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An evolutionary life history explanation of sexism and gender inequality

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ABSTRACT

Predisposed to differences in parental investment, men and women are expected to enact different reproduction-oriented, accelerated life-history strategies when facing high extrinsic risks or resource insecurity. Sexual selection processes would strengthen the sex differences in support of such accelerated life-history strategy, causing women to divert more time and energy to reproductive activities and depend more on men's economic provisioning and therefore enforcing sexist attitudes and gender inequality. This paper provides empirical support for this life-history explanation of sexism based on data from the World Values Survey and four United Nations sources. The results generally support our explanation in the following manners: (1) Societal-level extrinsic risks (worries over intergroup violence) were associated with higher sexism. (2) Men were more sexist, and the association between individual-level resource insecurity and sexism was more moderate in countries and regions with greater society-level extrinsic risks. (3) Societal-level extrinsic risks (adult mortality) and resource availability were associated with higher and lower gender inequality, respectively, through the mediating effects of accelerated life-history strategies, indicated by adolescent birth rates and total fertility.

1. Introduction

Gender inequality generally refers to “the greater status and power of men than women that often emerges in the control of women's sexuality and other aspects of their behavior” (Wood & Eagly, 2002, p. 699). The past century saw a substantial decrease in gender inequality in many aspects (e.g., in political representation: Jacob, Scherpereel & Adams, 2014; in economic power: Goldin, 2006; in mate preferences: Buss, Shackelford, Kirkpatrick & Larsen, 2001; Chang, Wang, Shackelford & Buss, 2011), but the psychological basis for gender inequality in the form of sexism still persists to various degrees throughout the world (Wood & Eagly, 2012). Attitudes and stereotypes justifying traditional gender roles and gender inequality, which are referred to as sexism (Glick & Fiske, 1997, 2001; Glick et al., 2000), are still prevalent across societies, as shown by explicit measures (Diekman & Eagly, 2000) or implicit assessments (e.g., Rudman, Greenwald & Mcghee, 2001). Some consider sexism to be responsible for women'(s underrepresentation in academic, management, and political leadership positionsHausmann, Tyson & Zahidi, 2013; Jacob et al., 2014; United Nations Development Programme, 2011; for a review see Carli & Eagly, 2001).

Previous theories regarding sexism and power asymmetry between genders tend to focus on proximate factors ranging from agricultural technologies (e.g., Alesina, Giuliano & Nunn, 2011) to patriarchal social institutions (Hrdy, 1997). The current research, instead, examines an evolutionary life-history account of sexism and gender inequality (Zhu & Chang, 2019) based on the psychosocial acceleration theory (Belsky, 2012, 1991) and sexual selection theory (Andersson, 1994; Geary, 2002). We argue that a key trade-off in human life history (Del Giudice, Gangestad & Kaplan, 2015; Geary, 2002) is between reproductive efforts (mating, reproduction, and parenting) and somatic efforts (growth, health maintenance, and knowledge and skill development). An “accelerated” life-history strategy characterized by enhanced reproductive efforts is prioritized in situations of resource insecurity (i.e., uncertainty of the availability of material resources to sustain one's family) or in environments high in extrinsic risks (i.e., external morbidity–mortality threats that cannot be avoided through individual effort, such as wars and accidents; Chang & Lu, 2017; Ellis, Figueredo, Brumbach & Schlomer, 2009). Such an accelerated life-history strategy is enacted by both sexes, albeit in different ways. Females tend to devote most of their energy to raising children and become more reliant on males’ economic support, whereas males seeking mating success must engage in fierce intrasexual competition. These dynamics are exaggerated by sexual selection processes and are eventually conducive to sexist attitudes and male-favoring gender inequality (Zhu & Chang, 2019). In essence, an accelerated life-history strategy

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that emphasizes reproductive efforts (as opposed to a slow life-history strategy prioritizing somatic efforts) mediates the relation between stressful ecologies and gender inequality. The current research examined this account using data from the World Values Survey (WVS, Wave 6; Inglehart et al., 2014) and United Nations (UN) archives.

1.1. Biosocial and life-history explanations of sexism and gender inequality

Scholars have provided insights into sexism from various social constructionist perspectives (Glick & Fiske, 2001; Hrdy, 1997). One popular theory, the biosocial model (Wood & Eagly, 2002, 2012) emphasizes the interaction between "constraints and the opportunities imposed by each sex's physical attributes and reproductive activities" (Wood & Eagly, 2002, p. 709) and social, technological, and economic factors. This interaction causes men to be generally more efficient than women in skilled, wealth-accumulating tasks that take them away from home. In contrast, women are more efficient when participating in tasks near home (e.g., caring for children and domestic labors). This results in people associating different internal characteristics (males as agentic, females as communal) and power status (males as high power, females as low power) with the two genders based on such an efficiency-based, gendered division of labor. Therefore, the biosocial perspective regards sexist stereotypes as a function of perceived gender distribution in existing social roles, and men achieve greater power than women do via monopolizing social roles responsible for "warfare, agriculture, and production activities" (Wood & Eagly, 2002, p. 716).

Alternatively, evolutionary psychological models ((Buss & Schmitt, 2011); Schmitt, 2015; Schmitt et al., 2017), especially those that take a life-history perspective (Del Giudice et al., 2015) focus on the fundamental evolutionary challenges faced by both sexes. For sexually reproducing animals (including humans), energy and resources devoted to reproductive efforts (e.g., mating and reproductive activities) that produce and sustain a greater number of offspring are inevitably diverted away from somatic efforts (e.g., growth, skill development). In humans, physiological and psychosocial traits tend to converge into "human life-history strategies" that vary on a fast-slow continuum in ways consistent with this trade-off (Del Giudice et al., 2015; Geary, 2002). Overall, fast or accelerated life-history strategies are linked to prioritization of reproductive efforts earlier in one's life, whereas slow life-history strategies are linked to prioritization of somatic efforts and restricted sexuality (Del Diudice, 2009). According to the psychosocial acceleration perspective, this fast-slow trade-off is sensitive to one's developmental environment (Belsky, 2012; Belsky et al., 1991), which is linked to the harshness and unpredictability of external ecologies in terms of extrinsic risks and resources (Ellis et al., 2009; Zhu, Hawk & Chang, 2018).

Resource insecurity, which is related to higher exposure to morbidity–mortality risks for offspring in almost all human forager societies (Marlowe, 2000), has been demonstrated to be associated with parental harshness and insecure attachment, which, in turn, are linked to traits of accelerated life-history strategies. These traits include earlier sexual debut and higher sexual activities during adolescence, which are predicted by earlier pubertal development (Belsky, Houts & Fearon, 2010; (Belsky et al., 2010b)). In a longitudinal study, Belsky, Schlomer and Ellis (2012) found that lower income-to-needs ratio experienced during the early years was indirectly associated with higher adolescent sexuality through lower maternal parenting quality in childhood. By contrast, Ellis and Essex (2007) observed that fewer marital conflicts, higher quality parental care, and higher socioeconomic status predicted later sexual development in girls. Overall, accelerated life-history strategies are in accordance with increased reproductive efforts at an earlier age, which are adaptive to stressful environments that reduce the chance of offspring surviving to maturity, but less so in stable and competitive environments (Del Giudice et al., 2015).

An accelerated life-history strategy promotes bifurcated behavioral and psychological adaptations in the two sexes, which might underlie sexist attitudes and stereotypes. To begin, the imbalanced parental investment between the two sexes (Trivers, 1972) predisposes them toward different kinds of reproductive efforts. Men's reproductive success depends mostly on their access to more mates (Buss & Schmitt, 1993), which should cause them to prioritize mating. As a result, an accelerated life-history strategy should subject men to more intense intrasexual competition for mate control, activating a greater propensity toward physical aggression (Puts, 2010, 2016). Indeed, evidence has shown that even in modern contexts, features of physical dominance predict mating and reproductive success more accurately than likeability does for men (Hill, Hunt, Welling, Cárdenas & Puts, 2013; Kordsmeyer, Hunt, Puts, Ostner & Penke, 2018) but not for women (Sadalla, Kenrick & Vershure, 1987). These features are also advantageous in mate guarding or protection of female partners against other males in intergroup conflicts (McDonald, Navarrete & Van Vugt, 2012).

Unlike males, females have much less to gain from short-term mating efforts, which should predispose them to devote more energy to other reproductive efforts, such as parenting. Mothers are predisposed to offer greater direct care to their offspring than fathers, who might additionally discount their parental investment due to paternity uncertainty (Geary, 2000). Indeed, in most societies, men typically devote less time and energy to household labor and childcare than women do (Marlowe, 2000; Whiting & Edwards, 1988), and some evidence suggests that males reduce their paternal investment when facing higher risks of cuckoldry (Geary, 2000). Such different emphases of the two sexes on reproductive efforts, with men focusing more on competitive mating and women focusing more on communal nurturing, might prevent women, but not men, from spending time and effort on resource acquisition and personal development activities necessary for accumulating wealth. Meanwhile, men who managed to achieve mating and reproductive success by resource monopolization tend to pass down their wealth to their sons to ensure reproductive success in the next generation, especially in polygynous societies (Betzig, 2008). This constitutes one potential reason for sexist gender roles and gender inequality.

Another sex difference stemming from the accelerated life-history strategy is related to resources. In general, women have higher demands for resources than men due to energy-demanding reproductive activities such as pregnancy and breastfeeding, which also prevent them from efficiently participating in many economic production activities (Wood & Eagly, 2012). Women's relative vulnerability and helplessness during these critical periods also increase their reliance on men's provisioning, even in societies where women and men have similar contributions to subsistence (Marlowe, 2003). This might explain women's mate preference for men's resource acquisition ability (Buss & Schmitt, 1993; Li & Kenrick, 2006; Li, Bailey, Kenrick & Linsenmeier, 2002). Women's economic and physical dependence due to reproductive activities might also explain some women's conformity to benevolent sexism, which compliments feminine traits that depend on men's appreciation and implicitly justifies men-favoring gender inequality (Glick & Fiske, 2001). However, this does not mean that female dependence on male provisioning is a fixed trait. Recent studies exhibited that women with high resource availability, compared with women with low resource availability, were less likely to prioritize good-provider and good-gene traits to good-father traits in men (Lu, Zhu & Chang, 2015). Thus, modern societies that provide more financial stability and healthcare protections seem to diminish sexist mate preferences, replacing them with modernized, gender-egalitarian preferences that are more in line with slower life-history strategies among women.

Meanwhile, when both sexes enact accelerated life-history strategies, the sex with lower reproductive rate becomes reproductive resources in short supply (Trivers, 1972). Thus, men face the increased evolutionary challenge of identifying partners with high reproductive potential (Buss & Schmitt, 1993). In this regard, sexual selection has shaped men's preference for female traits advertising youth and

fecundity, including neotenous facial features (e.g., large eyes), little body hair, high-pitch voice, and deposition of fat on breasts and hips (Collins & Missing, 2003). These features are considered to be competitive in mating by women themselves (Fink, Klappauf, Brewer & Shackelford, 2014). Consistent with this extrapolation, a recent study showed that men with accelerated life-history strategy preferred fertility and good genes to fidelity and good mothers in their mate selections. Moreover, they were more sensitive to neotenous features in female faces (Lu, Wong, & Chang, 2017). Therefore, accelerated life-history strategies might facilitate a resource exchange between the two sexes through mutual mate selection, with women choosing men for resource provisioning and men choosing women for reproductive resources. Such mate selection standards, rather than actual social roles, might give rise to sexist attitudes justifying traditional gender roles (Zhu & Chang, 2019). In summary, from the life-history perspective, sexism and gender inequality might result from accelerated life-history strategies enacted by both sexes, rather than sex differences in economic efficiency.

1.2. Extrinsic risks and cross-societal variations in gender relations

The previous section outlined theoretical explanations of sexism and gender inequality from both biosocial and life-history perspectives. One limitation of the biosocial model is the lack of systematic analysis of potential society-level factors behind cross-societal variations in sexism and gender inequality. Nor can this model fully explain the persistence of gender roles in modern, post-industrial societies (e.g., Ebert, Steffens & Kroth, 2014; Evans & Diekman, 2009) or the findings of a positive association between sex differences and gender equalities across societies (e.g., in earning potentials and political representation; Schmitt, 2015; Schmitt et al., 2017).

One theory sheds light on the emergence of gender-egalitarian values, which are previously attributed to economic development or modernization (Dollar & Gatti, 1999), by focusing on society-level cultural evolution (Newson & Richerson, 2009). According to this kin-influence hypothesis, modern social networks, especially in urbanized areas, consist of fewer relatives (who derive inclusive fitness from relatives' reproduction efforts). This contributes to fertility decline and a value-shift from reproductive success (e.g., sexist and religious values) to cultural success (e.g., egalitarian and secular values; Newson, 2013, Newson & Richerson, 2009). Based on this account, the urbanization rate, which indicates modernization and the change in social networks, should be associated with increased support for egalitarian values and lower gender inequality.

The life-history perspective, in contrast, points to extrinsic morbidity-mortality risks as a key society-level predictor for the cross-societal difference in sexism and gender inequality. Extrinsic risks diminish the return from parental investment (Quinlan, 2007), especially for men, who additionally discount their parental investment in favor of mating efforts due to paternity uncertainty (Geary, 2000). In other words, men can afford to divert their time and energy to mating and escape childrearing duties without hurting their own reproductive success much. By contrast, women must devote more to parenting for similar reproductive gains as men at the expense of their personal development. This also forces them to rely more on men's provisioning. Thus, the "protective males and vulnerable females" stereotypes should be more accepted in societies facing higher levels of extrinsic risk, especially by men (Zhu & Chang, 2019). Conversely, in safe and stable societies, offspring competitiveness and well-being, which depends heavily on paternal investment (Geary, 2000), becomes more critical for ultimate reproductive success for both sexes (Lawson & Mace, 2011) than maximization of current reproduction efforts. Delaying reproduction and bearing fewer children free women from the burden of childcare and enable them to invest in education and careers, which in turn affords them independence from men's economic control. As a result, support for sexism and gender inequality would diminish in such societies, and reduced reproductive efforts allow both sexes to divert more energy to somatic efforts that are not gender-specialized.

One prominent source of extrinsic risk is intergroup violence in human evolutionary history (McDonald et al., 2012). Not only is intergroup violence prevalent, but the resulting vicious circle of retaliation also leads to high mortality in tribal societies (Chagnon, 1988; Gat, 2000). Combined with high mortality before adulthood in human evolutionary history (Volk & Atkinson, 2013), mortality caused by intergroup fighting might prompt heightened reproductive efforts to offset the unfavorable odds. Additionally, intergroup violence poses extra threats to fertile women as one of the incentives for fighting in pre-agricultural societies is to obtain mates (Gat, 2000; McDonald et al., 2012). This is supported by documentation of sexual assaults during intergroup conflicts in both modern warfare and warfare among primitive tribes (Thornhill & Palmer, 2000). Therefore, extrinsic risks in the form of intergroup violence should favor accelerated life-history strategies and might have shaped key aspects of the "protective males and vulnerable females" stereotypes.

However, this does not mean that there is no variance in human life-history strategy and sexist attitudes. Within a society, long periods of stability and low mortality rate should lead to changes in mate preferences that are opposite to those shaped by accelerated life-history strategies. Indeed, after World War II, one major change in mate preferences shown by several cross-sectional studies is the decreasing sex difference in preference for financial prospect (in United States 1939–1996: Buss et al., 2001; China 1980s-2008: Chang et al., 2011; Brazil 1984–2014: (Souza, Conroy-Beam, & Buss, 2016). Moreover, the importance of domestic skills and virginity also decreased over time, although the sex difference regarding women more than men desiring mates with good financial prospects has remained strong across societies (Buss et al., 2001; Chang et al., 2011). Thus, it is likely that society-level extrinsic risks might predict cross-societal patterns in sexism and, ultimately, gender inequality.

Unfortunately, existing research seldom considers extrinsic risks, whether in terms of intergroup violence or other causes, as a key predictor of sexism and gender inequality. Eagly and Wood (1999), in their re-analysis of a dataset containing 37 societies, found that women's empowerment was associated with reduced sex differences in mate preferences consistent with sexist gender roles (e.g., men as financial providers and women as homemakers). Similarly, Fuwa (2004) found across 22 countries that gender empowerment measure, economic development, female labor-force participation, gender norms, and welfare regimes were positively linked to a more equal division of domestic labor between men and women. Although these findings supported the links between sexism and gender inequality, they did not investigate external environmental predictors of them beyond economic development. Taking the life-history perspective, the current research sought to address this by examining cross-societal data that link sexism to individual-level resource insecurity and society-level indicators of extrinsic risks. We also sought to examine whether the relations between gender inequality and environmental factors such as extrinsic risks and resource availability are mediated by accelerated life-history strategy.

2. Study 1: ecological threats and sexist attitudes

The first study aims to examine links between stressful environmental threats and sexist attitudes using data from the latest World Values Survey (WVS, Inglehart et al. 2014). We used two-level hierarchical linear models to separate individual-level predictors of accelerated life-history strategies (e.g., individuals' self-reported resource insecurity) from society-level extrinsic risks. Specifically, we analyzed worries of intergroup violence, which affect everyone in the same society to a similar degree.

Based on the psychosocial acceleration theory (Belsky, 2012; Belsky et al., 1991), we hypothesized that both resource insecurity and intergroup violence, which favor accelerated life-history strategies,

would be associated with higher sexism. Based on our previous reasoning that men enjoy greater reproductive benefits when enacting accelerated life-history strategies, and that sexual selection processes serve to strengthen the "protective males" stereotype, we hypothesized that men would demonstrate higher sexism than women would. We also expected that this sex difference in sexism would be more prominent in societies with greater worries of intergroup violence, as in such societies, men's physical protection should be more highly valued by women than in peaceful societies. Moreover, in societies facing high intergroup violence, people might discount the importance of economic resources in reproductive choices (efforts spent accumulating resources, which can be easily seized by enemies, might generate higher reproductive success if diverted to immediate mating). In such cases, we anticipated a weaker association between economic resource insecurity and sexism in societies facing elevated intergroup violence.

2.1. Method

We used data from the latest wave of the WVS (Wave 6; Inglehart et al. 2014) completed in 2010–2014. The WVS is the largest non-commercial, cross-national, time series investigation of human beliefs and values, covering countries and regions representing vastly different levels of economic development and all major cultural zones in the world. The surveys were conducted with a common questionnaire using nationally representative samples. Because of a lack of individual-level information (e.g., sex, age, and number of children) and a relatively narrow sampling region, Hong Kong was excluded from our analyses. After excluding missing cases, 79,440 cases were included for analysis. The sample size ranged from 841 (New Zealand) to 3531 (South Africa). Descriptive statistics of the main variables in each society are provided in Table S1 in the Supplementary Material.

We calculated a composite score for sexism by averaging and recoding the scores of six items indicating evaluations and stereotypes that conformed to traditional gender roles (e.g., "A woman earning more money than her husband is almost certain to cause problems" and "Generally, men make better political leaders than women do"). The composite scores ranged from 1 to 4 (1 = *low sexism* and 4 = *high sexism*), and Cronbach's α for the six items was 0.76.

For individual-level predictors, we computed a resource insecurity score by averaging three items for each individual (Cronbach's $\alpha = 0.92$) that exhibited the frequency of financial difficulty faced by the family in question within 12 months: "gone without enough food to eat", "gone without medicine or medical treatment that you needed" and "gone without a cash income". These items were rated on a 4-point Likert scale (recoded: 1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*). A higher average score denoted a higher degree of resource insecurity. We also included sex (dummy coded: 0 = *female*, 1 = *male*), age, number of children, highest educational level attained, and subjective social class as individual-level predictors.

At the society level, we computed an intergroup violence score by averaging three items (Cronbach's $\alpha = 0.80$) representing intergroup violence faced by all people in a society. Specifically, respondents indicated on a 4-point scale (recoded: 1 = *not at all*, 2 = *not much*, 3 = *a great deal*, 4 = *very much*) to what degree are they worried about the situations regarding "a terrorist attack", "a civil war", and "a war involving my country". Individual-level scores were aggregated within each society to form the society-level score of intergroup violence. A higher score denoted a higher degree of extrinsic risk. A full list of WVS items comprising the composite measures used in our analysis is provided in the Supplementary Material alongside a confirmatory factor analysis revealing the structural validity of these composite measures.

2.2. Statistical analysis

Our analysis was conducted using hierarchical linear models (HLMs; Bryk & Raudenbush, 1992). Conceptually, HLMs are similar to linear regression but enable simultaneous consideration of individual- and society-level variance of the dependent variable. By enabling some individual-level regression coefficients to be randomly estimated across the society level, we were able to examine whether the effects of sex and individual-level resource insecurity on sexism differed by society and whether those differences could be explained by society-level intergroup violence.

The individual-level model was expressed as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j}G_{ij} + \beta_{2j}R_{ij} + \sum \beta_{kj}C_{ikj} + r_{ij} \quad (1)$$

where Y_{ij} is the sexism score of case i in society j; β_{0j} refers to the individual-level intercept for sexism; G_{ij} and R_{ij} denote individuals' sex and resource insecurity, respectively; and β_{1j} and β_{2j} represent the respective regression coefficients of individuals' sex and resource insecurity (slopes). The effects of k control variables are denoted by $\Sigma\beta_{kj}C_{ikj}$, where β_{kj} is the slope for each k individual-level control variable C_{ikj}. Finally, r_{ij} denotes the individual-level residual.

The individual-level intercept and the slopes for resource insecurity and sex were estimated as functions of society-level extrinsic risks, as expressed in the following society-level model:

$$\beta_{0j} = \mathrm{Y}_{00} + \mathrm{Y}_{01}W_j + u_{0j} \quad (2)$$

$$\beta_{1j} = \mathrm{Y}_{10} + \mathrm{Y}_{11}W_j + u_{1j} \quad (3)$$

$$\beta_{2j} = \mathrm{Y}_{20} + \mathrm{Y}_{21}W_j + u_{2j} \quad (4)$$

$$\beta_{kj} = \mathrm{Y}_{k} \quad (5)$$

where Y_{00} is the society-level intercept; Y_{01}, Y_{11}, and Y_{21} denote the effects of intergroup violence within each society (W_j) on the overall intercept (β_{0j}), the slope of sex, and the slope of resource insecurity, respectively; and u_{0j}, u_{1j}, and u_{2j} are residuals. The slopes of the control variables (β_{kj}) were fixed across countries/regions.

2.3. Results and discussion

Regarding society-level bivariate correlations, the means of each society's resource insecurity, intergroup violence, and average number of children were positively correlated with sexism ($r = 0.34, 0.54, 0.44$, respectively, $p < .01$ for all), whereas the mean of educational level in each society was negatively correlated with sexism ($r = -.31$, $p = .020$). The national mean of resource insecurity was correlated positively with that of intergroup violence ($r = 0.44$, $p = .001$) and negatively with the mean of educational level in the society in question ($r = -.28$, $p = .031$).

An analysis of the variance model (Model 0) revealed that approximately 29% of the total variance of sexism was accounted for by between-society differences. This justified the use of hierarchical linear modeling. We subsequently examined three models (see Table 1 for the results of all the HLM analyses). Model 1 included only individual-level control variables (age, number of children, educational level, and subjective social class), which accounted for 0.007 or 2.5% of the individual-level variance and 0.003 or 2.6% of the society-level variance. At the individual level, subjective social class and educational level were associated with lower sexism, whereas age was associated with higher sexism. Number of children was not associated with sexism.

Including sex and resource insecurity in Model 2 accounted for an additional 0.011 or 3.9% of the individual-level variance but no additional society-level variance. Sex and resource insecurity were positively associated with sexism, or in other words, males held sexist attitudes to a greater degree than did females, and males facing resource insecurity tended to have more sexist attitudes. Both age and number of children were associated with higher sexism, whereas educational level was associated with lower sexism. Subjective social class was not a significant predictor in this model.

Additionally including society-level intergroup violence as a

Table 1
Study 1: Hierarchical linear models for individual- and society-level effects on sexism.

	Model 0	Model 1	Model 2	Model 3
Overall Intercept (Y_{00})	2.240***	2.323***	2.235***	1.275***
	(0.044)	(0.046)	(0.010)	(0.247)
Slope of sex				
Intercept of the slope (Y_{10})	–	–	0.202***	0.007
			(0.016)	(0.088)
Intergroup violence (Y_{11})	–	–	–	0.071*
				(0.034)
Slope of resource insecurity				
Intercept of the slope (Y_{20})	–	–	0.053***	0.212**
			(0.012)	(0.048)
Intergroup violence (Y_{21})	–	–	–	−0.056**
				(0.016)
Intergroup violence (Y_{01})	–	–	–	0.346***
				(0.084)
Age	–	0.002***	0.002***	0.001***
		(0.000)	(0.000)	(0.000)
Number of children	–	0.004	0.009***	0.009***
		(0.002)	(0.002)	(0.002)
Educational level	–	−0.029***	−0.030***	−0.031***
		(0.003)	(0.002)	(0.002)
Social class (subjective)	–	−0.014**	−0.006	−0.005
		(0.004)	(0.005)	(0.005)
Variance component				
Individual-level (r_{ij})	0.285***	0.278***	0.267***	0.261***
Society-level (u_{0j})	0.116***	0.116***	0.113***	0.075***
Slope of sex (u_{1j})	–	–	0.015***	0.014***
Slope of resource insecurity (u_{2j})	–	–	0.004***	0.004***

Note: Standard errors are in parentheses.
* $p < .05$;.
** $p < .01$;.
*** $p < .001$.

predictor of both sexism and the slopes of sex and resource insecurity in Model 3 accounted for an additional 0.006 or 2.1% of the individual-level variance and an additional 0.038 or 32.8% of the society-level variance. Intergroup violence was associated with higher sexism and positively associated with the slope of sex, indicating that males were more likely to hold sexist attitudes in countries with higher intergroup violence. By contrast, intergroup violence was negatively associated with the slope of resource insecurity, which, notably, had a positive intercept, meaning that when no intergroup violence was present, resource insecurity was associated with higher sexism. However, in countries with more intergroup violence, the sexist effect of resource insecurity was less pronounced. The effect of intergroup violence accounted for a small amount of variance in the individual-level associations: 0.001 or 6.67% (from 0.015 to 0.014) of the variance for the slope of sex and less than 0.001 or 7.20% of the variance for the slope of resource insecurity.

Consistent with previous studies (e.g., Fuwa, 2004), we found that older individuals showed higher sexism, whereas those with higher educational levels showed lower sexism. Additionally, individuals with more children tended to hold more sexist attitudes than did those with fewer children. These findings are consistent with the evolutionary life-history explanation for sexism, as having more children likely indicates an accelerated reproductive strategy, which causes women to focus more on reproductive activities and to be more dependent on men's resource support. We found that males exhibited higher sexism than did females and that this trend was stronger in societies facing greater intergroup violence. This is consistent with our extrapolation that the traditional, sexist "protective males" stereotype is more advocated in societies facing an elevated danger of intergroup conflicts. Moreover, given that males have more incentives to escape parenting duties to focus on mating compared with females, males likely gain more reproductive success from sexist gender roles than females do when enacting accelerated life-history strategies. This might explain why the sex difference in sexism was greater in societies with higher extrinsic risks.

Both individual-level resource insecurity and society-level intergroup violence were independently associated with higher sexism. However, the positive association between resource insecurity and sexism was weaker in countries with higher intergroup violence. This can be explained by a complementary relationship between resource insecurity and extrinsic risk. Because resource insecurity essentially affects individuals' life-history strategies through its impact on their exposure to extrinsic risks (e.g., poorer individuals with no shelter or stored food are more likely to suffer from changes in their environments), its effect is likely less severe among individuals who are already exposed to a high level of extrinsic risk than among those who are not. In other words, personal financial security likely has little influence on individuals who are exposed to violent conflicts or threats of terrorism.

3. Study 2: extrinsic risks, life-history strategies, and gender inequality

The second study examines the hypothesis that society-level gender inequality is positively associated with extrinsic risks and negatively associated with resource availability through indicators of accelerated life-history strategies. These associations were examined through a mediation analysis using nation-level data from four United Nations (UN) databases including UN Development Program (UNDP), UN Department of Economic and Social Affairs (UNDESA), World Health Organization (WHO), and UN Statistical Division (UNSD). This also enabled us to (1) include more societies than in Study 1 to enhance the generalizability of the findings and (2) test the alternative prediction from the kin influence perspective (Newson, 2009; Newson & Richerson, 2009). The kin influence hypothesis predicts that modernization and urbanization would deemphasize high fertility goals and promote gender equality through cultural influences of non-kin-based social networks. Therefore, we examined the proportion of the urban residents in the entire population (referred to as "urbanization") and predicted that urbanization should be negatively associated with fertility and, through this negative effect, associated with higher gender equality.

3.1. Method

The 2017 data of the Gender Inequality Index (GII) and Gender Development Index (GDI), both of which are provided by the UNDP, were used as main dependent variables. The GII is a composite measure reflecting inequality in achievement between women and men in three dimensions: reproductive health (maternal mortality ratio and adolescent birth rate), empowerment (proportion of women in parliament and proportion of women with secondary education), and economic status (female labor force participation rate). The GDI was calculated based on the ratio of female to male Human Development Index (HDI) values, thus reflecting gender equality. This index reflects gender gaps in human development achievements in the three basic dimensions of human development—health, knowledge, and living standards—by using the same component indicators as those of the HDI. Details of the calculation of these indices are available at Technical Notes 3 and 4 at http://hdr.undp.org/sites/default/files/hdr2018_technical_notes.pdf.

To assess accelerated life-history strategies, we included the adolescent birth rate (births per 1000 women aged 15 to 19 years) from the UNDESA (2010/2015)[1] and total fertility per woman from the WHO (2012). The former indicator has been used to reflect accelerated life-

[1] The adolescent birth rate is one component of the GII. However, we used earlier data to reflect the diachronic influences of life-history strategies on gender inequality.

history strategy in the literature (e.g., Van Leeuwen, Koenig, Graham & Park, 2014), whereas the latter constitutes a direct measure of reproductive efforts, which also reflects an accelerated life-history strategy. To assess ecological conditions across societies, we used the adult mortality rate for both sexes (probability of dying between age 15 and 60 years per 1000 people) from the WHO (2012) as the proxy for extrinsic risks. The per capita gross domestic product (GDP) at prices at the time of study from the database of the UNSD (2010) was used as the proxy for resource availability (opposite of resource insecurity). To account for the potentially nonlinear effect of GDP on actual resource availability, we log-transformed the raw data. Finally, we also included in the model the percentage of the population living in urban areas reported by the WHO (2012). Based on the rationale of the kin influence hypothesis (Newson & Richerson, 2009), the modern urbanization process reduces the proportion of relatives in individuals' social networks, thus weakening the pro-reproduction kin influence and the associated sexist cultural norms.

3.2. Statistical analysis

After excluding nations with missing data, the final analysis included 92 nations. We estimated two sets of indirect effects by using a path model (see Fig. 1 for detailed predictions): (1) indirect effects of adult mortality on the GII and GDI through the adolescent birth rate and total fertility and (2) indirect effects of log-transformed per capita GDP on the GII and GDI through the adolescent birth rate and total fertility. Model estimation was conducted using maximum likelihood estimation in Mplus 7 (Muthén & Muthén, 1998–2011). The indirect effects were estimated using the bootstrap method (Preacher & Hayes 2004) with 10,000 bootstrapped resamples.

3.3. Results and discussion

Correlations among the main variables are presented in Table 2. The descriptive statistics of the main variables for each society are provided in Table S2 in the Supplementary Material. The estimation results of the path model are shown in Fig. 2.

The GII and GDI were not significantly correlated. Adolescent birth rate was positively and significantly correlated with total fertility ($r = 0.39$). Both adolescent birth rate and total fertility were associated with a higher GII (βs = 0.26, 0.31, ps = 0.031, 0.042, respectively). Total fertility was associated with a lower GDI ($\beta = -.65$, $p < .001$), whereas adolescent birth rate exhibited a trend of association with a higher GDI ($\beta = 0.32$, $p = .067$). Adult mortality was associated with a higher adolescent birth rate ($\beta = 0.48$, $p < .001$) and higher total fertility ($\beta = 0.36$, $p = .009$) but not directly associated with the GII or GDI (βs = 0.10, 0.16, respectively, ps > 0.10). Log-transformed per capita GDP was associated with a lower adolescent birth rate ($\beta = -.44$, $p < .001$) and lower total fertility ($\beta = -.38$, $p = .009$), and had direct yet opposite effects on the GII ($\beta = -.33$, $p = .007$) and GDI ($\beta = 0.40$, $p = .004$). Urbanization was not significantly associated with any of the mediators or dependent variables (βs < 0.20, ps > 0.10).

Regarding indirect effects, adult mortality had a positive total indirect effect on the GII through the adolescent birth rate and total fertility ($\beta = 0.24$, $p = .001$, CI_{95} [.09, 0.38]), albeit not separately (βs = 0.13, 0.11; ps = 0.062, 0.089; CI_{95} [−.01, 0.26], [−.02, 0.24], respectively). Adult mortality was negatively associated with the GDI through total fertility ($\beta = -.24$, $p = .032$, CI_{95} [−.45, −.02]) but not through the adolescent birth rate ($\beta = 0.15$, $p = .059$, CI_{95} [−.01, 0.31]), resulting in the absence of a total indirect effect on GDI ($\beta = -.08$, $p = .397$, CI_{95} [−.28, 0.11]). Log-transformed per capita GDP had a negative total indirect effect on the GII through adolescent birth rate and total fertility ($\beta = -.23$, $p = .002$, CI_{95} [−.38, −.09]), albeit not separately (βs = −.12, −.12; ps = 0.057, 0.051; CI_{95} [−.24, 0.00], [−.23, 0.00], respectively), and was associated with the GDI positively through total fertility ($\beta = 0.25$, $p = .005$, CI_{95} [.08, 0.41]) but negatively through adolescent birth rate ($\beta = -.14$, $p = .044$, CI_{95} [−.28, −.003]). This led to the absence of a total indirect effect on the GDI ($\beta = 0.11$, $p = .279$, CI_{95} [−0.09, 0.30]).

The results generally supported our hypothesis that extrinsic risks are associated with accelerated life-history strategies, which, in turn, are associated with greater gender inequality. We did not find support for the alternative, kin influence hypothesis, as the percentage of the urban population did not predict life-history strategies or gender equality indices. The negative effects of adult mortality on gender equality (higher GII, lower GDI) paralleled those of intergroup violence on sexism in Study 1, while the positive effects of log-transformed per capita GDP on gender equality (lower GII, higher GDI) paralleled those of resource insecurity in Study 1. However, we should refrain from drawing any causal inferences based on the correlational data. The two indices of gender relations are also not mutually replaceable, as the combination of adolescent birth rate and total fertility mediated the associations between ecological conditions and the GII. By contrast,

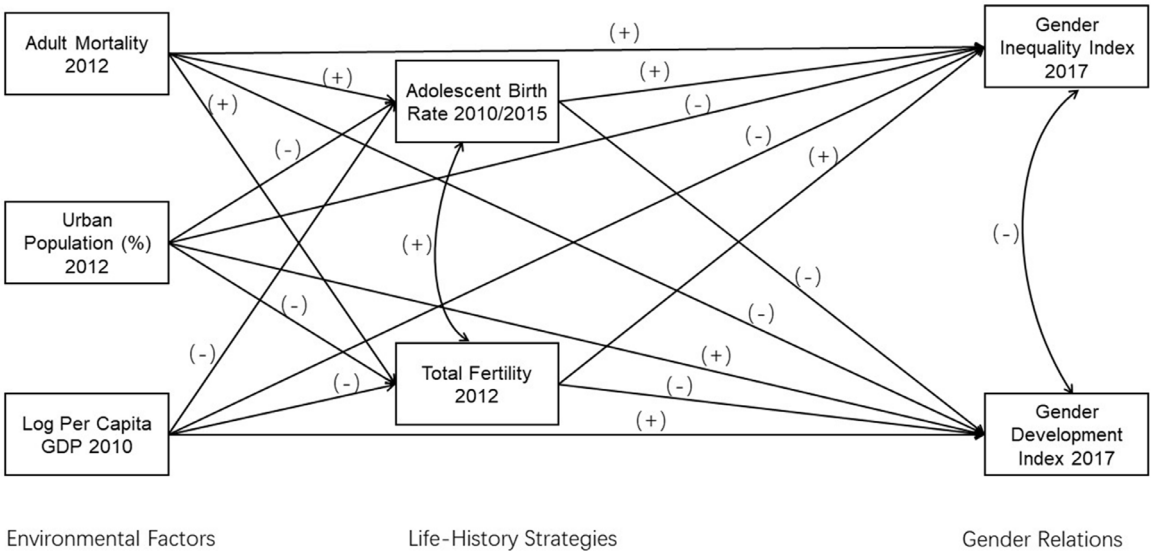

Fig. 1. Study 2: Hypothesized relations among environmental factors, life-history strategies, and indicators of gender relations. Notations on the arrows represent numbered hypothetical directions of the associations: (+) and (-) indicate positive and negative associations, respectively.

Table 2
Study 2: Correlations among main variables.

	1	2	3	4	5	6
Gender Inequality Index 2017 (1)	1					
Gender Development Index 2017 (2)	−0.597***	1				
Adolescent birth rate (3)	.792***	−0.411***	1			
Total fertility (4)	.748***	−0.577***	.795***	1		
Adult mortality (5)	.698***	−0.346***	.699***	.701***	1	
Log per capita GDP (6)	−0.746***	.453***	−0.681***	−0.662***	−0.714***	1
Urban population (7)	−0.600***	.366***	−0.475***	−0.554***	−0.635***	.707***

*** $p < .001$.

only total fertility mediated the association between ecological conditions and the GDI. Additionally, the two indicators of accelerated life-history strategies (total fertility and adolescent birth rate) might function independently, as they are associated with the GDI in opposite directions. The somewhat unexpected finding that adolescent birth rate had a tendency to be positively associated with gender equality (GDI) might reflect a limitation in our data sources, making it difficult to clearly distinguishing predictors from dependent variables. Nevertheless, this study showcases the advantage of using society-level archival data to demonstrate macro-level ecological effects and effects of life-history strategies on gender relations.

4. General discussion

The present paper presents an evolutionary explanation of sexism and gender inequality, postulating that they are linked to ecologically sensitive expressions of life-history strategies of the two sexes. This life-history account received preliminary support in our analyses. Firstly, the results inspire an ecological explanation (in addition to technological factors, cultural norms, or "modernization") of the variability in sexist attitudes and gender inequality. As revealed by Study 1, both individual-level resource insecurity and society-level intergroup violence predicted higher sexism. In addition, an interaction between the two levels of ecological threats was observed. Society-level intergroup violence may have overshadowed individual-level resource insecurity such that the detrimental effect of resource insecurity was less severe in societies with high intergroup violence. Moreover, the results of Study 1 also highlight the increased sex difference in sexism in the face of extrinsic risks. This is consistent with the extrapolation that men gain more reproductive interests than women do in ecologies favoring accelerated life-history strategies due to their less parental investment compared with that of women. Study 2 further corroborated the claim that extrinsic risks are associated with gender inequality through accelerated life-history strategies. Study 2 provided preliminary evidence that fertility, as an indicator of accelerated life-history strategy, might be a crucial mediator between ecological conditions and gender inequality. In general, most of the observed ecological effects on sexism and gender inequality conform to the principles of sexual selection and life-history trade-offs (Andersson, 1994; Del Giudice et al., 2015; Geary, 2002). Like the kin influence hypothesis (Newson & Richerson 2009), we postulate that a focus on current reproductive success is conducive to gender inequality. However, our findings do not support attributing this mainly to biased social learning in kin-dominated social networks (which is more prevalent in pre-industrial, non-urbanized societies), as urbanization was not related to either indicator of gender relations.

The current account seeks to understand sexism and gender inequality from an evolutionary life-history perspective. This does not necessarily preclude the roles of cultural norms and social factors. Instead, we demonstrated that, when distal causes are considered, proximate cause such as do not explain a significant amount of variance in the dependent variables. By incorporating the variable of urbanization in Study 2, we tested the kin influence hypothesis (Newson & Richerson, 2009) that modernization and changes in social networks gradually replaced sexist "reproductive success" norms with nonsexist "cultural success" norms (Newson, 2009). After adult mortality and log-transformed per capita GDP had been controlled for, the effect of urbanization on gender inequality was not significant. Of course, it would be premature to assume that the ecological factors we assessed (morbidity-mortality risks, resource insecurity) are the only direct causes of

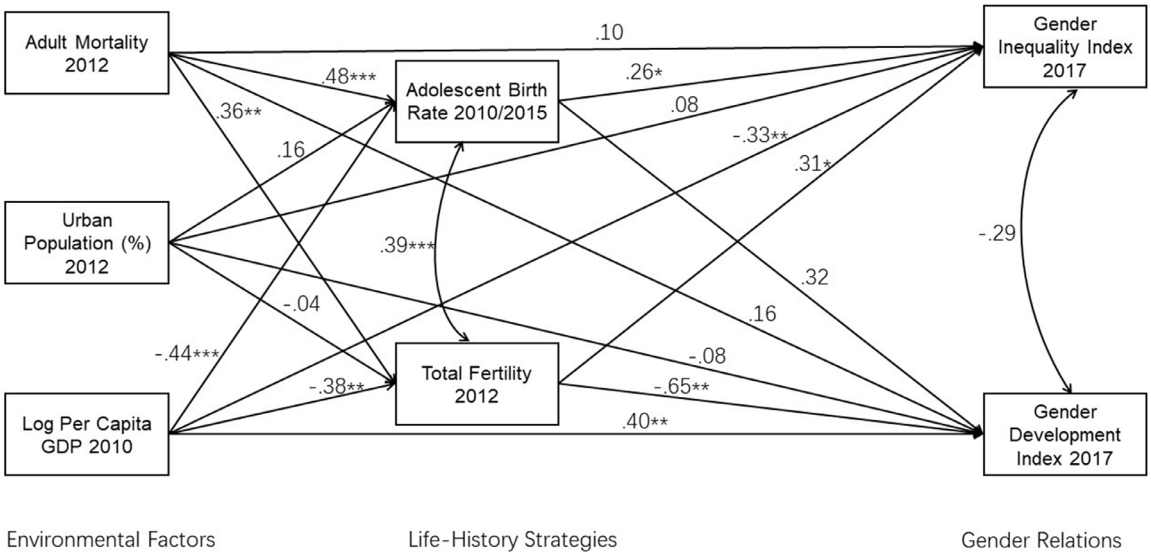

Fig. 2. Study 2: Results of the path models depicting relations among environmental factors, life-history strategies, and indicators of gender inequality.
* $p < .05$; ** $p < .01$; *** $p < .001$.

sexism and gender inequality. Some might argue that these effects might still function through cultural norms. Indeed, previous research has shown that the restrictiveness of cultural norms is ultimately linked to similar ecological conditions (e.g., Gelfand, Raver, Nishii & Yamaguchi, 2011). It is important to note, however, that cultural norms and life-history strategies are not necessarily incompatible phenomena. Rather, a meaningful future direction would be to examine the relation between them and how they interact with each other in affecting gender equality.

Our account differs from Wood and Eagly's (2002, 2012) biosocial model in several ways. First, the biosocial model attributes the distinction of gender roles to the relative efficiency of the two sexes in performing different activities (Wood & Eagly, 2002, 2012). However, mere efficiency cannot fully explain the "protective males and vulnerable females" stereotype, or the cross-societal variations in sexism and gender inequality. In contrast, we attribute sexism to both sexes' drive to maximize their reproductive success in ecologies that favor accelerated life-history strategies. Importantly, this does not mean that all kinds of sex differences reflect sexism and gender inequality. Recent reviews of evidence showed that, in many cases, sex differences are smaller in societies with higher gender inequality (Schmitt, 2015; Schmitt et al., 2017). This may be interpreted as an effect of modernized gender roles that reduce female economic dependence on males, which allows both sexes to "pursue more freely the values they inherently care more about" (Schwartz & Rubel-Lifshitz, 2009, p. 171; Stoet & Geary, 2018). One notable exception includes the sex difference in mate preferences for resources, which is larger in less gender-egalitarian societies (Schmitt, 2015). This implies that mate preferences for resources are particularly relevant to gender inequality, which is consistent with our reasoning from the evolutionary life-history perspective.

A second theoretical discrepancy between our account and the biosocial account has to do with the mechanism of sexual selection, which is regarded by Wood and Eagly (2002) as an "essentialist" account of gender roles that are unconditionally manifested in any ecologies. In contrast, we posit that due to imbalanced reproductive rates and parental investment of the two sexes, sexual selection might serve to exaggerate sex differences in mate preferences and sexist attitudes in accordance with an accelerated life-history strategy, which prevails in unpredictable, dangerous environments. This allows us to predict that men would show higher sexism than women in societies facing higher degrees of extrinsic risks, which is supported by the results of Study 1.

Another viewpoint worth consideration is that sex differences in personality traits might also contribute to gender inequality in social status and income (e.g., Jonason, Koehn, Okan & O'Connor, 2018). Indeed, previous research has demonstrated that men scored higher than women in group dominance orientation (Sidanius, Pratto & Brief, 1995). This, combined with men's higher proclivity toward physical aggression than that of women (Cummins, 2006), might serve to promote male-dominated hierarchies. By contrast, women scored higher than men on self-estimated emotional intelligence traits (Petrides & Furnham, 2000), which might give them an edge over men in accumulating social resources (e.g., prestige, favor, and reputation). Thus, in societies where people's status depends more on physical contests and combat abilities than on social resources, such sex differences in personality traits are likely to contribute to gender inequality.

This explanation of gender inequality does not necessarily contradict our account, though. As previous research has noted, Dark Triad characteristics (i.e., narcissism, psychopathy, and Machiavellianism) was linked to short-term mating, especially for men (Jonason, Li, Webster & Schmitt, 2009). This link between Dark Triad personality and short-term mating strategy, which is compatible with an accelerated life-history strategies, is seen as adapted to volatile, unpredictable environments (Jonason, Valentine, Li & Harbeson, 2011). In other words, sex differences in personality traits might stem from an interaction between ecological conditions and sexual selection pressures. The resulting effects on gender inequality, therefore, should also depend on ecological conditions in ways predicted by the life-history trade-off between reproductive efforts (e.g., mating) and somatic efforts (e.g., skill development). Thus, sex differences in personality traits such as narcissism might be exaggerated in environments that favor an accelerated life history, which contributes to male advantages in the competition for dominant status. Future research on sex differences in personality would, therefore, benefit from the consideration of environment-contingent expression of personality traits.

Admittedly, our empirical examination of the life-history account of sexism and gender inequality is only preliminary and suffers from several limitations given the data we used. These include (1) potential conflations between dependent variables and predictors (e.g., between adolescent birth rate and indicators of gender inequality and gender equality); (2) the vagueness of some variables (e.g., adult mortality rates include mortality caused by non-extrinsic factors); (3) the possibility that some key factors affecting sexism and gender inequality are not included. For example, monogamy as a mating system might prevent men from exerting power over women, thus facilitate gender egalitarian values and institutions. Modern societies with socially or legally-imposed monogamy tend to be more gender-egalitarian than ancient societies practicing polygyny. Moreover, monogamy, which indicates reproductive gender equality, seems to be independent of ecological conditions. Evidence has shown that contemporary hunter-gatherer societies that live in resource-scarce environments (e.g., !Kung San Bushmen of the Kalahari Desert and the Inuits of the Arctic) are more monogamous than tribes with more sedentary and affluent subsistence styles (e.g., horticultural societies; Marlowe, 2000). However, monogamy (which is practiced by most societies today) cannot fully explain the cross-societal variations in sexism and gender inequality. The current research focuses on more distal, environmental factors than key mediators such as monogamy on gender relations. These limitations point to promising future research questions, for example: (1) whether men and women are more likely to demonstrate or accept the "protective males and vulnerable females" gender roles when in romantic relationships or when romantic motives are activated; (2) whether such sexually motivated endorsement of sexist gender roles is affected by individual experiences of extrinsic risks and resource insecurity.

5. Conclusion

There is more to the research on sexism and gender inequality than the search for cultural norms and technological advances that enable the "subordination of women" by men. The evolutionary life-history account focuses on the different behavioral and psychosocial responses of the two sexes when enacting accelerated life-history strategies. Specifically, extrinsic morbidity-mortality risks and resource insecurity favor accelerated life-history strategies, which prompt both sexes to prioritize reproductive efforts. Because men have higher reproductive rates, whereas women have higher initial parental investment, women tend to divert an increased amount of energy away from somatic efforts and become dependent on men's economic support when enacting an accelerated life-history strategy. Meanwhile, men focus more on mating and resource-acquisition abilities than women do. These bifurcated strategies might be reflected in mate preferences, sexist attitudes, and, eventually, gender inequality. Conversely, in safe and stable environments, societal competition would prompt both sexes to enact slower life-history strategies. This would ease the burden of direct parental investment of women and reduce their economic dependence on men, allowing both sexes to devote more time and energy to somatic efforts and to abandon sexist stereotypes, which reflect adaptive mate preferences in the current environment. Eventually, this should minimize gender inequality, even though not necessarily eliminating sex differences (Schmitt et al., 2017).

A systematic investigation of ecological effects on sexism and gender inequality is necessary for a deeper understanding of these

phenomena. Such an investigation should in no way serve to justify existent gender inequality, however. Our findings that cross-societal variations in sexism and gender inequality are linked to changeable ecological conditions should debunk any claim that gender inequality is an essential feature of human social organization or an innate attribute of the human species in all ecological conditions.

Declaration of Competing Interest

None.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.paid.2019.109806.

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