

The religiosity gender gap in 14 diverse societies

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Abstract

Scholars of religion have long sought to explain the persistent finding that women tend to report greater religiosity than men. However, the size of this ‘gender gap’ may depend on the measure of religiosity employed, the religious tradition being sampled, and socio-demographic factors. Here, we conduct a systematic cross-cultural investigation into the prevalence of, and explanations for, the religiosity gender gap in 2,002 individuals from 14 diverse societies. While variation exists across societies, women in general indicate greater mental commitment to (i.e. thinking and worrying more about) their community’s moralistic god, more frequent participation in rituals for their community’s moralistic god, and more frequent prayer. While we find that the gender gap extends beyond the Christian world, no such difference was seen in religious commitment towards more local gods, to which men tend to show greater commitment. Tentative support is provided for explanations relating gender differences in religiosity to lower formal education and greater mentalising among women, however an explanation for greater religious commitment to local gods among men remains elusive. Nevertheless, our data suggest that the moralising gods of some contemporary world religions, unlike local deities and traditions, have evolved in ways that make them more appealing to women.

Introduction

One of the most widely cited findings in the study of religion is that women tend to be more religious than men (Argyle & Beit-Hallahmi, 1975; Beit-Hallahmi & Argyle, 1997; Collett & Lizardo, 2009; Francis, 1997; Stark, 2002; Walter & Davie, 1998). Numerous studies over many decades have shown that women report a greater interest in religion (Sasaki, 1975), are more committed to their faith (Argyle & Beit-Hallahmi, 1975), and pray more than men (Beit-Hallahmi & Argyle, 1997; Davie, 1990; Miller & Stark, 2002; Schnabel, 2016). Some have gone as far as to suggest that women indicate greater religiosity than men on every possible measure (Argyle & Beit-Hallahmi, 1975), and that this trend holds in countries and religions across the world (e.g. Stark, 2002).

However, scholars of religion question whether the ‘gender gap’ in religiosity is as consistent as some have claimed (Cornwall, 1989; Feltey & Poloma, 1991; Sullins, 2006). Firstly, the size of the gender gap may depend on what is measured. Some have argued that women’s greater reported religiosity could be driven by a prevailing tendency in the literature to operationalize religiosity solely as a subjective rating of religion’s importance in one’s life (e.g. Miller & Stark, 2002; Stark, 2002), ignoring measures of religious practice (Sullins, 2006). When studies do consider multiple dimensions of religiosity, evidence is mixed; while some find that women consistently rate themselves higher on measures of religious ritual (Cornwall, 1989; Roth & Kroll, 2007), others find smaller effects for ritual (Davie, 1990; Sullins, 2006), or fail to find an effect at all (Beit-Hallahmi & Argyle, 1997).

Secondly, the size of the gender gap might depend on the religious tradition being sampled. While studies consistently show that Christian women tend to indicate that religion plays a more central role in their lives than do Christian men, Muslim men and women tend to indicate similar levels of commitment and participation (Hackett et al., 2016; Sullins, 2006). Further,

survey evidence suggests that Hindu and Buddhist men and women report similar attendance rates at worship services (Hackett et al., 2016), and in some countries, Jewish and Muslim men report attending synagogue or mosque more regularly (Lazerwitz, 1961; Sullins, 2006). It is unclear whether such differences in participation reflect gender differences in personal religious commitment versus other factors, such as explicit doctrinal demands, or less obvious interactions between gender roles and ritual domains.

Thirdly, most research has focused on world religions, in particular monotheistic traditions with powerful moralistic deities in large-scale societies (e.g. de Vaus & McAllister, 1987; Miller & Hoffmann, 1995; Schnabel, 2016; Walter & Davie, 1998). Many religions contain multiple deities and spirits within their pantheon, but demographic patterns of religiosity related to more local gods and indigenous religious practices have been largely ignored by researchers. Testing the universality of the religiosity gender gap, and explanations for it, requires studies that go beyond measuring religious commitment to monotheistic deities and their associated ritual traditions, to consider a more diverse range of potentially less morally-concerned local deities within small and larger-scale societies (e.g. Purzycki et al., 2016b).

Theoretical accounts for the gender gap in religiosity

Accompanying, and often motivating, attempts to quantify the religiosity gender gap, social scientists have sought to explain why gender differences in religiosity exist and persist (Luckmann, 1967; Martin, 1967). Here we consider four broad categories of explanation for the religiosity gender gap: 1) a risk aversion account (Hoffmann, 2009; Miller & Hoffmann, 1995; Miller & Stark, 2002), 2) a reproductive strategy account (Kurzban et al., 2010; Weeden et al., 2008), 3) a mentalizing account (Norenzayan et al., 2012), and 4) a structural location account (de Vaus & McAllister, 1987; Norris & Inglehart, 2008; Trzebiatowska & Bruce, 2012). These accounts are not mutually exclusive.

Risk aversion account

The risk aversion account attributes the religiosity gender gap to differential tolerance for spiritual and/or social risk for irreligiosity among men and women. This account builds upon criminological research, which has consistently found that men show higher levels of risk-taking than women (Booth & Dabbs, 1993; Byrnes, Miller, & Schafer, 1999; Wilson & Daly, 1985), and are more likely to engage in ‘risky’ behaviours such as drinking, smoking, drug-taking, speeding, gambling, and sexual promiscuity than women (Gottfredson & Hirschi, 1990; Gove, 1985). Proponents of a risk aversion explanation argue that religious belief and participation may be partly understood as a strategy to mitigate the risk of punishment by god or community members for irreligiosity (Miller & Stark, 2002; Stark, 2002). The first reason for risk aversion parallel’s the logic behind Pascal’s wager; in certain faiths, religious belief may lead to eternal life if the religion is true, however the best a non-believer can attain after death is annihilation if the religion is untrue, and the worst is eternal damnation in hell if it is true (Miller & Hoffmann, 1995; Roth & Kroll, 2007). Even without afterlife beliefs, perceived risks of supernatural punishment may motivate more religiosity in women than men if the former are more risk averse. Second, irreligiosity can confer social costs; even in many secular societies people exhibit an intuitive moral prejudice against non-believers (Gervais et al., 2017). In communities where the majority of people are religious, being irreligious could lead to particularly severe sanctions, such as ostracism, banishment and death (Johnson & Krüger, 2004).

Reproductive strategy account

A more recently-developed account argues that individual differences in religiosity can be explained as an outcome of people pursuing different reproductive strategies (Kurzban et al., 2010; Weeden et al., 2008; Weeden & Kurzban, 2013). Contemporary world religions set a

moral premium on fidelity, high fertility, heterosexual marriages as the basis of the family unit. Individuals engaging in pre-marital sex and infidelity face the threat of social and spiritual punishment for transgressing sacred sexual norms (Weeden et al., 2008). These strict norms around sex are argued to favour the interests of people pursuing high-commitment mating strategies by deterring marriage infidelity, reducing women's risk of mate abandonment, and men's risk of cuckoldry (Weeden & Kurzban, 2013). Within this framework, individuals who want to pursue high-commitment relationships and incentivize their partners to remain faithful and committed are more likely to be drawn to religions that preach those values.

This account predicts that men tend to report less religiosity than women because a higher frequency of men than women are pursuing low commitment strategies in many populations (Kirkpatrick, 2005; Weeden et al., 2008). While, in theory, men stand to gain more than women from more, and likely lower commitment matings (Bateman, 1948), this logic is debated by some evolutionary biologists (Parker & Birkhead, 2013) and in practice such strategies' payoffs are limited by male-male competition (Brown et al., 2009; Kokko & Jennions, 2003). Nonetheless, while on average men may not receive higher fitness benefits than women by following low-commitment strategies, high status males who gain a disproportionate benefit from low-commitment strategies could theoretically drive the gender gap.

Mentalizing account

The cognitive ability to represent and reason about other minds (Mitchell, 2009; Waytz et al., 2010), known as mentalizing or 'theory of mind', is thought to be crucial to forming mental representations of gods (Barrett, 2000; Waytz et al., 2010). Deficits in mentalizing ability are more common in men than in women (Baron-Cohen & Wheelwright, 2004; Mitchell, 2009). Hence, the mentalizing account of gender differences in religiosity argues that women tend to be more religious than men due to their generally greater mentalizing ability. This is expected

to be particularly evident regarding commitment to the kinds of moralising deities characteristic of major world religions, which entail elaborate mental state attributions. The mentalizing account is supported by work showing that, within a North American student sample, gender differences in belief in a personal god are mediated by greater mentalizing ability among women (Norenzayan, Gervais, & Trzesniewski, 2012; although cf. Maij et al., 2017).

Structural location account

A fourth account proposes that contrasting social roles for men and women in society have contributed to gender differences in religiosity (de Vaus & McAllister, 1987; Steggerda, 1993; Thompson, 1991). This argument tends to take one of three forms. First, the *Social networks and support* version argues that while men engaged in paid work can benefit from social networks and support at the workplace, for example through male friendship and camaraderie, women's primary role as homemakers and caregivers means that they may feel greater social isolation (Moberg, 1962), and may be motivated to seek child-rearing support (Martin, 1967). Under this account women are hypothesised to be more religious to the extent that they are disproportionately likely to seek social networks and alloparental care provided by religious institutions (de Vaus & McAllister, 1987; Martin, 1967; Shaver et al., 2019). This argument was developed to apply to urban market economies where many women cannot rely on a network of relatives who live nearby. Its relevance outside this context remains unclear.

Second, the *Secularisation* version of the structural location account proposes that women's relative absence from the workplace and limited access to secular education provided in school may have isolated them from so-called 'secularising forces' that have led to the gradual erosion of religion's centrality in the daily lives of people in many Western countries (Berger, 1967; Trzebiatowska & Bruce, 2012; Wilson, 2016). Through workforce participation and secular

education, people may be increasingly exposed to values and meaning outside of religion (Luckmann, 1967), such as a sense of civic responsibility, lessening the appeal of religion and/or reducing the perceived plausibility of religious teachings.

Finally, a more recent *Existential security* version argues that women tend to be more vulnerable to periods of existential insecurity than men (Norris & Inglehart, 2008; Voas et al., 2013; Walter & Davie, 1998). Defined in its broadest sense as “the extent to which survival is seen as secure or uncertain” (Norris & Inglehart, 2008: 3), enduring gender inequalities in political power and economic opportunities make women more vulnerable to economic insecurity. Within this framework, women may be drawn to religion because they find greater comfort believing in a deity that listens and responds to their anxieties in this life and may reward them after death, or because they can benefit more than men from economic support provided by religious institutions (Chen, 2010; Chesnut, 2003; Zapata, 2018).

The current study

Here, we conduct a systematic cross-cultural investigation into the prevalence of, and explanations for, the religiosity gender gap in a sample of 2,002 individuals from 14 diverse societies. We employ religiosity and demographic survey data collected by investigators of the Cultural Evolution of Religion Consortium (CERC) between 2013 and 2015 (Lang et al., 2019; Purzycki et al., 2016a, 2016b). We obtained information on a wide range of measures of religiosity, including questions about personal religious commitment, beliefs, practices, and socio-demographic context. Further, we collected data on beliefs about and commitment to two categories of supernatural agents –Moralistic and Local. Moralistic gods were identified within each society as gods highly concerned with morality, specifically with interpersonal prosocial behaviour. In contrast, local gods were identified during earlier interviews as supernatural agents of local importance who were chosen on the basis of their having less concern for

interpersonal morality (although they may nevertheless be concerned with behaviour that does not involve interpersonal morality, such as compliance with certain rites, rituals or taboos). The selection of deities investigated includes powerful creator deities from the Buddhist, Hindu and Christian world religions, a moralistic deity indigenous to Inland Tanna (Kalbabab), and a variety of less moralizing local deities and spirits.

We use the CERC dataset to quantify the religiosity gender gap and establish the extent to which the gap is consistent across measures of religiosity, in different religious traditions, and towards different kinds of deities. Finding that women indicate greater religiosity than men across some measures of religious commitment to moralistic gods, we then test a range of predictions under each of the four theories outlined above (see Table 1 for the list of fully operationalised pre-registered hypotheses). While these accounts are not an exhaustive list of proposed explanations for the gender gap, they are some of the most developed and provide predictions we can test with the CERC dataset for where one should see a gender gap and what should moderate and mediate this difference.

First, we test two hypotheses under the risk aversion account. To the extent that women are more averse to risking supernatural punishment for unbelief, the gender gap in religiosity should be greater when the perceived threat of supernatural punishment for unbelief is larger (H1A). Alternatively, or in addition, if women are more averse to social sanctions for unbelief, the gender gap in religiosity should be larger when social threat is perceived to be higher (H1B). We note that the risk aversion account makes no strong predictions for which measures of religiosity we should see a gender gap, nor whether this difference should be unique to moralistic or local gods.

Second, if, as proposed by the reproductive morality account, the religiosity gender gap can be explained by greater male aversion to religious institutions that moralise against short-term and

multiple-mate mating strategies, the gender gap in religiosity should be restricted to religious traditions and deities that police sexual mores. We therefore expect the gender gap to be larger with respect to the more morally-concerned deities (H2A), which in our sample reflect world religions that indeed tend to regulate sexuality for both men and women. Previous research confirms that local gods tend to be less morally concerned (Purzycki et al., 2016b), and indeed we chose local gods for this study that fit this criterion. Further, this theory predicts that engaging in a high-commitment reproductive strategy, proxied by being married, should be associated with religiosity. However, to the extent that marriage curtails men's intentions to pursue short-term mating strategies more than it changes women's intentions, marital status may be a better predictor of religiosity in men than women (H2B). This mechanism would suggest a larger gender gap for unmarried than married individuals. Furthermore, if high-status men are most likely to benefit from having multiple mates, they should exhibit lower religiosity than lower status men and women (H2C). Finally, gender differences in religiosity should be greater in societies with greater opportunities for males' reproductive interests to deviate from those of women – e.g. in societies with low ratios of men to women where men may be able to obtain multiple mates (H2D). We note that the reproductive strategy account makes no strong predictions about whether the gender gap should be larger for certain measures of religious commitment.

Third, if the mentalizing account is correct and gender differences in religiosity reflect differences in mentalizing ability, we would expect women to mentalize more (worry and think more) about gods generally, and particularly moralistic gods, since these are concerned with interpersonal social behaviour (H3A). We are unable to test predictions linking religiosity measures to mentalizing ability *per se* because our data do not include such measures.

Lastly, we test three versions of the structural location account outlined above. A more general prediction made by multiple versions of the structural location account is that employment in

the workforce might provide alternate sources of social networking and support to religious institutions, expose people to secular values and norms, and generate regular income that can ward off existential threats associated with resource scarcity. This theory therefore predicts that gender differences in access to work should explain (H4A) and moderate (H4B) the religiosity gender gap.

Testing predictions based on the three versions of the structural location account requires more specific hypotheses about the role of work, formal education, material insecurity, child rearing, and alternative social networks, and how they affect religious affiliation. First, if women's greater religiosity is attributable to their greater desire for social networks and support provided by religious institutions, then measures of religious participation should drive the religiosity gender gap (H4C). Further, the gender gap should widen for women requiring greater access to networking and support systems for child-rearing (i.e. mothers of many young children) (H4D), and narrow when alternative, non-religious sources of networking and support systems (proxied by time at market) are available (H4E). While highly structured religious traditions often associated with moralistic gods can provide a variety of social institutions to aid adherents in their daily lives, we have no data on the specific provisions linked to local god worship in our sample. As such, the moralistic gods provide a clearer test of these predictions.

Second, if women's greater religiosity is due to their slower rate of secularisation, then gender differences in access to secular information via formal education should explain the religiosity gender gap (H4F). While the secularisation version proposes that the religiosity gender gap may be explained by men and women becoming less religious at different rates, the account appears to make no strong predictions about whether the gender gap should be larger for moralistic gods or local gods, or for certain measures of religious commitment.

Finally, if the gender gap in religiosity is due to religion's ability to allay greater existential anxiety among women, then the gender gap in religiosity should be greater concerning commitment towards deities who can better allay anxieties (due to perceived benevolence and potential for salvation in the afterlife; H4G), and in cultures where women are exposed to greater existential threat than men (due to economic hardship [H4H] or gender inequality [H4I]). Furthermore, women's greater perceived existential insecurity than men should at least partly mediate the gender gap (H4J). We note that the existential security account does not make strong predictions about which measures of religiosity should show the largest gender gaps.

Table 1. Hypotheses testing predictions derived from explanations for the religiosity gender gap, whether the hypothesis was pre-registered, and whether the hypothesis was supported, partially supported or not supported. Pre-registration information is available at <https://osf.io/xg7kp/>

Account name	Level	Causal relation	Pre-Reg.	Hypothesis	Result
Risk aversion					
H1A supernatural risks	ind.	moderator	Yes	Women's religiosity should be particularly higher than men's when one's deity is perceived as more punitive and/or as influencing life after death.	No support
H1B social risks	ind.	moderator	Yes	To the extent that greater average religiosity in a community indicates a stronger social norm of religiosity, higher average religiosity of one's community should be associated with particularly greater religiosity of women relative to men.	No support
Reproductive strategy					
H2A moralistic gods	deity	moderator	Yes	Insofar as moralistic gods police sexual mores, and this is more incompatible with men's preferences, women should report greater religiosity towards their moralistic god than men, while gender differences with respect to less morally-concerned local gods are likely to be smaller or non-existent.	Partial support
H2B marriage	ind.	moderator	Yes	Married men should be relatively more religious than unmarried men, whereas marital status should have less of an effect on female religiosity.	No support
H2C status	ind.	moderator	Yes	To the extent that high status men are more competitive in obtaining multiple mates than low status men, high status men should be less religious than low status men, and women.	No support
H2D sex ratios	pop.	moderator	Yes	Higher single male to female ratios limit men's opportunities to acquire multiple mates, thus reducing sex differences in reproductive strategies and therefore the religiosity gender gap.	No support
Mentalizing					
H3A mental commitment	ind.	mediator	No	Women should report greater religiosity generally, although this effect should be strongest for moralistic gods and for measures of mental commitment (worrying and thinking about god). To the extent that mental commitment drives behaviour, mental commitment measures should mediate the effect of gender on behavioural measures (e.g., ritual participation and prayer).	Partial support
Structural location					
H4A employment	ind.	mediator	Yes	Gender differences in workforce participation should mediate the relationship between gender and religiosity.	No support
H4B employment	pop.	moderator	Yes	Populations with a higher share of women in paid employment should show smaller gender gaps.	No support
Social networks and support					
H4C ritual participation	ind.	mediator	Yes	Women will report greater frequency of ritual practices towards moralistic gods. To the extent that participation in rituals drives belief, ritual participation measures should mediate the effect of gender on mental commitment to moralistic gods.	Partial support
H4D child-rearing support	ind.	moderator	Yes	To the extent that women are motivated to seek child-rearing resources provided by religious institutions, the gender gap should be greatest those in need of child-rearing support.	No support

H4E time in market	ind.	mediator	Yes	Gender differences in time spent at market should mediate the relationship between gender and religiosity.	No support
<i>Secularisation</i>					
H4F education	ind.	mediator	Yes	Formal education is a secularizing force and thus predicts less religiosity in both men and women. Gender differences in exposure to formal education should mediate the relationship between gender and religiosity.	Partial support
<i>Existential security</i>					
H4G rewarding deity	ind.	moderator	Yes	To the extent that moralistic gods are perceived to be more benevolent, and more likely to be able to influence life after death, women should indicate greater religiosity towards moralistic gods, but not local gods. Nevertheless, the effect of gender on religiosity should be greatest among women who believe in a rewarding god, and a god that can influence life after death.	Partial support
H4H economic insecurity	pop.	moderator	Yes	The gender gap in moralistic god religiosity should be greater in societies with higher levels of economic insecurity.	No support
H4I gender inequality	pop.	moderator	Yes	The gender gap in moralistic god religiosity should be greater in societies with higher levels of gender inequality.	No support
H4J food insecurity	ind.	mediator	Yes	Women are more religious because they disproportionately benefit from religions' ability to allay existential anxieties. Under this scenario, women should report greater perceived food insecurity, which should in turn predict greater moralistic god religiosity. As such, perceived food insecurity is expected to mediate the relationship between gender and religiosity.	No support

Method

Pre-registration and Open Access. The present data were collected as part of the Evolution of Religion and Morality Project (Lang et al., 2019; Purzycki et al., 2016a) carried out in collaboration with CERC. The data were compiled over two waves of data collection to investigate questions around belief in supernatural agents and cooperation. Further information on the measures and protocols for both waves can be found online (<https://osf.io/6ha2d/>). The datasets for Wave 1 and Wave 2 can also be accessed online (Purzycki et al., 2016a; <https://osf.io/epkbw/>). The present study used a subset of relevant variables from both Wave 1 and Wave 2. Our hypotheses and analysis strategy were pre-registered after data collection, but before the lead authors had access to the full dataset. Our pre-registration document is available at <https://osf.io/eka9m/>. Due to problems fitting appropriate models, three pre-registered hypotheses involving ordinal moderated mediation are not reported here.

Participants. Over both waves of data collection, we recruited 2,228 participants (1,226 women; Mean age = 37.0, SD = 14.8) from 15 different field sites: (1) Coastal and (2) Inland Tanna, Vanuatu; (3) Cachoeira and (4) Marajó, Brazil; (5) Samburu and (6) Turkana, Kenya; (7) Lovu and (8) Yasawa, Fiji; (9) Huatasani, Peru; (10) Kananga, Democratic Republic of Congo; (11) Mysore, India; (12) Tyva, Russia; (13) Hadza, Tanzania; (14) Sursurunga, Papua New Guinea; and (15) Mauritius (see Table 2 for basic site characteristics). Due to divergent religiosity measures at the Hadza site, we were forced to exclude all participants from this site from both waves. Recruitment for this study was conducted via different methods at different sites, though random sampling on the street was the most common (See Supplementary Materials in Lang et al., 2019 for details). Sites that collected data over two waves sampled different participants at each time; we therefore use data from both waves in these sites. For the purposes of this study we excluded participants from our analyses for whom we had no

information on gender, or who did not identify as male or female. After implementing these criteria, we had a working sample size of 2002 participants (1,126 women; Mean age = 36.9, SD = 14.87) from 14 field sites.

Table 2. Site descriptions

Site	Wave	N	% Female	Moralistic God	Local God	Sampling	Economy
Cachoeira	II	262	68	Christian God	Candomblé God (<i>Ogum</i>)	Chain sample (temples)	Market
Coastal Tanna	I + II	178	50	Christian God	Garden spirit (<i>Tupunus</i>)	Cluster sample (census)	Horticulture
Huatasani	II	94	61	Christian God	Mountain Spirits/Christian Saints	Random/chain sample (street)	Farming/ Herding
Inland Tanna	I + II	112	49	<i>Kalbaban</i> (Traditional)	Garden spirit (<i>Tupunus</i>)	Entire community	Horticulture
Kananga	II	200	61	Christian God	<i>Kadim</i> /Ancestor spirits	Random sample (census)	Market
Lovu	I	76	68	Hindu Bhagwan	None available	Door-to-door	Market
Marajó	I	77	52	Christian God	Virgin Mary	Random sample (census)	Market
Mauritius	I + II	243	41	Hindu Shiva	Spirit (<i>Nam</i>)	Random sample (street)	Market/ Farming
Mysore	II	165	43	Hindu Shiva	Chamundeshwari	Random sample (street)	Market
Samburu	II	40	70	Christian God (<i>Nkai</i>)	None available	Random sample (households)	Herding
Sursurunga	II	163	55	Christ. God (<i>Káláu</i>)	Spirit (<i>Sírmát</i>)	Random/chain sample (street)	Horticulture
Turkana	II	236	61	Christ. God (<i>Aku</i>)	Ancestor spirits	Door-to-door	Herding
Tyva	I	81	72	Buddha Burgan	Spirit-masters (<i>Cher eezi</i>)	Random/chain sample (street)	Market/ Herding
Yasawa	I	75	55	Christian God	Ancestor spirits (<i>Kalou-vu</i>)	Door-to-door (cluster)	Fishing/ Farming

Religiosity measures. We attempted to measure commitment to two supernatural agents at each site: one deity highly concerned with interpersonal moral conduct (“moralistic god”), and another supernatural agent of local importance expected to have less concern for moral conduct (“local god”). Moral concern was defined as concern for behaviours such as lying, theft, or murder. These two kinds of supernatural agents were chosen at each site following ethnographic interviews about local religious beliefs and traditions (Lang et al., 2019; Purzycki et al., 2016a). Religiosity surveys were then conducted at each site targeting different aspects of religious beliefs and practices towards each culture’s moralistic and local gods. For the present study, we utilise measures of religiosity that target specific aspects of mental and behavioural religious commitment.

We develop composite measures of mental and behavioural religiosity. Our primary measure of *mental commitment* to moralistic and local gods was calculated by combining scores on two five-level ordinal measures: how frequently one thinks about each deity, and how frequently one worries about what each deity thinks about them. The scores on each composite measure were then standardised between 0 and 1. Our primary measure of *behavioural commitment* to moralistic and local gods was how frequently one engages in practices that involve talking to, or appeasing, each deity. We also obtained data from some sites on three more specific aspects of religious commitment; a yes/no measure of stated belief in the population’s moralistic and local gods (hereafter *belief*); how frequently one performs rituals or ceremonies devoted to moralistic and local gods (hereafter *ritual practices*); and how frequently one engages in prayer (hereafter *prayer*) at some Hindu and Christian sites. We conceptualise prayer as a ‘special case’ of behavioural commitment associated with the world religions in our sample, comprising communication with a deity or deities, often but not always accompanied by a personal request for help. While our initial ethnographic interviews at each site showed that all cultures indicated regular engagement in practices to talk to or appease their moralistic gods, many of these

cultures lacked a distinct conceptualisation of private prayer. In addition, since prayer questions were only included in the Wave II protocol, prayer was not asked about at sites that only took part in Wave I.

Participants were also asked a range of questions concerning beliefs about each deity, some of which we use to test predictions derived from the different explanations of the gender gap (for the scales of each dependent and independent religiosity measure used, see Supplementary Information Section 1). First, we used perceived punitiveness of each deity as a proxy for supernatural risks for irreligiosity. This was operationalized as the mean score of three ordinal responses concerning how often each participant thinks the deity punishes people for a) lying, b) stealing, and c) murder. Second, we utilise a binary measure of whether or not the respondent believes that the moralistic or local god can influence life after death. Finally, we use an ordinal measure of how often one's moralistic or local god rewards people for good behaviour.

Demographic measures. Participants at all sites were asked the same series of demographic questions. We use a variety of these measures to test explanations for the religiosity gender gap; these include marital status, the number of days one usually works for a wage or goes to market per month, age, number of children, years of formal education, and logged annual income in USD. We consider two proxies of social status; 1) annual income (in USD) relative to others in one's community, which we operationalise as income split into quintiles for each site, and 2) years of formal education. In addition, we proxy perceived food insecurity by summing scores on four binary questions; whether one is, or is not, worried that one's household will have a time when it is not able to buy or produce enough food in the next a) week, b) month, c) year, and d) five years (Hruschka et al., 2014; Purzycki et al., 2018).

We also consider country-level data including the share of women in paid employment, GDP per capita, and gender inequality. These measures were obtained from the United Nations

Development Programme (UNDP) Human Development Data (HDD) reports from 1990-2015. Estimates of male to female sex ratios in the population were obtained from the CIA World Factbook. For each site, we used national level data from the most recent estimate available.

Analyses. Analyses were conducted using linear regressions with appropriate distributions for each outcome variable. Our composite mental commitment measure was fit using ordinary least-squares regressions. Ordinal outcome measures (behavioural commitment, ritual practices and prayer) were fit with ordered logit models. The binary outcome measures (belief in moralistic and local gods) were fit with logistic regressions. As our data are nested within different populations, we included higher-level random intercept effects for site when we ran models on more than two sites. We do not include a site-level slope term for gender in the global analysis. The effect of gender reported in our global analysis is therefore the average gender effect weighted across populations in our sample. All models include a global mean-centred fixed effect for participant age. To provide more interpretable gender coefficients in analyses that involve moderation, we mean-centred all numeric, non-binary, moderators before running analyses.

Our analyses were conducted in two parts. First, we quantified the religiosity gender gap by regressing gender on each dependent measure of religiosity. These models do not address the causes of the gender gap and therefore did not control for any additional variables. Second, we tested the hypotheses that attempt to explain the gender gap. As we only aimed to explain gender differences in religiosity where they existed, and because the accounts we test claim to explain women's greater religiosity, we only tested our explanatory hypotheses on the religiosity measures where women rated themselves as significantly more religious across the whole sample. All mediations were carried out by calculating the Average Causal Mediation Effects (ACME) and Average Direct Effect (ADE) estimated within the Mediation package in R (Tingley et al., 2014). We estimated quasi-Bayesian Monte Carlo confidence intervals with

5000 bootstrap resamples for all mediation analyses. As the Mediation package is incompatible with hierarchical ordinal models, we ran multilevel OLS regressions when calculating ACME and ADE effects on ordinal dependent variables.

To model population-level predictors of the religiosity gender gap, we included the relevant national-level variables as fixed effects in regression analyses. We include random intercept effects for site, and random slope effect for gender, thus allowing every site to have its own effect of gender. To facilitate model identification, group-level variables were mean-centred and scaled by dividing the centred values of each variable by their standard deviations.

Results

Quantifying the religiosity gender gap

Do women report greater religiosity than men?

For the subset of sites where we had other measures of religious commitment, we found that overall women expressed 1.4 times the odds of a given frequency of ritual practice to their moralistic god compared to men (OR = 1.39, 95% CI = [1.13, 1.72], $p = 0.002$; Figure 1A), and 1.5 the odds of reporting above a given frequency of prayer (OR = 1.50, 95% CI = [1.16, 1.93], $p = 0.002$; Figure 1A). In addition, we found that across sites, women had twice the odds as men of believing in the moralistic god (OR = 1.96, 95% CI = [0.83, 4.96], $p = 0.136$). However,, though this effect was not statistically significant at the 0.05 level. The non-significance is not surprising given 98% of participants across our sample indicated they believed in the moralistic god, leaving little variation in belief for the model to explain. Consequently, we did not estimate site-level gender differences in belief in the moralistic god or include it in subsequent analyses testing explanations for gender differences in religiosity.

In contrast to the moralistic god data, we find no evidence that women show greater religious commitment than men towards local gods - if anything, men report greater commitment than women to local gods (See Figure 1b; Table S1 in Supplementary Materials Section 2). Regarding our primary measures of religious commitment, women had 0.73 odds of reporting above a given frequency of behavioural commitment to local gods compared to men (OR = 0.73, 95% CI = [0.59, 0.91], $p = 0.005$) and tend to report lower mental commitment to local gods, although the latter is not statistically significant at the 0.05 level ($\beta = -0.02$, 95% CI = [-0.06, 0.01], $p = 0.215$). For the subset of sites where we had other measures of religious commitment, we do not find reliable differences for gender effects on reported frequency of ritual practices to local gods (OR = 0.98, 95% CI = [0.76, 1.26], $p = 0.860$). Women do report lower rates of belief in local gods, although again, this is not statistically significant at the 0.05 level (OR = 0.86, 95% CI = [0.63, 1.17], $p = 0.342$).

Is the gender gap consistent across sites?

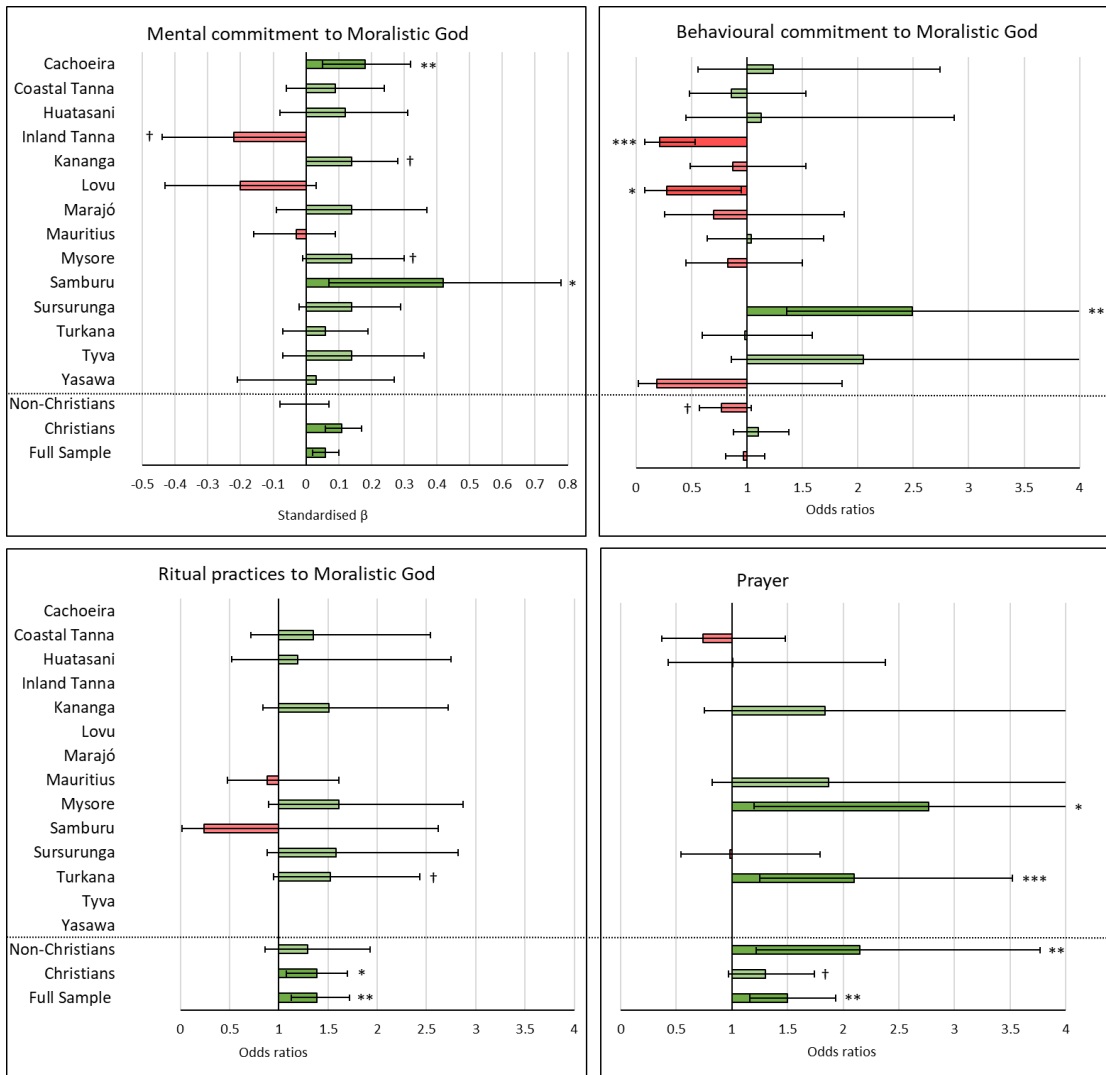
Figure 1 reveals considerable variation in the size and direction of gender differences in religiosity between sites. No religiosity measures showed a consistent direction in gender differences across all sites, although prayer and ritual practices towards the moralistic god came close, with women scoring higher than men at all sites except Coastal Tanna (prayer) and Samburu (ritual practices). Our two primary measures of religious commitment to moralistic gods – mental commitment and behavioural commitment – include sites at which women report significantly higher commitment and sites at which men report significantly higher commitment. Commitment to local gods also shows considerable variation across sites, with Inland and Coastal Tanna notable as showing significantly higher levels of commitment to local gods among men across several measures (Figure 1; Table S1 in Supplementary Materials Section 2).

Is the gender gap a Christian phenomenon?

We find some evidence that the size of the gender gap in religious commitment varied between sites with the Christian moralistic god versus non-Christian moralistic gods (Figure 1a; Table S1 in Supplementary Materials Section 2). While women at Christian sites indicated greater mental commitment to their moralistic gods than men, $\beta = 0.11$, 95% CI = [0.06, 0.17], $p < 0.001$, participants in non-Christian sites showed no gender gap in this measure, $\beta = 0.00$, 95% CI = [-0.08, 0.07], $p = 0.949$. The interaction between site religion (Christian versus non-Christian) and gender was significant at the 0.05 level, providing support for the claim that the gender gap in mental commitment was greater at Christian sites (See supplementary Table S2). Behavioural commitment towards moralistic gods showed a small difference in the gender gap between Christian (OR = 1.10, 95% CI [0.88, 1.38], $p = 0.402$) and non-Christian (OR = 0.77, 95% CI = [0.57, 1.04], $p = 0.084$) sites, though this difference was only significant at the 0.1 level, OR = 0.69 95% CI = [0.47, 1.02], $p = 0.060$ (Supplementary Table S2). At the subset of sites for which we have data, frequency of participation in ritual practices towards moralistic gods also showed no appreciable difference in the gender gap between Christian and non-Christian sites (Supplementary Table S3). Women indicated greater frequency of prayer than men at the five Christian sites (OR = 1.30, 95% CI = [0.97, 1.74], $p = 0.085$) and two non-Christian Hindu sites (OR = 2.15, 95% CI = [1.22, 3.77] $p = 0.008$), although the effect was significantly larger at the Hindu sites (OR = 1.97, 95% CI = [1.05, 3.72], $p = 0.036$; Table S1 in Supplementary Materials Section 2) where women were nearly twice as likely as men to report scores above a given frequency of prayer.

Gender gaps in belief in, and mental or behavioural commitment to local gods were not different at sites with the Christian moralistic god compared to non-Christian sites (Supplementary Tables S2 & S3).

A



B

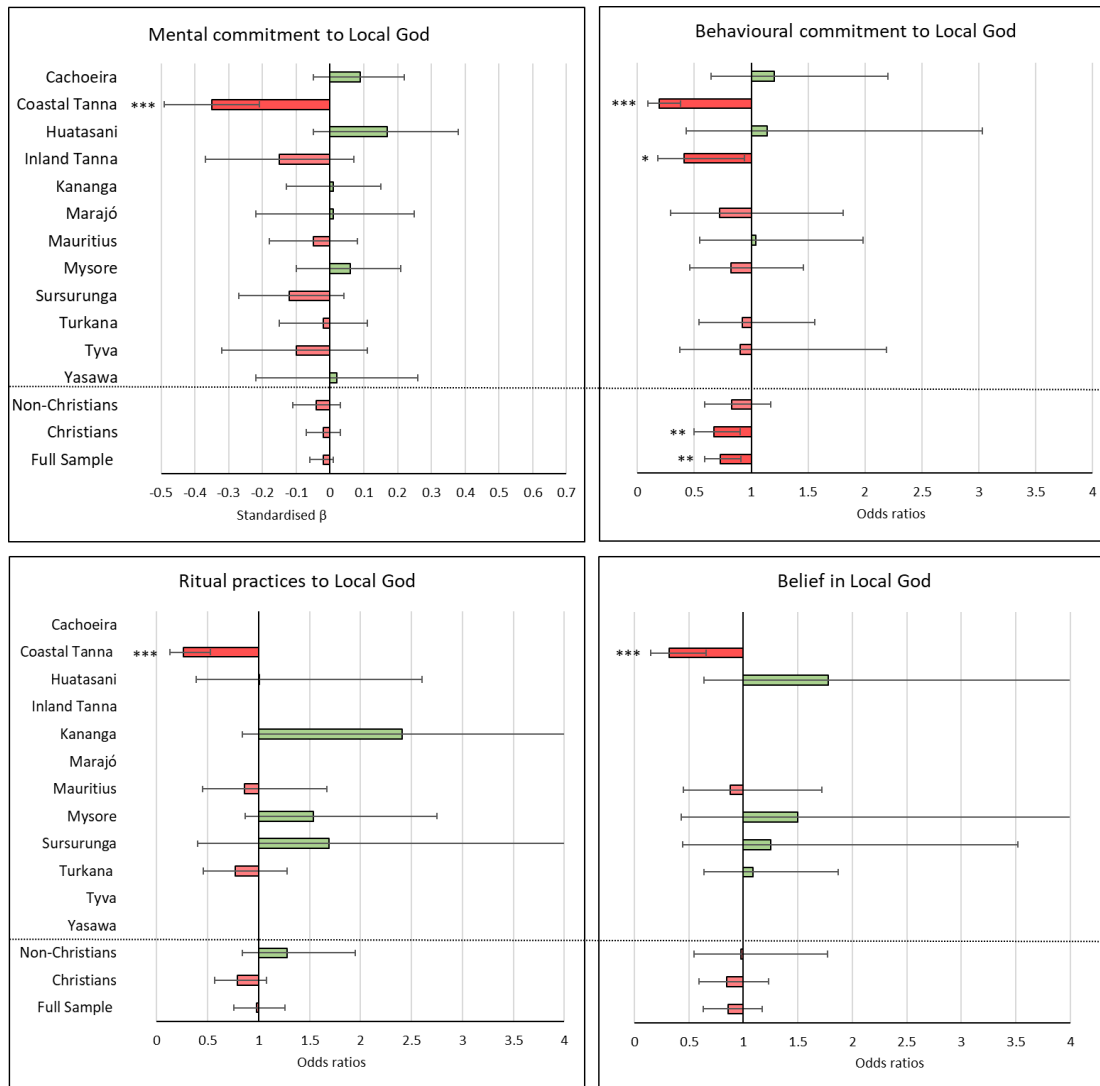


Figure 1. Coefficients of gender, predicting each measure of religiosity to A) Moralistic and B) Local gods by site and across sites. Men were the reference category in each model: positive β -estimates and Odds ratios greater than one indicate greater female religiosity. All error bars represent 95% confidence intervals. All models included a mean-centred effect of participant age across sites where the model included participants from multiple sites. Where number of sites was greater than two, models predicting religiosity across several groups (below dashed line) included a higher-level effect for site. The gender coefficients for prayer for the Samburu and Inland Tanna sites are not shown due to prayer being at ceiling and insufficient sample size ($n = 9$), respectively. Kananga data are not presented for belief in Local God as all participants at this site indicated a lack of belief in their local god. Kananga, Yasawa & Sursurunga data are not presented for belief in Local God as these models could not converge due to low variation, with observations clustered around zero. † $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

What explains the religiosity gender gap?

Table 1 summarizes results from tests of hypotheses derived from the risk aversion, reproductive morality, mentalizing and structural location accounts for greater religiosity among women. As we only sought to explain the gap where it existed across our sample, we tested predictions on three measures of religiosity: mental commitment to moralistic god, frequency of ritual practices to moralistic god, and frequency of prayer. Whilst elements of some predictions were confirmed, none of the explanations we tested received unqualified support. Below we summarize the key findings. A detailed report of all the tests is available in the Supplementary Material Section 3.

Risk aversion

We find no support for hypotheses derived from the risk aversion account, that beliefs about a deity's perceived punitiveness or influence over life after death (H1A; supplementary Tables S4 & S5) or that average religiosity of one's community (H1B; supplementary Table S6) would increase the gender gap. Indeed, contra H1A, belief in perceived punitiveness was, in fact, reduced religiosity in women relative to men (see supplementary Table S5; Figure S1).

Reproductive strategy

Our findings summarized in Figure 1 show that, consistent with H2A, women reported greater religiosity than men on three out of four measures of religiosity towards the moralistic god. However, one of our primary measures of religiosity, behavioural commitment to the moralistic god, showed no overall difference between men and women. Further, we find evidence that religious commitment to local gods is, if anything, greater among men, which cannot be explained by the reproductive strategy account.

The regression results in Supplementary Table S7 indicate that divorced men were less mentally committed to their moralistic god, controlling for age, but we find no evidence of this across the other religiosity measures, nor do we find an effect of being single across any religiosity measure (H2B). We find no support for the prediction that high-status men (as proxied by income or education) are less religious than low status men, and women (H2C; supplementary Tables S8 & S9), nor do we find support for the prediction that the religiosity gender gap is smaller in populations with higher single male to female sex (H2D; supplementary Table S10).

Mentalizing

In partial support of the mentalizing account, women report greater mental commitment towards moralizing gods (H3A; Figure 1). Mental commitment to moralistic gods also partially mediates the effect of gender on ritual participation and prayer (Table 3), explaining around a third and a fifth of the gender effect in ritual practices to moralistic god and prayer, respectively. However, our finding that religious commitment to local gods is, if anything, greater among men, is not consistent with the mentalizing account as a general explanation for gender differences in religiosity.

Table 3. Results of a mediation analysis, testing whether the gender gaps in ritual practices to moralistic god and prayer are mediated by mental commitment to moralistic god.

	Ritual practices to Moralistic God	Prayer
ACME	0.08*** [0.04, 0.13]	0.05** [0.02, 0.08]
ADE	0.14* [0.01, 0.28]	0.19** [0.08, 0.29]
Total Effect	0.22** [0.08, 0.37]	0.23*** [0.12, 0.35]
Prop. Mediated	0.36** [0.16, 0.91]	0.21** [0.08, 0.42]

Note: Numbers in square brackets indicate quasi-Bayesian Monte Carlo confidence intervals with 5000 bootstrap resamples. ACME, average causal mediation effect; ADE, average direct effect; prop., proportion. Mediation models included a mean-centred effect of participant age and a higher-level effect of participant site. * $p < .05$. ** $p < .01$. *** $p < .001$.

Structural location

We find no support for the two general predictions derived from the structural location account – that gender differences in workforce participation should mediate the relationship between gender and religiosity (H4A; supplementary Table S12) and that populations with a greater proportion of women in paid employment should have smaller gender gaps (H4B; supplementary Table S13).

Regarding the social networks and support version of the structural location account, we find evidence that women participate in rituals towards moralistic gods and pray more frequently than men on average, and that these measures of religiosity partially mediate the gender gap in mental commitment to moralistic gods (H4C; supplementary Table S14), each explaining about a third of the gender gap in mental commitment to moralistic gods. However, women did not score higher than men across sites on our primary measure of behavioural commitment towards moralistic gods. Further, we found no evidence that the gender gap was greatest for women with greater need for child-rearing support (i.e. it was not moderated by parents' age and number of children; H4D; supplementary Table S15), nor was the gap explained by gender differences in time spent at market (H4E; supplementary Table S16).

We find evidence of a mediation effect of formal education on the religiosity gender gap in mental commitment and ritual participation to moralistic god (See Table 17), though this effect was small, explaining around a tenth of the main effect of gender on these measures of religiosity, and was only significant at the 0.1 level in the latter measure. We find no significant mediation effect of years of education on the religiosity gender gap in prayer.

Table 4. Results of a mediation analysis, testing whether the gender gap in religiosity is mediated by years of formal education.

	Mental commitment to Moralistic God	Ritual practices to Moralistic God	Prayer
ACME	0.003*** [0.00, 0.01]	0.02† [-0.00, 0.05]	0.01 [-0.00, 0.03]

ADE	0.026** [0.01, 0.05]	0.19* [0.04, 0.33]	0.22*** [0.11, 0.33]
Total Effect	0.030** [0.01, 0.05]	0.21** [0.07, 0.35]	0.23*** [0.12, 0.34]
Prop. Mediated	0.109** [0.03, 0.37]	0.10† [-0.00, 0.39]	0.05 [-0.02, 0.16]

Note: Numbers in square brackets indicate quasi-Bayesian Monte Carlo confidence intervals with 5000 bootstrap resamples. ACME, average causal mediation effect; ADE, average direct effect; prop., proportion. Mediation models included a mean-centred effect of participant age and a higher-level effect of participant site. * $p < .05$. ** $p < .01$. *** $p < .001$.

We also find little support for the existential security version of the structural location account. Like the reproductive strategy account and the mentalizing account, the existential security version of the structural location account predicts women will show greater religiosity towards moralistic but not local gods. As noted above and summarized in Figure 1a, women report greater religiosity than men on three out of four measures of religiosity towards the moralistic god, but we find no gender gap in behavioural commitment to moralistic gods across sites. Further, the existential security account cannot explain the greater religious commitment to local gods we observe among men (Figure 1). We find no evidence that the observed gender gap in religious commitment to moralistic gods is greater among women who believe in a rewarding god, or a god who can influence life after death (H4G; supplementary Tables S5 & S18). Likewise, we find no support for the prediction that the religiosity gender gap is greater in societies with higher levels of economic insecurity (H4H; supplementary Table S19) or gender inequality (H4I; supplementary Table S20). Finally, whilst women report greater material insecurity than men, we find no evidence that material insecurity mediates the effect of gender on mental commitment or ritual practices towards moralistic gods, or prayer (H4J; supplementary Table S21).

Discussion

Our results, combining multiple measures of religiosity across 14 diverse societies reveal a complicated relationship between gender and religiosity. Across our sample, women generally

reported greater mental commitment towards their communities' moralistic gods than men. Data from a subset of sites also shows women generally reported a higher frequency of ritual participation towards moralistic gods and a higher frequency of prayer, but we find no gender gap in our primary measure of behavioural commitment to moralistic gods across sites. Strikingly, women generally scored no higher than men on any of our local god religiosity measures. In fact, men generally reported greater local god religiosity than women. Notwithstanding these general trends, all of our religiosity measures show considerable variation across sites in the size and direction of gender differences in religiosity.

These findings undermine claims that women are universally more religious than men. When discussing gender differences in religiosity, our results suggest whether we are talking about mental or behavioural commitment matters, which behaviours we consider matters, the nature of the deity matters, the cultural context matters, and these factors may interact in complex ways. Intriguingly, we find some evidence that the gender gap in mental commitment to the community's moralistic god is greater in communities where that god is the Christian god. However, the other measures of religious commitment to moralistic gods do not show this pattern, and for prayer we find the reverse – it is the two Hindu communities where we find the greatest gender gap. This counts against the argument that greater religiosity among women is a uniquely Christian phenomenon.

Given these complex patterns, it is perhaps no surprise that none of the suite of explanations for greater religiosity among women that we evaluated received unqualified support. Of the 17 hypotheses evaluated in Table 1, twelve were not supported and five received partial support. Of the five hypotheses receiving partial support, four related to where we would observe the gender gap in religiosity – the reproductive strategy (H2B) and mentalizing (H3A) accounts, as well as the social support (H4C) and existential security (H4G) versions of the structural location accounts, predicted women would score higher than men on at least some measures of

religious commitment to moralistic gods but not (or to a lesser degree) for local gods. The mentalising account (H3A) also predicted that, consistent with our data, the gender gap would be clearest for mental commitment to the community's moralistic god. However, none of these explanations predicted that men's religious commitment towards local gods would be at least as high as women's. Further, whilst we found that mental commitment to moralistic god partially mediated the effect of gender on ritual participation and prayer (consistent with the mentalising account, H3A), we also found that ritual participation and prayer partially mediated the effect of gender on mental commitment to moralistic gods (consistent with the social support version of the structural location account, H4C). The fact that we find evidence for mediation in both directions means we can say little about the likely drivers of the relationship, other than that the two measures are moderately correlated.

The fifth hypothesis to receive partial support was the prediction, under the secularization version of the structural location account, that years of formal education would mediate the effect of gender on religious commitment (H4F). We found support for this prediction concerning mental commitment and ritual participation towards moralistic gods, although the latter was only significant at the 0.1 level. This finding is consistent with the argument that women's reduced access to formal education across our sites has meant that they have been less exposed to secular ideas and values through the education system and therefore are less likely to have given up on religion than men (Berger, 1967; Trzebiatowska & Bruce, 2012). While the mediation effect of formal education is weak, this may reflect features of our sample. Many participants may have attended religiously affiliated schools that could have included religious instruction, potentially attenuating any secularising effect of education. In addition, roughly half our sample did not complete primary school, with only about one fifth completing secondary school. If the effects of formal education on religiosity relate primarily to post-secondary education, this may not be evident in our sample.

Perhaps the clearest pattern in our data is the finding that women score higher than men on measures of religiosity towards moralising gods, but not towards local gods. This raises the possibility that some features of world religions and their powerful moralising deities have evolved to be more appealing to women. Stark (1996) has previously proposed that Christianity was successful in part because it appealed more to women, who were then more likely to pass on their faith to their children. Such a process could have selected for supernatural beliefs and rituals that increasingly appealed to women in Christianity and other world religions as they spread into larger, more complex societies. Consistent with this explanation for the patterns we observe, the only community that did not have a moralistic god from a world religion (*Kalbaban* in Inland Tanna) was also the only community in which men showed a significantly greater commitment to their moralistic god than women. Some of the gender gap explanations we evaluate represent possible mechanisms through which feminization of beliefs and practices could be achieved - by appealing more to female reproductive strategies, mentalizing abilities or existential insecurity – but the broader suite of hypotheses we tested failed to find clear support for any one of these mechanisms as an explanation for current variation in the gender gap.

Crucially, the above explanation allows for the possibility that men and women are drawn to different aspects of their societies deities and may even represent the same gods in different ways. To the extent that the differential gender roles mean that men are more likely to regularly engage in activities that elicit fundamental needs such as success in conflict, hunting, farming, and acquiring wealth and status, they could be drawn to deities that are associated with traditionally masculine traits and domains of interest (Baker & Whitehead, 2020; Cassese & Holman, 2017). Relatedly, while women tend to report greater rates of belief in a wide range of pseudoscientific (Wilson, 2018) and paranormal subjects (Irwin, 2001; Vitulli et al., 1999),

there is some evidence that men could be more likely to profess belief in agentic extraordinary life forms, such as UFOs (Rice, 2003). Together, these findings suggest that men could be drawn to agentic paranormal beings who might interfere in male-associated domains. In Tanna, for example, we find some evidence that the Tannese men indicate greater religiosity towards their society's local god, local supernatural forces like *Tupunus* and *Kapiel*, which are important religious agents, but are predominantly associated with traditionally male domains of gardening and weather control (See Vardy & Atkinson, in this Special Issue). One prediction elicited by these ideas is men should therefore be more likely to be drawn to more punitive, and women more benevolent, aspects of their society's deities. However, when we test this with our data, we find no evidence that men believe that their deity is more punitive ($b = 0.02$, 95% CI = [-0.00, 0.05], $p = 0.10$) or that women tend to believe that their deity is more rewarding (OR = 1.14, 95% CI = [0.95, 1.37], $p = 0.148$), thus failing to support this prediction.

While we sought to explain the religiosity gender gap by testing some of the most developed theoretical accounts, we were unable to test every possible explanation; future lines of enquiry might explore a range of other accounts not included here. Future studies might consider, for example, whether gender differences in religiosity might have developed as a consequence of religion's ability to facilitate parental cooperation through sexual signalling and mate discrimination (Bulbulia et al., 2015). According to this account, aspects of religion which can signal mate value in ways that are biased towards one gender, for example prayer as a signal of a female's fidelity in a domestic setting, could lead to gender differences in these domains. Another potential avenue for investigation could be to consider the role of acute existential risk on gender differences in religiosity. It is possible that an 'existential anxiety' account has greater explanatory power in contexts of severe existential risk, for example where death in childbirth is common, or where women regularly suffer from serious forms of marginalisation.

While these kinds of risks may be prevalent among our societies, we lack adequate data to test this idea.

While we can remain agnostic about the origins of some of the gender differences that precipitate the religiosity gender gap, more developmental approaches might consider the pathways through which the relevant gender differences are acquired and expressed through the life course. Intriguingly, a survey of the transgender community in the US showed higher rates of religious affiliation among transgender women than transgender men (Rosser et al., 2007)). This suggests the importance of adult gender roles rather than early developing factors in the expression of religiosity.

We note several general limitations to these findings. First, our measure of mental commitment to moralistic gods exhibited low variation at some sites, with maximum commitment being the mode across all sites. This may partly be a consequence of a reliance on three or four-point Likert scales, restricting variation around each level of this variable. Other measurements of religiosity in future may improve estimates of the gender gap and religiosity more generally. Second, the predictor variables available in our dataset were not designed for the purpose of testing between the four explanations for the gender gap evaluated here. In addition, the national-level variables we used to test some hypotheses do not account for variation within nations and specific features of each study site. It may be that measures that more precisely target the mechanisms and sites of interest will reveal a clearer picture of the underlying causes of gender differences in religiosity. Third, despite sampling from a diverse array of populations practicing various religious traditions, most of our sites were primarily Christian communities, none were Muslim and only one was not dominated by a world religion. Our findings reinforce the importance of cultural context on gender differences in religiosity and highlight the need for more work on yet more diverse religious traditions. Fourth, more work is needed to examine how the variables of interest might interact to produce or explain gender effects in religiosity;

for example, while we test the interactions between gender, education, and relative income separately, we do not consider three-way interactions in our models, or any of the multitude of more complex interactions that are possible. Our sample size, the number of variables involved, and potential problems with multicollinearity when fitting models with multiple levels of interaction, mean it is not possible to test these more complex models.

Despite these limitations, overall, our results show that across 14 diverse societies women generally reported greater religiosity than men towards their communities' moralistic god on measures of mental commitment and ritual participation, as well as frequency of prayer. Further, we provide some of the first evidence that greater religiosity among women appears limited to moralistic gods; if anything, men indicate greater religiosity towards local deities. Whilst we failed to find unambiguous support for any particular explanation for the gender gap, the pattern of religiosity we observe is broadly consistent with the feminization of some world religions. This suggests that explaining any gender gap in religiosity is likely to require going beyond simplistic appeals to evolved differences between the male and female mind, to consider how processes of cultural evolution can select for traditions that differentially exploit the minds and social roles of men and women.

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Author contributions

T.V. and Q.D.A conceived the project and drafted the manuscript with C.M., M.L., C.P., M.S. and J.H. C.L.A., Q.D.A., A.B., E.C., E.K.K., C.H., C.L, S.M., R.A.M., C.M., C.P., B.G.P, M.S., T.V., J.L.W., A.K.W., and D.X. collected data. T.V. conducted all analyses and made all graphs and tables. All authors provided input on methods and the manuscript.

References

- Argyle, M., & Beit-Hallahmi, B. (1975). *The Social Psychology of Religion*. Routledge & K. Paul.
- Baker, J. O., & Whitehead, A. L. (2020). God's penology: Belief in a masculine God predicts support for harsh criminal punishment and militarism. *Punishment & Society*, 22(2), 135–160. <https://doi.org/10.1177/1462474519850570>
- Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders*, 34(2), 163–175.
- Barrett, Justin. L. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, 4(1), 29–34.
- Bateman, A. J. (1948). Intra-sexual selection in *Drosophila*. *Heredity*, 2(3), 349–368.
- Beit-Hallahmi, B., & Argyle, M. (1997). *The Psychology of Religious Behaviour, Belief and Experience*. Routledge.
- Berger, P. L. (1967). *The Sacred Canopy: Elements of a Sociological Theory of Religion*. Doubleday.
- Booth, A., & Dabbs, J. M. (1993). Testosterone and Men's Marriages. *Social Forces*, 72(2), 463–477. <https://doi.org/10.1093/sf/72.2.463>

- Brown, G. R., Laland, K. N., & Mulder, M. B. (2009). Bateman's principles and human sex roles. *Trends in Ecology & Evolution*, *24*(6), 297–304.
- Bulbulia, J., Shaver, J., Greaves, L., Sosis, R., & Sibley, C. (2015). *Religion and parental cooperation: An empirical test of Slone's sexual signaling model* (pp. 29–62).
- Byrnes, J., Miller, D., & Schafer, W. D. (1999). *Gender Differences in Risk Taking: A Meta-Analysis* (Vol. 125). <https://doi.org/10.1037/0033-2909.125.3.367>
- Cassese, E. C., & Holman, M. R. (2017). Religion, Gendered Authority, and Identity in American Politics. *Politics and Religion*, *10*(1), 31–56.
- Chen, D. L. (2010). Club Goods and Group Identity: Evidence from Islamic Resurgence during the Indonesian Financial Crisis. *Journal of Political Economy*, *118*(2), 300–354. <https://doi.org/10.1086/652462>
- Chesnut, R. A. (2003). *Competitive spirits: Latin America's new religious economy*. Oxford University Press.
- Collett, J. L., & Lizardo, O. (2009). A power-control theory of gender and religiosity. *Journal for the Scientific Study of Religion*, *48*(2), 213–231.
- Cornwall, M. (1989). Faith Development of Men and Women over the Life Span. In Stephen J. Bahr & Evan T. Peterson (Eds.), *Aging and the Family* (pp. 115–139). Lexington Books.
- Davie, G. (1990). Believing without Belonging: Is This the Future of Religion in Britain? *Social Compass*, *37*(4), 455–469. <https://doi.org/10.1177/003776890037004004>
- de Vaus, D., & McAllister, I. (1987). Gender Differences in Religion: A Test of the Structural Location Theory. *American Sociological Review*, *52*(4), 472. <https://doi.org/10.2307/2095292>

- Feltey, K. M., & Poloma, M. M. (1991). From sex differences to gender role beliefs: Exploring effects on six dimensions of religiosity. *Sex Roles, 25*(3–4), 181–193.
<https://doi.org/10.1007/BF00289853>
- Francis, L. J. (1997). The psychology of gender differences in religion: A review of empirical research. *Religion, 27*(1), 81–96.
- Gervais, W. M., Xygalatas, D., McKay, R. T., Elk, M. van, Buchtel, E. E., Aveyard, M., Schiavone, S. R., Dar-Nimrod, I., Svedholm-Häkkinen, A. M., Riekkki, T., Klocová, E. K., Ramsay, J. E., & Bulbulia, J. (2017). Global evidence of extreme intuitive moral prejudice against atheists. *Nature Human Behaviour, 1*(8), s41562-017-0151–017.
<https://doi.org/10.1038/s41562-017-0151>
- Gottfredson, M. R., & Hirschi, T. (1990). *A General Theory of Crime*. Stanford University Press.
- Gove, W. (1985). The Effect of Age and Gender on Deviant Behavior: A Biopsychosocial Perspective. In A. S. Rossi (Ed.), *Gender and the Life Course* (p. 115:144). Aldine.
- Hackett, C., Cooperman, A., Schiller, A., & Cornibert, S. S. (2016). *The Gender Gap in Religion Across the World*. Pew Religion and Public Life Project.
<http://www.pewforum.org/2016/03/22/the-gender-gap-in-religion-around-the-world/>
- Hoffmann, J. P. (2009). Gender, Risk, and Religiousness: Can Power Control Provide the Theory? *Journal for the Scientific Study of Religion, 48*(2), 232–240.
- Hruschka, D., Efferson, C., Jiang, T., Falletta-Cowden, A., Sigurdsson, S., McNamara, R., Sands, M., Munira, S., Slingerland, E., & Henrich, J. (2014). Impartial Institutions, Pathogen Stress and the Expanding Social Network. *Human Nature, 25*(4), 567–579.
<https://doi.org/10.1007/s12110-014-9217-0>
- Irwin, H. J. (2001). Age and sex differences in paranormal beliefs after controlling for differential item functioning. *European Journal of Parapsychology, 16*, 102–106.

- Johnson, D., & Krüger, O. (2004). The good of wrath: Supernatural punishment and the evolution of cooperation. *Political Theology*, 5(2), 159–176.
- Kirkpatrick, L. A. (2005). *Attachment, Evolution, and the Psychology of Religion*. Guilford Press.
- Kokko, H., & Jennions, M. (2003). It takes two to tango. *Trends in Ecology & Evolution*, 18(3), 103–104.
- Kurzban, R., Dukes, A., & Weeden, J. (2010). Sex, drugs and moral goals: Reproductive strategies and views about recreational drugs. *Proceedings of the Royal Society B: Biological Sciences*, 277(1699), 3501–3508. <https://doi.org/10.1098/rspb.2010.0608>
- Lang, M., Purzycki, B. G., Apicella, C. L., Atkinson, Q. D., Bolyanatz, A., Cohen, E., Handley, C., Kundtová Klocová, E., Lesorogol, C., & Mathew, S. (2019). Moralizing gods, impartiality and religious parochialism across 15 societies. *Proceedings of the Royal Society B*, 286(1898), 20190202.
- Lazerwitz, B. (1961). Some Factors Associated with Variations in Church Attendance. *Social Forces*, 39(4), 301–309.
- Luckmann, T. (1967). *The Invisible Religion: The Problem of Religion in Modern Society*. Macmillan.
- Maij, D. L., van Harreveld, F., Gervais, W., Schrag, Y., Mohr, C., & van Elk, M. (2017). Mentalizing skills do not differentiate believers from non-believers, but credibility enhancing displays do. *PloS One*, 12(8).
- Martin, D. (1967). *A Sociology of English Religion*. SCM.
- Miller, A. S., & Hoffmann, J. P. (1995). Risk and Religion: An Explanation of Gender Differences in Religiosity. *Journal for the Scientific Study of Religion*, 34(1), 63. <https://doi.org/10.2307/1386523>

- Miller, A. S., & Stark, R. (2002). Gender and religiousness: Can socialization explanations be saved? *American Journal of Sociology*, *107*(6), 1399–1423.
- Mitchell, J. P. (2009). Inferences about mental states. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1309–1316.
- Moberg, D. (1962). *The Church as a Social Institution*. Prentice-Hall.
- Norenzayan, A., Gervais, W. M., & Trzesniewski, K. H. (2012). Mentalizing Deficits Constrain Belief in a Personal God. *PLoS ONE*, *7*(5), e36880.
<https://doi.org/10.1371/journal.pone.0036880>
- Norris, P., & Inglehart, R. (2008). Existential security and the gender gap in religious values. *Conference on Religion and International Affairs, New York, NY*.
- Parker, G. A., & Birkhead, T. R. (2013). Polyandry: The history of a revolution. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *368*(1613), 20120335–20120335. <https://doi.org/10.1098/rstb.2012.0335>
- Purzycki, B. G., Apicella, C., Atkinson, Q. D., Cohen, E., McNamara, R. A., Willard, A. K., Xygalatas, D., Norenzayan, A., & Henrich, J. (2016a). Moralistic gods, supernatural punishment and the expansion of human sociality. *Nature*, *530*(7590), 327–330.
<https://doi.org/10.1038/nature16980>
- Purzycki, B. G., Apicella, C., Atkinson, Q. D., Cohen, E., McNamara, R. A., Willard, A. K., Xygalatas, D., Norenzayan, A., & Henrich, J. (2016b). Cross-cultural dataset for the evolution of religion and morality project. *Scientific Data*, *3*, 160099.
<https://doi.org/10.1038/sdata.2016.99>
- Purzycki, B. G., Ross, C. T., Apicella, C., Atkinson, Q. D., Cohen, E., McNamara, R. A., Willard, A. K., Xygalatas, D., Norenzayan, A., & Henrich, J. (2018). Material security, life history, and moralistic religions: A cross-cultural examination. *PLOS ONE*, *13*(3), e0193856. <https://doi.org/10.1371/journal.pone.0193856>

- Rice, T. W. (2003). Believe It Or Not: Religious and Other Paranormal Beliefs in the United States. *Journal for the Scientific Study of Religion*, 42(1), 95–106.
<https://doi.org/10.1111/1468-5906.00163>
- Rosser, B. S., Oakes, J. M., Bockting, W. O., & Miner, M. (2007). Capturing the social demographics of hidden sexual minorities: An internet study of the transgender population in the United States. *Sexuality Research & Social Policy*, 4(2), 50–64.
- Roth, L. M., & Kroll, J. C. (2007). Risky Business: Assessing Risk Preference Explanations for Gender Differences in Religiosity. *American Sociological Review*, 72(2), 205–220. <https://doi.org/10.1177/000312240707200204>
- Sasaki, M. (1975). Status inconsistency and religious commitment. In R. Wuthnow (Ed.), *The religious dimension: New directions in quantitative research* (pp. 15–35).
- Schnabel, L. (2016). The gender pray gap: Wage labor and the religiosity of high-earning women and men. *Gender & Society*, 30(4), 643–669.
- Shaver, J. H., Sibley, C. G., Sosis, R., Galbraith, D., & Bulbulia, J. (2019). Alloparenting and religious fertility: A test of the religious alloparenting hypothesis. *Evolution and Human Behavior*, 40(3), 315–324.
- Stark, R. (1996). *The rise of Christianity: A sociologist reconsiders history*. Princeton University Press.
- Stark, R. (2002). Physiology and faith: Addressing the “universal” gender difference in religious commitment. *Journal for the Scientific Study of Religion*, 41(3), 495–507.
- Steggerda, M. (1993). Religion and the Social Positions of Women and Men. *Social Compass*, 40(1), 65–73. <https://doi.org/10.1177/003776893040001008>
- Sullins, D. P. (2006). Gender and religion: Deconstructing universality, constructing complexity. *American Journal of Sociology*, 112(3), 838–880.

- Thompson, E. H. (1991). Beneath the Status Characteristic: Gender Variations in Religiousness. *Journal for the Scientific Study of Religion*, 30(4), 381.
<https://doi.org/10.2307/1387275>
- Tingley, D., Yamamoto, T., Hirose, K., Keele, L., & Imai, K. (2014). *Mediation: R package for causal mediation analysis*.
- Trzebiatowska, M., & Bruce, S. (2012). *Why are Women more Religious than Men?* Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199608102.001.0001>
- Vardy, T., & Atkinson, Q. D. (Special Issue). Religion and the extent of prosocial preferences on Tanna Island, Vanuatu. *Current Issue*.
- Vitulli, W. F., Tipton, S. M., & Rowe, J. L. (1999). Beliefs in the paranormal: Age and sex differences among elderly persons and undergraduate students. *Psychological Reports*, 85(3 Pt 1), 847–855. <https://doi.org/10.2466/pr0.1999.85.3.847>
- Voas, D., McAndrew, S., & Storm, I. (2013). Modernization and the gender gap in religiosity: Evidence from cross-national European surveys. *KZfSS Kölner Zeitschrift Für Soziologie Und Sozialpsychologie*, 65(S1), 259–283.
<https://doi.org/10.1007/s11577-013-0226-5>
- Walter, T., & Davie, G. (1998). The Religiosity of Women in the Modern West. *The British Journal of Sociology*, 49(4), 640. <https://doi.org/10.2307/591293>
- Waytz, A., Gray, K., Epley, N., & Wegner, D. M. (2010). Causes and consequences of mind perception. *Trends in Cognitive Sciences*, 14(8), 383–388.
- Weeden, J., Cohen, A. B., & Kenrick, D. T. (2008). Religious attendance as reproductive support. *Evolution and Human Behavior*, 29(5), 327–334.
<https://doi.org/10.1016/j.evolhumbehav.2008.03.004>

- Weeden, J., & Kurzban, R. (2013). What predicts religiosity? A multinational analysis of reproductive and cooperative morals. *Evolution and Human Behavior*, 34(6), 440–445. <https://doi.org/10.1016/j.evolhumbehav.2013.08.006>
- Wilson, B. R. (2016). *Religion in Secular Society: Fifty Years On* (S. Bruce, Ed.). Oxford University Press.
- Wilson, J. A. (2018). Reducing Pseudoscientific and Paranormal Beliefs in University Students Through a Course in Science and Critical Thinking. *Science & Education*, 27(1), 183–210. <https://doi.org/10.1007/s11191-018-9956-0>
- Wilson, M., & Daly, M. (1985). Competitiveness, risk taking, and violence: The young male syndrome. *Evolution and Human Behavior*, 6(1), 59–73. [https://doi.org/10.1016/0162-3095\(85\)90041-X](https://doi.org/10.1016/0162-3095(85)90041-X)
- Zapata, O. (2018). Turning to God in Tough Times? Human Versus Material Losses from Climate Disasters in Canada. *Economics of Disasters and Climate Change*, 1–23. <https://doi.org/10.1007/s41885-018-0029-2>