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How kinship and marriage customs influence nutritional outcomes among males and females

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Abstract

Malnutrition in its various forms is a serious problem in many countries, contributing to human suffering, large healthcare costs, and hampered economic and human development. While various policies to reduce malnutrition exist, such policies typically fail to consider cultural factors. Here, we contribute to the scant literature on cultural practices and nutrition, focusing on issues of gender discrimination and intra-household resource allocation. In particular, using representative panel data from Indonesia covering a period of 22 years, we analyze how ethnic-based kinship systems and marriage customs influence the nutritional status of male and female individuals. We find that patrilocal practices contribute to a higher body mass index (BMI) among males, in comparison to both males in other cultural settings and females. Matrilocality contributes to a higher BMI among females in comparison to females in other cultural settings but not in comparison to males. Bride price practices increase BMI among both male and female individuals. Quantile regressions show that the effects on increasing BMI are especially pronounced among those already overweight, whereas discrimination against females is particularly pronounced among the underweight. Our findings underline that cultural practices matter for nutritional outcomes. Better understanding the links in different cultural settings is important for effective nutrition policies, especially given the fact that different malnutrition problems coexist in many countries.

Keywords: obesity, kinship, bride price, patrilocality, matrilocality, Indonesia
JEL Codes: I10, J15, J16, Z13

1. Introduction

Malnutrition comes in various forms, including undernutrition, micronutrient deficiencies, and overweight and obesity (FAO, 2023; Popkin et al., 2020; Swinburn et al., 2019; World Health Organization, 2016). In many countries, different forms of malnutrition coexist, contributing to high morbidity, mortality, large healthcare costs, and hampered economic and human development. Progress in reducing malnutrition is currently too slow; overweight and obesity are actually on the rise in most parts of the world, including low- and middle-income countries (Popkin et al., 2020). Sustainable Development Goal 2, aiming to abolish all forms of malnutrition by 2030, will most likely not be achieved (FAO, 2022). Malnutrition is determined by various economic, social, and ecological factors. In addition, cultural factors can be important determinants as well (UNICEF, 2020) but are often overlooked. Examples of cultural practices that may influence nutrition outcomes are kinship systems, son preferences, and marriage traditions, just to name a few (Chakraborty & Das, 2005; Dasgupta, 2016; Rathore & Das, 2022). In this study, we try to link such cultural practices to nutrition outcomes of male and female individuals.

Cultural practices can play an important role in terms of how food and other resources are distributed within the household. Often, discrimination against female household members is observed. This already starts at young ages, with girls in some cultural settings receiving smaller amounts of nutritious foods and less healthcare treatment than boys (Briones et al., 2018; Haddad et al., 1996). Female adolescents and adults additionally face risks of domestic violence, excessive workloads, early marriage, and high fertility, all of which can also contribute to negative nutrition and health outcomes (Harris-Fry et al., 2017; Kunto & Hilde Bras, 2019; Lowes, 2020; Lowes & Nunn, 2017; Rathore & Das, 2022; Sear et al., 2002; Sear & Mace, 2008).

Many existing studies analyze links between cultural practices and gender inequality in terms of various economic and social dimensions, including education outcomes (Ashraf et al., 2020), employment (Lowes & Nunn, 2017; Rammohan & Johar, 2009), wages, and access to productive resources, pensions, and government transfers (Bargain et al., 2022; Bau, 2021; Collins et al., 2022). However, relatively few studies look at links between cultural practices and nutrition outcomes. Some work exists on culture, food consumption preferences, and perspectives of body image in relation to overweight and obesity (Brown, 1991; Klaczynski et al., 2004; O'Dea, 2008). Several studies point at gender gaps in nutritional outcomes, including the fact that women in many low- and middle-income countries are more affected by overweight and obesity than men, which is likely due to female cultural restrictions (Ameye & Swinnen, 2019; Popkin et al., 2020; Roemling & Qaim, 2012). A few studies analyze the role of son preferences and patrilineal kinship systems for gendered nutrition and health outcomes in different countries (Allendorf, 2013; Briones et al., 2018; Harris-Fry et al., 2017; Levine & Kevane, 2003; Lowes & Nunn, 2017; Lowes, 2020; Ren et al., 2014; Sear & Mace, 2008). The results of this research are mixed, underlining that the effects and the underlying mechanisms are probably not uniform and depend on many local conditions.

In this study, we focus on Indonesia, which is an interesting country to study links between cultural practices and gendered nutrition outcomes for at least two reasons. First, Indonesia has been experiencing a profound nutrition transition over the last 25 years, with undernutrition still existing in some pockets but overweight and obesity rates rising rapidly (Popkin et al., 2020; Roemling & Qaim, 2012). Second, Indonesia is a culturally very diverse country with different ethnicities, kinship systems, and marriage traditions (Kunto & Hilde Bras, 2019). Both patrilocal and matrilocal kinship systems exist in Indonesia. In patrilocal societies, men hold most of the power and control over resources, while women primarily handle domestic duties. A common practice in these societies is the payment of a bride price, aiming to compensate the bride's family for the 'loss' of their daughter from the lineage group (Ashraf et al., 2020). Yet, bride price practices are not confined to patrilocal societies. In matrilocal societies, women can assume prominent economic roles and also enjoy inheritance rights (Bau, 2021).

In particular, we aim to understand how the cultural practices of patrilocality, matrilocality, and bride price influence the nutrition transition in Indonesia. Effects of these cultural practices on intra-household distribution of food and nutrition resources likely already start during childhood but are expected to extend into adulthood. We focus on adults and their nutritional outcomes because for adults longer-term panel data are available, which is of great advantage for the statistical analysis. We use data from the Indonesian Family Life Survey (IFLS), a longitudinal survey of more than 12,000 adults spanning the period from 1993 to 2014, and combine this with relevant ethnographic information. Panel data regression models with correlated random effects help us to reduce issues of endogeneity when estimating the associations between the various cultural practices and nutritional outcomes in terms of men's and women's body mass index (BMI). In addition, we also use quantile regressions to test whether the associations differ at different points of the BMI distribution. This is important because increases in BMI are positive for nutrition and health among underweight but not among overweight and obese individuals.

The rest of this paper is organized as follows. In the next section, we discuss the theoretical concept explaining how the concrete cultural practices of patrilocality, matrilocality, and bride price may affect nutritional outcomes. Section 3 describes the data and statistical methods used in the empirical analysis. The results are presented and discussed in section 4, while section 5 concludes.

2. Theoretical framework

To understand how cultural practices may affect nutrition, we build on established conceptual frameworks examining the impact of cultural practices on household resource allocation, with a focus on gender disparities (Ashraf et al., 2020; Bau, 2021; Chakraborty & Das, 2005; Levine & Kevane, 2003). In this study, we define gender as comprising male and female identities. For a particular household, the probability of gender-based resource allocation is a function of the parents' utility function, defined as follows:

$$U_p = c_1 + \theta c_2 + \vartheta U_f\left(h_\nu^f, i_\nu^f\right) + \gamma U_m(h_\nu^m, i_\nu^m) \qquad (1)$$

where c_1 and c_2 denote parents' consumption in two different periods, present and future. θ reflects the parents' discount rate for future costs and benefits, and ϑ and γ denote parents' preferences regarding their children's gender, with *f* standing for female and *m* for male. h_ν^f and h_ν^m signifies the parents' allocation of resources to females and males within cultural context ν. Resources relevant for nutrition and health can encompass nutritious food, healthcare, and preventive measures. Lastly, i_ν^f and i_ν^m represent cultural practices.

We are particularly interested in the cultural practices of patrilocality, matrilocality, and bride price, all of which are common in Indonesia, depending on the ethnicity (Ashraf, 2009; Bau, 2021; Levine & Kevane, 2003; Lowes & Nunn, 2017; Rammohan & Johar, 2009). People belonging to patrilocal ethnicities usually practice co-residence with the paternal side of the family after marriage. Examples include the Betawi, Banjar, and Manado ethnicities in Indonesia. People belonging to matrilocal groups usually practice co-residence with the maternal side of the family after marriage. Examples include the Minangkabau, Toraja, and Bugis ethnicities in Indonesia. Neolocal ethnicities also exist in Indonesia, meaning that people do not adhere to co-residential cultures. In neolocal communities, newlyweds can live independently from their relatives. These cultural kinship systems are mutually exclusive. The practice of bride price is different and can occur in all ethnicities and kinship systems, even though it is more common in male-dominated communities. Bride price refers to payments from the husband's family to the wife's family. The amount of the bride price varies and is typically negotiated case by case.

The different cultural practices can influence parents' current and future consumption. For instance, parents can receive support from co-residing with their children, affecting future consumption (c_2), accounting for nutrition costs and income. Assuming that parents maximize their utility, we propose the following hypothesis about the relationship between kinship practices and nutritional outcomes:

Hypothesis 1: Nutrition allocation to females is higher in ethnicities practicing matrilocality, while nutrition allocation to males is higher in ethnicities practicing patrilocality. This also results in different BMI between female and male adults.

In predicting which household members would receive more resource allocation based on cultural practices, we rely on the equilibrium concept of locality practices established by Bau (2021). In particular, we predict that $\alpha^{f}_{mat} - \alpha^{m}_{mat} \geq \alpha^{f}_{neo} - \alpha^{m}_{neo} > \alpha^{f}_{pat} - \alpha^{m}_{pat}$, where α^{f} and α^{m} are the shares of nutrition resources received by female and male children in matrilocal, neolocal, and patrilocal ethnicities, respectively. One interesting question is what group to compare with. Do females (males) in matrilocal (patrilocal) ethnicities only receive more nutrition resources and have higher BMI than females (males) in other ethnicities or also more than the opposite sex in the same and other ethnicities? This question will be addressed empirically below.

Concerning the cultural practice of bride price, we propose the following hypothesis:

Hypothesis 2: The payment of a bride price leads to higher nutrition allocation to females, and possibly also males. Bride price attenuates some of the effects of locality practices.

Previous research on education investments (Ashraf et al., 2020) suggests that parents tend to invest more in the education of their daughters in societies with bride price customs compared to similar societies without such customs. The reason might be that daughters with higher human capital endowments can fetch a higher bride price upon marriage. In the same vein, we would expect that bride price practices may lead to increased nutrition allocation to females. Bride price practices are more common in male-dominated societies, which may mean that sons in these societies receive more nutrition resources than sons in other societies. There is a partial overlap of patrilocal societies and bride price customs. In these situations, we would expect that the bride price custom attenuates the female discrimination in nutrition allocation to some extent. But bride price customs also exist in societies that are not patrilocal, so that disentangling the effects of both cultural practices may be worthwhile.

In our third hypothesis, we are interested to test whether the effects of cultural practices on nutrition outcomes differ with nutritional status:

Hypothesis 3: The effect of cultural practices on nutritional outcomes varies across individuals with differing nutritional status, especially when considering the two ends of the BMI distribution.

Previous studies by Jolliffe (2011) and Lakdawalla and Philipson (2009) suggest that the effects of various economic factors on nutrition are stronger at the tail ends of the BMI distribution. This is because both the upper and lower tails represent the more vulnerable population groups that are also more susceptible to the effects of explanatory variables. We are not aware of previous research that analyzes heterogeneous associations between cultural variables and nutrition outcomes, but we expect that different effects at the lower and upper tails of the BMI distribution are likely.

3. Materials and methods

3.1 Data

This study relies on two main data sources: first, the IFLS panel data, and second, data on cultural practices from the Ethnographic Atlas 1967. The IFLS is a nationally representative longitudinal survey that was conducted in five waves, 1993, 1997, 2000, 2007, and 2014. The survey covers over 7,200 households in 13 provinces across the various Indonesian islands, representing 83% of the population, only excluding the eastern parts of Indonesia (Strauss et al., 2016). The sample size increased over time, as new household members and split households were also captured. The survey collected information on individual health and anthropometric indicators, ethnicity, and a wide range of household and contextual socioeconomic variables. We use a total of 87,819 observations from adults 19-65 years old. Due to missing data, the actual sample for some parts of the analysis is smaller. In addition to the interviews and measurements at household and individual levels, IFLS also collected community-level data on demography, infrastructure, socioeconomic variables, and cultural practices in 321 enumeration areas through interviews with village leaders and other local experts.

The second data source, the Ethnographic Atlas 1967, compiles information on traditional cultural practices of 1,291 ethnicities worldwide (Murdock, 1967). These data contain cultural practices such as residence after marriage and bride price customs, among other ethnographic details. This international dataset was validated by ethnographers globally and cross-referenced with similar studies on ethnicity practices in Indonesia. Cultural practices associated with each individual were identified by matching the ethnicity information from IFLS with the information from the Ethnographic Atlas. However, ethnicity information in the IFLS was only available from wave 2000 onward. Hence, we trace each individual from previous waves and assign them to the ethnicity information collected in 2000. For a few individuals that were no longer included in the 2000 wave, we assigned ethnicity information based on community details and the language in which the survey interviews were conducted.

3.2 Measurement of key variables

The main nutrition outcome variable used in our study is BMI of male and female adults, which is based on individual weight and height measurements from the IFLS. Based on BMI, we categorize individuals into nutritional status groups, using World Health Organization recommendations for Asian populations, with cutoffs for overweight and obesity somewhat lower than for Western populations (Roemling and Qaim, 2013; Tan, 2004). We use the following groups and cutoffs: underweight, if the BMI is below 18; normal weight, if the BMI is between 18 and 23; overweight, if the BMI is above 23 (for Western populations, this cutoff is at 25); obese, if the BMI is above 27 (for Western populations, this cutoff is at 30).

The main explanatory variables in this study are the cultural practices of patrilocality, matrilocality, and bride price. As mentioned above, these practices differ by ethnicity, so we use the ethnicity information from the IFLS to assign cultural practices to individuals. An alternative would have been to assign cultural practices based on the community that the individual lives in, as was done in previous research (Levine & Kevane, 2003). However, using community data may have two potential drawbacks. First, community data may be less precise than ethnicity data, because not all communities are ethnically homogenous. Second, if cultural practices are determined at the community level, they are closely (or sometimes perfectly) correlated with other community-level variables, which makes controlling for confounding factors in the regressions more difficult. This is why we consider ethnic-based assignment of cultural practices preferable.

Nevertheless, one may ask to what extent traditional ethnic practices are actually followed by people belonging to that ethnicity, because individual adherence to ethnic-based traditions may change over time. Looking at actual kinship and marriage practices of all individuals and households is not possible in our case, because these details are not available for the entire sample. Moreover, it could lead to serious endogeneity issues, because actual individual choices are likely correlated with unobserved factors that could also influence nutrition outcomes. Fortunately, information about actual locality and bride price practices is available from IFLS for a subsample of married women and men. We use this subsample to show that ethnic-based cultural practices are significantly correlated with actual practices, even after controlling for community-based practices (Table A1 in the Appendix), concluding that ethnic-based cultural practices are valid explanatory variables in our context.

3.3 Regression models for estimating mean effects

We use panel data regression models of the following form to estimate associations between cultural practices and nutritional outcomes:

$$Y_{i,e,t} = \beta_0 + \beta_1 Culture_{e,t} + \beta_2 Female_{i,e,t} + \beta_3 Culture_{e,t} \times Female_{i,e,t} + \gamma_1 X_{i,e,t}$$

$$+\gamma_2 Z_{c,t} + \gamma_3 T_t + \alpha_i + u_{i,t} \quad (2)$$

where $Y_{i,e,t}$ is the nutrition outcome variable of individual *i* (BMI, overweight/obesity status) belonging to ethnicity *e* at time *t*. $Culture_{e,t}$ is a vector of the ethnic-based cultural practices, patrilocality, matrilocality, and bride price. We conduct separate estimations for locality and bride price practices, as well as combined estimations to explore the interplay of these cultural factors. Additionally, we introduce an interaction term of the cultural practices with $Female_{i,e,t}$ to evaluate gendered differences. Thus, the effect of the cultural practices for male individuals is characterized by the coefficient β_1 (in comparison to males in other ethnicities), the effect for female individuals is characterized by $\beta_1 + \beta_3$ (in comparison to females in other ethnicities), and the difference in the effects for males and females within the same culture is characterized by β_3.

In these regressions, we control for individual and household characteristics, $X_{i,e,t}$, including age, a square term of age, years of schooling, working status, urban versus rural residence, household size, per capita expenditure, and being Muslim. We also include household food consumption variables, such as the share of staple foods, consumption of vegetable oil, and meat/fish, as these may also capture certain cultural factors that are different from kinship and marriage practices. We test the results with and without including these food consumption variables. We also control for community-level characteristics, $Z_{c,t}$, including road availability, access to clean water, electricity, healthcare centers, agricultural activities, wages in agriculture, population density, and school availability. Furthermore, we include a set of dummies for the survey waves, *T*. α is the individual-specific error term, whereas u is the unexplained variation of time *t* and individual i.

We will start with estimating the models in equation (2) with a random effects (RE) panel estimator. However, the RE estimator assumes that the individual-specific error term is uncorrelated with the explanatory variables, which is not necessarily the case due to possible unobserved heterogeneity. The fixed effects (FE) estimator is a solution to control for time-invariant unobserved heterogeneity, but it requires the explanatory variables of interest to vary over time. Our main explanatory variable of interest, $Culture_{e,t}$, does not vary over time for individual *i*, meaning that the FE is not an option in our case. A suitable alternative is the correlated random effects (CRE) estimator, which controls for time-invariant unobserved heterogeneity without requiring all explanatory variables of interest to be time-variant (Wooldridge, 2019). This is achieved by including time-average effects of all time-variant explanatory variables as additional covariates. The CRE models are defined as follows:

$$Y_{i,e,t} = \beta_0 + \beta_1 Culture_{e,t} + \beta_2 Female_{i,e,t} + \beta_3 Culture_{e,t} \times Female_{i,e,t} + \gamma_1 X_{i,e,t}$$

$$+\gamma_2 Z_{c,t} + \gamma_3 T_t + \gamma_4 \bar{X} + \alpha_i + \varepsilon_{i,t} \qquad (3)$$

where $\bar{X}$ is the vector of time averages for all the time-variant explanatory variables across the various survey waves.

3.4 Quantile regression models

The models in equations (2) and (3) estimate average associations between cultural practices and nutrition outcomes for male and female individuals. However, given that the effects may be different for individuals with better or worse nutritional status and an increase in BMI is not necessarily better for all, it is also of interest to analyze heterogenous effects. We hypothesized that the effects of cultural factors are more pronounced at the tail ends of the BMI distribution. We test this hypothesis by using unconditional quantile regressions (UQR) (Firpo et al., 2009). We first calculate the recentered influence function (RIF) of every τ-th quantile of Y (the BMI distribution), where for any given q_τ that is estimated using the unconditional sample analog of τ-th quantile, we use the density function $f_Y(\hat{q}_\tau)$ following the kernel method:

$$\widehat{RIF}\ (Y; \hat{q}_\tau) = \hat{q}_\tau + \frac{\tau - 1\{Y_i \leq \hat{q}_\tau\}}{f_Y(\hat{q}_\tau)} \tag{4}$$

We divide the τ-th quantile of the BMI distribution based on the nutritional status cutoffs for underweight, normal weight, overweight, and obesity (Jolliffe, 2011). Next, we estimate a regression model on the RIF estimates using CRE. Due to the complexities of incorporating the quantiles of the sums of the random variables in the estimation, we use a pooled OLS estimator combined with the Mundlak-Chamberlain device by adding $\bar{X}$ to the unconditional quantile regressions of BMI (Wooldridge, 2010).

4. Results

4.1 Descriptive statistics

In examining the BMI distributions of adults in Indonesia between 1993 (wave 1 of the IFLS) and 2014 (wave 5), we find a considerable increase over time (Fig. 1). This increase is observed for both males and females, but it is more pronounced for females. Male mean BMI increased from 21.14 in 1993 to 22.63 in 2014; female mean BMI increased from 21.86 to 24.60 during the same period (Table A2 in the Appendix). In 2014, 41% of the male adults and 60% of the female adults were either overweight or obese. At the same time, 8% of the males and 6% of the females were still underweight in 2014.

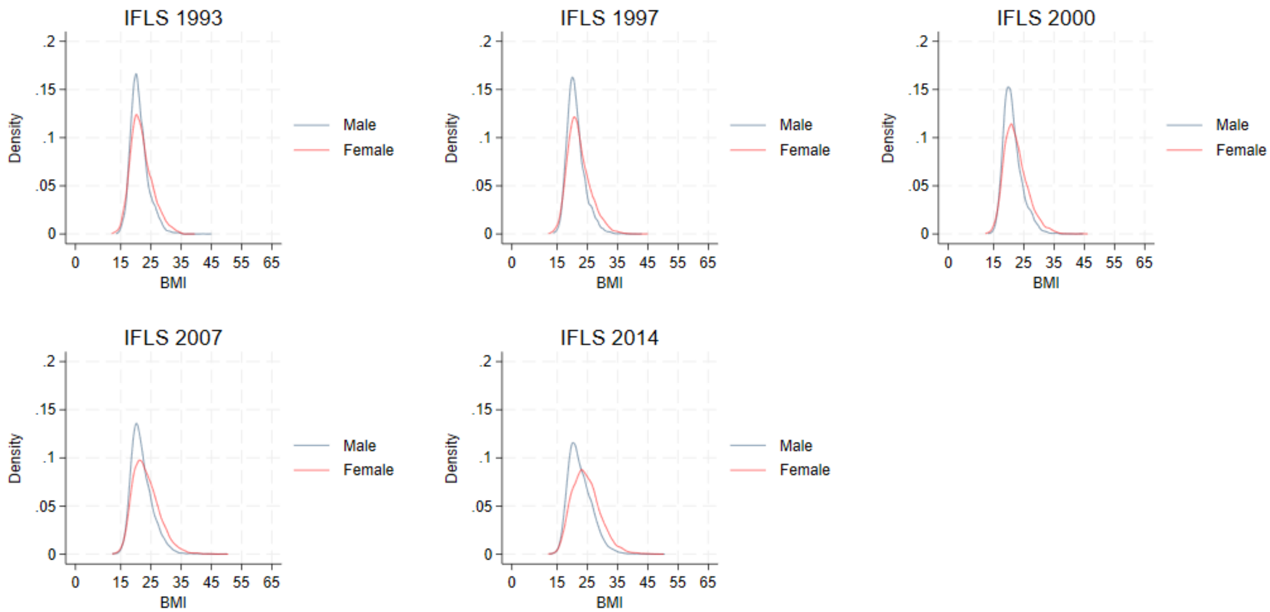


Figure 1: BMI density functions for male and female adults in Indonesia (1993-2014)

Concerning ethnic-based cultural practices, of all adults in our sample, 20% belong to patrilocal, 10% to matrilocal, and 70% to neolocal ethnicities. Nineteen percent of the adults belong to ethnicities with bride price practices and 81% to ethnicities without. Table A3 in the Appendix shows some differences in nutritional outcomes between the cultural groups. The mean BMI for males is somewhat higher in patrilocal than in matrilocal and neolocal ethnicities. For females, the observed BMI differences between locality practices are small. For both, males and females, mean BMI is higher in ethnicities with bride price practices than in ethnicities without.

Table A4 in the Appendix shows descriptive statistics of the other covariates that we use in the regression analysis, differentiating by ethnic-based cultural practices. Individuals belonging to patrilocal ethnicities are somewhat better off than individuals belonging to other ethnicities in terms of higher mean education levels and per capita expenditures. There are also some differences in terms of food consumption patterns and other socioeconomic variables, but the magnitude of these differences is mostly small.

4.2 Mean effects of cultural practices and nutritional outcomes

Effects of locality practices

We now estimate the panel data regression models explained in equations (2) and (3) above. We mostly rely on the CRE estimates from equation (3), as these better address endogeneity issues resulting from unobserved heterogeneity. The results are summarized in Table 1. Panel A of Table

1 shows the effects of the different cultural practices on male adults (coefficient β_1). As hypothesized, patrilocality contributes to higher male BMI. The CRE coefficient in column (3) suggests that patrilocality leads to a 0.244 increase in male BMI, after controlling for confounding factors. This is in comparison to male adults in neolocal ethnicities as the reference group.

Panel B of Table 1 shows the effects on female adults (coefficients $\beta_1 + \beta_3$). Patrilocality has no significant effect on female BMI in comparison to females in neolocal ethnicities. However, in comparison to males, females have a 0.214 lower BMI as a result of patrilocal practices (as shown in panel C, column (3), which represents the female interaction coefficient β_3). In contrast, matrilocality has no direct effect on males, but it increases female BMI by 0.277 in comparison to females in neolocal ethnicities. In matrilocal ethnicities, females seem to receive the same nutrition allocation as males, as indicated by the statistically insignificant female interaction term for matrilocality in panel C. These gendered BMI effects support our first hypothesis that nutrition allocation to females is higher in ethnicities practicing matrilocality, while nutrition allocation to males is higher in ethnicities practicing patrilocality. These results also hold when not including food consumption variable as controls, as shown in Table A6 in the Appendix.

Table 1: Associations between ethnic-based cultural practices and adult BMI

	RE		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
A. Effect among males						
Patrilocality	0.268***		0.244***		0.175*	0.097
	(0.075)		(0.077)		(0.095)	(0.096)
Matrilocality	0.063		0.076		0.008	-0.013
	(0.095)		(0.097)		(0.105)	(0.106)
Bride price		0.151**		0.177**	0.124	0.204**
		(0.072)		(0.072)	(0.096)	(0.096)
B. Effect among females						
Patrilocality	0.024		0.03		-0.188*	-0.233**
	(0.087)		(0.087)		(0.108)	(0.109)
Matrilocality	0.215**		0.277**		0.073	0.102
	(0.107)		(0.109)		(0.118)	(0.12)
Bride price		0.206**		0.245***	0.313***	0.388***
		(0.082)		(0.082)	(0.109)	(0.11)
Panel C. Difference between females and males (female interaction term)						
Patrilocality	-0.244**		-0.214**		-0.363***	-0.329**
	(0.108)		(0.106)		(0.135)	(0.133)
Matrilocality	0.152		0.201		0.065	0.115
	(0.142)		(0.141)		(0.157)	(0.154)
Bride price		0.055		0.068	0.188	0.184
		(0.108)		(0.107)	(0.143)	(0.142)
Panel D: Overall effect for adults without female interaction term						
Patrilocality	0.140**		0.132**		-0.018	-0.079
	(0.061)		(0.063)		(0.077)	(0.079)
Matrilocality	0.146**		0.186**		0.045	0.051
	(0.073)		(0.076)		(0.081)	(0.083)
Bride price		0.180***		0.213***	0.227***	0.304***
		(0.055)		(0.057)	(0.074)	(0.076)
Observations	65551	74308	65551	74308	65551	65551
Mean outcome	22.412	22.35	22.412	22.35	22.412	22.412

Note: *** p<0.01, ** p<0.05, * p<0.10. Coefficients from panel data regression models with robust standard errors in parentheses. Individual, household, and community control variables were included in estimation, as shown in Table A5 in the Appendix. RE, random effects estimator. CRE, correlated random effects estimator.

In panel D of Table 1, we show alternative results of models that do not include female interaction terms, so that we cannot differentiate between effects for male and female individuals. These results suggest that both patrilocal and matrilocal practices significantly increase adult BMI. However, this is a misleading result, as it masks the contrasting effects for males and females. Evidently, differentiating by gender is important when analyzing the effects of ethnic-based cultural practices.

Effects of bride price practices

The effects of bride price practices are also shown in Table 1. Bride price practices increase female BMI by 0.245 in comparison to females without this cultural practice (Table 1, panel B, column 4). At the same time bride price practices also increase male BMI by 0.177 in comparison to males without this cultural practice (panel A, column 4). As mentioned, bride price practices are more common in male-dominated societies, which may explain the effect for males. The female interaction term for bride price is not statistically significant (panel C), suggesting that the effects for male and female individuals are similar. These findings support the first part of our second hypothesis, namely that bride price practices lead to higher nutrition allocation to females, and also to males.

The second part of the second hypothesis is about bride price practices attenuating some of the effects of locality practices. In order to test this, we run additional models where we combine locality and bride price practices in the same models, as shown in columns (5) and (6) of Table 1. Again, we mostly rely on the CRE estimates in column (6). For male individuals (panel A), both patrilocality and bride price have positive coefficients, but only the latter is statistically significant. This may be due to a certain overlap of both practices, meaning that the two variables are positively correlated. In contrast, the coefficient for patrilocality becomes negative and significant for female individuals (panel B), meaning that without bride price practices, patrilocality has a negative effect on female BMI. This negative effect is attenuated through bride price practices, indicated by the significantly positive coefficient for bride price in column (6) of panel B. Furthermore, we observe that the significant effect of matrilocality on female BMI disappears after additionally controlling for bride price. These findings support the second part of our second hypothesis. Obviously, there are important interactions between kinship and marriage practices.

Effects on overweight/obesity

Patrilocal practices increase the BMI for males, matrilocal practices increase the BMI for females, whereas bride prices practices increase the BMI for both females and males. BMI is not necessarily a comprehensive measure of healthy nutrition, as weight gains in adults are primarily the result of food energy intakes exceeding body energy expenditures, whereas excess food energy can be still be associated with micronutrient deficiencies. Nevertheless, in situations like

Indonesia, where overweight and obesity are rapidly rising, it is still interesting and important to understand to what extent cultural practices contribute to overweight and obesity. This is analyzed here by using overweight as a binary nutrition outcome variable in the panel data regressions. The results are summarized in Table 2. Indeed, the CRE estimates in column (3) suggest that patrilocality increases the likelihood of overweight among men by 2.8 percentage points (panel A), whereas matrilocality increases the likelihood of female overweight by 4.6 percentage points.

Bride price practices increase the likelihood of overweight among males by 2.4 percentage points and among females by 1.8 percentage points (column 4 of Table 2, panels A and B). The bride price effect on male and female overweight remains positive and significant also when simultaneously controlling for locality practices (column 6). The patrilocality effect for males turns insignificant when controlling for bride price, while the matrilocality effect for females remains positive and significant. These effects clearly suggest that matrilocality and bride price practices contribute to female overweight. These effects remain almost identical also when not including the food consumption controls (Table A8 in the Appendix).

Table 2: Associations between ethnic-based cultural practices and overweight

	RE		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Effect on males						
Patrilocality	0.054***		0.028***		0.028**	0.019
	(0.009)		(0.009)		(0.012)	(0.012)
Matrilocality	0.019		0.008		0.002	-0.002
	(0.012)		(0.012)		(0.013)	(0.013)
Bride price		0.022***		0.024***	0.013	0.022*
		(0.009)		(0.009)	(0.012)	(0.012)
Panel B. Effect on females						
Patrilocality	0.012		-0.008		-0.015	-0.02*
	(0.009)		(0.01)		(0.012)	(0.012)
Matrilocality	0.041***		0.046***		0.025*	0.024*
	(0.012)		(0.012)		(0.013)	(0.013)
Bride price		0.015*		0.018**	0.02*	0.028**
		(0.009)		(0.009)	(0.012)	(0.012)
Panel C: Difference between females and males (female interaction term)						
Patrilocality	-0.042***		-0.036***		-0.043***	-0.039**
	(0.013)		(0.012)		(0.016)	(0.016)
Matrilocality	0.022		0.038**		0.023	0.026
	(0.017)		(0.017)		(0.018)	(0.018)
Bride price		-0.007		-0.007	0.007	0.006
		(0.012)		(0.012)	(0.017)	(0.017)
Panel D: Overall effects on adults (without including female interaction term)						
Patrilocality	0.017**		0.016**		0.005	-0.002
	(0.007)		(0.007)		(0.009)	(0.009)
Matrilocality	0.022***		0.024***		0.014	0.012
	(0.008)		(0.009)		(0.009)	(0.009)
Bride price		0.018***		0.021***	0.017**	0.025***
		(0.006)		(0.006)	(0.009)	(0.009)
Observations	65551	74308	65551	74308	65551	65551
Mean outcome	.371	.365	.371	.365	.371	.371

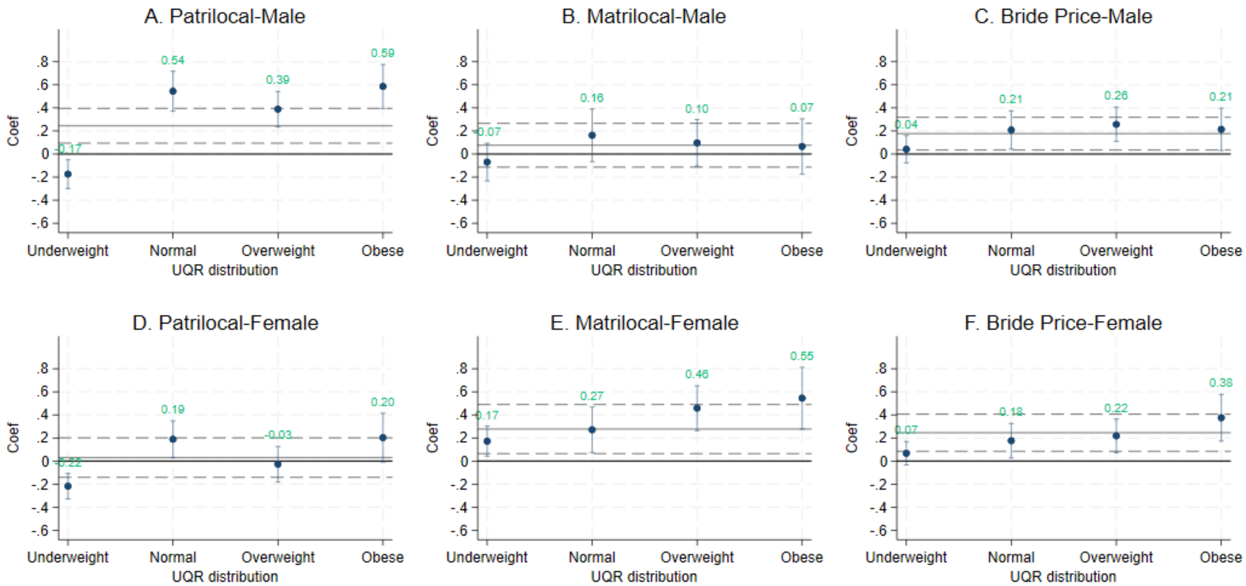
Note: *** p<0.01, ** p<0.05, * p<0.10. Coefficients from panel data regression models with robust standard errors in parentheses. Individual, household, and community control variables were included in estimation, as shown in Table A7 in the Appendix. RE, random effects estimator. CRE, correlated random effects estimator.

4.3 Heterogeneous effects of cultural practices on BMI

The results so far referred to the effects of cultural practices on male and female BMI at the mean. However, an increase in BMI can be good or bad, depending on where on the BMI distribution an individual is located. Therefore, it is important to also examine how the relationship between cultural practices and nutritional outcomes looks at different points of the BMI distribution. As explained above, we use quantile regressions and evaluate effects for four different BMI groups, namely underweight, normal weight, overweight, and obese. Results are shown in Fig. 2.

Patrilocality is associated with an increase in BMI for normal weight, overweight, and obese males, but not for underweight males (panel A of Fig. 2). In fact, the increase is strongest for obese males, whereas for underweight males a slightly negative effect (a BMI decrease of 0.17) is observed. For underweight females, patrilocality also has a significantly negative effect (panel D). For normal weight females, the effect of patrilocality is positive, whereas for overweight and obese females the effects are statistically insignificant. Matrilocality has no significant effects on any of the male groups (panel B), but it significantly increases BMI for all female groups (panel E). Strikingly, the BMI effect of matrilocality is smallest for underweight females and largest for obese females. Bride price also increases BMI the most for obese females, whereas for underweight females the effect is small and statistically insignificant (panel F).

For males, similar distributional patterns of bride price are observed (panel C). These findings support our third hypothesis that the effect of cultural practices on nutritional outcomes varies across individuals with differing nutritional status, especially when comparing the two ends of the BMI distribution. The strong BMI-increasing effects of some of the cultural practices on obese males and females and the BMI-decreasing effect of patrilocality on underweight males and females are particularly worrisome. Our findings imply that ethnic-based cultural practices may further reinforce some of the malnutrition problems in Indonesia.



Notes: Results from unconditional quantile regressions (UQR) with correlated random effects (CRE). Patrilocal and matrilocal practices were jointly included in the same regressions. Bride price effects were estimated with separate regressions (for joint estimates including all three cultural practices in the same regressions, see Fig. A1 in the Appendix). Point estimates with 95% confidence intervals are shown. For comparison, the horizontal straight lines indicate the average CRE results from Table 1 (dashed lines above and below are 95% confidence intervals).

Figure 2: Associations between ethnic-based culture practices and BMI for different groups

5. Conclusion

In this study, we have analyzed associations between different cultural practices and nutritional outcomes in Indonesia. In particular, we have examined the implications of patrilocality, matrilocality, and bride price practices for male and female BMI. We have exploited panel data from adult individuals spanning a period of 22 years. Panel data regression models with correlated random effects have helped us to control for unobserved time-invariant heterogeneity. Even though some of the hypothesized effects of cultural practices on the intra-household allocation of nutritional resources already occur at childhood ages, longer-term panel data for children are not available. We argue that the nutritional effects of cultural practices also extend into adulthood so that looking at effects among adults can provide valuable insights.

The data from Indonesia reveal significant changes in the BMI distributions and nutritional status of male and female adults over the 22 years of observation. The BMI distributions notably shifted to the right, meaning that underweight decreased whereas overweight and obesity increased.

Overweight and obesity rates are consistently higher among females than males, which is a common observation not only in Indonesia but also in most other low- and middle-income countries (Ameye & Swinnen, 2019; Popkin et al., 2020; Rachmi et al., 2017; Roemling & Qaim, 2012, 2013).

In terms of the cultural practices considered, we produced three major findings, confirming our research hypotheses. First, patrilocality is positively associated with the BMI of males, whereas matrilocality is positively associated with the BMI of females. Second, bride price practices are associated with a higher BMI among both males and females. Furthermore, when including all three ethnic-based cultural practices into the same regressions, bride price practices attenuate some of the effects of patrilocality, because of a positive correlation between patrilocality and bride price practices. Third, the nutritional effects of all three cultural practices differ along the BMI distribution. The strongest BMI-increasing effects are observed among those who are already obese, whereas patrilocality has BMI-decreasing effects on underweight males and females.

Our results are consistent with existing theories of gendered resource allocation within households. Households are more likely to allocate nutrition and health resources to the gender that is preferred by cultural customs, as this maximizes the return to the households via transfers or care work in old age. The first main result supports this theory by showing that practices of co-residence with paternal parents (patrilocality) increase nutritional outcomes among males compared to males from neolocal societies. These results align with previous studies analyzing gendered effects of cultural practices on other wellbeing outcomes. In patrilocal cultures, parents are more likely to allocate resources to males, as they are typically more dominant economically in these cultural settings. This allocation is often seen as a contribution to the lifetime resources of the parents and a form of old-age insurance (Dasgupta, 2016; Rathore & Das, 2022). Patrilocality may lead to discrimination against females in some situations, as our results suggest and as previous studies have also shown (Allendorf, 2013; Bargain et al., 2022; Bau, 2021; Briones et al., 2018; Collins et al., 2022; Dasgupta, 2016; Harris-Fry et al., 2017; Rammohan & Johar, 2009; Sear & Mace, 2008). Bride price practices can attenuate this female discrimination to some extent.

We also found that co-residence with maternal parents (matrilocality) increases nutritional outcomes among females compared to females from other locality cultures. This is aligned with previous studies indicating that matrilocality influences investment in female household members, as parents consider their female children as a kind of old-age insurance (Bau, 2021; Lowes, 2020; Sear et al., 2002; Sear & Mace, 2008). However, after controlling for bride price the significant effect of matrilocality disappears, suggesting that bride price practices have a stronger impact on females' nutritional outcomes than co-residence with their kin.

Bride price practices result in higher BMI scores for males and females and attenuate some of the effects of locality. For females, the result can be explained by parents expecting a higher bride price payment when their daughter is well nourished and healthy, leading to larger allocation of nutrition and health resources to females (Ashraf et al., 2020; Bau, 2021; Lowes & Nunn, 2017). This is in line with previous work in Indonesia and Ghana showing that bride price practices have positive effects on female education (Ashraf et al., 2020; Lowes & Nunn, 2017). However, nuanced interpretation is required. In some situations, bride price practices can also have negative effects on females, such as domestic violence, early marriage, or high fertility during times of economic shocks (Corno et al., 2020; Lowes & Nunn, 2017).

For males, the BMI-increasing effect of bride price practices may be unexpected on first sight. However, this BMI-increasing effect among males is not in comparison to females in bride price-practicing ethnicities but in comparison to other males in ethnicities without bride price practices. Bride price practices are more common in male-dominated societies with son preferences, so in these societies males receive more nutrition and health resources than in other societies.

The ethnic-based cultural practices benefiting specific genders more than others have long-standing historical roots. Historically, receiving more food meant being better nourished and healthier. In the context of the more recent nutrition transition, with rapidly rising overweight and obesity rates, this is no longer the case. Nowadays, receiving consistently more food because of traditional cultural practices can contribute to overweight and obesity, as our results also underline. Patrilocality tends to increase overweight among males, matrilocality tends to increase overweight among females, and bride price practices tend to increase overweight among both males and females. Our quantile regression results show that the BMI-increasing effects are strongest at the upper end of the BMI distribution. At the same time, patrilocality practices in particular have negative BMI effects on those males and females that are underweight anyway. These findings imply that cultural practices nowadays further reinforce some of the malnutrition problems in Indonesia.

Our results clearly suggest that nutrition and health policies should consider cultural factors more explicitly. Knowledge about the nutrition implications of certain cultural practices can help to develop and implement culturally-sensitive interventions and policies that promote healthier nutrition and lifestyles and raise awareness about specific nutritional risks. Health and nutrition campaigns are often targeted at women. While women’s empowerment needs to be promoted, it will be important to include men as well, especially in patrilocal and other male-dominated societies, as in these societies many relevant decisions on intra-household resource allocation are made by males. Cultural practices are unlikely to change if males are not included in awareness campaigns and other policy interventions.

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6. Appendix

Table A1: Associations between ethnic-based cultural practices and actual practices

	Actual Matrilocality		Actual Patrilocality		Actual Bride Price	
	(1)	(2)	(3)	(4)	(5)	(6)
Ethnic matrilocal	0.128***	0.099***	-0.078***	-0.054***		
	(0.015)	(0.017)	(0.013)	(0.015)		
Ethnic patrilocal	-0.117***	-0.088***	0.076***	0.049***		
	(0.012)	(0.014)	(0.011)	(0.012)		
Community matrilocal		0.053***		-0.051***		
		(0.011)		(0.010)		
Community patrilocal		-0.123***		0.071***		
		(0.015)		(0.013)		
Ethnic bride price					0.012**	0.016***
					(0.006)	(0.006)
Community bride price						0.008*
						(0.004)
Observations	9421	7802	8945	7431	26626	23408
$R2$	0.037	0.061	0.020	0.034	0.536	0.571
Mean outcome	.279	.275	.299	.294	.302	.315

Note: *** p<0.01, ** p<0.05, * p<0.10. Regression models 1-4 were completed for a subset of married women above 50 years of age. Regression models 5-6 were completed for a subset of ever-married women and men above 50 years of age because the survey question was focused on the bride price payment history of couples. Bride price payment includes house, money, jewelry, and cattle. Analysis was also done to married adult population at the age of 25-49 and the results remain unchanged.

Table A2: Development of adult nutritional status in Indonesia (1993-2014)

	IFLS 1993	IFLS 1997	IFLS 2000	IFLS 2007	IFLS 2014
Male					
Body mass index(BMI)	21.14	21.19	21.31	22.00	22.63
	(2.99)	(3.01)	(3.20)	(3.64)	(3.91)
Underweight (BMI<18)	0.11	0.11	0.11	0.09	0.08
	(0.32)	(0.31)	(0.32)	(0.29)	(0.28)
Overweight (BMI≥23)	0.22	0.22	0.24	0.32	0.41
	(0.41)	(0.42)	(0.43)	(0.47)	(0.49)
Obesity (BMI>27)	0.04	0.05	0.06	0.10	0.14
	(0.21)	(0.21)	(0.24)	(0.29)	(0.34)
Female					
Body mass index (BMI)	21.86	22.20	22.40	23.39	24.60
	(3.67)	(3.87)	(3.98)	(4.42)	(4.73)
Underweight (BMI<18)	0.12	0.11	0.10	0.08	0.06
	(0.33)	(0.31)	(0.30)	(0.27)	(0.23)
Overweight (BMI≥23)	0.33	0.35	0.38	0.48	0.60
	(0.47)	(0.48)	(0.49)	(0.50)	(0.49)
Obesity (BMI>27)	0.10	0.12	0.12	0.19	0.28
	(0.30)	(0.32)	(0.33)	(0.39)	(0.45)
Observations	11841	15337	20285	24268	27464

Table A3: Nutritional status of male and female adults based on cultural practices (data pooled across survey waves)

	Neolocal	Matrilocal	Patrilocal	No bride price	Bride price	Neolocal-bride price	Matrilocal-bride price	Patrilocal-bride price
Male								
Body mass index	21.77	21.82	22.19	21.76	22.08	21.74	21.83	22.19
	(3.45)	(3.56)	(3.71)	(3.49)	(3.71)	(3.50)	(3.37)	(3.82)
Underweight (BMI<18)	0.10	0.10	0.09	0.10	0.10	0.12	0.08	0.10
	(0.29)	(0.30)	(0.29)	(0.30)	(0.30)	(0.33)	(0.27)	(0.30)
Overweight (BMI≥23)	0.29	0.31	0.35	0.30	0.34	0.29	0.29	0.36
	(0.46)	(0.46)	(0.48)	(0.46)	(0.47)	(0.46)	(0.46)	(0.48)
Obesity (BMI>27)	0.08	0.08	0.11	0.08	0.11	0.09	0.07	0.12
	(0.28)	(0.27)	(0.31)	(0.28)	(0.31)	(0.28)	(0.26)	(0.32)
Number of samples	28084	3791	8257	32438	7694	563	1706	5425
Female								
Body mass index	23.16	23.36	23.34	23.09	23.40	22.26	22.89	23.70
	(4.36)	(4.38)	(4.40)	(4.35)	(4.48)	(4.14)	(4.31)	(4.53)
Underweight (BMI<18)	0.08	0.07	0.08	0.09	0.08	0.14	0.10	0.07
	(0.28)	(0.26)	(0.27)	(0.28)	(0.28)	(0.35)	(0.29)	(0.26)
Overweight (BMI≥23)	0.45	0.48	0.47	0.45	0.48	0.39	0.43	0.50
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)
Obesity (BMI>27)	0.18	0.18	0.19	0.17	0.19	0.14	0.16	0.21
	(0.38)	(0.39)	(0.39)	(0.38)	(0.40)	(0.34)	(0.37)	(0.41)
Number of samples	33207	4964	9516	38470	9217	649	2248	6320
Observations	61291	8755	17773	70908	16911	1212	3954	11745

Table A4: Descriptive statistics of covariates by ethnic-based cultural practices

	Locality Cultures						Bride Price (BP)		
	A. Neolocal	B. Matrilocal	C. Patrilocal	A-B	A-C	B-C	D. No BP	E. BP	D-E
Demography									
Female	0.53	0.54	0.52	-0.0144**	0.00796	0.0223***	0.52	0.53	-0.00591
	(0.50)	(0.50)	(0.50)	(-2.62)	(1.92)	(3.56)	(0.50)	(0.50)	(-1.45)
Age in year	37.63	37.88	36.75	-0.250	0.877***	1.127***	37.82	36.75	1.068***
	(12.18)	(12.26)	(11.96)	(-1.87)	(8.73)	(7.42)	(12.46)	(11.95)	(10.59)
Age in year squared	1564.45	1585.20	1493.95	-20.75	70.50***	91.25***	1585.68	1493.48	92.21***
	(991.97)	(998.01)	(961.61)	(-1.90)	(8.64)	(7.45)	(1018.84)	(958.40)	(11.22)
Years of schooling	5.50	5.69	5.94	-0.195***	-0.437***	-0.242***	5.56	5.87	-0.316***
	(4.47)	(4.62)	(4.70)	(-3.95)	(-11.67)	(-4.12)	(4.53)	(4.60)	(-8.53)
Being married	0.80	0.75	0.78	0.0541***	0.0211***	-0.0330***	0.78	0.76	0.0270***
	(0.40)	(0.43)	(0.41)	(12.19)	(6.33)	(-6.22)	(0.41)	(0.43)	(8.01)
Have work in the past week	0.73	0.68	0.73	0.0541***	-0.00503	-0.0591***	0.72	0.69	0.0278***
	(0.44)	(0.47)	(0.44)	(11.00)	(-1.37)	(-10.42)	(0.45)	(0.46)	(7.51)
Live in urban areas	0.53	0.51	0.51	0.0242***	0.0207***	-0.00350	0.53	0.55	-0.0246***
	(0.50)	(0.50)	(0.50)	(4.41)	(5.01)	(-0.56)	(0.50)	(0.50)	(-6.05)
Religion: Islam	0.97	0.90	0.64	0.0767***	0.334***	0.257***	0.90	0.81	0.0900***
	(0.16)	(0.31)	(0.48)	(37.02)	(149.10)	(47.50)	(0.30)	(0.39)	(35.17)
History of smoking	0.33	0.31	0.33	0.0222***	0.00778*	-0.0144*	0.33	0.33	0.00524
	(0.47)	(0.46)	(0.47)	(4.30)	(1.99)	(-2.46)	(0.47)	(0.47)	(1.37)
Households variables									
Household size	4.45	5.06	4.72	-0.606***	-0.269***	0.337***	4.58	4.90	-0.313***
	(1.95)	(2.24)	(2.10)	(-27.73)	(-16.36)	(12.45)	(2.04)	(2.22)	(-18.53)
Real expenditure/capita	13.29	13.35	13.42	-0.0639***	-0.137***	-0.0732***	13.30	13.38	-0.0787***
	(0.78)	(0.79)	(0.76)	(-7.29)	(-20.96)	(-7.38)	(0.80)	(0.78)	(-11.94)
Female household head	0.16	0.18	0.13	-0.0122	0.0382***	0.0504***	0.16	0.15	0.00955*
	(0.37)	(0.38)	(0.33)	(-1.87)	(8.16)	(7.22)	(0.36)	(0.35)	(2.05)
Working female	0.31	0.30	0.32	0.0174***	-0.00569	-0.0231***	0.31	0.28	0.0213***
	(0.46)	(0.46)	(0.47)	(3.43)	(-1.48)	(-3.97)	(0.46)	(0.45)	(5.69)
Share of staple food expenditure	0.14	0.15	0.14	-0.0134***	-0.00440***	0.00900***	0.14	0.14	0.00376***
	(0.12)	(0.13)	(0.13)	(-10.00)	(-4.38)	(5.49)	(0.12)	(0.12)	(3.65)
Share of cooking oil expenditure	0.02	0.03	0.02	-0.00108***	0.00226***	0.00335***	0.02	0.02	0.00152***
	(0.03)	(0.03)	(0.02)	(-3.80)	(11.12)	(11.86)	(0.02)	(0.02)	(7.48)
Share of meat/fish expenditure	0.10	0.12	0.11	-0.0211***	-0.0113***	0.00981***	0.10	0.12	-0.0164***
	(0.08)	(0.09)	(0.08)	(-23.76)	(-17.00)	(9.12)	(0.08)	(0.09)	(-24.13)
Own TV/HH appliances	0.88	0.89	0.88	-0.00565	0.00215	0.00780	0.87	0.89	-0.0161***
	(0.32)	(0.32)	(0.33)	(-1.59)	(0.80)	(1.91)	(0.33)	(0.31)	(-6.00)
Share of food expenditure	0.55	0.57	0.56	-0.0137***	-0.00723***	0.00644**	0.55	0.57	-0.0162***
	(0.17)	(0.17)	(0.17)	(-7.37)	(-5.17)	(2.96)	(0.17)	(0.17)	(-11.51)
Community variables									
Garbage/manure exposure	0.26	0.34	0.33	-0.0825***	-0.0658***	0.0167*	0.27	0.36	-0.0905***
	(0.44)	(0.47)	(0.47)	(-14.85)	(-15.60)	(2.47)	(0.44)	(0.48)	(-21.53)

Pop. density (population/size of district)	2.47	1.92	2.25	0.556***	0.220***	-0.336***	2.39	2.10	0.283***
	(2.29)	(2.72)	(2.55)	(20.81)	(10.94)	(-9.88)	(2.37)	(2.74)	(13.69)
Farmland share	0.27	0.25	0.52	0.0206***	-0.248***	-0.269***	0.33	0.18	0.151***
	(0.34)	(0.33)	(5.00)	(5.48)	(-12.40)	(-5.17)	(2.38)	(0.30)	(8.46)
Clean water access	0.27	0.39	0.29	-0.127***	-0.0207***	0.106***	0.29	0.22	0.0776***
	(0.44)	(0.49)	(0.45)	(-25.16)	(-5.52)	(17.72)	(0.46)	(0.41)	(20.77)
Clean toilet access	0.72	0.65	0.73	0.0696***	-0.0107*	-0.0803***	0.70	0.72	-0.0246***
	(0.45)	(0.48)	(0.45)	(12.21)	(-2.52)	(-12.21)	(0.46)	(0.45)	(-5.73)
Electricity access	0.98	0.99	0.99	-0.0152***	-0.0124***	0.00286*	0.98	0.99	-0.0169***
	(0.14)	(0.08)	(0.09)	(-9.96)	(-11.00)	(2.54)	(0.15)	(0.08)	(-14.65)
Car road available	0.94	0.96	0.97	-0.0144***	-0.0214***	-0.00699**	0.94	0.96	-0.0150***
	(0.23)	(0.20)	(0.18)	(-5.69)	(-11.55)	(-2.89)	(0.23)	(0.20)	(-8.13)
Health facility available	0.91	0.90	0.88	0.00675*	0.0288***	0.0221***	0.92	0.87	0.0532***
	(0.28)	(0.29)	(0.32)	(2.12)	(11.67)	(5.51)	(0.27)	(0.34)	(22.35)
Nutritional outcomes									
Body Mass Index	22.52	22.69	22.81	-0.172***	-0.285***	-0.113*	22.47	22.80	-0.323***
	(4.03)	(4.12)	(4.13)	(-3.73)	(-8.24)	(-2.09)	(4.03)	(4.20)	(-9.42)
Underweight (BMI<18)	0.09	0.08	0.09	0.00539	0.00394	-0.00145	0.09	0.09	0.00325
	(0.29)	(0.28)	(0.28)	(1.66)	(1.62)	(-0.40)	(0.29)	(0.29)	(1.33)
Overweight (BMI≥23)	0.38	0.40	0.42	-0.0227***	-0.0356***	-0.0129*	0.38	0.41	-0.0352***
	(0.49)	(0.49)	(0.49)	(-4.09)	(-8.57)	(-2.00)	(0.48)	(0.49)	(-8.57)
Obesity (BMI>27)	0.13	0.14	0.15	-0.00508	-0.0168***	-0.0117*	0.13	0.15	-0.0224***
	(0.34)	(0.35)	(0.36)	(-1.30)	(-5.71)	(-2.53)	(0.34)	(0.36)	(-7.76)
Observations		92929		74101	83427	28330	105839		105839

Note: *** p<0.01, ** p<0.05, * p<0.10. The differences in covariates between locality and bride price culture is tested using T-test

Table A5: Associations between ethnic-based cultural practices and adult BMI (full model results for models without female interaction terms, panel D of Table 1)

	Random Effect		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Cultural practices						
Patrilocality	0.140**		0.132**		-0.018	-0.079
	(0.061)		(0.063)		(0.077)	(0.079)
Matrilocality	0.146**		0.186**		0.045	0.051
	(0.073)		(0.076)		(0.081)	(0.083)
Bride Price		0.180***		0.213***	0.227***	0.304***
		(0.055)		(0.057)	(0.074)	(0.076)
Individual Characteristics						
Female	1.084***	1.013***	0.678***	0.670***	1.084***	0.679***
	(0.051)	(0.047)	(0.063)	(0.057)	(0.051)	(0.063)
Age in year	0.347***	0.342***	0.355***	0.347***	0.347***	0.355***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Age in year squared	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Years of schooling	0.016***	0.018***	-0.004	-0.004	0.016***	-0.004
	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)
Being married	0.399***	0.400***	0.134***	0.140***	0.401***	0.135***
	(0.038)	(0.035)	(0.046)	(0.044)	(0.038)	(0.046)
Have work in the past week	0.031	0.041	0.072**	0.076***	0.032	0.072**
	(0.029)	(0.027)	(0.031)	(0.029)	(0.029)	(0.031)
Live in urban areas	0.410***	0.466***	0.024	0.038	0.404***	0.022
	(0.038)	(0.036)	(0.055)	(0.055)	(0.038)	(0.055)
Religion: Islam	-0.239***	-0.364***	0.060	0.067	-0.281***	0.061
	(0.071)	(0.057)	(0.148)	(0.141)	(0.071)	(0.148)
History of smoking	-0.531***	-0.553***	-0.209***	-0.220***	-0.532***	-0.209***
	(0.039)	(0.036)	(0.047)	(0.044)	(0.039)	(0.047)
Household characteristics						
Household size	0.028***	0.027***	0.009	0.009	0.027***	0.009
	(0.007)	(0.006)	(0.008)	(0.007)	(0.007)	(0.008)
Real expenditure/capita	0.334***	0.352***	0.176***	0.183***	0.334***	0.176***
	(0.019)	(0.018)	(0.021)	(0.020)	(0.019)	(0.021)
Share of staple food expenditure	-0.115	-0.160*	0.211**	0.157	-0.110	0.211**
	(0.097)	(0.090)	(0.103)	(0.097)	(0.097)	(0.103)
Share of cooking oil expenditure	0.675*	0.630*	0.418	0.323	0.683*	0.418
	(0.385)	(0.367)	(0.411)	(0.397)	(0.385)	(0.411)
Share of meat/fish expenditure	-0.053	0.093	-0.149	-0.114	-0.059	-0.147
	(0.139)	(0.130)	(0.148)	(0.140)	(0.139)	(0.148)
Own TV/HH appliances	0.051*	0.068**	-0.074**	-0.060**	0.050*	-0.074**
	(0.029)	(0.027)	(0.031)	(0.029)	(0.029)	(0.031)
Share of food expenditure	-0.296***	-0.326***	-0.130*	-0.124*	-0.298***	-0.130*
	(0.074)	(0.070)	(0.077)	(0.074)	(0.074)	(0.077)
Community characteristics						

Garbage/manure exposure	0.032	0.003	0.072***	0.051**	0.031	0.072***
	(0.022)	(0.021)	(0.023)	(0.022)	(0.022)	(0.023)
Pop. density (pop/hasq)	0.031***	0.032***	0.008*	0.007	0.032***	0.008*
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Farmland share	0.002	0.002	0.004	0.004	0.002	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Clean water access	0.019	0.019	0.002	-0.010	0.025	0.003
	(0.025)	(0.024)	(0.027)	(0.026)	(0.025)	(0.027)
Clean toilet access	0.049**	0.060***	0.010	0.016	0.048**	0.010
	(0.023)	(0.022)	(0.024)	(0.023)	(0.023)	(0.024)
Electricity access	-0.123*	-0.103*	-0.237***	-0.221***	-0.125*	-0.237***
	(0.064)	(0.060)	(0.070)	(0.067)	(0.064)	(0.070)
Car road available	0.020	0.015	0.019	0.016	0.020	0.019
	(0.039)	(0.037)	(0.043)	(0.041)	(0.039)	(0.043)
Health facility available	-0.235***	-0.201***	-0.254***	-0.246***	-0.233***	-0.254***
	(0.042)	(0.040)	(0.044)	(0.042)	(0.042)	(0.044)
Time averages						
Mean years of schooling			0.024***	0.028***		0.025***
			(0.007)	(0.007)		(0.007)
Mean being married			0.907***	0.797***		0.914***
			(0.076)	(0.068)		(0.076)
Mean have worked in the past week			-0.204***	-0.150**		-0.193**
			(0.079)	(0.069)		(0.079)
Mean live in urban areas			0.311***	0.366***		0.290***
			(0.084)	(0.080)		(0.084)
Mean household size			0.041**	0.035**		0.040**
			(0.016)	(0.014)		(0.016)
Mean real expenditure/capita			0.516***	0.494***		0.524***
			(0.054)	(0.047)		(0.054)
Mean religion: Islam			-0.346**	-0.441***		-0.403**
			(0.170)	(0.155)		(0.170)
Mean history of smoking			-0.914***	-0.854***		-0.918***
			(0.081)	(0.074)		(0.081)
Mean share of staple food expenditure			-1.534***	-1.273***		-1.482***
			(0.340)	(0.284)		(0.340)
Mean share of cooking oil expenditure			4.604***	3.801***		4.656***
			(1.452)	(1.196)		(1.454)
Mean share of meat/fish expenditure			1.401***	1.875***		1.296***
			(0.487)	(0.400)		(0.486)
Mean own TV/hh appliances			0.738***	0.572***		0.727***
			(0.102)	(0.088)		(0.102)
Mean share of food expenditure			-0.796***	-0.857***		-0.825***
			(0.244)	(0.209)		(0.244)

Mean garbage/manure exposure			-0.287***	-0.339***		-0.293***
			(0.068)	(0.061)		(0.068)
Mean pop. density (pop/hasq)			0.093***	0.081***		0.097***
			(0.015)	(0.013)		(0.015)
Mean farmland share			-0.013	-0.012		-0.005
			(0.015)	(0.014)		(0.015)
Mean clean water access			-0.013	0.065		0.032
			(0.069)	(0.063)		(0.070)
Mean clean toilet access			0.037	0.013		0.034
			(0.076)	(0.067)		(0.076)
Mean electricity access			0.851***	0.485**		0.809***
			(0.246)	(0.190)		(0.245)
Mean car road available			-0.184	-0.220*		-0.185
			(0.149)	(0.126)		(0.149)
Mean health facility available			0.544***	0.638***		0.566***
			(0.112)	(0.104)		(0.112)
Observations	65551	74308	65551	74308	65551	65551
Mean outcome	22.412	22.35	22.412	22.35	22.412	22.412

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table A6: Associations between ethnic-based cultural practices and adult BMI (without consumption controls)

	RE		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Effect on males						
Patrilocality	0.258***		0.202***		0.165*	0.028
	(0.076)		(0.077)		(0.096)	(0.096)
Matrilocality	0.053		0.059		-0.002	-0.047
	(0.095)		(0.097)		(0.105)	(0.106)
Bride Price		0.146**		0.179**	0.125	0.241**
		(0.072)		(0.073)	(0.096)	(0.096)
Panel B. Effect on females						
Patrilocality	0.013		-0.008		-0.199*	-0.293***
	(0.087)		(0.087)		(0.108)	(0.109)
Matrilocality	0.207*		0.275**		0.065	0.084
	(0.107)		(0.109)		(0.119)	(0.12)
Bride Price		0.201**		0.248***	0.313***	0.418***
		(0.082)		(0.082)	(0.109)	(0.11)
Panel C: Difference between females and males (female interaction term)						
Patrilocality	-0.245**		-0.210**		-0.364***	-0.321**
	(0.108)		(0.106)		(0.136)	(0.134)
Matrilocality	0.154		0.216		0.067	0.132
	(0.143)		(0.141)		(0.157)	(0.155)
Bride Price		0.054		0.069	0.188	0.177
		(0.108)		(0.107)	(0.144)	(0.142)
Panel D: Overall effects on adults (without including female interaction term)						
Patrilocality	0.130**		0.092		-0.029	-0.143*
	(0.061)		(0.063)		(0.077)	(0.079)
Matrilocality	0.137*		0.177**		0.036	0.025
	(0.073)		(0.076)		(0.081)	(0.083)
Bride Price		0.175***		0.216***	0.227***	0.338***
		(0.055)		(0.057)	(0.074)	(0.076)
Observations	65560	74329	65560	74329	65560	65560
Mean outcome	22.412	22.35	22.412	22.35	22.412	22.412

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table A7: Associations between ethnic-based cultural practices and overweight (full model results for models without female interaction terms, panel D of Table 2)

	RE		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Cultural practices						
Patrilocality	0.017**		0.016**		0.005	-0.002
	(0.007)		(0.007)		(0.009)	(0.009)
Matrilocality	0.022***		0.024***		0.014	0.012
	(0.008)		(0.009)		(0.009)	(0.009)
Bride Price		0.018***		0.021***	0.017**	0.025***
		(0.006)		(0.006)	(0.009)	(0.009)
Individual Characteristics						
Female	0.111***	0.105***	0.075***	0.075***	0.111***	0.075***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Age in year	0.038***	0.037***	0.039***	0.037***	0.038***	0.039***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age in year squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Years of schooling	0.003***	0.003***	-0.000	-0.001	0.003***	-0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Being married	0.068***	0.067***	0.029***	0.029***	0.068***	0.029***
	(0.005)	(0.005)	(0.007)	(0.006)	(0.005)	(0.007)
Have work in the past week	-0.001	-0.001	0.008*	0.008*	-0.001	0.008*
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)
Live in urban areas	0.058***	0.063***	0.020**	0.022***	0.058***	0.020**
	(0.005)	(0.005)	(0.008)	(0.008)	(0.005)	(0.008)
Religion: Islam	-0.032***	-0.043***	0.023	0.021	-0.035***	0.023
	(0.009)	(0.007)	(0.022)	(0.022)	(0.009)	(0.022)
History of smoking	-0.084***	-0.084***	-0.030***	-0.031***	-0.084***	-0.030***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.007)
Household characteristics						
Household size	0.004***	0.004***	0.000	0.001	0.004***	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real expenditure/capita	0.052***	0.053***	0.024***	0.025***	0.052***	0.024***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Share of staple food expenditure	-0.034**	-0.030**	0.020	0.014	-0.033**	0.020
	(0.015)	(0.014)	(0.016)	(0.015)	(0.015)	(0.016)
Share of cooking oil expenditure	0.117**	0.120**	0.085	0.089	0.118**	0.085
	(0.057)	(0.054)	(0.062)	(0.060)	(0.057)	(0.062)
Share of meat/fish expenditure	-0.006	0.025	-0.038*	-0.030	-0.007	-0.037*
	(0.021)	(0.019)	(0.023)	(0.021)	(0.021)	(0.023)
Own TV/HH appliances	0.022***	0.022***	0.004	0.005	0.022***	0.004
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Share of food expenditure	-0.056***	-0.059***	-0.027**	-0.022*	-0.056***	-0.027**
	(0.012)	(0.011)	(0.013)	(0.012)	(0.012)	(0.013)
Community characteristics						

Garbage/manure exposure	-0.003	-0.005	0.004	0.003	-0.003	0.004
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)
Pop. density (pop/hasq)	0.005***	0.005***	0.001	0.001*	0.005***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Farmland share	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Clean water access	0.002	0.003	-0.001	-0.002	0.003	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Clean toilet access	0.014***	0.016***	0.009**	0.011***	0.014***	0.009**
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Electricity access	0.005	0.014	-0.010	-0.005	0.004	-0.010
	(0.010)	(0.009)	(0.012)	(0.011)	(0.010)	(0.012)
Car road available	0.002	0.000	0.002	0.001	0.002	0.002
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Health facility available	-0.013**	-0.011*	-0.020***	-0.021***	-0.013**	-0.020***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Time averages						
Mean years of schooling			0.003***	0.004***		0.003***
			(0.001)	(0.001)		(0.001)
Mean being married			0.086***	0.077***		0.087***
			(0.009)	(0.009)		(0.009)
Mean have worked in the past week			-0.031***	-0.027***		-0.030***
			(0.009)	(0.008)		(0.009)
Mean live in urban areas			0.015	0.024**		0.014
			(0.011)	(0.010)		(0.011)
Mean household size			0.006***	0.005***		0.006***
			(0.002)	(0.002)		(0.002)
Mean real expenditure/capita			0.061***	0.056***		0.061***
			(0.006)	(0.006)		(0.006)
Mean religion: Islam			-0.058**	-0.064***		-0.063**
			(0.024)	(0.023)		(0.025)
Mean history of smoking			-0.104***	-0.095***		-0.104***
			(0.011)	(0.010)		(0.011)
Mean share of staple food expenditure			-0.166***	-0.107***		-0.162***
			(0.040)	(0.034)		(0.040)
Mean share of cooking oil expenditure			0.283*	0.196		0.287*
			(0.161)	(0.139)		(0.161)
Mean share of meat/fish expenditure			0.210***	0.270***		0.201***
			(0.056)	(0.047)		(0.056)
Mean own TV/hh appliances			0.055***	0.043***		0.054***
			(0.012)	(0.011)		(0.012)
Mean share of food expenditure			-0.093***	-0.111***		-0.095***

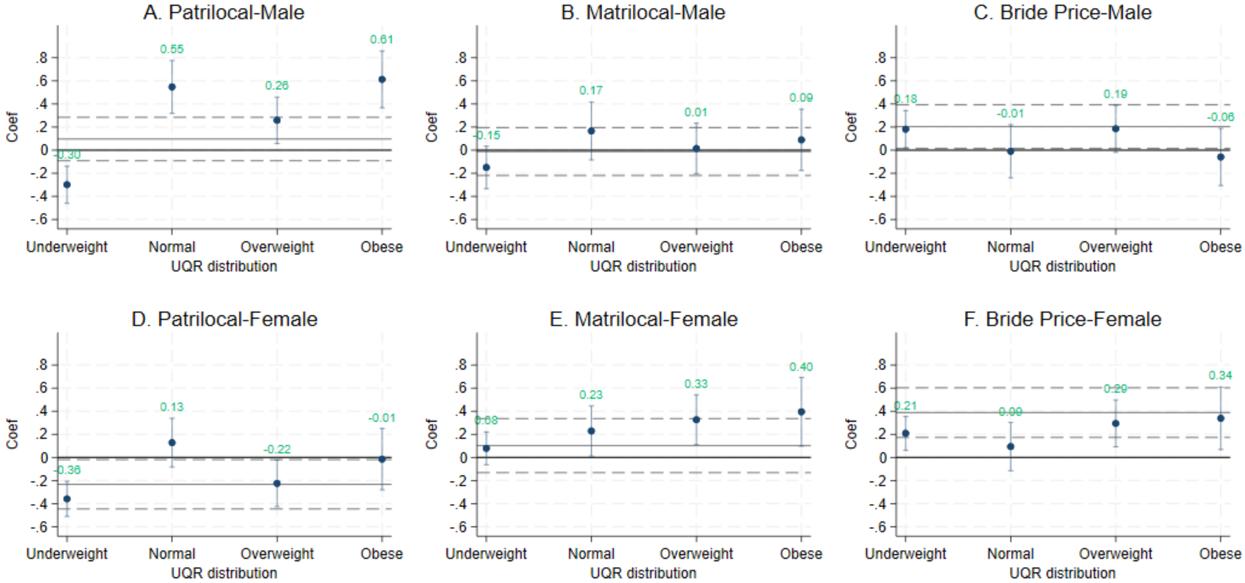
			(0.029)	(0.025)		(0.029)
Mean garbage/manure exposure			-0.028***	-0.032***		-0.029***
			(0.008)	(0.007)		(0.008)
Mean pop. density (pop/hasq)			0.010***	0.008***		0.011***
			(0.002)	(0.002)		(0.002)
Mean farmland share			-0.000	-0.000		0.000
			(0.002)	(0.002)		(0.002)
Mean clean water access			0.004	0.012		0.008
			(0.009)	(0.008)		(0.009)
Mean clean toilet access			0.008	-0.001		0.008
			(0.009)	(0.008)		(0.009)
Mean electricity access			0.057*	0.059***		0.053*
			(0.030)	(0.023)		(0.030)
Mean car road available			-0.021	-0.021		-0.021
			(0.018)	(0.016)		(0.018)
Mean health facility available			0.056***	0.065***		0.058***
			(0.013)	(0.012)		(0.013)
Observations	65551	74308	65551	74308	65551	65551
Mean outcome	0.371	0.365	0.371	0.365	0.371	0.371

Note: *** p<0.01, ** p<0.05, * p<0.10.

Table A8: Associations between ethnic-based cultural practices and adult overweight (without consumption controls)

	RE		CRE		RE	CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Effect among males						
Patrilocality	0.035***		0.031***		0.026**	0.012
	(0.009)		(0.009)		(0.012)	(0.012)
Matrilocality	0.006		0.006		-0.000	-0.006
	(0.012)		(0.012)		(0.013)	(0.013)
Bride price		0.021**		0.025***	0.013	0.026**
		(0.009)		(0.009)	(0.012)	(0.012)
Panel B: Effect among females						
Patrilocality	-0.003		-0.005		-0.017	-0.026**
	(0.009)		(0.009)		(0.012)	(0.012)
Matrilocality	0.032***		0.037***		0.023*	0.022*
	(0.012)		(0.012)		(0.013)	(0.013)
Bride price		0.014		0.018**	0.02*	0.031***
		(0.009)		(0.009)	(0.012)	(0.012)
Panel C: Difference between females and males (female interaction term)						
Patrilocality	-0.039***		-0.036***		-0.043***	-0.039**
	(0.012)		(0.012)		(0.016)	(0.016)
Matrilocality	0.026		0.031*		0.023	0.028
	(0.016)		(0.016)		(0.018)	(0.018)
Bride price		-0.007		-0.007	0.007	0.005
		(0.012)		(0.012)	(0.017)	(0.017)
Panel D: Overall effects on adults (without including female interaction term)						
Patrilocality	0.015**		0.012*		0.003	-0.008
	(0.007)		(0.007)		(0.009)	(0.009)
Matrilocality	0.020**		0.023***		0.013	0.010
	(0.008)		(0.009)		(0.009)	(0.009)
Bride price		0.017***		0.021***	0.017**	0.029***
		(0.006)		(0.006)	(0.009)	(0.009)
Observations	65560	74329	65560	74325	65560	65560
Mean outcome	0.371	0.365	0.371	0.365	0.371	0.371

Note: *** p<0.01, ** p<0.05, * p<0.10.



Notes: Results from unconditional quantile regressions with correlated random effects (CRE). Patrilocal, matrilocal, and bride price practices were jointly included in the same regressions. Point estimates with 95% confidence intervals are shown. For comparison, the horizontal straight lines indicate the average CRE results from Table 1 (dashed lines above and below are 95% confidence intervals).

Figure A1: Associations between ethnic-based culture practices and BMI for different groups (all cultural practices included in the same regressions)