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Religious Involvement Is Associated With Higher Fertility and Lower Maternal Investment, but More Alloparental Support Among Gambian Mothers

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ABSTRACT

Objectives: Human childrearing is cooperative, with women often able to achieve relatively high fertility through help from many individuals. Previous work has documented tremendous socioecological variation in who supports women in childrearing, but less is known about the intracultural correlates of variation in allomaternal support. In the highly religious, high-fertility setting of The Gambia, we studied whether religious mothers have more children and receive more support with their children.

Methods: We randomly sampled 395 mothers and 745 focal children enrolled in the Kiang West (The Gambia) Longitudinal Population Study cohort. Structured interviews asked mothers who and how often people invest in their children, and about their religious practices. Data were collected at participants' homes on electronic tablet-based long-form surveys and analyzed using the Bayesian hierarchical models.

Results: Religiosity was weakly associated with women's higher age-adjusted fertility. Maternal religiosity was negatively related to maternal investment in focal children, but positively associated with total allomaternal support. Specifically, a woman's religiosity was positively associated with allomaternal support from matrilineal kin, other offspring, and affinal kin, but unrelated to paternal, patrilineal, and non-kin investment.

Conclusions: These results suggest that higher fertility among religious mothers may be supported by high levels of investment from biological and affinal kin. Matrilineal kin, other siblings, and affinal kin seem to be the most responsive to a woman's religiosity. Our findings cast doubt on interpretations of women's religious behaviors as signals of fidelity, and instead suggest they may be part of strategies to enable collective allomaternal resources and higher relative fertility.

1 | Introduction

Compared to the other great apes, human life histories are unique. Despite a long period of offspring maturation, and high levels of investment required for successful development, human females reproduce at a faster rate than our closest relatives (Hill and Kaplan 1999; Walker et al. 2007). Evolutionary anthropologists are in broad agreement that human reproduction is cooperative, and that allomaternal support to mothers contributes to an ability to simultaneously rear multiple, energetically expensive offspring (Hrdy 2005, 2011; Kramer 2010; Nelson 2020). The support that mothers receive with childrearing allows for earlier weaning, shorter interbirth intervals, and thus higher fertility than would be possible than if they were the sole carers of their children (Galdikas and Wood 1990; Kuzawa and Bragg 2012). Indeed, studies find that in societies with high fertility and high mortality, in particular, the presence of kin is associated with earlier onset of reproduction, shorter interbirth intervals, and higher fertility (Sear 2018; Snopkowski and Sear 2013, 2016).

1.1 | Allomaternal Investment in Human Life History

Who helps mothers raise their children is tremendously ecologically variable; nonetheless, the most consistent and important allomothers include grandparents (Coall and Hertwig 2010), fathers (Hewlett 2004), other offspring (Kramer 2005), aunts, and uncles (McBurney et al. 2002), as well as to a lesser extent, non-kin (Jang et al. 2022). Of all allomothers, the presence of maternal grandmothers has been found to be the most often positively associated with child survival and well-being (Sear and Mace 2008). Mothers-in-law do help women with their children, and in rare contexts support women more than their own mothers (Daly and Perry 2019), but in general their levels of allomaternal investment are much lower than a woman's mother's investment (Perry and Daly 2017). A child's maternal and paternal grandfathers also support women's reproduction in some contexts, but typically at lower levels than their grandmothers (Sear and Mace 2008). Similarly, a mother's siblings are more likely to provide maternal support than her husband's siblings (Gaulin, McBurney, and Brakeman-Wartell 1997; McBurney et al. 2002). Though there are notable exceptions where patrilineal allomaternal support is greater (Borgerhoff Mulder 2007; Daly and Perry 2019), a general pattern of greater help from the matriline has been referred to as a "matrilateral bias" in human allomothering (Perry and Daly 2017). A matrilateral bias is even evident in many patrilocal societies where women are geographically closer to affinal kin than to their natal kin group, but nonetheless receive more support from their own kin despite greater dispersal (Gibson and Mace 2005; Sear and Mace 2008). A mother's older offspring, especially daughters, also consistently contribute to allomaternal support, both in terms of childcare of their siblings, as well as through their own productive labor, and thus often subsidize their mothers' ongoing reproduction (Kramer 2005).

Paternal investment is also ecologically variable. In some cultures, fathers increase food production when they have young children (Marlowe 2003), and invest heavily in children (e.g., Hewlett 1993), whereas in others they invest infrequently (Marlowe 2000), although even when paternal investment is rare, it may promote child health and survival (Hill and Hurtado 2009). In general, however, paternal investment in marriages, education, and social connections is often more important for children at older ages (Scelza 2010; Shenk and Scelza 2012).

Broadly, allomaternal investment can either be in addition to maternal investment, or act as a substitute for maternal investment, thereby freeing the mother to engage in fitness related tasks other than childcare. Additive allomaternal investments can be expected to result in better child outcomes, while substitutive allomothering is expected to either be neutral with respect to child well-being, or even negatively related to child outcomes if the allomothering is of lower quality than maternal care (Emmott and Page 2019). Given the higher potential reproductive rates of human males, patrilineal kin may be expected to more often contribute to substitutive care of children (increasing a woman's fertility), whereas matrilineal kin may more often engage in additive care (increasing child outcomes) (Emmott and Page 2019; Kushnick 2012; Leonetti et al. 2007).

Although there are notable exceptions (e.g., Gibson and Mace 2005; Rosenbaum et al. 2021; Snopkowski and Sear 2016), most of the existing literature on allomothering has examined associations between the presence or absence of a potential allomother in the household or village (or if that individual were alive vs. dead) on maternal fertility and child outcomes, rather than the level and quality of that investment. Previous research has focused on who helps mothers with children, as well as the assumed outcomes of that help, but much less is known about when or which mothers receive help (Snopkowski and Sear 2015). In general, when children are younger, they receive more allomaternal care, particularly more direct care (temporal rather than provisioning investments) than when they are older (Rosenbaum et al. 2021), and in some cases this involves mothers moving for temporary periods to get support from matrilineal kin. In both patrilocal Bangladesh (Perry 2017) as well as among the Himba of Namibia (Scelza 2011), for example, many mothers return to their natal villages when they give birth to receive support from their mothers. Furthermore, in Indonesia, mothers with more children receive more childcare help from their mothers, as do women who are economically disadvantaged, or engaged in extra-household labor (Snopkowski and Sear 2015). Although existing research points to the general conditions under which women receive greater allomaternal support in terms of the timing of reproduction, or the cross-cultural patterns of support from specific carers, much less is known about the cultural factors that lead to intra-cultural variation in levels of allomaternal support.

1.2 | Allomaternal Support and Religiosity

Outside of understanding the effects of post-marital residence on the availability of potential allomothers, research to date has not examined how culture might structure within-population variation in allomothering. One potential source of variation in allomaternal support may be due to a mother's involvement in the local religion (Shaver 2017). Across human cultures,

people spend significant energy, resources, and time engaged in ritual behaviors directed at supernatural entities, behaviors that are not obviously related directly to reproduction nor somatic maintenance. The universality of these practices has prompted social scientists across several disciplines to propose that their functionality lies in their communicative potential (Iannaccone 1994; Kurzban and Christner 2011; Lang and Kundt 2023; Sosis and Alcorta 2003). By repeatedly engaging in religious practice, an individual is able to signal commitment to a community's cooperative norms, reliably assort with others who are also committed (Lang et al. 2022, 2024), and subsequently reap the benefits of more efficient and reliable cooperation between committed coreligionists (Sosis and Alcorta 2003). This kind of signaling can be honest when the perceived costliness of religious activities is lower for committed than for uncommitted individuals (Sosis 2003). One collective resource available to religious mothers may be increased allomaternal support, and greater allomaternal support among some religious groups may contribute to the higher relative fertility typically found among religious mothers (as compared with less or non-religious mothers) (Shaver 2017). Indeed, studies conducted in contemporary Western settings have found that the members of religious groups have higher fertility (Adsera 2006; Frejka and Westoff 2008; Peri-Rotem 2016; Philipov and Berghammer 2007; Shaver et al. 2019, 2020), engage in higher levels of allomothering (Shaver et al. 2019, 2020), and that religious women have larger and more kin-dense social networks (Lynch et al. 2022) and receive more support from kin (Spake et al. 2024a, 2024b).

In explaining religion's prevalence in the world today, the majority of contemporary evolutionary theories of religion focus on the ways in which religion encourages widespread cooperation among unrelated individuals and thus can stabilize large-scale social living (e.g., Johnson 2005; Norenzayan et al. 2014; Watts et al. 2015). These theories assume that religion encourages and supports cooperation in settings where kin-based cooperation is limited in scale. However, sociological studies conducted in post-industrial Western societies document consistent and positive associations between religious involvement and the breadth and strength of family ties. For example, religious families in the West are more cooperative (Choy 2020), engage in more frequent kin interactions (Murphy 2008), and have stronger family orientations in general (Mahoney et al. 2003). A person's religiosity is also associated with a higher perceived relationship quality with their parents and grandparents, and religious grandparents are more likely to provide support to their grandchildren (King 2003; King and Elder Jr. 1999). Thus, in addition to the positive relationship between religion and non-kin cooperation that is often stressed in the evolutionary literatures, religious individuals also receive more kin support. It is likely that increased cooperation among religious families has a stronger influence on the higher fertility in these communities than non-kin cooperation, although the dynamics between religion and family are less well-studied outside of the West.

Evolutionary theories of religion that do draw attention to family dynamics tend to focus on the male/female pair bond, the nuclear family in general (e.g., Weeden, Cohen, and Kenrick 2008), and largely ignore the cooperative nature of human reproduction. For example, some evolutionary psychological theories propose that religion mitigates the differential risks associated with reproduction for males and females as a reproductive unit (Weeden, Cohen, and Kenrick 2008). This line of work suggests that belief in supernatural sanctions against female adultery and male abandonment can help males to avoid misattributed paternity and females to find partners who will invest heavily in their mutual offspring. In support of these models, researchers point to the higher salience of moral norms that enforce monogamy in religious communities, relative to norms for moral breaches unrelated to reproduction, such as lying or stealing (Weeden, Cohen, and Kenrick 2008; Weeden and Kurzban 2013), as well as a greater emphasis placed upon religion by individuals when they become parents (Blekesaune and Skirbekk 2023; McCullough et al. 2005). Support for these theories is found among some groups of Christian parents in American, where religious involvement is associated with higher levels of maternal and paternal investment (Bartkowski and Xu 2000). Other work has focused on the potentially coercive mate-guarding aspects of religion and how men may recruit religion to increase paternity certainty (Boster, Hudson, and Gaulin 1998; Strassmann et al. 2012). For example, among the Dogon of Mali, accurate perceptions of paternity certainty are differentially associated with the severity of religiously sanctioned menstrual taboos which themselves vary across three locally practiced religions (Strassmann et al. 2012). Similarly, the extent of Muslim veiling across cultures is correlated with the harshness of the environment, which has been interpreted as male safeguarding of paternal investment which is expected to be critical under harsh ecological conditions (Pazhoohi et al. 2017). Other research suggests that severe environments are not associated with paternal investment, but are associated with increased allomaternal investment (Martin et al. 2020).

1.3 | Current Study

Below we investigate the effects of maternal religiosity on fertility, maternal investment, and allomaternal support from kin and non-kin across 23 villages in rural Gambia. First, we test the broad prediction that a woman's religious involvement is positively associated with her fertility and allocare toward a focal child. Second, we examine the relative contributions of different kin and non-kin investment in focal children. Previous longitudinal (1950–1974) analysis at the field site has suggested the importance of some allomothers over others: maternal grandmothers were found to be positively associated with child survival and nutrition, whereas the presence of fathers, maternal grandfathers, and both paternal grandparents was not associated with child wellbeing (Sear, Mace, and McGregor 2000). Third, based on assumptions that religion functions to communicate trust and commitment, we predict that woman's religiosity will be positively associated with non-kin investment. Fourth, we evaluate the prediction that a woman's religiosity functions to communicate paternity certainty. If a major function of a woman's religious involvement is to increase paternity certainty and reduce the risks associated with investing in non-kin, as some theories predict, then investment from fathers and their kin can be expected to be most responsive to a mother's religiosity. Similarly, we evaluate whether the extent of veiling among women is associated with allomaternal support from her husband and his kin. Finally, we examine whether allomaternal support from

different kin groups is additive or substitutive. We conclude with additional analyses examining whether or not allomaternal support among religious women is reciprocal.

2 | Methods

2.1 | Study Population

Our sample was randomly drawn from the Kiang West Longitudinal Population Study (KWLPS) cohort. The Kiang West Longitudinal Population Study cohort consists of about 14,000 people living across 36 villages in the West Kiang region of The Gambia (Hennig et al. 2017). The population of West Kiang is primarily Mandinka, with smaller populations of Fula and Jola ethnicities. People in West Kiang are agriculturalists who farm rice, maize, millet, and groundnuts during the wet season and ground nuts and other small crops during the dry season. Rice is cultivated by women, and is the primary subsistence crop. The people of West Kiang are Muslim, practice patrilocal post-marital residence, and many marriages are polygynous. Across the West Kiang cohort, fertility is high with a current TFR of 5.5 (Hennig et al. 2017).

We randomly sampled women of both reproductive and post-reproductive age (18–60 years) who had at least one child. Our recruitment protocol allowed recruiting two women living in the same compound, however if two women from the same compound were recruited, one had to belong to the reproductive aged group (18–44 years) and the other to the post-reproductive aged group (45–60 years). For each woman, we asked questions about up to two focal children. If the woman was in the reproductive aged group, we asked about up to two co-resident children under the age of 17 years, and if she was in the post-reproductive aged group, we asked about two adult children 17–30 years of age who did not have to be co-residing with her. For a randomly-selected subset of women, we also surveyed the husband if he was residing in the compound with her.

The total sample consisted of 705 women and 1355 focal children living across 23 villages. However, in the present study we analyzed data only from mothers ($n = 395$) with focal children ($n = 746$) aged 17 and younger (age range of children from 0.3 to 17.5), which resulted in one village being omitted. The villages included in our study were chosen because they varied in their levels of wealth, development, and market integration. Some villages are closer to the main paved road and hence closer to the more developed coastal region, whereas other villages are more difficult to access with sometimes impassable dirt roads.

2.2 | Data Collection

Data collection was part of a larger cross-cultural study investigating the relationships between religion, family size, and child outcomes (Spake et al. 2021; Spake et al. 2024a, 2024b). A standardized cross-cultural survey was modified and adapted to the local Gambian context through focus groups that solicited local norms around the types of childcare typically performed and exchanged in the community for children of various ages, religious practices and whether and how they varied across age, gender, or religiosity, as well as marriage and family planning ideals. The information from the initial focus groups was used to finalize the first version of our questionnaire. This questionnaire was then piloted and adjusted until the interviewers were satisfied with its performance. In other words, we continued to pilot until interviews were smooth, all errors in questions and/or answer choices had been flagged and fixed, and participants no longer reported confusion at the questions they were being asked (though we did not avoid all technical errors, see below). The process of piloting took roughly 1 month, and included modifications of the questionnaire made after focus group discussions, during interviewer training, as well as over the pilot study, during which each section of the survey was trialed roughly 20 times.

Data were collected by local researchers at participants' homes, in the Mandinka language (with very few in Fula or Jola where appropriate), on electronic tablet-based long-form surveys run through Open Data Kit (ODK), open-source survey software (Hartung et al. 2010). Surveys with mothers varied depending on the size of their social networks, but typically lasted between 1 and 3 h. If the length of interviews conflicted with childcare or other domestic tasks, interviewers made multiple trips to a home to collect data, so as to not disrupt women's productivity too extensively. Women were asked a variety of questions including reproductive histories, household assets, their social networks, who helps them with childcare, and the frequency of that help.

This project was conducted in collaboration with the Medical Research Council (MRC) Gambia Unit, London School of Hygiene and Tropical Medicine. Ethical approval was first granted through the University of Otago, and then approved by the scientific committee and the local ethics committee at the MRC Gambia Unit.

2.3 | Measures

2.3.1 | Religiosity

The overwhelming majority of people in The Gambia are Muslim, and Islam structures daily life across the country. The overall picture of religiosity represented by our data was that most people are highly religious. For example, one question asked women "how important is religion in your life?" with five options ranging from "Not important at all" to "Very important." Only 8% (55) of respondents answered "Important" while the remaining 92% (649) answered "Very important."

Given ceiling effects of many of our religion questions, religiosity scores were constructed with a bottom-up approach using items that exhibited heterogeneity. A factor analysis revealed that three variables (number and frequency of different collective religious activities, and number of private religious activities) loaded on a common factor, which provided us with sufficient evidence for constructing one general index of religiosity representing private and collective aspects of the local religion. This index was internally consistent (Cronbach's alpha = 0.699) and congruent with focus group discussions in which women indicated that people use these behavioral cues to assess the relative religiosity of others in the village. Other aspects of religion such

as subjective assessments of one's religiosity were unrelated to each other and/or were highly homogenous (i.e., the overwhelming majority of women rated themselves as "about the same" religiosity as other women in the village). Therefore, our religiosity scale represents a locally sensitive measure of latent religiosity with sufficient variation to be used as the main predictor in our analyses (see Figure 1). More information on the religiosity scale is accessible from our Table S1 in Supporting information. Note that although our analyses were performed on the sample of 395 mothers (we only analyzed data from mothers whose focal children were 17 and younger), we constructed the religiosity score with the whole sample.

2.3.2 | Main Outcome Variables

2.3.2.1 | Age-Adjusted Fertility. Because most survey respondents were still of reproductive age, we calculated age-adjusted fertility as the residual of a linear regression of number of all births (including children not living at the time of data collection) on maternal age (Schaffnit et al. 2019). Only 11 mothers were older than 45, their ages ranged from 45.9 to 53.7, with and average age of 48.9. We included these women in the age-adjusted fertility estimations.

2.3.2.2 | Allomaternal Investment. After focus group discussions, and in line with previous research, we measured both direct allomothering and provisioning allomothering (e.g., Scelza et al. 2020) differently for different aged children. Specifically, we made a distinction between children less than 5 years old, and those at or older than that threshold, as this threshold is when children begin attending formalized education and therefore require additional provisioning support for school fees, uniforms, and/or supplies. However, we transformed measures for different aged children to a common scale and analyzed them together in order to provide greater statistical power.

Four questions were used to assess direct allomothering for children less than 5 years old, by asking mothers who helped them in the past 2 weeks with (1) washing, (2) cooking for, (3) playing with, and/or (4) supervising the focal child. For children aged 5 years and older, direct allomothering was assessed by asking mothers who helped them in the past 2 weeks with (1) cooking or feeding, (2) playing with, (3) supervising, (4) assisting with schoolwork, and/or (5) giving advice to the focal child.

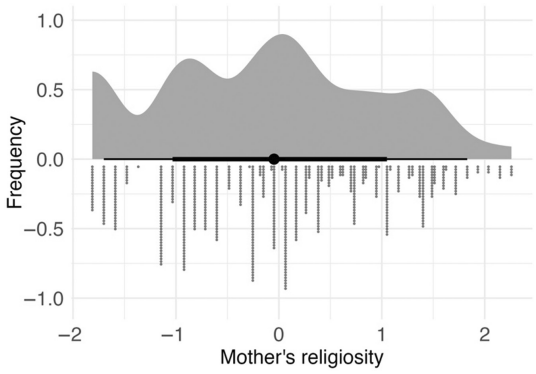

FIGURE 1 | Distribution of the latent religiosity scale. Note that the scale's unit is in standard deviations.

To quantify provisioning allomothering toward young children, mothers were asked who, in the last 3 months, (1) gave food, money, or gifts, (2) had taken the focal child shopping for things, and/or (3) paid for medical care for the child. For older children, provisioning allomothering questions asked mothers who, in the last 3 months (1) gave food, money, or gifts, (2) had taken the focal child shopping for things, (3) paid for medical care, and/or (4) paid school fees or educational expenses for the child.

Once participants generated a list of allomothers who engaged in the aforementioned tasks, we then asked participants to provide information about each helper, including their relationship to the woman. Finally, we asked women to tell us how often they received help with specific childcare tasks from each person who helped them (for direct care, options included: multiple times per day, once a day, a few times per week, once a week, once in 2 weeks, never/not at all; for provisioning, options included: more than five times, four to five times, two to three times, once, never).

To create standardized allomaternal investment scores for different carers among children of different ages, we first converted all values to a scale that varied between 0 and 1 where 0 indicates that type of care is never practiced, and 1 indicates that it was practiced multiple times a day (the highest frequency on our scale). These values were then summed and divided by the number of types of care that comprised the scale (if a mother did not know or refused to provide information on frequency, we calculated the overall allomaternal care mean from the remaining tasks). Thus, a paternal direct care score 0.6 means that a father looked after his child a few times a week, 0.8 equated to once a day, and a child with score of 1.0 had a father who performed direct care multiple times a day. Next, with categories of allomothers that include more than one person, such as "all alloparents," we summed those scores to obtain the standardized score of total help provided to the child by different categories of alloparents (not including the mother or the father).

We created two initial categories, one for fathers and on for all other alloparents, and then the latter was then broken into several other categories for more detailed exploration and included the categories of siblings, patrilineal kin, matrilineal kin, affinal kin, and non-kin. More detailed categories were not created (e.g., maternal aunts, father's mother, sisters, and brothers) because of low numbers of carers in those categories, which would have prevented us from making meaningful comparisons.

Since a child's father may be deceased or might not live with the mother and children, we performed several steps to make sure our results cannot be driven by these biases (i.e., to avoid situations where a deceased father is given an allocare score of 0). To deal with non-living and separated fathers, we only calculated allomothering scores for fathers who were currently living. Unfortunately, due to an error in the survey software (which was fixed about a third of the way through data collection), we do not have information on a mother's current relationship with the father for 34% of focal children. Out of 491 children for whom we have data on the father's living status, 465 had a father

who is currently married to their mother. Similarly, we did not calculate sibling allomothering scores of focal children who had no living siblings ($n = 11$).

Categories of carers were created based upon mothers' reported relationships to people in their support networks. These included 30 pre-defined categories (e.g., "your biological mother," "spouse's parent," "friend," "other relative," "other non-relative"). The category of "other relative" included 1102 "others" that we recoded manually. Five cases were unidentified and 154 cases were the offspring of mothers' co-wives. Unidentified cases were only included in the category of all alloparents, but co-wives' offspring might be either patrilineal kin or non-kin depending upon whether the focal mother's husband is the (grand)father of these children (and are therefore half-siblings with the focal child). We decided to only include these carers in the category of all alloparents. However, we replicated the analyses with these individuals included in patrilineal kin and non-kin separately, and these results are not substantially different from the original models (Supporting information, Tables S6, S7, S10, and S11).

The category of non-kin includes neighbors, friends, and non-specified/others while the affinal kin category included people who were related to the members of the focal child's family but not to the focal child themselves, such as mother's sister's husband. Moreover, we also included adopted children, step-relatives, and one godfather in the affinal kin category. The coding scheme is accessible from an R script at OSF.

2.3.2.3 | Maternal Investment. Maternal investment scores were derived in a way similar to allomaternal scores. Apart from being an outcome variable in some of our models, maternal investment scores were included in statistical models to examine the possibility that allomothering from some family members may be substitutive or additive.

To measure direct maternal investment of young children (less than 5 years old), mothers were asked how often in the last week they: (1) washed, (2) cooked, (3) played with, and/or (4) supervised their baby. For older children (5 years and older), maternal investment was measured by asking mothers how many times in the past 2 weeks they: (1) cooked or fed, (2) sat and chatted/teased/hung out with, (3) supervised, (4) taken or brought home from school, (5) helped with homework, and/or (6) given advice or counseling to the focal child.

To assess maternal provisioning of both young and older children, mothers were asked how many times they provided any money, food to eat (not breastfeeding), or other goods (clothes, medicine) for the focal child in the past 3 months. Frequency options for direct and provisioning maternal care were the same options as the allomothering questions (for direct care: multiple times per day, once a day, a few times per week, once a week, once in 2 weeks, never/not at all; for provisioning, options included: more than five times, four to five times, two to three times, once, never). Maternal investment scores for both direct and provisioning were normalized on a scale from 0 to 1 in the same fashion as the allomaternal scores described above.

2.3.3 | Covariates

Directed acyclic graphs (DAGs) were constructed to determine the minimal set of variables for inclusion in models. DAGs (see Figures S1 and S2 in Supporting information) allow the simulation of complex causal structures of a set of variables to determine which variables are necessary to include as covariates and to exclude those that may be confounds. DAGs suggested the inclusion of household's wealth, food insecurity, distance from markets, and mother's age because these might affect both religiosity and child investment (Becker and Lewis 1973). We did not include number of children in models because it acts as post-treatment confounding variable, which mediates any potential effect of religiosity on maternal or allomaternal investment. The only models in which we include number of children is in models examining sibling allomothering, as we were interested in the effect of religiosity on investments provided by each sibling, and dropping number of children from the model would allow the interpretation that religiosity only increases the number of potential siblings allomothers but not their individual support. Finally, we included focal child's sex and age as basic demographic variables. The model on fertility also included Western education because of its often negative relationship with women's fertility (Martin 1995).

2.3.3.1 | Market Distance. To construct a measure of distance from markets, we used five variables that asked mothers how long it takes to travel to a small shop, large shop, upper basic school, the main road, and a medical doctor. To deal with extreme outliers that were most likely data entry errors (8.5 h to the main road, see Table S2 in Supporting information for details), we assign means to values higher than five standard deviations (total $n = 16$). Answers were transformed to minutes, averaged for each participant, and log transformed.

2.3.3.2 | Total Household Wealth. To construct a measure of wealth, mothers were asked about their ownership of various material assets ($N = 38$) to which we assigned estimated prices from markets where residents would have obtained them and then weighted according to the total number of each asset. We created a wealth score by taking the log score of the sum of all weighted assets (see Supporting information Section S2).

2.3.3.3 | Food Insecurity. A food insecurity index was built according to Ballard et al. (2014). Mothers answered the following three questions on scales with four options (0 = "Never", 1 = "Rarely", 2 = "Sometimes", 3 = "Often"): (1) In the past 4 weeks, how often was there no food of any kind in your household because of lack of resources to get food?, (2) In the past 4 weeks, did you or any household member go to sleep at night hungry because there was not enough food?, (3) In the past 4 weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? Scores of 1 and 2 were recoded as 1, and a score of 3 was recoded as 2. Next, scores were summarized across respondent mothers. No mother scored above 1 which made the variable of food insecurity a binary variable, therefore this variable took the value of 1 if the household experienced any hunger in the past 4 weeks, and 0 if it did not.

2.3.3.4 | English Education. English education was treated as a dichotomous variable with 1 assigned to mothers who ever an attended an English school.

Table 1 displays descriptive statistics of all non-standardized variables. For clarity, we include raw fertility (not age-adjusted) and raw wealth calculated in Gambian dalasi (1 dalasi ~0.015 USD) in Table 1. Instead of standardized market integration, Table 1 displays raw proximity to markets in minutes (average of the three items used to create the latent score of market proximity).

2.4 | Analytical Strategy

Across all analyses we built multivariate, multilevel linear Bayesian models with the brms package (Bürkner 2017) in R, version 4.1.3 (2022). We estimated the following equation:

$$Y_{ijk} = \beta_{0+}\beta_1 \text{religiosity}_{ijk} + \beta_2 \text{controls\_child}_{ijk} + \beta_n \text{controls\_mother}_{jk} + \epsilon_{ijk} + \text{village}_k + \text{mother}_j$$

where Y_{ijk} is either provisioning or direct care provided to child i by a given category of carers of the mother j in village k, where β_0 is the intercept, $\beta_1 \text{religiosity}_{jk}$ is the religiosity of mother j in village k, $\beta_2 \text{controls\_child}_{ijk}$ are controls measured on the level of child i of mother j in village k, $\beta_n \text{controls\_mother}_{jk}$ are controls measured on the level of mother j in village k, $\epsilon_{ijk}+$ is error term for child i of mother j in village k. Because a village's location could affect residents' market integration, wealth, and religiosity (see Figure S3 in Supporting information), we included village_k as a random effect to exclude any observed effects that are driven by differences between villages. We also included mother_j as a random effect because most of the mothers in the current study have two children from whom we collected data. Models where a mother is the observation unit omitted $\beta_2 \text{controls\_child}$. In supplementary analyses we included village as a random slope (in addition to random intercept) to examine the possibility that results could be driven by village-level differences across multiple variables (e.g., religiosity and fertility). Although our models reveal that there is little evidence in support of this possibility (Tables S18–S31), adding village as a random slope increased uncertainty for two models. We indicate these cases below.

For all models, we ran four chains at 2000 iterations per chain, with the first 1000 iterations set as a warmup period. All R-hat values were between 1.00 and 1.01, indicating chain convergence in all models.

Investments scores, predictors, and covariates (except for dummy variables) were standardized by deducting the mean and dividing by the standard deviation before entry into models. Variables were not standardized in instances where the original outcome scale has a clear interpretation and served as main predictor or outcome, specifically fertility and the number of non-offspring cared for by a woman (in an additional analysis).

TABLE 1 | Descriptive statistics of key covariates.

Variable	M	SD
Main analyses		
Total fertility	5.96	2.55
Mother's age	36	6.69
English education (yes = 1)	0.31	
Total household wealth in $USD	17557.88	13322.29
Distance from markets in minutes	59.21	27.44
Food insecurity (yes = 1)	0.04	
Child's age	7.90	4.27
Child's gender (male = 1)	0.53	
Additional analyses		
Religious veiling (yes = 1)	0.80	
Number of non-offspring cared for in the last 2 weeks	0.91	1.30

3 | Results

3.1 | Main Analyses

3.1.1 | Maternal/Allomaternal Investment

Figure 2 depicts the relative contributions of mothers, fathers, and alloparents to child investment. Findings indicate that mothers engage in the most direct care and provisioning of a child. Fathers and both matrilineal and patrilineal kin groups invest considerably in a child, as do a child's siblings, and individuals not biologically related to the child. Note that in Figure 2 we removed the category of all alloparents since this is a composite of all categories that do not include the mother and the father.

3.1.2 | Women's Religiosity and Fertility

For each standard deviation increase in maternal religiosity, age-adjusted fertility increased by 0.17 (95% CI = [−0.01, 0.34], see Figure 3, and compare Tables S3 and S18 in Supporting information where the effect is more uncertain when village is included as a random slope). While the least religious mothers in our sample were estimated to have around 0.16 children less than expected for their age, the most religious mothers were estimated to have 0.51 more children than expected for their age, or a difference of 0.67 births between the least and most religious mothers at the same age.

3.1.3 | Religiosity and Maternal/Allomaternal/Alloparental Investment

Models revealed that maternal religiosity was negatively associated with both direct maternal investment ($b = -0.10$, 95% CI = [−0.15, −0.04]) and provisioning ($b = -0.14$, 95% CI = [−0.23, −0.06]) care (Figure 4). There was no evidence

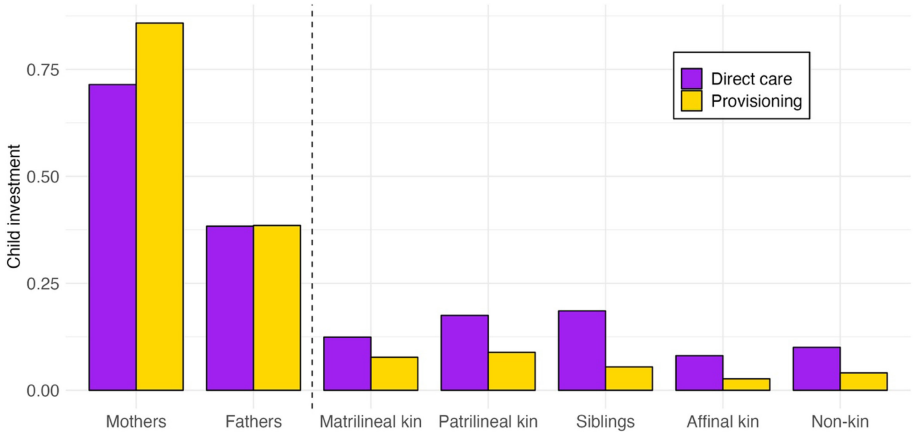

FIGURE 2 | Total child investment by relationship to the focal child. The bars represent investment that children receive from all people in the category (on a scale from 0 to 1). Indexes include different items for mothers and allomothers; the dashed vertical line separates categories with one person (on the left) from categories that can include more than one person (on the right); we removed the category of all alloparents since it is composite of all categories on the right of the dashed line.

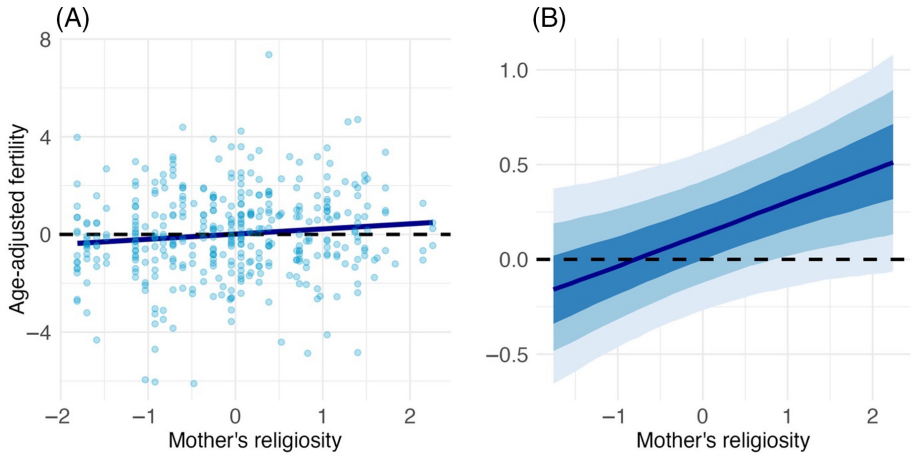

FIGURE 3 | Effects of mother's religiosity on age-adjusted fertility. Note that the *y*-axis is the original non-standardized scale. Plot (A) represents the correlation between fertility and religiosity without any covariates. Plot (B) represents predictions derived from the statistical model (Table S2 in Supporting information) that includes all covariates. Different shades of blue represent 50%, 80%, and 95% credible intervals (going from dark to light, respectively).

for an association between maternal religiosity and paternal direct care ($b = 0.03$, 95% CI = [−0.09, 0.14]) nor provisioning ($b = -0.05$, 95% CI = [−0.16, 0.06]). By contrast, maternal religiosity was positively associated with direct care ($b = 0.22$, 95% CI = [0.13, 0.31]) and provisioning ($b = 0.13$, 95% CI = [0.04, 0.22]) from all alloparents. Further models suggest that maternal religiosity was positively associated with both direct ($b = 0.10$, 95% CI = [0.01, 0.20]) and provisioning care ($b = 0.08$ 95% CI = [−0.01, 0.18]) from matrilineal kin, although the credible interval of the latter included zero (and see SM 24 where the effect of matrilineal support on provisioning allocare is attenuated when including village as a random slope). No evidence for an association between maternal religiosity and allomaternal investment from patrilineal kin was found either in terms of direct care ($b = 0.01$, 95% CI = [−0.08, 0.10]) or provisioning ($b = 0.03$, 95% CI = [−0.06, 0.12]). Maternal religiosity was associated with more direct care ($b = 0.11$, 95% CI = [0.03, 0.20]) of a focal child by that child's siblings, but was unrelated to provisioning ($b = 0.02$, 95% CI = [−0.07, 0.12]) from siblings. Maternal religiosity was also positively related to direct care ($b = 0.21$, 95% CI = [0.11, 0.31]) and provisioning ($b = 0.17$, 95% CI = [0.08, 0.25]) from affinal kin. Finally, maternal religiosity was found to be unrelated to direct care ($b = 0.03$, 95% CI = [−0.06, 0.13]) and provisioning ($b = -0.02$, 95% CI = [−0.11, 0.07]) from non-kin. Given that maternal religiosity was negatively related to maternal direct care and provisioning but positively related to all allomaternal investment, we next examined the effect of a mother's religiosity on total investment in a child (i.e., maternal + paternal + alloparental investment). The results of these models indicated that maternal religiosity was associated with higher total direct care ($b = 0.18$, 95% CI = [0.10, 0.26]) but unrelated to provisioning toward the focal child ($b = 0.01$, 95% CI = [−0.08, 0.10]). See Tables S4–S14 for full model parameters of all analyses.

3.1.4 | Are Allomaternal Investments Among Religious Mothers Additive or Substitutive?

The above analyses found that maternal religiosity is negatively associated with both maternal direct care and maternal provisioning. However, maternal religiosity was positively related

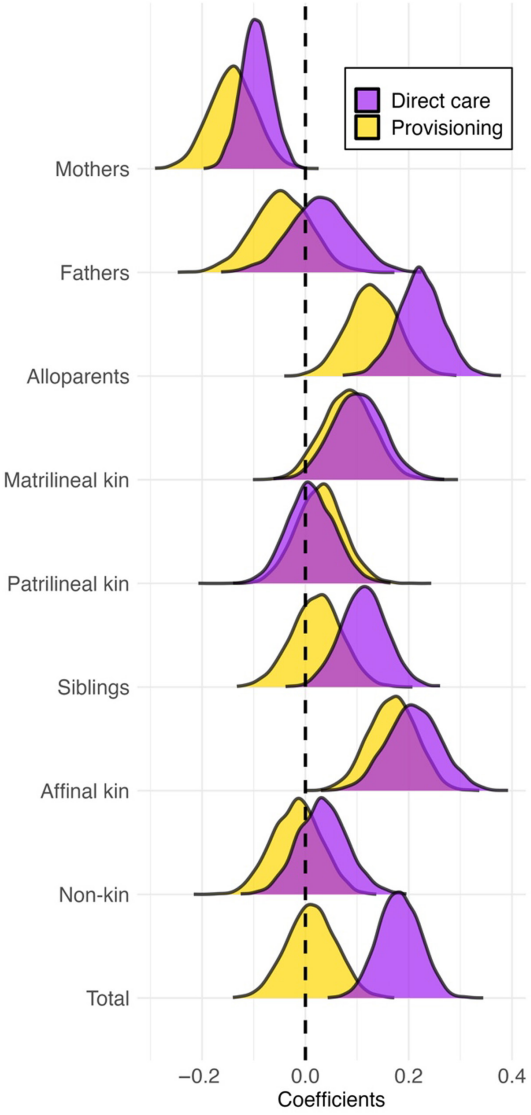

FIGURE 4 | Associations between mother's religiosity and child investment. The distributions represent posterior beta coefficients. Note that all effect sizes are displayed on a standardized scale of standard deviations.

to most forms of allomaternal investment, which raises the question as to whether or not higher levels of allomaternal investment among religious mothers is a substitute for maternal investment. In terms of direct care, maternal investment was positively related to paternal direct care ($b = 0.17$, 95% CI = [0.07, 0.26]), patrilineal direct care ($b = 0.09$, 95% CI = [0.02, 0.16]), and direct care from siblings ($b = 0.08$, 95% CI = [−0.004, 0.17]), although the credible intervals of siblings' investments included zero. Maternal direct care was also positively related to direct care from all alloparents ($b = 0.09$, 95% CI = [0.02, 0.16]). No relationship was observed between maternal investment and non-kin direct care ($b = 0.03$, 95% CI = [−0.04, 0.10]), direct care from affinal kin ($b = -0.03$, 95% = [−0.09, 0.03]) nor matrilineal direct care ($b = -0.04$, 95% CI = [−0.10, 0.03]).

Maternal provisioning was found to be positively related to paternal provisioning ($b = 0.24$, 95% CI = [0.17, 0.32]). We found no evidence for a relationship between maternal provisioning and provisioning from matrilineal kin ($b = -0.01$, 95% CI = [−0.08, 0.06]), siblings ($b = 0.02$, 95% CI = [−0.04, 0.09]), patrilineal kin ($b = 0.05$, 95% CI = [−0.02, 0.11]), affinal kin ($b = -0.00$, 95% CI = [−0.07, 0.06]), or non-kin ($b = -0.04$, 95% CI = [−0.11, 0.03]). Collapsing all alloparents together, there was no association between provisioning by mother and all alloparents ($b = 0.02$, 95% CI = [−0.05, 0.08]).

3.2 | Additional Analyses

3.2.1 | Is Allomaternal Support Reciprocal?

The above analyses suggest that maternal religiosity returns allomaternal benefits, especially in the form of additional direct care provided by matrilineal kin, siblings, and affinal kin. These results could be the due to altruism on behalf of allomothers, or because religious mothers may engage in more reciprocal allomothering. To test between these possibilities, we analyzed a question that asked how many children [other than mother's own] under the age of 5 years that a woman provided childcare for in the past 2 weeks? We built a generalized negative binomial model for count data with number of non-offspring children cared for (in a non-standardized form) as an outcome variable, with food insecurity, wealth, market proximity, mother's age, and number of own children as covariates. The results of the model (Table S15) suggest a considerable positive relationship between mother's religiosity and number of non-offspring cared for in the past 2 weeks (Incidence Rate Ratio = 1.49, 95% CI = [1.30, 1.71]). We visualize the association in Figure 5. The model predicted that in the past 2 weeks, the least religious mothers took care of 0.28 non-offspring children, whereas the most religious mothers took care of 1.36.

3.2.2 | Is Religious Veiling Associated With Higher Investment From Fathers and Patrilineal Kin?

The above results did not find evidence for a relationship between mothers' religiosity and investment from fathers or their kin, which at least partially refutes theories which assume that religious displays by women increase paternity certainty and return higher levels of investment (Moon 2021; Weeden, Cohen, and Kenrick 2008). Since studies supporting these theories often stress religious veiling as an important mechanism that men use to increase paternity certainty, we replicated the above models with paternal and patrilineal kin child investment as outcomes and with religious veiling as a predictor. The religious veiling variable was assigned a 1 if a mother reported that she typically wears a hijab ($n = 311$) or a niqab ($n = 2$) when leaving the home and a 0 if she wears a traditional local African headwrap ($n = 82$). Models (Tables S16 and S17 in Supporting information) provide no evidence for an association between either form of the veil and direct paternal investment ($b = -0.12$, 95% CI = [−0.37, 0.13]) nor provisioning ($b = -0.07$, 95% CI = [−0.30, 0.16]). There was also no evidence for a difference in patrilineal direct care ($b = -0.10$, 95% CI = [−0.30, 0.09]) nor patrilineal provisioning ($b = 0.01$, 95% CI = [−0.19, 0.22]) provided to children among mothers who practice Islamic veiling.

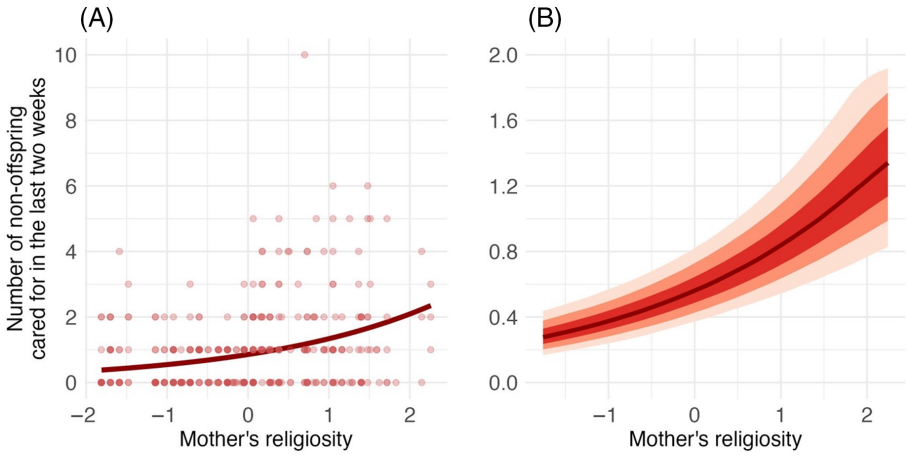

FIGURE 5 | Effects of maternal religiosity on care directed toward non-offspring. Plot (A) represents the raw association without covariates. Plot (B) represents predictions derived from the statistical model that includes all covariates. Different shades of red represent 50%, 80%, and 95% credible intervals (going from dark to light, respectively).

TABLE 2 | Summary of main findings.

	Association between maternal religiosity and allomaternal investment		Relationship between allomaternal investment and maternal investment	
	Direct care	**Provisioning**	**Direct care**	**Provisioning**
Mothers	Negative	Negative		
Fathers	None	None	Additive	Additive
Alloparents	Positive	Positive	Additive	None
Matrilineal kin	Positive	Positive	None	None
Patrilineal kin	None	None	None	None
Siblings	Positive	None	Additive	None
Affinal kin	Positive	Positive	None	None
Non-kin	None	None	None	None
Total	Positive	None		

4 | Discussion

Our findings (summarized in Table 2) suggest that, in The Gambia, a woman's religiosity is positively but weakly associated with her fertility, negatively associated with her investment in her own children, in terms of both direct care and provisioning, but positively related to most forms of allomaternal care, especially direct care. These increased levels of allomaternal support received by more religious women appear to be additive and not substitutive, so that children of religious mothers receive more total care, particularly physical care. Not only do religious women receive more support, but they also help other women with childcare more often. Together, these results suggest that a woman's religious involvement may be part of a cooperative strategy to enable high fertility through cooperative childrearing. Although more detailed longitudinal research is required for definitive conclusions, these results raise the possibility that because of higher levels of allomaternal support, women who are more religious are able to achieve higher fertility without a loss in per child investment.

Some studies, conducted in the West, suggest a positive relationship between religiosity and parental investment in children (Bartkowski and Xu 2000), while here we find a negative relationship between religiosity and maternal investment. Reductions in maternal investment found here may be because of the higher fertility of religious mothers and the dilution of resources that occurs with larger family sizes (Becker and Lewis 1973; Lawson 2009; Lawson and Mace 2011). Our results may also reflect the costs of religious involvement (Sosis and Alcorta 2003), for example through religious attendance or charitable provisioning, and/or the higher levels of allomothering engaged in by religious mothers. These results may also reflect cultural and/or religious differences in maternal investment strategies. Without behavioral observation, however, we are unable to distinguish between these alternatives, which may not be mutually exclusive.

Maternal support can affect maternal fertility either directly (through allocare) or indirectly (through support to mothers themselves) (Emmott and Page 2019). We here measured investment in children by allomothers, but support to children

indirectly through cooperative support to the mother (e.g., financially or when the mother is sick) is also likely to affect fertility and child development (Spake et al. 2024b). A positive relationship between religion and maternal investment found in the West may be due to increased helping among religious mothers, but not necessarily increased allomothering, which is less frequent in Western contexts (Spake et al. 2024b). Future work ought to simultaneously model the dynamics of support to women, which may indirectly affect child investment, and allomaternal investment to children, and how the relative importance of the two may work hydraulically, as well as vary across contexts.

Our additional analyses indicate that more religious mothers invest more in children that are not their biological children. This finding may suggest two interpretations. First, it is possible that religion increases mother's willingness to cooperate (Duhaime 2015), and the observed positive association between religiosity and alloparental care could be because of increased reciprocity among these women (Page et al. 2019). Second, the religious behavior that we measured may function as costly signals of commitment to cooperate, and the observed positive association between religiosity and alloparental care is a consequence of religious signaling (Chvaja et al. 2023). However, the correlational nature of our study cannot distinguish between these possibilities and future work is needed to disentangle causal pathways of these real-world associations. Moreover, we did not find any relationship between maternal religiosity and investment from non-kin, which might suggest a lack of support for costly signaling interpretations of these findings because theoretically signaling should be effective were other mechanisms do not scaffold cooperation, such as kinship. However, many women in our sample may not have frequent interactions with non-kin. Moreover, we found that affinal kin invest more in the children of religious mothers, and while affinal kin are relatives, they are not genetically related to the focal children in our study. Thus, repeated religious signaling may increase trust and contribute to a person's willingness to invest in non-blood relatives in this field site.

We found maternal religiosity to be negatively associated with maternal investment and positively associated with allomaternal investment, which suggest that allomaternal investment among more religious mothers may be substitutive. However, we also found that allomaternal support from many types of individuals (including a combined measure of all alloparental investment) were either unrelated to maternal investment, or positively related to maternal investment. These results suggest that allomaternal care is this context is not substitutive. Instead, these results suggest that many forms of allomothering in The Gambia are additive and therefore may be associated with better child outcomes. Similar results were found in Indonesia where women who received help from their own parents also received higher support from their parents-in-law (Snopkowski and Sear 2015). We stress, however, that our measures cannot assess these tradeoffs directly, and more detailed behavioral observations are necessary to examine the differences between additive and substitutive allomaternal support among different family members as well as among non-kin, and how these impact child outcomes. Additionally, future work ought to examine the socioeconomic and health factors that lead to some children receiving very high levels of investment from mothers and kin.

Several studies predict that a woman's religiosity communicates paternity certainty to her husband, and in return, these religious women are expected to receive higher levels of paternal investment in offspring (e.g., Weeden, Cohen, and Kenrick 2008). These studies tend to focus on the nuclear family and largely ignore familial influences on reproduction, but by the logic of paternity certainty, a woman's religiosity would also be expected to be positively associated with support from patrilineal kin. Instead, we find that maternal religiosity is unrelated to both paternal and patrilineal investment. In additional tests we find no relationship between the extent of Islamic veiling and paternal nor patrilineal investment. Rather, it is matrilineal kin, other siblings, and affinal kin who are the most responsive to maternal religiosity. Together these findings cast doubt that in The Gambia Islamic practice communicates paternity certainty.

Our results suggest that matrilineal kin, who are known to be critical carers in this setting (Sear, Mace, and McGregor 2000), and siblings, are more likely to respond positively to maternal religiosity and invest in a child than people related to the child through the male line. We do note, however, that many kin groups contribute to caring for children (Figure 3), many of whom contribute at levels roughly equal to or higher than matrilineal kin (Figure 2). It is possible that matrilineal kin may be more likely contribute to higher levels of childcare under critical conditions when the child is in danger of dying, which our data cannot address. The difference in our results may also reflect changes that have occurred at the field site over the last 30–40 years, or the difference in methods employed in different studies.

It is important to highlight that our measures of religiosity were self-reported. Self-report can be problematic, especially in domains of strong cultural significance, such as religion (Shaver et al. 2021). To gather ethnographically sensitive measures of religion, we conducted several focus groups that prompted women to indicate how they are able discern gradients of religiosity in their communities. We then used these qualitative data to ask several questions of women and used data reduction techniques to determine the best way of analyzing religious variation (see Table S2). Many of the questions that are likely more susceptible to identity signaling biases ("how important is your religion to your identity") were removed due to ceiling effects, and the remaining variation in this measure appears roughly normal, or even negatively skewed (Figure 1). While we cannot rule out that self-report biases affect our data, we believe our data collection and analysis techniques mitigated these concerns to a large extent. Though behavioral observation of religious behavior would be less problematic, such methods do not easily lend themselves to studies of this scale.

We found only a weak relationship between a woman's religiosity and her age-adjusted fertility. Because we were primarily interested in the relationship between maternal religiosity and allocare toward a woman's children, we only sampled mothers. Our design, therefore, cannot directly speak to the effect of religion on overall fertility. In other words, our results do not generalize to the whole population because we do not measure the effect of religiosity on fertility across mothers and non-mothers. However, because our sample is drawn from a high fertility

population, there are likely few very mothers without children. Despite these limitations, we still observe a small effect of religiosity on age-adjusted fertility among mothers.

5 | Conclusion

The last 30 years have seen a surge in theoretical and empirical work on the evolution of religion (Wilson 2002; Purzycki and Sosis 2022). This work has been dominated by approaches that focus on the effects of religion on cooperation among non-kin (e.g., Johnson 2005; Norenzayan et al. 2014; Watts et al. 2015). Our results find that maternal religiosity is strongly related to kin support, but is unrelated to non-kin support. Our previous work found similar relationships in Bangladesh where more religious women have larger and more kin-dense social network (Lynch et al. 2022). These results suggest that future work should examine the effects of religion on familial and extra-familial support in tandem to arrive at a more complete picture of the functional role of religion in human societies.

A reduction in allocare is often implicated in the fertility declines associated with market integration (e.g., Turke 1989). Processes of market integration also coincide with processes of secularization and fertility differentials between religious and secular people (Shaver et al. 2019). Prior research indicates that religious people in post-industrial Western societies exhibit higher relative fertility and are the recipients of greater allomaternal (Shaver et al. 2019) and general social support (Shaver et al. 2020). Our results presented here further point to the importance of religion for motivating support and fertility.

Author Contributions

John H. Shaver, Rebecca Sear, Mary K. Shenk, and Richard Sosis designed the project and secured funding. Laure Spake, Jainaba Badjie, and John H. Shaver collected the data in collaboration with Andrew M. Prentice and Carla Cerami from the MRC Unit The Gambia at LSHTM. Radim Chvaja, John H. Shaver, and Laure Spake preformed the analyses. John H. Shaver and Radim Chvaja drafted the initial manuscript, and all authors edited subsequent drafts and approved the final version.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Open Practice

The data for this project cannot be published in raw format due to ongoing data collection. We therefore provide a finalized dataset that includes final indexes and variables entered into models. We provide a processing R script for inspection analyses with a finalized dataset. Everything is accessible from: https://osf.io/dhfwv/?view_only=7b95f6c61b59483baee99749424002a4.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.