

Indicators of climate change and violence against women predict estimated prevalence of modern slavery: An Ecofeminist Perspective

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Abstract

Climate change, violence against women (VAW), and modern slavery are significant human rights crises to which women are disproportionately vulnerable. Our research examined the complex relationship between indicators of climate change, VAW, and the estimated prevalence of modern slavery across 180 countries. Regression analysis revealed significant results suggesting that countries where climate change and VAW are prevalent may support conditions that exacerbate vulnerability to exploitation. Results are placed within a gender framework, highlighting ecofeminism theory for an examination of patriarchal and capitalistic systems and their relationship to the oppression of women, the degradation of the environment, and modern slavery.

Full Text

Climate change has profound political and economic implications for social justice and gender equality and is a key social determinant of health (Harmer et al., 2020). Deviations from long-term mean temperatures and increasing instances of natural disasters have been associated with declines in women's economic and social rights (Eastin, 2018). Climate change has also been connected to a myriad of adverse human outcomes such as increased disease prevalence, poverty, resource scarcity, and increased socioeconomic inequalities worldwide (Levy & Platz, 2015; Ogden et al., 2019; Prüss-Ustün et al., 2017; World Meteorological Organization [WMO], 2020). Rapidly changing global weather patterns contribute to increasing food insecurity, particularly in the Global South (WMO, 2020), as changes in precipitation and temperature and increases in CO₂ levels adversely impact global agriculture, with women at a 10% increased risk of hunger as compared to men (Food and Agriculture Organization of the United Nations [FAO], 2019). Environmental stressors also contribute to resource scarcity, such as loss of agricultural production, decreased profits, and poor livestock health, which can serve as push factors for forced migration and conflict due to competition for resources. Similarly, research indicates that poverty and economic migration are foundational drivers of human exploitation, especially for women (Aronowitz, 2009; Cho, 2015; Noyori-Corbett & Moxley, 2016; World Bank Group [WBG], 2017).

Increases in mean land temperature and natural disasters have also been associated with increased rates of societal conflict and violence towards women and girls across cultures (Banford & Froude, 2015; Brown et al., 2007; Cook, 2011; Hsiang et al., 2011; 2013; Scheffren et al., 2019). Some of the most prevalent forms of violence against women and girls (VAW) globally are femicide, sexual violence, and child marriage. Further, in 2020, nearly half of the world's international migrants were women and girls (United Nations Department of Economic and Social Affairs [UNDESA], 2020). Furthermore, the increasingly adverse effects of climate change threaten to exacerbate existing drivers of gender inequality, highlighting the need to address climate justice within a gender framework. We hypothesize that countries where VAW and climate change are prevalent will have a higher estimated prevalence of modern slavery victimization. We propose an ecofeminism theoretical framework where climate change and VAW are maintained within patriarchal structures and neoliberal systems of extractivist capitalism.

Climate Justice

There is growing evidence that the effects of natural disasters, primarily associated with climate change, are likely to have the greatest impact on the most vulnerable populations globally (Kumala Dewi & Dartanto, 2019). Additionally, populations with high levels of poverty may lack the resources necessary to combat the adverse effects of climate change, further perpetuating existing risk factors and exacerbating the adverse human consequences of climate events (Department of Economic and Social Affairs [DESA], 2016; Nobre et al., 2019). Vulnerable populations, such as women, face the most significant risks from climate change (Benevolenza & DeRigne, 2019). Research has indicated that these populations face increased economic insecurity and exposure to violence and exploitation in the wake of disasters (Banford & Froude, 2015; DESA, 2016; Kumza, 2019; Levy & Platz, 2015; Marshall et al., 2020; Raleigh et al., 2015; Scheffran et al., 2019; Thurston et al., 2021), with some scholars identifying climate change as a *threat/risk multiplier* (Brown et al., 2007). Most significantly, poverty and climate change are deeply interlinked in that those experiencing poverty are more likely to be impacted by climate change, and climate change further exacerbates poverty (DESA, 2016). Climate change *multiplies* these risks, thereby increasing their deleterious effects.

Studies have indicated that the geographical regions most vulnerable to the adverse effects of climate change, such as the Global South, are often more likely to struggle with weak governance, corruption, civil unrest, and economic and food insecurities (Hsaing et al., 2011; 2013; Raleigh et al., 2015; Scheffran et al., 2019; Wendling et al., 2020). Globally, the top 30 most fragile or failing states are located in Sub-Saharan Africa (Mazo, 2010), which, according to the ND-GAIN Country Index, is the region at the highest risk for

climate change (Chen et al., 2019). Additionally, a growing number of natural disasters and extreme weather events contributed to forced migration for more than 18 million individuals in 2019 (WMO, 2020).

Climate Justice and Women

Research has indicated that gaps in gender equality across developing countries are largely attributed to a lack of development, although socio-cultural factors driven by patriarchal ideals also contribute (Jayachandran, 2015). Research has indicated that women are more likely to be impoverished, are less capable of adapting to present and future climate change impacts, and are less likely to participate in and contribute knowledge to policymaking processes that facilitate gender-specific adaptation or climate change mitigation efforts (Denton, 2010; Van Aelst & Holvoet, 2016). Additionally, decreased access to clean water and sanitation, loss of support from extended family members, increased sexual and gender-based violence, and increased disease procurement disproportionately impact females in disaster situations (Bankston, 2013; Fisher, 2010; True, 2013). Therefore, disproportionate gender disparities regarding climate change vulnerability may reflect and reinforce preexisting gender inequalities perpetuated by hegemonic masculinity, patriarchal systems (Eastin, 2018), and neoliberal capitalist ideals. Further, women are more vulnerable than men in the same natural disaster setting, with studies highlighting the relationship between exposure to humanmade and natural disasters and increased rates of VAW (Benevolenza & DeRigne, 2019; Campbell et al., 2016). Furthermore, women are at higher risk for psychological trauma following disasters (Banford & Froude, 2015; Juran & Trivedi, 2015).

Gendered vulnerability plays a vital role when an individual is forced to make decisions regarding migration following a disaster. For example, displaced women and their children may need to rely on strangers for food and shelter (Rehmani, 2020), which can be a security risk for those already vulnerable. Research suggests that the adverse effects of climate change and related climate disasters, combined with a worldwide low status and agency of women and girls and the effects of pre-and post-disaster poverty, are associated with declines in women's overall safety and fundamental human rights (Eastin, 2018).

Violence Against Women and Girls

The United Nations Declaration on the Elimination of Violence against Women (CEDAW) defines violence against women (VAW) as "any act of gender-based violence that results in or is likely to result in, physical, sexual, or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life" (United Nations [UN], 1993, p. 2). The UN recognizes VAW as a pervasive global human rights violation (UN Development Fund for Women, 2006). In 2018, a third of females 15 years and older worldwide were victims of sexual or physical violence (UN Women, 2019), with sustained prevalence rates over the past decade (Fosu, 2021; WHO, 2013). VAW occurs fairly evenly across the globe, with a 5-10% increase in Africa, the Middle East, and South-East Asia in 2020 (Akhmedshina, 2020). Gender-based VAW is rooted in a power differential between men and women perpetuated by deeply embedded patriarchal systems, placing women at a disproportionately higher risk than men (Pandea et al., 2020; Velopulos et al., 2019). Further, women and girls are victimized at higher rates than men and boys. Although gender-based VAW occurs in many forms, our work highlights rape, femicide, child marriage, and modern slavery.

Femicide

Femicide describes the gender-based homicide of women (Dawson & Carrigan, 2021; Grzyb et al., 2018) and is widely viewed as the murder of women and girls for reasons of ownership, control, power, dominance, gender-based hate, sexual gratification, or simply for their lack of value (Grzyb et al., 2018). Like other forms of VAW, femicide is rooted in a complicated matrix of gender inequality, societal gender-role expectations, and systemic gender-based discrimination (Dawson & Carrigan, 2021). Further, high rates of femicide in a country may indicate higher rates of gender inequality, misogyny, and the presence of stereotyped gender roles that normalize VAW as a socially accepted practice (Walklate et al., 2019). High rates of femicide may also reflect a lack of women's participation in legislation, as research has indicated that higher death rates for women following disasters are directly linked to their lack of rights (Gadoth & Heymann, 2020)

Child Marriage

Child marriage refers to formal marriages and informal unions in which children live with a partner in a domestic partnership (Parsons et al., 2015). Although child marriage affects children of all genders, females are disproportionately victimized. Each year,

approximately 12 million girls worldwide are married before the age of 15 (Girls Not Brides, 2022). Child marriage prevalence rates are higher in the Global South, with approximately 1 in 3 global child marriages occurring in sub-Saharan Africa (UNICEF, 2021). Despite being an acceptable and common practice in some cultures, child marriage is widely considered by international human rights agreements to be a form of VAW and a human rights violation (Horii, 2020). Although poverty and gender inequality have been identified as push factors for child marriage, emerging research indicates that climate change is positively correlated with increased rates of child marriage across countries (Asadullah et al., 2021; Figueroa et al., 2020; McLeod et al., 2019). Although customs vary across cultures, child marriage is considered a form of modern slavery internationally (Horii, 2020).

Modern Slavery

Currently, there is no single widely accepted definition of modern slavery, and existing definitions are controversial (Cameron et al., 2021; Mende, 2019). However, some key elements emerge across definitions; control, a victim's lack of agency, and exploitation (Fitzpatrick-Cho, 2017; Mende, 2019). Further, modern slavery is often used as an umbrella term to describe all forms of commercial human exploitation or human trafficking. Modern slavery occurs in almost every geographical region (Landman, 2020) and is an urgent global human rights crisis, with an estimated 40.3 million victims worldwide (Craig et al., 2019; Walk Free Foundation [WFF], 2018). Additionally, modern slavery can be considered a pervasive and egregious form of VAW as the majority of overall victims (71%) are female; and 99% of sex trafficking victims are female (ILO, 2018; WFF, 2018). Robust literature documents the disproportionate effect of modern slavery victimization on women and girls (Cameron et al., 2021; Sidun & Flores, 2020).

While no evidence has provided conclusive causation, studies indicate that modern slavery is maintained within a framework of oppression, including multifaceted social, political, and anthropomorphic dynamics, resulting in disparities across intersectional domains (Cameron et al., 2020; Sidun & Flores, 2020). For example, women and girls are often less valued within patriarchal structures than their male counterparts and are more likely to be sold into slavery by families for financial gain (Kakar, 2020). Additionally, the feminization of poverty, which describes disproportionate economic disparities for females fuelled by a lack of access to education, social supports, and traditional cultural perspectives, further contributes to vulnerability to exploitation (Cameron et al., 2020; Russell, 2014; Shimazaki, 2021).

Further, research indicates that the relationship between modern slavery and climate change may have a bidirectional relationship where modern slavery exacerbates climate change and the adverse effects of climate change are a push factor for modern slavery (Bales & Sovacool, 2021; Decker & Hasche, 2019). In addition, research indicates that victims of human exploitation are often enslaved in environmentally destructive industries such as deforestation and mining (Wagner et al., 2020; Widana, 2021), which are primary contributors to climate change. Research supports our position that the complex matrix of push and pull factors for modern slavery intertwined with VAW and climate change are situated within patriarchal and extractivist capitalist structures driven by profit. Next, we situate our work within ecofeminist theories to synthesize a more comprehensive understanding of the relationship between the oppression of women, the degradation of the environment, and modern slavery.

An Ecofeminist Perspective

With a primary focus on the patriarchy, radical feminism first emerged in the 1970s, addressing the hierarchal relationships among men, which have manifested as institutionalized male control over women (Walby, 1989). Many theories grounded in feminism have connected the oppression of women to the degradation of the environment. One of the earliest was Francoise d'Eaubonne (1974), who coined the term *ecofeminisme*, representing women's role in saving the environment for the good of all humankind. More broadly, ecofeminism theory purports strong "historical, experiential, symbolic, and theoretical" associations between the "domination of women and domination of nature" (Warren, 1990, p. 125). A common framework across all ecofeminism theories suggests that oppression predicated on socioeconomic and demographic factors is grounded in the same ideology that degrades nature and non-human species (Gaard, 1997). Patriarchal structures and neoliberal capitalism ensure that cultural, economic, and political systems are controlled by men for the benefit of men. Within these systems, men can justify the subordination of women based on their devalued status within constructed patriarchal moral and ethical values. A similar process occurs with the degradation of the environment; feminism and environmentalism are connected in that fluctuations in the status of one can be reflected or transmuted in the other (Sultana, 2014).

Additionally, decolonial feminist scholars propose that women's experience in the majority world is inextricably linked to the systemic inequities of global power structures such as colonialism, capitalism, and patriarchal systems (Gaard, 2011; Grabe et al., 2016, which value nature, women, and non-human species as having a lower status than men. Further, research purports that modern slavery is fueled by capitalistic ideals that are driven by profit (Rioux et al., 2020). Furthermore, gender-based violence is a sexist phenomenon rooted in the inequality that exists between genders across cultural and geographical boundaries. The Istanbul Convention has noted that VAW is part of a more extensive patriarchal system in which women have historically been positioned subordinate to men (Council of Europe, 2011).

Intersectional Identities for Women

Women exist at the nexus of several intersecting identities influenced by many cultural, economic, political, and personal domains – identities that contribute to a lower status for women globally. Intersectionality, the term used to describe lived experience through the lens of multiple intersecting factors and identities, specifically those associated with oppression, was first introduced as part of the discourse surrounding critical race theory (Crenshaw, 1989; 2017). Critical race theory, drawing from legal studies and radical feminism, purports that race is ordinary and common and therefore unseen and that racism *serves the patriarchy and capitalism*, and therefore society sees no reason to address it (Delgado & Stefancic, 2001). Similarly, we propose that the oppression of women and the degradation of the environment are in service to the patriarchy and capitalism and are therefore unseen, widely accepted, and not commonly or adequately addressed by standing institutional structures. Additionally, patriarchal systems often prevent women from realizing economic and political opportunities, thereby limiting their autonomy and voices. Therefore, a common thread of ecofeminism theory, critical race theory, and intersectionality is the oppression of certain groups, such as women, and the environment in service to patriarchal ideologies and capitalism.

The Present Study

Past research has addressed many possible contributors to modern slavery vulnerability, including structural and gender inequalities, cultural considerations, economic factors, ineffective governance, and gendered violence (Barner et al., 2014; Cameron et al., 2020; Sidun & Flores, 2020). In addition, research has indicated that females are disproportionately vulnerable to violence, exploitation, natural and humanmade disasters, and the adverse consequences of climate change (Arora-Jonsson, 2011; Benevolenza & DeRigne, 2019; Bradshaw & Fordham, 2015; Enarson, 2012; Noyori-Corbett & Moxley, 2016; Tomkins et al., 2018). Despite a growing body of literature addressing climate change and modern slavery, no studies have investigated the intersection of measurable indicators of climate change and violence against women as predictors of the estimated prevalence of modern slavery across countries. We suggest that the oppression of women in the form of violence and exploitation, and the degradation of the Earth as represented by specific climate change indicators, have been perpetuated by – and are in service to – patriarchal systems of inequality and oppression. Research has also indicated that VAW increases after disasters of any kind, and natural disasters are increasing globally due to factors associated with climate change. Our study aims to identify which specific indicators of climate change and VAW are associated with a higher estimated prevalence of modern slavery. We hypothesized that our full model of specific indicators of climate change and VAW would predict increased modern slavery victimization across countries.

Method

Our study examined the complex relationship between selected indicators of climate change, VAW, and the estimated prevalence of modern slavery. Country-level data from public archival data sets were utilized from multiple sources. Indicators of VAW were obtained from the UN Office of Drugs and Crime (UNODC; 2018), the Organization for Economic Cooperation and Development (OECD; 2022), and the WBG (2017). Climate change indicators were obtained from the Environmental Performance Index (EPI; Wendling et al., 2020). Data regarding the estimated prevalence of modern slavery was obtained from the 2018 Global Slavery Index (GSI; WFF, 2018).

Violence Against Women

Indicators of VAW were femicide, which is represented as the percentage of female homicide victims (age 15+) in a country (UNODC, 2018), rape rate for women (age 15+) (UNODC, 2018), percentage of women who have experienced physical and/or sexual intimate partner violence in their life (OECD, 2022), and percentage of women ages 20-24 married by age 18 (WBG, 2017). It is

important to note that while the UNODC defines rape as penetration without consent, the definition of rape may vary across reporting countries.

Estimated Prevalence of Modern Slavery

The GSI 2018 reflects the estimated prevalence of modern slavery across 198 countries (WFF, 2018). A detailed technical appendix for the GSI can be found at <https://www.globallslaveryindex.org/about/the-index/>

Climate Change

The EPI ranks 180 countries on environmental health and ecosystem vitality across 32 performance indicators and 11 issue categories, including the climate change issue category (Wendling et al., 2020). Indicators reflect achievement regarding established environmental policy targets at the country level. A technical appendix for the EPI 2020 can be found at: <https://epi.yale.edu/downloads/epi2020technicalappendix20200803.pdf>

Procedure

Data sets were combined, and regression analysis with backward removal was used to analyze the predictive ability of specific indicators of climate change and VAW in relation to the estimated prevalence of modern slavery victims across countries. The backward removal process removed each regression equation if the individual beta value was $p > .10$. Two analyses were conducted.

Analysis 1

For Analysis 1, the EPI 2020 climate change issue category was used as a single independent variable to represent climate change. This variable is comprised of CO₂ growth rate (13.2%), CH₄ growth rate (3.5%), F gas growth rate (2.4%), N₂O growth rate (12%), black carbon growth rate (1.2%), CO₂ from land cover (0.6%), greenhouse gas intensity growth rate (1.2%), and greenhouse gas emissions per capita (0.6%). Analysis 1 also utilized four indicators of VAW as additional predictors: percentage of female homicide victims (age 15+) (UNODC, 2018), rape rate for women (age 15+) (UNODC, 2018), percentage of women who have experienced physical and/or sexual intimate partner violence in their lifetime (OECD, 2022), and percentage of women ages 20-24 married by age 18 (WBG, 2017). The dependent variable was the estimated prevalence of modern slavery from the 2018 Global Slavery Index (WFF, 2018).

Analysis 2

For Analysis 2, the eight individual components of the climate change issue category were entered as separate predictor variables and included CO₂ growth rate, CH₄ growth rate, F gas growth rate, N₂O growth rate, black carbon growth rate, CO₂ from land cover, greenhouse gas intensity growth rate, and greenhouse gas emissions per capita. Analysis 2 included the same five indicators of VAW and the same dependent variable as Analysis 1.

Results

Correlation analysis was used to determine relationships between independent and dependent variables for both analyses (see Tables 1 and 2). Descriptive statistics, correlations, and statistical analyses were conducted in SPSS v.26 (IBM Corp, 2019). The assumptions of normality, homoscedasticity, linearity, and absence of multicollinearity were met. Regression analysis with backward removal was used to test the hypothesis and find the best model of indicators of VAW and climate change that predict the estimated prevalence of modern slavery across countries. Results supported the hypothesis.

Table 1

Bivariate Correlations and Descriptive Statistics (N = 43)

	1	2	3	4	5	6
1. Modern Slavery	-					
2. EPI	-.47**	-				
3. Femicide	.36**	-.09	-			
4. Rape Rate	-.21	-.08	-.46**	-		
5. Lifetime Sexual VAW	.22	-.30*	.02	.21	-	
6. % Women married by age 18	-.06	-.09	-.33*	.15	.32*	-
<i>M</i>	5.56	47.4	19.9	9.07	28.0	18.7
<i>SD</i>	6.12	13.1	9.70	10.1	15.1	10.6
<i>Note.</i> 1-tailed sig. * $p < .05$; ** $p < .01$ Note: EPI: Environmental Performance Index, VAW: Violence Against Women						

Table 2

Bivariate Correlations and Descriptive Statistics (N = 31)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Modern Slavery	-												
2. Femicide	.37*	-											
3. Rape Rate	-.49**	-.44**	-										
4. Lifetime Sexual VAW	.07	-.15	.40*	-									
5. % Women married at 18	-.26	-.28	.13	.27	-								
6. CO ₂	-.38*	.04	-.03	-.22	-.11	-							
7. CH ₄	-.25	-.01	-.16	.14	.37*	.42**	-						
8. F Gas	-.12	-.15	-.04	.07	.17	.24	.04	-					
9. NO ₂	-.44*	-.38*	.16	.14	.27	.25	.48**	.03	-				
10. Black Carbon	-.09	-.07	-.07	-.15	-.18	.46*	.39*	.37*	.26	-			
11. CO ₂ Landcover	-.12	-.20	.07	-.31*	-.33*	-.15	-.45*	-.14	-.17	.01	-		
12. Greenhouse Gas	.10	.00	-.15	.18	.36*	.01	.22	.18	.32*	.06	-.48**	-	
13. Greenhouse Gas/capita	.05	-.10	-.20	.09	.40*	-.31*	-.29	.37*	.03	.19	-.19	.42	-
<i>M</i>	5.06	21.3	8.68	26.6	16.9	40.1	65.3	89.9	51.7	48.6	62.7	48.1	53.2
<i>SD</i>	2.99	9.40	10.6	13.5	9.98	13.6	26.2	6.61	26.6	29.5	25.4	15.7	24.9
<i>Note.</i> 1-tailed sig. * $p < .05$; ** $p < .01$ Note: VAW: Violence Against Women													

Analysis 1

Regression analysis returned four models. All models were significant at $p < .001$. The full model $F(5, 37) = 3.93, p = .006$, adj. $R^2 = .26$ predicted 26% of the variance in the estimated prevalence of modern slavery across countries (see Table 3). The final model achieved the largest effect size, $F(2, 40) = 9.41, p < .001$, adj. $R^2 = .29$, contained the predictors femicide and the EPI 2020 climate change issue category, and predicted 29% of the estimated prevalence of modern slavery across countries (see Table 4). Results supported our hypothesis that specific indicators of VAW and climate change would significantly predict the estimated prevalence of modern slavery.

Table 3

Results Analysis 1: Full Model

	<i>t</i>	β	<i>p</i>	<i>df</i>	<i>F</i>	<i>Adj.R²</i>
			.006	5, 37	3.93	.259
EPI	-3.02	-.42**	.005			
Femicide	1.43	.23	.162			
Rape Rate	-1.03	-.16	.310			
Lifetime Sexual VAW	0.90	.14	.376			
% Women married at 18	-0.28	-.04	.780			

Note. * $p < .05$, ** $p < .01$ EPI: Environmental Performance Index, VAW: Violence Against Women

Table 4

Results Analysis 1: Final Model

	<i>t</i>	β	<i>p</i>	<i>df</i>	<i>F</i>	<i>Adj.R²</i>
Overall Model			< .001	2, 40	9.41	.286
EPI	-3.36	-.44**	.002			
Femicide	2.44	.32*	.019			

Note. * $p < .05$, ** $p < .01$

Analysis 2

Results returned ten models. All models were significant. The full model $F(12, 18) = 3.18, p = .013$, adj. $R^2 = .47$ predicted 47% of the variance in the estimated prevalence of modern slavery across countries (see Table 5). The model with the largest effect size (Model 5), $F(8, 22) = 5.46, p < .001$, adj. $R^2 = .54$, predicted 54% of the estimated prevalence of modern slavery across countries and contained the predictors rape rate, lifetime VAW, CO₂ growth rate, CH₄ growth rate, F gas growth rate, N₂O growth rate, black carbon growth rate, and CO₂ from land cover (see Table 6). Results of Analysis 2 were also consistent with the hypothesis.

Table 5

Results Analysis 2: Full Model

Variables in the Model 5	<i>t</i>	β	<i>p</i>	<i>df</i>	<i>F</i>	<i>Adj.R²</i>
Overall Model			.013	12,18	3.18	.466
Femicide	-.18	-.03	.862			
Rape Rate	-3.22	-.60	.005			
Lifetime Sexual Violence	1.72	.31	.103			
% Women married by 18	-.42	-.08	.677			
CO ₂	-1.46	-.35	.162			
CH ₄	-.98	-.29	.340			
F Gas	-.89	-.18	.384			
NO ₂	-1.62	-.31	.123			
Black Carbon	1.73	.35	.102			
CO ₂ Land cover	-1.32	-.25	.204			
Greenhouse Gas	.56	.11	.580			
Greenhouse Gas per capita	-.76	-.18	.457			
<i>Note. *p</i> < .05, <i>**p</i> < .01, Note: VAW: Violence Against Women						

Table 6

Results Analysis 2: Model 5: Largest Effect Size

Model 5	<i>t</i>	β	<i>p</i>	<i>df</i>	<i>F</i>	<i>Adj.R²</i>
Overall Model			.001	8, 22	5.46	.543
Rape Rate	-4.25	-.63**	<.001			
Lifetime Sexual VAW	2.26	-.36*	.034			
CO ₂	-1.33	-.21	.198			
CH ₄	-2.41	-.45*	.025			
F Gas	-1.96	-.28	.063			
NO ₂	-1.72	-.25	.100			
Black Carbon	2.29	.37*	.032			
CO ₂ Land cover	-1.86	-.28	.077			
<i>Note. *p</i> < .05, <i>**p</i> < .01, Note: VAW: Violence Against Women						

Discussion

We hypothesized that specific indicators of climate change and VAW would predict the estimated prevalence of modern slavery across countries. The proposed models were highly significant across both analyses, indicating that specific VAW and climate change indicators are associated with an increased estimated prevalence of modern slavery. For the first analysis, results indicate that the EPI largely influenced the overall significant results for the full model. Therefore, a second analysis was conducted to determine which of the eight individual EPI climate change indicators were mainly driving the significant results.

Results support our position that the degradation of the Earth deeply intersects with VAW and the oppression of women through modern slavery victimization. Results further highlight possible ideological connections between the exploitation of the Earth and the oppression of women within the patriarchal system of extractivist capitalism. Further critical analysis is needed to understand better the cultural nuances of patriarchal systems and how they influence gender-based violence, gendered hierarchies, the enslavement of women and girls, and the degradation of the environment.

Violence Against Women and Girls

For Analysis 1, while the overall model was significant, none of the individual VAW predictors were significant in the full model. However, femicide was the single VAW predictor in the final model and had a significant, moderate, and positive relationship ($\beta = .32, p = .019$) with the estimated prevalence of modern slavery across countries. As noted earlier, climate change can act as a threat/risk multiplier, exacerbating existing risk factors for women and other vulnerable populations (Huntjens et al., 2018). Therefore, with the introduction of climate change, femicide rates may increase in countries where women are already at a disproportionate risk for victimization. We propose a similar relationship between climate change and other forms of VAW.

Correlation analysis indicated a moderate inverse relationship ($r = -.26$) between child marriage rates and the estimated prevalence of modern slavery, indicating that child marriage may be a protective factor for girls when considering modern slavery victimization. Additionally, research indicates that an increased risk of child marriage is correlated with natural disasters and climate change consequences as families compete for resources, thereby increasing the overall risk of VAW and vulnerability for exploitation (Asadullah et al., 2021; Figueroa et al., 2020; McLeod et al., 2019). Also, in some societies, child marriage is considered a form of protection against rape and violence (Raj & Boehmer, 2013); however, studies indicate that female child brides are more likely to experience domestic violence, abuse, and rape than their non-married peers (Ahmed et al. 2013; Raj et al. 2009).

For Analysis 2, while the full model was significant, rape rate was the only significant VAW predictor in the full model and had a strong negative relationship ($\beta = -.63, p < .001$) with the outcome variable. These results indicate that as reported rape rates decrease, the estimated prevalence of modern slavery increases. We propose that these seemingly contradictory results are likely due to crimes against women, such as rape, not being frequently reported or recognized as a crime in countries where women experience high rates of oppression and gender inequality- which studies have indicated are push factors for modern slavery victimization.

Climate Gender Framework

The adverse effects of climate change are experienced differently across geographical regions and demographic factors such as gender, particularly when comparing the global North and South (Arora-Jonsson, 2011). This phenomenon is likely due to a disproportionate number of fragile economic and political states in the global South, which has also experienced a high rate of deleterious climate effects such as desertification and low crop yields (Chen et al., 2022). These effects have had significant differential economic, social, and health impacts. For example, research indicates that women in sub-Saharan Africa have experienced rising rates of intimate partner violence and poor pregnancy outcomes, such as miscarriages, stillbirths, and low birth rates in the wake of increased drought and changing weather patterns (Davenport et al., 2020; Epstein et al., 2020). Further, studies indicate that women in sub-Saharan Africa are among the poorest in the world due to their lack of economic participation, which is primarily driven by gender exclusion (Efobi et al., 2018; McFerson, 2010).

Changing weather patterns are associated with poor agricultural yields, decreased forest habitat – particularly in African and Amazonian tropical forests – and a lack of clean water sources (Mahmoud et al., 2020; Mpandeli et al., 2018), often leading to gender-based consequences. For example, women and girls often have to travel long distances to collect water for their families. Such domestic chores can increase the risk of violence and exploitation (Geere et al., 2018). Additionally, climate change contributes to global food insecurity (Raleigh et al., 2015), and women and girls are often tasked with sourcing and preparing food. When they return empty-handed, they are at increased risk for domestic violence and abandonment.

In Analysis 2, black carbon had a significant, moderate, and positive relationship ($\beta = .37, p = .032$) with the estimated prevalence of modern slavery. Black carbon, also known as soot, has anthropogenic roots and has been identified as a primary contributor to glacial melt (Mani, 2021), with high prevalence rates in the Global South, particularly Southeast Asia. Glacial melt threatens water resource security and has been linked to increasing rates of natural disasters such as flooding (Kushawaha et al., 2021; Mani,

2021), with indigenous populations and subsistence farmers most at risk. The human causes of black carbon deposits have been linked, among others, to cooking with unclean fuel sources (Mani, 2021), with cooking a domestic chore that is primarily conducted by women and girls (Cameron et al., 2021). Glacial melt also contributes to rising sea levels and human displacement, predominantly affecting indigenous peoples (Griggs & Reguero, 2021).

Climate change also contributes to increased illness and disease worldwide (Ogden et al., 2019). Women are often the sole primary caregivers for the sick, which further increases their domestic burden, and is a barrier to seeking educational and economic opportunities, which contributes to exploitation vulnerability (Zhongming et al., 2021). Additionally, a major consequence of sexual VAW is unwanted and unplanned pregnancies (Adedze & Osei-Yeboah, 2019), further exacerbating the domestic burdens inherently placed on women in many cultures. Additionally, rising population rates strain existing resources. Resource scarcity can lead to increased domestic and societal conflict, resulting in increased VAW and exploitation. Furthermore, the feminization of poverty, combined with the dangers of displacement and migration that often follow natural disasters and climate change, further increases the risk of exploitation for women and girls (Bradshaw & Fordham, 2015; Melo, 2019; Olubukola, 2020). Additionally, when conceptualizing climate change as a risk multiplier, existing vulnerabilities to violence and exploitation are exacerbated by climate change and subsequent natural disasters.

The goal of situating climate change within a gender framework is not to discount the effects for men but rather to highlight the disproportionate consequences differentiated by gender. Additionally, due to gendered hierarchies, intervention and mitigation strategies that facilitate women's empowerment may not be the same as those indicated for men. Further, research indicates that gender parity for women in development areas supports rather than detracts from men's well-being (Gadoth & Heymann, 2020). Future research integrating climate change and gender is necessary to highlight the factors that build resiliency in women and girls across the globe.

Limitations

There are several limitations to this study. First, the cross-sectional study design does not allow for establishing causal conclusions from country-level data. Additionally, the lack of consistency regarding definitions, measurement, and collection procedures regarding the primary indicators for this study across reporting bodies. For example, the definitions of VAW, particularly rape and modern slavery, can vary widely and are subject to political and cultural influences. While UN agencies have provided structure for data management to address such limitations, a lack of consistency across indicators is still probable. Further, the illicit nature of human trafficking contributes to difficulty measuring victimization, therefore resulting in a lack of consistent, comprehensive data sources, which may result in empirical inconsistencies. Additionally, the complex and possibly bidirectional relationship between environmental destruction and modern slavery further compounds the precise estimation of variables, especially in regions where definitions of constructs are not consistent or monitored (Bales & Sovacool, 2021).

Conclusion

Results suggest that specific indicators of climate change and VAW are part of a complex web of human and environmental factors with anthropogenic consequences that may increase women's vulnerability to modern slavery. Further, the adverse human consequences of climate change and the sustained and increasing rates of VAW and exploitation in the form of modern slavery disproportionately affect women and girls worldwide. Furthermore, these atrocities are perpetuated within patriarchal and capitalistic systems. Results have important implications for policymaking, governing bodies, humanitarian aid efforts, and other forums addressing gender and structural inequalities at national and global levels. Additionally, results can inform intervention programs that foster empowerment and resilience in vulnerable populations, particularly women and girls. Future research from within a gender framework is needed to understand better the factors that lie at the nexus of VAW, climate change, modern slavery, and gendered hierarchies. Increased climate legislation and innovative government policies are needed to reduce a broad spectrum of vulnerabilities for women and girls. Further, women's voices must be central to the decision-making process across all domains of society. Empowering women and girls is key to future solutions to the climate crisis and aligns with UN Sustainable Development Goal 5.

Declarations

Competing interests: The authors declare no competing interests or financial conflicts.

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