, domestic violence is often accepted as a form of discipline, with increasing cases, especially in rural areas (UNICEF, 2016). While men are typically seen as perpetrators, studies show both genders can be victims, though females are disproportionately affected (Osah & Opakunbi, 2021). The repercussions of domestic violence include social and academic setbacks, family separation, and health challenges from trauma, tearing apart community fabric (Oloyede & Osundina, 2021). The Sustainable Development Goals (SDGs) aim to eliminate all forms of violence, particularly against women and children, but progress is slow (UN SDG report, 2023). Estimating the incidence of domestic violence is challenging due to underreporting and survey methodology issues, as victims often hesitate to disclose their experiences.

Capture Recapture Approach For Estimating the number Of victims domestic violence in Nigeria, its diverse forms, and the socio-economic factors that contribute to it. Ayobami (2013): Investigated the

sociological implications of domestic violence on children's growth and development. The study found that children from violent homes are prone to psychological imbalances and criminal tendencies, suggesting that reducing juvenile delinquency could foster more stable psychological growth. Oluremi (2015): Examined domestic violence against women, identifying types, causes, effects, and management strategies. The study recommended comprehensive premarital counseling and the establishment of government-funded counseling centers to support victims and perpetrators. Nwanna and Kunnuji (2016): Researched domestic violence by women against their intimate partners using data from NDHS 2013. The study found that factors such as region, education, marital and employment status, experience of violence, and partner's alcohol consumption were significant predictors of domestic violence against men. Udoyen et al. (2017): Analyzed the effect of socio-economic factors on intimate partner violence in the Niger Delta. The study concluded that income and educational level significantly affect intimate partner violence, manifesting in various forms of abuse. Uzoma (2017): Investigated domestic violence and its predictors among married women in southeast Nigeria. The study found that over 50% of the women had experienced domestic violence, with unemployment, younger age, poor education, and a large number of children increasing the risk. Abonyi et al. (2019): Conducted research on domestic violence against women in rural communities of Ebonyi State. The study used both quantitative and qualitative methods, revealing that women faced physical, economic, and psychological abuse, with socio-economic factors playing a significant role.

Methodology

Study Area

Kunini is one the major towns and one of the ten political wards in Lau Local Government Area, in Taraba State. It falls under Taraba North Senatorial District alongside Jalingo, Ardo-kola, Zing, Yorro and Karim lamido Local Government areas. It also forms a Federal constituency alongside Ardo-kola and Karim lamido Local Government Areas.

Lau Local Government Area has an area of 1,660 km^2. It is bounded by Zing, Ardo-kola, Yorro Local Government Areas with a population of 95190 as at the 2006 national population census and 149, 600 as estimated by united nations in 2023.

Method of Data Collection

Data on victims of domestic violence was collected from 3 facilities, namely; General hospital, Kunini, Nigerian Police Force, Kunini and the Magistrate court, Kunini between the year 2018-2022. Registers was collected from the three facilities, each candidate has the following unique identifiers as listed below; first name, last name, age, gender, tribe and locations.

Matching

All three registers were presented on a spreadsheet and matched based on the predefined criteria to identify cases common (the overlaps). When four of the unique identifiers (first name, last name, age, gender, tribe and locations) are correctly matched, the individual is considered identified.

Method of Data Analysis

The matching was done using the three registers to identify cases common, the degree of overlap between the lists was removed after matching the lists; a three-source log-linear capture recapture was used to perform the analysis for the data to fit the log-linear models. The analysis will be performed using R software 4.2.2; the model incorporates the expected value of the random variable, the total population size, the probabilities of being on each list, and an interaction parameter that accounts for

list dependency. The output of the analysis produced an estimate of the population size, confidence interval and the Akaike Information Criterion (AIC), for selection of the most appropriate model.

A three-source Capture-Recapture study determines an estimate based on identifying individuals who appear in one, two or all three data sets within a specify year, (2018-2022). The Figure 3.1 described the three-source capture-recapture. It shows that individuals may be found common between any pair of sources as represented in the Figure 3.1 by GH^* NPF (General Hospital and Nigerian Police Force), GH^* MC (General Hospital and Magistrate court), NPF^* MC (Nigerian Police Force and Magistrate court) and GH^* NPF^*MC (General Hospital, Nigerian Police Force and Magistrate court). The remaining individuals are unique to each source: GH (General Hospital), NPF (Nigerian Police Force) and MC (Magistrate court).
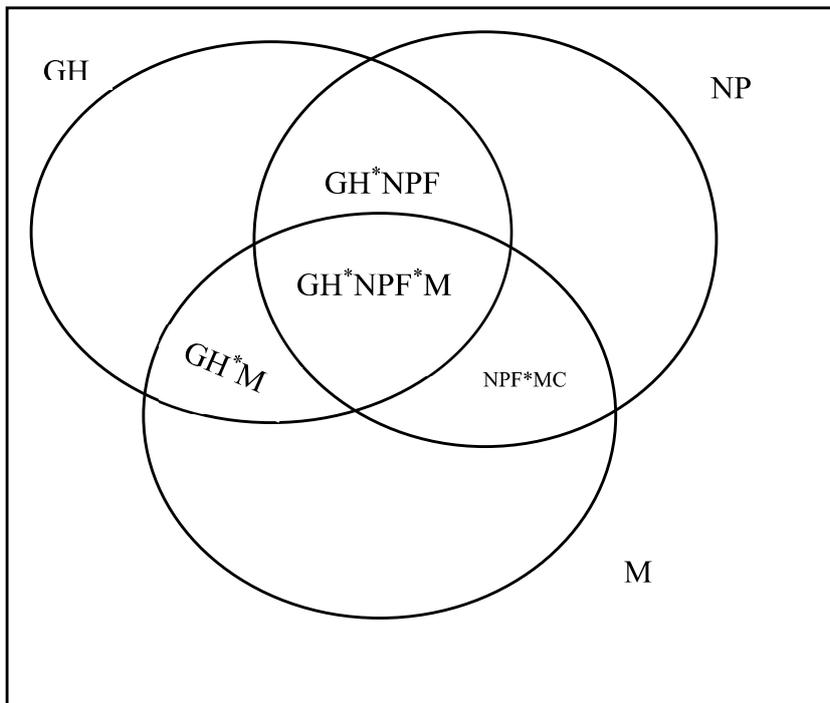

Figure 3.1: A venn diagram representing the data source.

2.4.1 *Log-Linear Model for Three Way Categorical variables*

Let (n) denote number of sample units for which we observe

π_{ijk} = P (i = General Hospital, j = Nigerian Police Force, k = Magistrate Court; $i = 1$, $j = 2, k = 3$) and Log n π_{ikj} = $\log\left(\mu_{ikj}\right)$

The general log-linear model for three categorical variables is given as,

$$\text{Log}\,(\mu_{ijk}) = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12} + \mu_{ik}^{13} + \mu_{jk}^{23} + \mu_{ijk}^{123} \tag{3.1}$$

Where;

$\text{Log}\,(\mu_{ikj}) =$ is the log of the expected cell frequency of the cases for cell *ijk*.

μ = is the overall mean of the natural log of the expected frequencies.

$\mu_i^1 =$ the main effect for GH

$\mu_j^2 =$ the main effect for NPF

$\mu_k^3 =$ the main effect for MC

$\mu_{ij}^{12} =$ the interaction effect for GH and NPF

$\mu_{ik}^{13} =$ the interaction effect for GH and MC

$\mu_{jk}^{23} =$ the interaction effect for NPF and MC

$\mu_{ijk}^{123} =$ the interaction effect for GH, NPF and MC

Assumptions for Using Log-linear Models

Observations are independent from each other.

All observations are identically distributed.

The number of observations is large.

The observations follows a poisson distribution

Table 3.1 describes Log-linear models for three-way categorical variables

Table 2.1: Log-linear Models for Three-Dimensional Table

Log-linear models symbol	Variables
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3$	(1,2,3)
$Log\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12}$	(12,3)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ik}^{13}$	(13,2)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{jk}^{23}$	(23, 1)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12} + \mu_{ik}^{13}$	(12, 13)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12} + \mu_{jk}^{23}$	(12, 23)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ik}^{13} + \mu_{jk}^{23}$	(13, 23)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12} + \mu_{jk}^{23} + \mu_{ik}^{13}$	(12, 23, 13)
$\text{Log}\,\mu_{ijk} = \mu + \mu_i^1 + \mu_j^2 + \mu_k^3 + \mu_{ij}^{12} + \mu_{jk}^{23} + \mu_{ik}^{13} + \mu_{ijk}^{123}$	(12, 13, 23,123)

2.5 Total Coverage for Registered and Unregistered Cases.

The total coverage for registered and unregistered cases can be estimated using equation 3.2

$$\text{Total coverage (TC)} = \frac{\text{number of observed cases}}{\text{number of estimated cases}} * 100 \qquad (3.2)$$

2.6 Model Selection Criteria

Log-linear models will be fitted to the observed cells. How well a model fits the data is assessed using the deviance statistics and a model is usually selected based on the Akaike Information Criterion AIC, a model with the smallest AIC value and deviance is considered.

$$AIC = -2Log(L) + 2P \qquad (3.3)$$

Where;

L = the likelihood under the fitted model

P = The number of estimated parameters included in the model (i.e. number of variables and the intercept).

Data Presentation

The data on domestic violence was obtained or gathered between 2018 and 2022 (i.e., five years) from three (3) data sources. Due to the sensitive nature of domestic violence, the data cannot be revealed. 1,279 cases of domestic violence were noted throughout the three sources. The Nigeria Police Force Kunini (NPF) had 141 cases, the Magistrate Court Kunini (MC) had 308 cases, and the General Hospital Kunini (GH) had 830 cases.

Results and Discussion

Matching process was carried out by comparing the lists of domestic abuse victims that were documented in these three data sources to one another in order to identify common victims that appeared in multiple data sources. Demographic details about the victim that is first name, last name, age, gender, tribe and locations were thoroughly verified to ensure that the information matched correctly. There were 1,279 victims in all that were found to be registered in the data sources as shown in table 4.1.

**Table 3.1: Number of Victims of Domestic Violence Registered in the three Data Sources**

GH	MC	NPF	TOTAL
830	308	141	1279

Figure 4.1 illustrates that 1136 victims of domestic violence were discovered in the three (3) registers; records based on GH only included 738 cases, NPF only included 78 cases, and MC only included 198 cases. 30 victims were captured in MC and NPF, 12 victims were captured in GH and NPF facilities alone, and 59 victims were captured in GH and MC facilities, indicating 122 victims were apprehended across multiple facilities, with 21 victims apprehended across all three (3) sources.

Based on the sources of identification, the distribution of cases is displayed in Appendix 1.

Figure 4.1: Data matching

Total number observed after matching (N) =1136
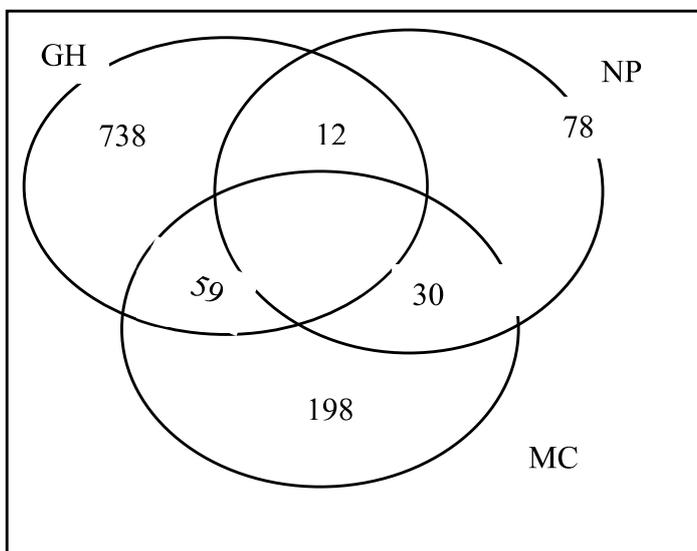
The matching shows the presence or absence of domestic violence cases in the data sources as shown in table 4.2.

Table 4.2: Matching

Match	GH	MC	NPF	Frequency
1.	1	1	1	21
2	1	1	0	59
3.	1	0	1	12
4.	0	1	1	30
5.	0	0	1	78
6.	0	1	0	198
7.	1	0	0	738

1=presence

0=absence

Model Fitting

The result of the analysis shows eight potential models in the three way log linear approach: Model 1 solely displays the main effect (independence), with no components indicating an interaction or relationship (see Appendix II). Appendices 3 to 9 contain models 2 through 7, which have distinct interactions.

Thus, Model 1, modeled the number of victims of domestic violence, this model is identified by GH+MC+NPF, that is, there is no interaction between the number of victims in GH, MC, NPF. Model 2 is identified by GH*MC and GH*NPF, this implies that, the number of cases is suspected between GH*MC and GH*NPF interactions. Model 3 represents the interactions between MC*GH and MC*NPF, while Model 4 shows the number of cases captured between NPF*GH and NPF*MC interactions. Model 5 is identified by GH*MC interaction. Model 6 pointed out the interaction between GH*NPF. Model 7 indicated the number of DV interaction between MC*NPF and Model 8 display the interactions between GH*MC*NPF. This Model 8 is the saturated model as it contains the main effects, two way interaction and three way interactions. All these 8 models were analyzed and the best fit was obtained. The parameter estimates of all eight models is presented in Table 4.3 and the summary of results is presented in Table 4.4

To fully understand Table 4.3;

(***) means significant at 0.1 percent

(**) means significant at 1 percent

(*) means significant at 5 percent

Table 3.3: Parameter Estimates of all the Eight (8) Models.

Model	Parameters	Estimate	StdError	Z-value	P-value
1	(Intercept)	7.42917	0.10723	69.28	<2e-16 ***
GH		-0.87467	0.10182	-8.59	<2e-16 ***
MC	-2.09890	0.09529	-22.03		<2e-16 ***
NPF		-2.94459	0.11065	-26.61	<2e-16 ***
2	(Intercept)	6.2438	0.2263	27.593	< 2e-16 ***
GH		0.3357	0.2293	1.464	0.143
MC		-0.9555	0.2148	-4.448	8.68e-06 ***
NPF		-1.8871	0.1959	-9.632	< 2e-16 ***
GH:MC		-1.2825	0.2449	-5.236	1.64e-07 ***
GH:NPF		-1.2973	0.2645	-4.905	9.33e-07 ***

3	(Intercept)	8.4757	0.3123	27.143	2e-16 ***
GH	-1.8718		0.3101	-6.036	1.58e-09 ***
MC		-3.2274	0.3202	-10.079	< 2e-16 ***
NPF		-4.1190	0.2910	-14.154	< 2e-16 ***
GH:MC		0.8245	0.3362	2.452	0.0142 *
MC:NPF		2.5018	0.3289	7.606	2.82e-14 ***
4	(Intercept)	7.81467	0.15282	51.136	< 2e-16 ***
GH	-1.21073		0.14832	-8.163	3.27e-16 ***
MC	-2.52641		0.13529	-18.674	< 2e-16 ***
NPF		-3.58149	0.19140	-18.712	< 2e-16 ***
GH:NPF		0.02511	0.24811	0.101	0.919
MC:NPF		1.95842	0.22141	8.845	< 2e-16 ***
5	(Intercept)	7.1163	0.1723	41.295	< 2e-16 ***
GH		-0.5576	0.1705	-3.270	0.00108 **
MC		-1.7484	0.1793	-9.753	< 2e-16 ***
NPF		-2.7596	0.1299	-21.242	< 2e-16 ***
GH:MC		-0.4897	0.2144	-2.284	0.02237 *
6	(Intercept)	7.3068	0.1239	58.977	< 2e-16 ***
GH		-0.7507	0.1197	-6.271	3.59e-10 ***
MC		-2.0185	0.1015	-19.891	< 2e-16 ***
NPF		-2.7494	0.1494	-18.397	< 2e-16 ***
GH:NPF		-0.4349	0.2321	-1.874	0.061
7	(Intercept)	7.8057	0.1245	62.71	<2e-16 ***
GH		-1.2018	0.1189	-10.11	<2e-16 ***
MC		-2.5195	0.1166	-21.60	<2e-16 ***
NPF		-3.5688	0.1443	-24.73	<2e-16 ***
MC:NPF		1.9515	0.2105	9.27	<2e-16 ***
8	(Intercept)	9.3298	0.4477	20.838	< 2e-16 ***
GH		-2.7259	0.4462	-6.109	1.00e-09 ***
NPF		-4.9731	0.4332	-11.481	< 2e-16 ***
MC		-4.0415	0.4421	-9.143	< 2e-16 ***
GH:NPF		0.8541	0.3209	2.662	0.007773 **
GH:MC		1.5151	0.4208	3.600	0.000318 ***
NPF:MC		3.0860	0.3863	7.988	1.37e-15 ***
GH:NPF:MC		NA	NA	NA	NA

Table 4.4: Summary of the Capture-Recapture Estimation Models Fitted to the 3 lists of Victims of Domestic Violence Registered in the 3 Data Sources

S/N	Model	K	Df	AIC	Population Estimate	95% C.I. Upper	Lower	Deviance
1.	GH + MC + NPF	3	3	140.28	1684.40	1367.71	2082.96	90.124
2.	GH +MC+NPF+GH*MC+GH*NPF	5	1	116.51	1650.80	1948.75	1469.73	62.359
3.	GH+MC+NPF+MC*GH+MC*NPF	5	1	60.96	5933.00	10440.56	3841.82	6.8092
4.	GH+MC+NPF+NPF*GH+NPF*MC	5	1	67.81	3612.68	4503.39	2983.81	13.655
5.	GH+MC+NPF+GH*MC	4	2	137.06	2367.91	2867.41	2015.80	84.906
6.	GH+MC+NPF+GH*NPF	4	2	138.64	2626.40	3040.93	2307.52	86.488
7.	GH+MC+NPF+MC*NPF	4	2	65.82	3590.65	4283.45	3067.19	13.665
8.	GH+MC+NPF+GH*MC+MC*NPF+GH*NPF+GH*MC*NPF	7	0	56.16	12404.88	28879.15	5890.98	-4.3965e-14

K, number of parameters; DF, degree of freedom; AIC, Akaike information criterion; CI, confidence interval.

Discussion of Result

From Table 4.3, Model 1 shows that all parameters are significant with p-values less than 0.05 Comparing the absolute value of the Z-score, we found that NPF has the highest value of 26.61 thus it is the most critical parameter followed by MC with the value of 22.03 then GH with the value of 8.59; from Model 2, all the p-values are significant except the main effects of GH and the absolute value of Z-value indicates that NPF is more critical with the value of 9.632. Model 3 all effects are significant except MC*GH interaction effect similarly the absolute value of the Z-value shows that NPF has 14.154 which is the highest. In the same way, Model 4, Model 5, Mode 7 and Model 8, NPF is most critical in recorded cases of domestic violence. In model 8, all the main effects, two-way interactions are significant but three-way interactions not significant.

AIC was employed and based on the result presented in Table 4.4, model 8 has the smallest AIC of 56.16 but it is a saturated model and based on the principle of parsimony and cannot be the best fit, model 3 is then considered with AIC of 60.96 and is selected as the best fit. The result in model 3 is shown in Table 4.5 with the total estimated population of the victims of domestic violence at 5933 which implies that about (5933-1136) = 4797 victims of domestic violence were yet to report their cases. (see Table 4.5).

Table 4.5: The Result of the Best Model Selected

Model	Population Estimate	Confidence Interval	Unregistered Cases (n)	AIC	Degree of freedom
GH+MC+NPF+MC*NPF	5933	(3841,10441)	4797	60.96	1

Total Coverage for Registered and Unregistered Cases of Domestic Violence in the Study Area.

$$\text{Total coverage (TC)} = \frac{\text{Number of observed cases}}{\text{Number of estimated cases}} \times 100$$

The result of the analysis in model 3 shows that the estimated population of victims of domestic violence between 2018-2022 in the study area is 5933, while the register of the three sources shows that the number of observed cases after matching is 1136. Hence,

$$\text{Total coverage} = \frac{1136}{5933} \times 100 = 19.15\%$$

Thus, the total coverage stood at 19.15%, this implies that only 19.15% of the victims of domestic violence are recorded in the study area, between the period under study, 80.85% were not recorded.

Table 4.6 shows how victims were captured in multiple, indicates that 48.36% were capture in GH*MH, GH*NPF with 9.84%, MC*NPF with 24.59% and GH*MC*NPF with 17.21%,.

Table 4.6: Recapture Statistics

Data source	Multiple cases	Percentage (%)
GH*MC	59	48.36
GH*NPF	12	9.84
MC*NPF	30	24.59
GH*MC*NPF	21	17.21

Table 4.7 indicates that GH facility recorded 64.89% of coverage completeness, in the same vain MC recorded 24.08%, and NPF got 11.04%; the result indicates the fact that of all the three (3) data sources only GH got or recorded up to 50% data coverage completeness.

Table 4.7: Complete Data Capturing Showing the Estimated Coverage.

Data source	Number of registered	Percentage of registered (%)
GH	830	64.89
MC	308	24.08
NPF	141	11.02

Conclusion

The capture-recapture method, originally developed for animal research, has been adapted to study human populations, providing reliable and accurate estimates of domestic violence burden. This study utilized a three-source capture-recapture technique to estimate the number of domestic violence victims in Kunini, Lau Local Government area of Taraba State. The analysis, conducted using the R package and a log-linear three-way categorical model, revealed that many individuals were not registered with any data sources, highlighting the method's potential to reduce overestimation. The results showed that 122 victims were registered in more than one data source, with GH recording the highest coverage (64.89%), followed by MC (24.08%) and NPF (11.02%). The capture-recapture analysis estimated about 5933 victims in the study area, with only 19.15% registered, indicating that 80.85% were not identified. Based on these findings, it is recommended to deploy this method across Taraba State and expand data collection and analysis on domestic violence. Further research should apply capture-recapture to other situations, such as persons with mental illness, street children, and co-infectious diseases in Taraba State.

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