Monks relax sibling competition over parental resources in Tibetan populations

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Data Availability Statement: Analyses reported in this article can be reproduced using the data provided by Zhou, Ge et al (2022) (we reduced the number of covariates for the analyses in Tables 1-2 and have not included data for the analysis in Tables 3-4 to protect the identity of the participants).

Abstract

Why parents in some societies induce some of their sons to become religious celibates is an evolutionary puzzle. Some have speculated that this might be associated with brother competition for family resources. However, the behavioral ecology of monks and the possible links with competition between brothers remains unexplored. Here, we use demographic data from Amdo Tibetan agropastoralists in western China to evaluate what factors determine the probability of becoming a monk and explore the possible association between wealth and having a monk brother. We found that boys with at least one older brother are more likely to be induced by their parents to become celibate monks. Patrilocal heads of household, who inherit parental property, are more likely to be first-born sons, whereas men who marry uxorilocally, that is they move to their wife's household, are generally second or later born sons. Moreover, we find that men with at least one monk brother are wealthier than men who only have non-celibate brothers. Together, these results suggest that sending a son to the monastery is way for parents to decrease competition between brothers over family resources. Harsh and resource-limited environments, like the one we consider, can lead to the emergence of communal households, including polyandrous families, which used to be common in Tibetan areas. Directing one son to become a religious celibate offers a potentially effective solution to brother competition in our population.

Keywords：religious celibacy, Buddhist monks, brother competition, inheritance, post-marital residence, agropastoralists

INTRODUCTION

Conflict among siblings can arise from competition for parental care and other resources and often leads to severe costs that can sometimes outweigh the benefits of cooperation between relatives (Trivers 1974; Clutton-Brock 1991; Godfray and Parker 1992; West et al. 2002; Hudson and Trillmich 2008; Losos et al. 2013). Various forms of sibling competition over parental provisioning have been documented in animals, including scramble begging and jockeying for position within nests (Mock and Parker 1997). Sometimes acute rivalry can even result in siblicide (Evans 1996; Viñuela 1999). Sibling aggression has also been shown to function to maintain ranks in dominance hierarchies (Drummond 2006) or to acquire priority for territory inheritance (Kokko and Johnstone 1999). Dispersal away from the natal nest, after reaching sexual maturity, often offers a way to escape this competition (Ekman and Griesser 2002; Satoh et al. 2021). In other cases, however, dispersal can be very costly, because it entails an increased risk of mortality especially where ecological conditions are harsh. This has been shown to contribute to favoring cooperative breeding, where some individuals do not attempt to reproduce and instead assist related breeders in the care and rearing of young (Emlen 1982; Arnold and Owens 1998; Hatchwell and Komdeur 2000; Koenig and Dickinson 2016; Branconi et al. 2020).

Humans invest substantially in their offspring and competition between siblings is intense, starting with the extended period of childhood. For instance, in pre-industrial Maya populations in rural Mexico, having younger siblings is detrimental to children's growth, suggesting reduced parental attention to children's health in larger families (Kramer et al. 2016). In contemporary Britain, having more siblings is negatively associated with birth length, growth rate and height at

74 age 10, which may have downstream effects on later survival (Lawson and Mace 2008a). Having
75 an additional sibling markedly reduces the amount of care that parents give to later born offspring
76 (Lawson and Mace 2008b). Studies in the Mosuo, a matrilineal society in south-western China,
77 found that women usually have fewer offspring and a later age at first birth if more sisters are co-
78 resident, with the older, more dominant women in the same generation usually gaining higher
79 reproductive success (Ji et al. 2013; Wu et al. 2013). In contrast, in several hunter-gatherer
80 communities with relatively low resource inequality, number of siblings is not associated with
81 female fertility (Borgerhoff Mulder et al. 2009).

82 Sibling competition is particularly intense over parents' heritable resources, which are owned
83 by men in most societies. Transfers of wealth at marriage and inheritance across generations are
84 substantial in many societies (Borgerhoff Mulder et al. 2009) and the presence of multiple siblings
85 often leads to the division of family property, especially in populations with low dispersal rates
86 (Mace 1996; Mace 1998; Gibson and Gurmu 2011). Studies in the Gabbra and the Kipsigis – two
87 agropastoralist societies in Kenya where inherited property, such as land or livestock, determines
88 a man's chances of marriage and reproductive success – show that competition over resources
89 between siblings can be very costly (Mace 1996; Borgerhoff Mulder 1998; Borgerhoff Mulder
90 2007). Having older brothers is associated with lower reproductive success for later born sons,
91 while the presence of more sisters, who do not inherit, often has a positive effect on reproductive
92 success (Mace 1996). This pattern might be related to the practice of bridewealth payments at
93 marriage in these societies: sons need livestock to marry whereas, when daughters get married,

94 they provide their families with additional livestock. Furthermore, competition between siblings
95 is modulated by the availability of resources. Competition between brothers over inherited
96 farmland increases with each additional brother when land is limited; but having many brothers
97 is not associated with increased competition when families do not own land or when this is
98 assigned by the government to all adults (Voland and Dunbar 1995; Gibson and Gurmu 2011).

99 Parents can alleviate competition over wealth inheritance among their children by investing
100 their resources in them strategically and especially by limiting the number of inheritors.
101 Unigeniture is the practice of leaving the entirety of one's estate to a single child. The inheritor,
102 who in most societies is a son, can be the first born (primogeniture), the last born (ultimogeniture)
103 or it can be chosen by the parents independently of birth order (Goody 1976; Hrdy and Judge
104 1993; Harrell 1997). Sexual abstinence is required for at least some religious practitioners in many
105 of the world's major religions, especially in Christianity, Buddhism, Hinduism, Jainism and some
106 Sufi sects within Islam (Qirko 2002). Some studies have speculated that, in Medieval, Early
107 Modern and 19th century Europe, inducing a son to become a monk was part of a wealth
108 investment strategy aimed at achieving unigeniture, while offering non-inheriting sons an
109 alternative career. The aim was to increase lineage survival (Boone 1986; Hill 1999; Deady et al.
110 2006) or avoid dividing land into small allotments that could not support a new couple (Goody
111 1976).

112 The behavioral ecology of monks has not been investigated anywhere in the world and non-
113 western cultures and religions have been relatively neglected in studies of religious celibacy. It is

114 unclear what the resource implications of having a monk brother are, whether indeed this leads to
115 greater access to resources for non-celibate men and lower competition between brothers.
116 Moreover, the factors that influence a boy's chances of being chosen by his parents to become a
117 monk have also not been explored.

118 Tibetan agropastoralists in Amdo, the north-eastern part of the Tibetan plateau in western China,
119 have a long history of Buddhist monasticism. Private property and monasticism were abolished
120 in China for two decades up until around 1980; but after that many families returned to facing
121 the decision of how to allocate their possessions to their children and whether to send a son to the
122 local monastery to become a celibate monk. Starting in 1958 both rangelands and livestock were
123 collectivised. Then, in the early 1980s, livestock were reallocated to individual households and
124 later, in the early 1990s, land was redistributed to households according to family size. Amdo
125 Tibetans are patrilineal, and post-marital residence is normatively patrilocal (Wu et al. 2015).
126 Both polyandry and polygyny were practised in the past, but nowadays, monogamy is
127 predominant (Du and Mace 2019). They now rely on animal husbandry, small-scale farming, and
128 limited government livelihood subsidies (Gyal 2015). Traditionally, in each generation, only one
129 son acquired full rights to family property. In some cases, parents chose a son to become a monk
130 at a young age, a practice that has continued until recently.

131 We have shown elsewhere that the long-term fitness of parents sending boys to the monastery
132 to become celibate monks is not reduced (Micheletti, Ge, Zhou et al 2022). Here, we test the
133 hypothesis that this is due to decreased competition between sons for parental resources. We

collected socio-demographic data from 21 villages of an Amdo Tibetan population in a county in Gansu province to investigate what factors influence the probability that a son is sent to the monastery. We studied the sibling configuration of heads of households, the individuals that generally inherit family property, to understand how birth order influences wealth inheritance. We also explored whether men with monk brothers are wealthier than those with non-monk brothers to establish whether sending a son to the monastery is a parental investment strategy to decrease sibling competition over family property.

METHODS

Study area

Socio-demographic data were collected in 2017 in a county in Gansu province, China. The study was approved by the School of Life Sciences, Lanzhou University, and the Research Ethics Committee of UCL (0449/003). This county is situated 2000-4920 meters above sea level and is part of Amdo (Tibetan: ཨ་མདོ; Chinese:安多), the north-eastern portion of the Tibetan Plateau. Historically, it was a separate political entity, ruled by a king, and is characterised by distinctive customs and traditions (Wei 2007; Yang 2007). Communication between villages is difficult and access to market towns is quite limited, because of the rugged nature of the terrain. The population is constituted almost exclusively by Amdo Tibetan agropastoralists. Most households own a small piece of land and some livestock, consisting of yaks, Tibetan sheep or both. Since 1958, many

153 Amdo Tibetans have gradually departed from nomadism and, in the past three decades, this area
154 is moving towards a skill-based wage economy, following local government policies of
155 sedentarism (Khar 2011). Although revenue from manual labour is rapidly becoming a secondary
156 source of income thanks to increasing market integration, income from yak sales remains primary
157 since the price of one typical yak is almost equal to the yearly wage of one labourer (Wei 2007).
158 Sale of yaks and of the dairy products made with their milk is the primary source of income for
159 the vast majority of the households in our sample (Goldstein and Beall 1990; Miller 2000; Du and
160 Mace 2018). Crops grown on land onwed by the households provide families only with basic
161 sustenance and are rarely sold on the market (Wei 2007). Elements of the nomadic lifestyle remain,
162 with young people moving to high-altitude tents to graze their household's livestock in the
163 summer and living in brick houses near the village during the winter. Older generations in each
164 household stay in the village home throughout the year to take care of the children and work on
165 the family farm. During the spring and the autumn, some young people return from their high-
166 altitude sites to the village to help with ploughing and harvesting.

167 Prior to the establishment of communism in the region, arable land was owned by local
168 aristocrats and monasteries. Each family unit hereditarily occupied leased estates and must fulfil
169 their primary civil responsibility of paying taxes and supplying labour imposed by the aristocrats
170 and the monasteries. The leased land was in most cases just large enough for one family to fulfil
171 its tax quota, which substantially limited the possibility of parcelling the estate between multiple
172 sons to start new families (Wiley 1984; Li 1988). Since the establishment of the People's Republic

of China in 1949, this area has experienced a series of socio-political changes that have influenced parental decisions regarding celibacy and inheritance for their sons. Initially, the state authorities did not try to change the traditional system. In 1958-59, farmland and livestock were redistributed among households to eliminate wealth inequality (Goldstein and Beall 1991). From 1964 to the end of the 1970s, a system of "collectives" (then "communes") was introduced. All estates were owned jointly by the commune, and production was redistributed following a "point system" based at least in part on individual performance (Goldstein and Beall 1991). In 1981, the Household Responsibility Policy was introduced: livestock were divided among families, whereas land remained communal and accessible to all herders (Goldstein and Beall 1991). In the mid-1980s and early 1990s, land was privatised too and assigned to each household based on the number of members (Miller 2000), even if it was still legally owned by the state.

When land and livestock were privatised, the state did not define a clear inheritance policy and this remains the case today (Wei 2007). It is thus possible that families reverted to traditional Tibetan inheritance rules. It is almost invariably men who own and manage the resources of the family unit, but where there were no sons to inherit the estate, daughters could inherit instead. Wealth is generally passed on to a son when he has reached adulthood, got married or has had children. Generally, one son remains patrilocal. The son who stays with his parents usually becomes the new head of the household and is granted most of the family properties, considered that he has an obligation to support his parents. Some ethnographic investigations suggest that, in most cases, it is the oldest man of the elder generation who holds power in the household

193 (Goldstein and Tsarong 1985). Other sons can either move to their wife's household and become
194 members of their family or migrate away from the natal village or area.

195 Fertility restrictions were not applied to ethnic minorities in China until the late 1980s (Attané
196 2002). A 1990 Gansu province regulation allowed urban Tibetans to have a maximum of two
197 children, whereas rural Tibetans – including people in our sample – were allowed a maximum of
198 three (Attané and Courbage 2000). Access to education has grown significantly in the last four
199 decades. Traditionally, monasteries were centres of education where only aristocratic families or
200 clergymen could be educated. Starting from the 1980s, education became greatly subsidised by
201 the local government and secular schools were established to allow farmers to be educated (Wu
202 2013). In 2000, primary and secondary education became compulsory, with curricula including
203 Tibetan and Chinese languages and the natural sciences.

204 The predominant religion in Amdo is Tibetan Buddhism. Sixteen monasteries – each housing
205 tens or even hundreds of monks – are present in the county, with seven located close to the villages
206 surveyed in this study. The government closed monasteries in 1958 and they gradually reopened
207 after the end of the Cultural Revolution in 1976. During the late 1970s and early 1980s, they
208 experienced a great revival (Slobodník 2004). Traditionally, monasteries were the centres of
209 cultural, political and economic life for Tibetan populations, and they continue to play a central
210 cultural role. Until recently, some families sent one son to the local monastery to become a
211 celibate monk when 7-10 years of age. In this area – as in the Tibetan plateau more generally
212 (Goldstein and Tsarong 1985; Herrou and Krauskopff 2010) – boys are generally sent to

monasteries close to their natal village, and are often entrusted to monk relatives who are willing to share their living quarters with them and instruct them in religious knowledge (Wei 2007) (see Supporting Information for additional information about a young monk's education in the monastery). Ordinary people hold monks in the highest regard and having monks in the family has been suggested to elevate its social standing (Wu 2013). All monks in our study site belong to the Geluk school of Tibetan Buddhism. Monks vow to live in poverty and for this reason are not supposed to inherit wealth from their families (none of the monks in our survey inherited wealth). They also commit to lifelong celibacy and any breach of this vow is sanctioned severely and may lead to expulsion from the monastery. While it has become more common in recent years, traditionally monks that returned to secular life faced public disapproval and ostracisation, so this was exceddingly rare (Caple 2019). Monks support themselves financially by performing various religious rituals for private households or the whole community during festivals (Jansen 2018). Young monks who are not able to participate in enough religious rituals to earn a living usually receive support from their natal families, and families sometimes continue to support their monk relative later in their life. With the implementation of the three-child policy in the late 1980s and the introduction of compulsory education, numbers of monks have declined sharply (Hao 2000).

Sociodemographic data

We collected detailed sociodemographic data from 530 households in 21 natural villages in a county in Gansu province. Natural villages are clusters of houses that do not necessarily

correspond to the larger administrative villages recognised by the local government. The households reported on a total of 3591 living people (1702 women and 1889 men). In each household, one adult man or woman was interviewed and asked about the age, sex, marital status, socioeconomic status and profession of all household members, including whether any members in the household were monks or nuns. In some cases, we were not able to obtain sibling information, because some people were absent at the time of the interview and the main interviewee could not recall this information. Interviews were conducted with the help of local translators, one adult man and one adult woman. Female interviewees were generally interviewed by a woman assistant. Participants were briefed regarding data anonymisation in the local language. Participants were briefed about the anonymity of our methods and data in local languages before giving consent. Informed consent was obtained from all participants.

Statistical analyses

Different subsamples were used for each analysis, depending on the questions being examined. We controlled for time effects by dividing individuals into 10-year birth year cohorts. We chose 10-year cohorts because they roughly coincide with major sociopolitical events that may have influenced the behaviours we study (1961-80 collectivisation, Cultural Revolution and its immediate aftermath; 1981-90 livestock redistribution and fertility limitations; 1991-2000 land privatisation; 2001-2010 compulsory primary education; see “Study area”). We also controlled for household wealth, using number of yaks owned as a measure, since livestock are a much more

253 significant source of income than either wage labor or crop production in our study site (see
254 “Study area”). Moreover, we controlled for distance to the county capital, as this may influence
255 parental decisions whether to send a son to the monastery in two ways. First, families who live
256 closer to the town might have easier access to the labor market and alternative careers for their
257 non-inheriting sons. Second, people in more isolated villages might be more religious and thus
258 more likely to make a son a monk. In all analyses, number of yaks and distance to the county
259 capital were standardised by substracting the mean value and dividing by the standard deviation.

260 To explore the factors influencing a male’s probability of being sent to the monastery by his
261 parents, we considered 1089 men born between 1961-2010, 230 of whom are monks and 859 non-
262 celibate men. Other 400 men born between 1961-2010 (22 monks and 378 noncelibate men) could
263 not be included because we could not obtain their sibling information.

264 We examined whether, for heads of household, having a monk brother is associated with
265 greater wealth, measured as number of yaks. We included in the analysis 210 non-celibate men
266 with at least one brother in cohorts 1961-1990, with 81 having monk brothers and 129 men having
267 non-celibate brothers. We used a generalised linear mixed model with Poisson regression with
268 the number of yaks as the outcome variable and whether a man has monk brother or not as our
269 key predictor, and with birth year cohort, distance to town, number of siblings as covariates.

270 For the analysis of a male’s probability of being sent to the monastery by his parents, we used
271 model comparison to determine the best fitting model based on Akaike Information Criterion
272 (AIC) values. For the analysis of wealth of heads of household, we used second-order Akaike

Information Criterion (AICc) values, which are corrected for small sample size (our analysis met the criterion for use of AICc that the sample size divided by the number of variables be less than 40; Burnham and Anderson 2002). In cases where ΔAIC or ΔAICc was less than 2, we used weighted-support model averaging to derive parameter estimates for the entire set of candidate models (this method results in a lower bias than using the parameter estimates for the model with the lowest AIC or AICc value; Burnham and Anderson 2002). Analyses were performed using R 3.4.3 (R Core Team 2014) using the following packages: 'lme4' for generalised linear mixed models (Bates et al. 201); 'MuMIn' for model selection and averaging (Bartoń 2020).

RESULTS

Each ever-married woman in our sample has on average 1.670 offspring (standard deviation [SD] = 0.980), of whom 0.080 (SD = 0.005) are monks. The sex ratio of the whole population excluding monks is 95.700 men per 100 women. The sex ratio at birth (age ≤ 5) of the whole population is 116.670; whereas the sex ratio at marriage age (14 ≤ age ≤ 25) of the whole population is 96.800 if monks are excluded and 109.240 if monks are included. The mean value of sex ratio of each village including monks is 110.990 (SD = 11.070), indicating a significantly male-biased sex ratio (one-sample proportion test, Null Hypothesis: proportion of men = 0.500, $\chi^2 = 9.630$, p = 0.0019, 95% CI = (0.510, 0.540)). The age structure of the 21 villages, obtained from the demographic data, shows evidence of the effects of the demographic transition and the three-child policy introduced in the 1980s (Figure 1). It also suggests that the presence of celibate monks skews the

operational sex ratio towards females. Figure 2 shows the proportion of monks versus non-celibate males in birth year cohorts ≤1940 and 10-year cohorts 1941-1950 through to ≥ 2011. None of the children born between 2011 and 2017 is a monk. Notice that the fact that more boys born between 1961 and 1980 were sent to the monasteries than in later cohorts may be linked to the revival of monasteries during that time.

Who becomes a monk?

We restricted our analysis to male celibates rather than including female celibates too as only five nuns were present in the population. The majority of monks have at least one older brother across all birth year cohorts and most of them do not have any younger brothers. First-born sons tend to be non-celibate, whereas a substantial proportion of second and later-born sons are monks (see Figure 3).

Having at least one older brother is significantly associated with a higher probability of being sent to the monastery: males who are second or later-born sons are more than seven times as likely to become monks as first-born males (odds ratio [OR] = 7.273, 95% CI = (1.605 – 2.363), $P < 0.001$; see Table 1, Table 2 and Table S1). In addition, the model including the number of older brothers substantially improves the model fitting relative to those with other covariates (see Table S1). The effect remains significant when restricting our analysis to men with at least one brother (N = 822 men, 219 monks, 603 non-monks; see TableS2). We do not find evidence of an

association between the number of younger brothers or number of sisters and the probability of being a monk, and these factors do not improve model fitting compared to the older brother model (see Table S1). Household wealth and distance from town also did not have an effect. Overall, these results suggest that birth order (i.e., number of older brothers) is a key predictor of parental decisions regarding which son should become a monk, whereas number of younger brothers and sisters does not appear to matter. However, parental decisions may have started to change in recent years, as in the most recent birth year cohort (2001-2010), a substantial proportion of monks are first born sons (see Figure 3).

Who becomes the heads of household?

Residential patterns of non-celibate men after marriage vary in our population: some men live in the household where they were born while their wives move to live with them (patrilocality), some move to their spouse's household (uxorilocality), others start a new household with their wives (neolocality), and yet other migrate out to the local town. There are 689 heads of household in our sample, 633 of whom are men and 56 are women. Here we focus exclusively on households headed by a man with at least one brother, to control for brother competition. Among the 272 male heads of household in 1961- 1990, 183 are patrilocal, 32 are uxorilocal, and 48 are neolocal (nine heads of household were excluded because we did not obtain information regarding their residential pattern). Most males in our sample who are not heads of household but live together with one are sons of the head of household, whereas very few are their younger brothers,

suggesting that adult brothers do not co-reside generally. Notice that men who migrated to town are not present in our sample.

Most patrilocal heads of household are first born sons, whereas the majority of uxorilocal heads of household have at least one older brother, i.e. they are second or later born sons (see Figure 4). Some married men are heads of neolocal families, with roughly half having no older brother and the other half having at least one. Overall, these frequencies suggest that first born sons tend to inherit control of the parental household, whereas second and later born sons live uxorilocally, form a new household in the same village or migrate elsewhere.

The wealth of men with monk brothers

To investigate the relation between having a monk brother and wealth (measured as number of yaks), we considered 210 men born between 1961 and 1990 who are the head of household and have at least one brother. We found that men with at least one monk brother are wealthier than men with only non-celibate brothers, after controlling for birth year cohort and distance to town (OR = 1.368, 95% CI = (0.260, 0.366), $P < 0.001$; see Table 3 and Table S3 for model selection, see Table 4 for the best fitted model). Moreover, having more older brothers is associated with a lower number of yaks (OR = 0.705, 95% CI = (-0.402, -0.297), $P < 0.001$; see Table 4), suggesting competition over family wealth. Having more sisters is also associated with a lower number of yaks (OR = 0.839, 95% CI = (-0.230, -0.121), $P < 0.001$; see Table 4), which suggests that the

payment of dowries may detract from the wealth available to brothers. We find that the number of yaks is lower for heads of household born in more recent cohorts compared to older ones. This effect might be linked to the degradation of yak pastures that followed land privatization in this area (Bai et al. 2021). We find that distance from town did not have an effect.

DISCUSSION

We have shown that, in an Amdo Tibetan agropastoralist population, parents often send a second or later-born son to the monastery to become a monk, who does not reproduce and does not inherit wealth, whereas the first-born son generally takes over the household from his parents. In addition, men who move to live with their wife's household are more likely to be second or later born. We have also shown that men with a monk brother are wealthier than men whose brothers are not religious celibates. Overall, these results suggest that brothers experience intense conflict over parental resources, and that sending a son to the monastery is a way for parents to decrease competition: by reducing the number of competitors, the remaining sons can inherit more wealth.

Our population lives in a saturated area, with limited resources and farmland. Such habitats are often associated with cooperative breeding in birds and mammals (Emlen 1982; Hatchwell and Komdeur 2000). However, in patrilineal systems such as the one we explored here, joint families where brothers and their spouses live together are intrinsically unstable as co-resident nuclear family units have conflicting interests (Harrell 1997). Fraternal polyandrous marriage where two

or more brothers share the same bride, is an alternative solution. It appears to be a way for families to avoid partitioning real and movable property and meet the high labour demands of harsh environments, such as Tibet and Nepal (Rahimzadeh 2020), but also parts of Sri Lanka and India (Starkweather and Hames 2012). Yet, ecological and economic constraints do not always guarantee the stability of polyandry in the face of spousal conflict. For example, conflict among brothers over resource allocation and sexual access to the single wife should increase with the number of co-husbands (Levine and Silk 1997; Haddix 2001). While polyandry might enhance the reproductive success of younger brothers when elder brothers are favoured to inherit parental properties (Smith 1998), junior brothers often end a polyandrous marriage and establish an independent family unit when a population is exposed to modernisation and new job opportunities (Goldstein 1978).

The cultural institution of lifelong religious celibacy offers parents a way to concentrate resources in one son. Since it completely prevents one son from competing with the other, this practice is likely a more cost-effective alternative to polyandry, at least in environents where the labour of two men is not strictly required to support a family unit. The increasing availability of job opportunities in towns not far from our study site (11.4% of men in our study area have experience as wage labourers) offer opportunities for non-inheriting sons. Together, the long-standing practice of sending a son to the monastery and the changing economic landscape of these areas might explain why polyandry is very rare in this area compared to other Amdo Tibetan populations, such as Maqu (Du and Mace 2018; Du and Mace 2019). However, further

390 investigation is required: it is possible that, in some areas, parents both send a son to the monastery
391 and marry their other sons polyandrously because environmental conditions are especially harsh.

392 In principle, it is also possible that monks are providing their families with additional material
393 or reputational benefits, thanks to the prestigious positions they hold in society. These effects
394 might further incentivise parents to send a son to the monastery. However, while monks receive
395 monetary compensation for the performance of religious rituals, they are not permitted to share
396 these revenues with their families, and generally monks abstain from involvement in the financial
397 affairs of their family in our population. Ethnographic studies show that monasteries play a central
398 role in Tibetan life, monks enjoy great respect in the community and having a monk relative has
399 been suggested to raise a household's social status (Wu 2013). This increased social prestige
400 accrued through connection with religious practitioners may contribute to the maintenance of the
401 practice of sending a son to the monastery. This parental decision may transform sibling conflict
402 into sibling cooperation, which bears analogies with cases where individuals benefit from the
403 presence of co-resident siblings that act as helpers (Mattison and Neill 2013; Mattison et al. 2018).
404 Nonetheless, whether households with a monk relative have higher social status remains a
405 question for future investigation.

406 In addition to the effects explored above, it is possible that parents might be engaging in bet
407 hedging (Olofsson et al. 2009). In Medieval Europe, noble families sometimes placed daughters
408 they could not supply with a dowry in a monastery, knowing that they could retrieve them in case
409 new financial opportunities to marry them materialised (Hager 1992). Similarly, parents in our

population might place a son in the monastery to keep him safe and retrive him, in case the first born dies. However, this was probably very rare, as monks in this society belong to the Geluk sect of Tibetan Buddhism, in which monks who returned to secular life suffered reputationl damage and were ostracised traditionally (Caple 2019). It is nonetheless possible that in more recent years, parental attitudes might be changing, partly influenced by government policies. A dip in the number of boys sent to monasteries in the 1991-2000 birth year cohort (see Figure 2) may reflect the impact of the implementation of mandatory primary education in the 2000s. A substantial proportion of monks in the most recent birth year cohort (2001-2010) are first born sons. It is possible that parents might be choosing monasteries instead of state schools for their children's education and are expecting that they will be able to abandon celibate life later on. Another possibility is that monasteries are trying to recruit monks with more urgency now that the government has made school attendance compulsory for all children. As a result, some families might be sending their eldest sons to monasteries encouraged by these cultural institutions, which play a significant role in these societies.

Our findings regarding the effect of birth order on parental decisions are in line with genealogical studies of noble families in Medieval and Early Modern Europe showing that first born sons are more likely to inherit and the probability of being directed towards other careers – military or clergy – increases with birth order (Boone 1986; Hill 1999). However, a study of census data of priests in 19th century Ireland found no effect of birth order (Deady et al. 2006). Hrdy and Judge (1993) suggest that choosing the first born over other sons gives parents more

time to invest resources in him and socialise him into his future role. Jeon (2008) developed an evolutionary invasion analysis showing that, under a broad set of conditions, parents are favoured to invest more in older offspring because at any one time they have a higher probability of surviving to reproductive age.

Results regarding the effect of absolute wealth on the frequency of religious celibacy are mixed. For example, in 19th century Ireland richer families were more likely to have a priest (Deady et al. 2006), whereas in contemporary United States, sons of larger, poorer Catholic families are more likely to become priests (Low 2015). In our population, we did not find that current family wealth influences parental decisions over which sons should become monks.

Overall, this study has shown that, in a Tibetan agropastoralist population, religious celibacy can decrease competition between brothers for access to resources. This is likely to be the main reason why men with a monk brother are on average wealthier, although we cannot exclude that monks might be providing reputational or material benefits to their brothers through the prestigious positions they hold in society. As schooling has become compulsory for children and new and more remunerative job opportunities have become available in nearby towns, the practice of sending a son to the monastery is disappearing in this area and both monasticism and family organisation are likely to change in the coming years.

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Figures and figure legends

Figure 1. Age-sex population pyramids of the 21 villages in our sample, faceted by gender. Each bar represents a 10-year age cohort (0-10, 11-20… through to 81+) and color indicates the proportion of celibate (red) and non-celibate (blue) individuals. Our sociodemographic sample comprises 1702 women (mean age = 35.61, SD = 22.17) and 1889 men (mean age = 32.65, SD = 20.10) in 21 villages. The mean number of households in each village is 28.88 (min = 11.00, max = 48.00, SD = 10.50) and the mean household size is 7.45 (min = 1.00, max = 15.00, SD = 2.18).

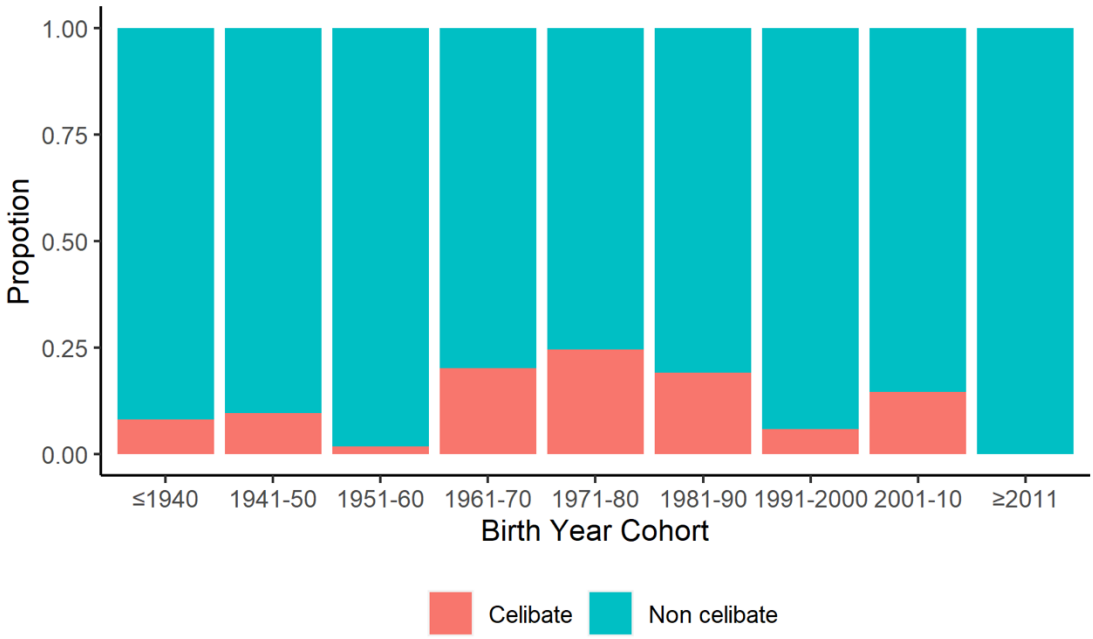

Figure 2. Proportion of monks (red) vs non-celibate men (blue) by birth year cohort.

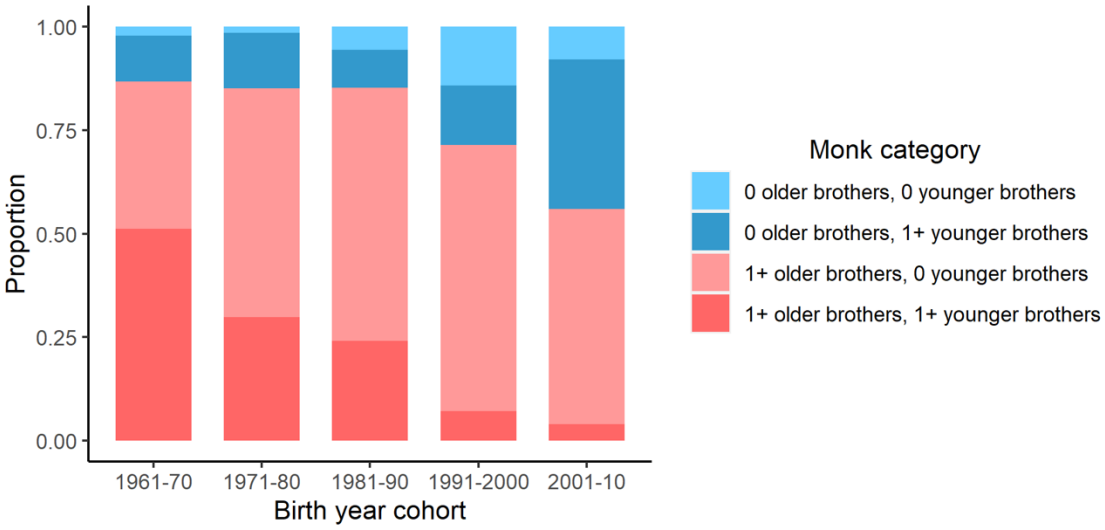

Figure 3. Proportion of monks with zero older brothers (blue), one or more older brothers (red), zero younger brothers (lighter shades), one or more younger brothers (darker shades), in each 10-year birth year cohort. The sample comprises 230 monks.

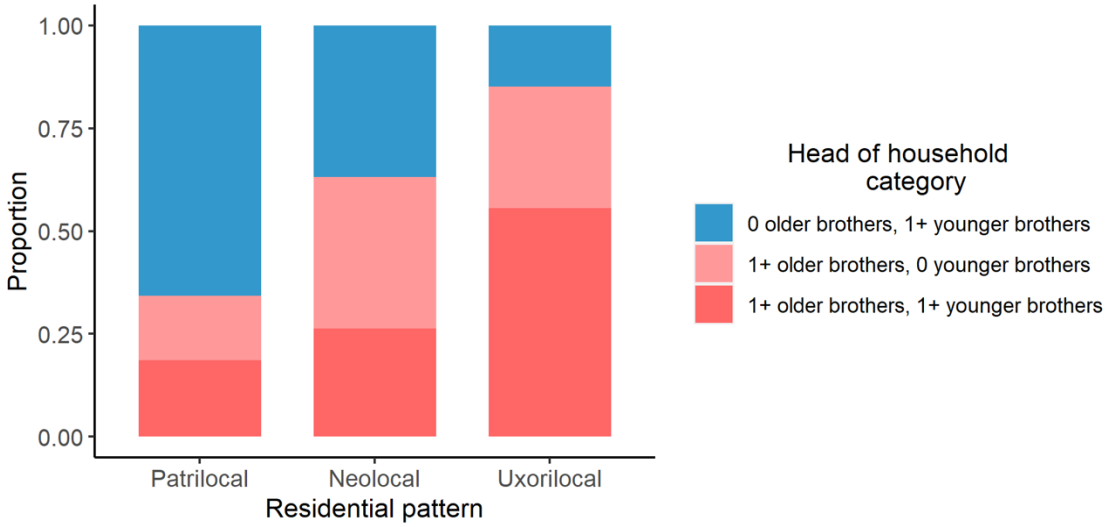

Figure 4. Proportion of heads of household with no older brothers and one or more younger brothers (blue), one or more older brothers and no younger brothers (light red), one or more older brothers and one or more younger brothers (dark red), categorized by residential pattern (patrilocal, neolocal, uxorilocal). The sample comprises 263 heads of household.

Tables and table legends

Table 1. Logistic regression models of determinants of the probability of a male being chosen to become a celibate monk as a function of sibling configuration. Each row represents a model with specific predictors. The control model contains birth year cohort, number of yaks and distance to town. Villages are included as a random effect. K is the number of parameters in the model; ΔAIC is the deviation in AIC; ω_i is the Akaike weight; LL is the log-likelihood. N = 1089 men (230 monks, 859 non-celibates).

Models	K	AIC	ΔAIC	ωi	LL
Control + No. older brother	9.000	939.693	0.000	0.524	-460.763
Control + No. older brother + No. younger brothers + No. sisters	11.000	939.889	0.196	0.476	-458.822
Control	8.000	1069.426	129.733	0.000	-526.647
Null	2.000	1126.866	187.173	0.000	-561.428

Table 2. Estimates for the averaged logistic regression model for assessing different predictors for the probability of a man being chosen to become a celibate monk (we used model averaging as ΔAIC < 2, see Table 1). Number of older brothers (0 vs 1+), number of younger brothers (0 vs 1+) and number of sisters (0 vs 1+) are included as fixed effects. Villages are included as a random effect. N = 1089 males (230 monks, 859 non-celibates). Significant effects are in bold.

Variables	Estimate	SE	95%CI	P value
Birthyear cohort (ref: 1961-1970)				
1971-1980	0.226	0.254	(-0.272, 0.724)	0.374
1981-1990	0.035	0.269	(-0.492, 0.562)	0.897
1991-2000	**-1.525**	**0.351**	**(-2.213, -0.837)**	**<0.001** ***
2001-2010	**-0.686**	**0.262**	**(-1.201, -0.171)**	**0.009** **
Livestock	0.023	0.087	(-0.147, 0.193)	0.791
Distance to town	0.108	0.089	(-0.066, 0.283)	0.223
No. older brothers (ref: 0)				
1+	**1.935**	**0.192**	**(1.559, 2.312)**	**<0.001** ***
No. younger brothers (ref: 0)				
1+	0.316	0.188	(-0.052, 0.685)	0.092
No. sisters (ref:0)				
1+	-0.136	0.176	(-0.481, 0.209)	0.439

Note: *p<0.05 **p<0.01 ***p<0.001; SE, standard error.

660 **Table 3.** Poisson regression models of determinants of wealth, measured as number of yaks, for
661 men with a monk brother and men with non-celibate brothers, as a function of sibling
662 configuration. The control model only contains birth year cohort and distance to town. Villages
663 are included as a random effect. K is the number of parameters in the model; ΔAICc is the
664 deviation in AICc; ω_i is Akaike weight; LL is log-likelihood. N = 210 men (81 monk brothers,
665 129 non-monk brothers).
666

Models	K	AICc	ΔAICc	ωi	LL
Control + No. older brothers + No. sisters + ≥ 1 monk brothers	8.000	7507.763	0.000	1.000	-3745.523
Control + No. older brothers + No.sisters	7.000	7639.053	131.291	0.000	-3812.250
Control	5.000	7876.189	368.426	0.000	-3932.947
Null	2.000	7941.535	433.773	0.000	-3968.739

667
668

669 **Table 4.** Estimates for the best-fitting Poisson regression model of wealth, measured as number
670 of yaks, for 210 male heads of household with at least one brother (81 of these men have at least
671 one monk brother and 129 have only non-celibate brothers). Significant effects are in bold.
672

Variables	Estimate	SE	95%CI	P value
Birthyear cohort (ref: 1961-1970)				
1971-1980	**-0.119**	**0.029**	**(-0.176, -0.062)**	**< 0.001*** **
1981-1990	**-0.269**	**0.040**	**(-0.348, -0.191)**	**< 0.001*** **
Distance to town	**-0.298**	**0.097**	**(-0.487, -0.108)**	**0.002 ** **
No. older brothers (ref: 0)				
1+	**-0.350**	**0.027**	**(-0.402, -0.297)**	**< 0.001*** **
No. sisters (ref: 0)				
1+	**-0.175**	**0.028**	**(-0.230, -0.121)**	**< 0.001*** **
≥ 1 monk brothers (ref: No)				
Yes	**0.313**	**0.027**	**(0.260, 0.366)**	**< 0.001*** **

673 Note: *p<0.05**p<0.01 ***p<0.001; SE, standard error.
674

Supplementary Information for

Monks relax sibling competition over parental resources in Tibetan populations

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Additional information about monks

Reproductive isolation of monks was ensured in two ways: through spatial segregation (boys were sent to monasteries to learn religious knowledge and to avoid contact with outside society) and through teaching of religious doctrines. According to Tibetan tradition, monks should be recruited before puberty and definitively before they have experienced sexual relations with girls. Therefore, many monks were brought to the monastery as young boys (Goldstein and Tsarong 1985).

Monasteries functioned like schools to a certain extent. After they entered, boys began by learning the Tibetan alphabet, then moved on to learn Tibetan and Buddhist culture. Boys studied for long hours, starting at dawn, and finishing not long before midnight. They sometimes embarked on a debating tour, which was a common way for scholars to test their knowledge (Schaik 2011). They would travel from one monastery to next, engaging in scholarly debates which could also serve as oral exams leading to various qualifications. This was also a good opportunity to take classes with famous teachers and hone their debating skills (Stein 1972). Young monks needed an adult to take them under their wing and teach them, at least until they reached their late teens when they would be able to live independently (Li and Li 1982).

Supplementary figures and tables

Table S1. Estimates of logistic regressions for assessing different predictors for the probability of a male being sent as a celibate monk in 21 villages. Each column except the control model represents a model with a specific predictor. Control model contains cohort of birth year, livestock and distance to town. Villages are included as a random effect. Number of older brothers (0 vs 1+), number of younger brothers (0 vs 1+) and number of sisters (0 vs 1+) are included as fixed effects. Significant effects are in bold. N = 1089 men (N = 230 monks, N = 859 non-monks).

Variable	Null	Control	+M1	+M2
Birthyear cohort (ref:1961-1970)				
1971-1980		0.200	0.207	0.247
		(-0.253, 0.653)	(-0.286, 0.700)	(-0.253, 0.747)
1981-1990		0.061	0.002	0.072
		(-0.409, 0.531)	(-0.507, 0.510)	(-0.465, 0.608)
1991-2000		**-1.700*****	**-1.554*****	**-1.493*****
		(-2.344, -1.057)	**(-2.227, -0.881)**	**(-2.190, -0.796)**
2001-2010		**-0.847*****	**-0.734****	**-0.633***
		(-1.306, -0.388)	**(-1.227, -0.242)**	**(-1.151, -0.115)**
Livestock		-0.015	0.025	0.021
		(-0.174, 0.144)	(-0.145, 0.194)	(-0.149, 0.192)
Distance to town		0.090	0.116	0.100
		(-0.068, 0.248)	(-0.054, 0.287)	(-0.076, 0.275)
No.Older brother (ref:0)				
1+			**1.891*****	**1.984*****
			(1.540, 2.242)	**(1.605, 2.363)**
No.Younger brother (ref:0)				
1+				0.316
				(-0.051, 0.684)
No.Sister (ref:0)				
1+				-0.136
				(-0.481, 0.208)
Constant	**-1.319*****	**-0.918*****	**-2.035*****	**-2.211*****
	(-1.469, -1.169)	**(-1.264, -0.573)**	**(-2.483, -1.587)**	**(-2.847, -1.574)**
AIC	1126.866	1069.426	939.693	939.889
Delta AIC	187.173	129.733	0.000	0.196
Observations	1089	1089	1089	1089
Groups	21Villages	21Villages	21 Villages	21 Villages
Note:		*p<0.05; **p<0.01; ***p<0.001		

Table S2. Estimates of logistic regressions for assessing different predictors for the probability of a male who has at least one brother being sent as a celibate monk in 21 villages. Each column except the control model represents a model with a specific predictor. Control model contains cohort of birth year, livestock and distance to town. Villages are included as a random effect. Number of older brothers (0 vs 1+), number of younger brothers (0 vs 1+) and number of sisters (0 vs 1+) are included as fixed effects. Significant effects are in bold. N = 822 men (N = 219 monks, N = 603non-monks).

Variable	Null	Control	+M1	+M2
Birthyear cohort (ref:1961-1970)				
1971-1980		0.233	0.237	0.236
		(-0.242, 0.708)	(-0.269, 0.743)	(-0.278, 0.750)
1981-1990		0.065	-0.026	-0.038
		(-0.430, 0.560)	(-0.550, 0.498)	(-0.597, 0.521)
1991-2000		**-1.577*****	**-1.600*****	**-1.626*****
		(-2.271, -0.882)	**(-2.318, -0.882)**	**(-2.373, -0.879)**
2001-2010		**-0.706****	**-0.721****	**-0.718****
		(-1.191, -0.222)	(-1.232, -0.210)	(-1.261, -0.176)
Livestock		0.004	0.047	0.043
		(-0.166, 0.174)	(-0.130, 0.225)	(-0.136, 0.222)
Distance to town		0.080	0.126	0.111
		(-0.091, 0.251)	(-0.054, 0.306)	(-0.074, 0.297)
No.Older brother (ref:0)				
1+			**1.636*****	**1.701*****
			(1.244, 2.027)	**(1.210, 2.193)**
No.Younger brother (ref:0)				
1+				0.087
				(-0.355, 0.530)
No.Sister (ref:0)				
1+				-0.121
				(-0.482, 0.240)
Constant	**-1.013*****	**-0.716*****	**-1.779*****	**-1.804*****
	(-1.167, -0.858)	**(-1.077, -0.355)**	**(-2.257, -1.301)**	**(-2.562, -1.046)**
AIC	956.990	919.024	840.637	844.154
Delta AIC	116.353	78.387	0.000	3.516
Observations	822	822	822	822
Groups	21Villages	21Villages	21 Villages	21 Villages
Note:		*p<0.05; **p<0.01; ***p<0.001		

Table S3. Estimates of the model predicting the wealth for monk brother and non-celibate brother. N = 210 men (81 monk brothers, 129 non-monk brothers). Significant effects are in bold.

Variable	Null	Control	+M1	+M2
Birthyear cohort (ref:1961-1970)				
1971-1980		**-0.135*****	**-0.153*****	**-0.119*****
		(-0.191, -0.079)	**(-0.211, -0.096)**	**(-0.176, -0.062)**
1981-1990		**-0.305*****	**-0.320*****	**-0.269*****
		(-0.381, -0.230)	**(-0.398, -0.242)**	**(-0.348, -0.191)**
Distance to town		**-0.253***	**-0.273****	**-0.298****
		(-0.452, -0.054)	**(-0.467, -0.078)**	**(-0.487, -0.108)**
No.Older brother (ref:0)				
1+			**-0.355*****	**-0.350*****
			(-0.408, -0.303)	**(-0.402, -0.297)**
No.Sister (ref:0)				
1+			**-0.159*****	**-0.175*****
			(-0.213, -0.104)	**(-0.230, -0.121)**
Whether have monk brothers (ref:no)				
yes				**0.313*** **
				(0.260, 0.366)
Constant	**3.260*****	**3.444*****	**3.690*****	**3.559*****
	(3.013, 3.507)	**(3.230, 3.658)**	**(3.478, 3.901)**	**(3.351, 3.767)**
AIC	7941.535	7876.189	7639.053	7507.763
Delta AIC	433.773	368.426	131.291	0.000
Observations	210	210	210	210
Groups	21Villages	21Villages	21 Villages	21 Villages
Note:		*p<0.05; **p<0.01; ***p<0.001		

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