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Chapter 5

Family Structure and Health in the Developing World: What Can Evolutionary Anthropology Contribute to Population Health Science?

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Abstract In this chapter, we consider what evolutionary anthropology contributes to the study of population health, focusing specifically on family structure and its relationship to child and adult physical health. Evolutionary anthropologists have now built a substantial body of literature on relationships between family structure and various dimensions of human wellbeing, particularly in the context of small-scale ‘traditional’ societies and developing rural communities most at risk of poor health outcomes. Crucially, they have also constructed theoretical models to account for variation in key dimensions of family structure in relation to individual, ecological, and cultural factors. Thus, evolutionary anthropologists have much to say, not only about the extent to which specific family structures may influence health but also why certain family forms may persist or change across time and space. Here, focusing on studies primarily conducted in sub-Saharan Africa, we review the literature on three interrelated dimensions of family structure and their relationship to health: (1) family size, (2) polygynous versus monogamous marriage, and (3) the role of extended kin. Using these examples, we highlight the theoretical and empirical contributions of evolutionary anthropology and draw out implications for population policy and related initiatives seeking to improve family health in the developing world.

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5.1 Introduction

Evolutionary anthropology has much to offer population health science, both as a rich and integrative theoretical framework and as an active producer of a now substantial body of relevant empirical literature. Here, we focus specifically on the study of family structure and its relationship to child and adult physical health in the developing world. Family and health are intimately tied. Family formation defines residence and relatedness, and so fundamentally determines patterns of resource production, allocation, and consumption. The family is also a key site for navigating conflicts of interest between individuals, including not only conflicts between consumers over limited resources but also conflicts between generations, between the sexes, and with and between extended kin, which often have different priorities to individuals within the nuclear family. All of these factors mean that family structure is anticipated to influence health. Health is also one of the many factors that determine the assortment of individuals into particular family structure types. Healthier individuals, for example, find it easier to reproduce successfully, are more likely to survive to old age, are more attractive as marriage partners, and are more able to assert their own autonomy or dominance when conflicts of interest arise. This bidirectional relationship between family structure and health represents an important research theme we return to throughout the chapter.

Population health science can be defined broadly as the study of health inequality within and between populations, including health outcomes, health determinants, and the design and critique of measures that may be taken to improve health and reduce inequality (Kindig and Stoddart 2003; Young 2005). Key to this perspective is the focus on health variation in the population as a whole, rather than considering only ill or high-risk individuals. Researchers working under this umbrella definition may also identify themselves variously as (social) epidemiologists, demographers, or economists, and, although there is a shared commitment to identifying both barriers and practical solutions for improving human wellbeing, there is no single overarching theoretical framework. While a range of methodologies are used, population health is most often studied through the analysis of large, systematically collected and representative data sets, such as censuses, cohort, and panel studies (David and Haberlen 2005). In the case of family structure and health in developing countries, a frequent source of information is the Demographic and Health Surveys (DHS)—national cross-sectional surveys carried out at regular intervals since the 1980s and funded primarily by the US Agency for International Development (www.measuredhs.com). Such data sets have a number of strengths; sample sizes are large, a broad range of information is collected, and surveys use a standardized questionnaire and protocols to facilitate comparative analysis. However, as we shall discuss, analyses of large-scale surveys such as the DHS often suffer important limitations.

Evolutionary anthropology in contrast is concerned with explicitly evolutionary models of human variation, including variation in both family structure and physical health. Its practitioners are committed to a more or less unified theoretical

framework that considers the diversity of human behaviour as reflective of plastic evolved solutions to problems posed by local physical and social environments across human history (Brown et al. 2011; Nettle et al. 2013; Winterhalder and Smith 2000). Research is thus primarily motivated by the elaboration and evaluation of alternative hypotheses regarding human adaptation. In this sense, evolutionary anthropology takes a ‘top-down’ approach to research, whereby the general theoretical principles of evolutionary biology are used to generate hypotheses that guide the study of specific phenomena. This contrasts with the ‘bottom-up’ approach more typical of population health science, which begins with the description of a particular health issue, which then may or may not lead to the generation or modification of a broader theoretical model to account for observed relationships, often in a piecemeal fashion. Furthermore, evolutionary models uniquely consider *ultimate causation*, i.e. explanations for behaviour grounded in terms of evolutionary history and adaptive function. This adds an additional and complementary layer of explanation to the consideration of *proximate causation* more characteristic of the social sciences, i.e. explanations grounded in the assumed properties of human physiology, psychology, and culture that do not simultaneously consider the origin and potential function of those properties (see Mayr 1961; Tinbergen 1963).

As a branch of anthropology, evolutionary anthropological research is usually carried out at the level of specific communities and well-defined cultural contexts, often focusing on the collection of data from populations where subsistence relies heavily on foraging, pastoralism, or small-scale agriculture. Such ‘traditional populations’ are often marginalised by population health scientists working in the developing world, where attention is more generously devoted to collecting and analysing data that are generalizable to the majority (i.e. typically nation states or culturally heterogeneous regional units). Thus, as Rende Taylor (2005) emphasizes, evolutionary anthropological studies are often particularly valuable in that they often combine both meaningful quantitative analysis, lacking in purely ethnographic studies in social anthropology, with a more nuanced interpretation at the family and community level that large-scale demographic studies rarely provide. It should be noted that not all quantitative research in anthropology is evolutionary, and in this respect the contributions of evolutionary anthropology blur with overlapping research traditions in biosocial anthropology (Panter-Brick and Fuentes 2009; Stevenson and Worthman 2013) and anthropological demography (Kertzer and Fricke 1997). Furthermore, while primary data collection from small-scale rural populations remains at the heart of evolutionary anthropology, increasingly researchers are incorporating analyses of secondary demographic data sets to address evolutionary questions (e.g. Goodman et al. 2012; Nettle and Pollet 2008; Lawson et al. 2012). This development is particularly welcome, because the use of similar sources of data undoubtedly encourages exchange between disciplines.

With these points in mind, the chapter is structured as follows. We first briefly characterize how evolutionary anthropologists view family structure within the broad comparative perspective of evolutionary biology. We then review how evolutionary anthropologists currently understand variation in family structure and its predicted relationships with the physical health of family members across three

interrelated dimensions: (1) family size, (2) polygynous versus monogamous marriage, and (3) the role of extended kin. For each of these dimensions, we consider how available data stack up against the predictive framework of evolutionary anthropology. We then reflect on the implications for population policy. These implications are not always unique to an evolutionary perspective, but rather drawn on important points of emphasis within the literature. We focus primarily on child and, to a lesser extent, maternal health, but consider adult male health where data are available. Our aim is to illustrate the theoretical and empirical contributions of evolutionary anthropology and to provide a general synthesis of the current literature, rather than conduct a fully exhaustive review. We make reference to more thorough reviews where possible and point out key issues of debate where they exist.

5.2 An Evolutionary View on the Human Family

Evolutionary anthropologists approach the study of the human family from the perspective of one or more of the three main cornerstones of evolutionary biology: (a) *life history*, (b) *sexual selection*, and (c) *altruism* (see Box 5.1). In all cases, research, first and foremost, takes an optimality approach to understanding behaviour (Parker and Maynard Smith 1990). This is because natural selection shapes the behaviour of all organisms in response to the pay-offs experienced to alternative behavioural ‘strategies’ across evolutionary history. This assumption, that human behaviour can be understood as functionally tied to the costs and benefits of action, brings evolutionary thinking very close to the principle of ‘utility maximization’ in economics (Nettle et al. 2013). However, an evolutionary perspective is distinct in at least two important ways.

Box 5.1 Theoretical cornerstones of evolutionary biology

a. Life history theory

Life history theory concerns the scheduling of events that describe an organism’s life cycle, e.g. age at sexual maturity, and the number and timing of births (Roff 2002; Stearns 1992). Observed life histories are constrained by the general principle that resources (time, energy, effort) allocated to one function cannot be allocated to another. Thus, natural selection acts to optimise fundamental life history ‘trade-offs’, including trade-offs between investing in reproduction versus somatic maintenance, between investing in mating versus parental effort, and between investing in offspring quantity versus quality (see Sect. 5.3). Human life history is remarkable among primates in a number of regards, including an extended juvenile period, high fertility and longevity relative to our body size, and the evolution of menopause (for comprehensive reviews, see Bribiescas et al. 2012; Kaplan et al. 2000; Lawson 2011; Mace 2000). Human life history also displays extensive phenotypic

range, with patterns of mating, reproduction, and parenting varying dramatically both within and between populations (Lawson and Mace 2011; Low 2007). A key aim of life history studies is therefore to consider whether or not this diversity can be understood as reflecting adaptive variation in resource allocation.

b. Sexual Selection

Sexual selection concerns the evolution of strategies to obtain and copulate with mates (Darwin 1871). As mammals, humans are characterized by internal gestation and lactation, and so the physiological aspects of parental investment are heavily weighted towards females. Trivers (1972) predicted that females thus represent a limiting resource with respect to male fitness and sexual selection will lead to high levels of intrasexual competition between males for access to females, while females will place relatively more emphasis on assessing the quality of potential reproductive partners. Recent theoretical reformulations however question the assumption that initial asymmetries in parental care predispose such sex roles and place emphasis on contextual factors such as local mate availability, variation in mate quality, and the costs associated with seeking new mates (Kokko and Jennions 2008). Reproductive behaviours of both sexes are seen as strategic and in response to the future pay-offs of a particular behaviour as opposed to being driven by past investment (sunken-cost fallacy; Dawkins and Carlisle 1976). Further complexity arises in humans because relationships between mating and reproductive success appear highly variable between cultures (reviewed in Brown et al. 2009). Nevertheless, understanding the different constraints and priorities of the sexes remains central to evolutionary models of human mating and marriage (see Sect. 5.4). An additional concern is the role of sexual conflict, i.e. the evolution of strategies to gain the upper hand when the interests of the sexes differ (Aloise et al. 2013; Borgerhoff et al. 2009). There is considerable anthropological evidence of male strategies to restrict female sexuality in particular, and since males typically exert more control over resources, there is good reason to believe sexual conflicts may often be resolved in the favour of men (Smuts 1995).

c. Altruism

Finally, models of *altruism* are of crucial importance to evolutionary studies of the family. Most importantly, altruism is predicted to be high between close genetic relatives (Hamilton 1964), explaining the evolution of parental care, but also the fact that kinship represents a universal feature of human social organization (Shenk and Mattison 2011). However, relationships between different categories of kin are not equal. More genetically distant relatives are predicted to more rarely engage in altruistic actions, and indeed several studies confirm that the degree of genetic relatedness is a robust independent predictor of social and financial investments between kin (Bowles

and Posel 2005; Gurven et al. 2000, 2002; Pollet 2007). Furthermore, the certainty of relatedness between kin may vary in important ways. Thus, fathers and paternal kin are predicted to invest more in children when confidence of paternity is high (Sect. 5.5). High rates of altruism are also anticipated in situations of mutual gain, including most obviously relationships between husbands and (co)wives, who share interests in cooperatively raising offspring, and in situations of both direct and indirect reciprocity (Trivers 1971). Indeed, the extent of cooperation between non-kin is extreme in humans, leading to much debate about the evolutionary mechanisms at play (Fehr and Fischbacher 2003; Henrich 2004; Lamba and Mace 2011).

Firstly, evolution by natural selection provides a grounding logic of why humans are predicted to behave optimally in the first place, a starting assumption that is taken for granted by economists. Moreover, evolutionary models anticipate that behaviour is deployed in the service of inclusive fitness, i.e. production of long-term genetic descendants, rather than physical or mental health, financial prudence, or other measures of personal or societal wellbeing (Hill 1993). Thus, an evolutionary perspective provides conceptual clarity with regard to what currency behaviour is predicted to be ultimately optimising (i.e. the ‘utility’ of behaviour). This observation has obvious immediate relevance to studies of population health. Supporting the view that humans generally behave in ways that maximize their inclusive fitness, positive correlations between indicators of ‘cultural success’ (e.g. social status, wealth) and reproductive success are a common feature of natural fertility populations (for evidence and discussion, see Borgerhoff Mulder 1987; Nettle and Pollet 2008).

The second important distinction is that, through consideration of the inherently imperfect proximate mechanisms of adaptation, evolutionary approaches also provide us with expectations about when we should expect departures from optimality. It is useful to consider three broad interrelated categories of adaptive mechanisms: *physiological*, *psychological*, and *cultural*. For example, the automatic suppression of ovulation when a woman is breastfeeding is widely understood as a physiological adaptation to avoid pregnancy at times when it could risk maternal or child survival (Ellison 1990). Likewise, family formation may be guided by evolved psychological mechanisms whereby motivations for child rearing subconsciously or consciously respond to environmental cues, such as local mortality risk (e.g. Mathews and Sear 2008; Nettle 2011) or the impact of reproduction on own or descendant socioeconomic success (Goodman et al. 2012; Kaplan and Gangestad 2005). Finally, humans undoubtedly rely heavily on socially learned information. Studies of ‘cultural evolution’ consider our reliance on differential social learning rules, such as tendencies to copy the most frequent behaviours (‘conformity bias’) or the behaviours of those deemed most successful (‘prestige bias’). Transmitted culture may also introduce new behavioural variants to a population, which may spread within and across

generations and evolve semi-independently of genetic or environmental influences (Brown et al. 2011; Mesoudi 2011; Richerson and Boyd 2008).

The specifics of these evolved ‘decision-making’ mechanisms can be considered imperfect because they are shaped by energetic, developmental, and phylogenetic (i.e. historical) constraints, limiting the option set of potential strategies available to the human organism. As natural selection effectively adapts behaviour to past, not present environments, mechanisms of adaptation are also predicted to deal somewhat poorly with environmental novelty resulting from rapid social or ecological change (Irons 1998; but see Laland and Brown 2006). Constraints aside, the results of optimality modelling are also dependent on the accurate conceptualisation of the pay-offs to alternative behaviours within environments and the degree of overlapping or conflicting interests between individuals (e.g. Borgerhoff Mulder and Rauch 2009). Thus, it is important to emphasize that evolutionary thinking rarely gives rise to single or obvious explanations for human behavioural diversity (Brown et al. 2011). Recognizing this fact, evolutionary anthropology is a rigorously empirical discipline, placing much value on testing competing predictions against available data. Since data on long-term inclusive fitness are often difficult to collect, much of this research makes use of more immediate proxies including fertility, child survival, and physical health, leading to much overlap with the population health literature.

5.3 Family Size

Human fertility (number of births), and consequently family size (number of living children/siblings), is highly variable, both between and within populations. Total fertility rates average around four to six for contemporary hunter-gatherers (Kelly 1995). Shifts to agriculture are generally associated with higher fertility and also improved child survival (Bentley et al. 2001; Sellen and Mace 1997, 1999). At the extremes, a population average of more than ten births per women has been recorded (Eaton and Mayer 1953). However, all forms of rural subsistence demonstrate a high degree of heterogeneity in demographic parameters (Randall 2008; Sellen and Mace 1997, 1999). At the global level, child mortality has declined substantially in recent decades, but fertility rates have dropped more slowly, particularly in sub-Saharan Africa leading to unprecedented population growth (Lee 2003). Indeed, the population of sub-Saharan Africa is set to double from 0.86 to 1.96 billion between 2010 and 2050 with some countries (e.g. Niger) tripling in size (Ezeh et al. 2012). This growth is generally viewed as having adverse consequences on population health via increased pressure on public services and infrastructure, a high ratio of young to working-age people, increases in maternal and child mortality, and environmental degradation. Consequently, much population policy in the developing world concerns effort to encourage lower fertility, primarily through expanding the uptake of modern contraceptive technologies (Bongaarts 1994; Ezeh et al. 2012; Schultz 2007).

Evolutionary anthropologists have studied both the ultimate causes and proximate mechanisms regulating human fertility and family size, primarily taking a life history perspective (see Box 5.1a). Thus, variation in reproductive behaviour is understood as the resolution of resource allocation trade-offs between reproduction and competing domains such as growth, survival, and the care of offspring (Kaplan et al. 2002; Kaplan 1996; Lawson and Mace 2011). This framework overlaps considerably with economic models of fertility which also emphasize the opportunity costs of reproduction, trade-offs between offspring quantity and quality, and resource flow between generations (Becker 1981; Caldwell 2005; Kaplan 1994), but also integrates more broadly with a consideration of physiological and cultural factors. Below, we review the evidence that fertility influences parental and child health, before discussing how evolutionary anthropologists account for variation in fertility, including the dramatic decline in fertility rates associated with population social and economic modernisation, i.e. the so-called demographic transition (Lee 2003; Borgerhoff Mulder 1998).

5.3.1 Trade-Offs Between Reproduction and Health

It is well recognized by population scientists that the ability to conceive and successfully complete a pregnancy is closely dependent on a woman's physical health, which therefore acts an important proximate determinant of variation in fertility, at least within the developing world (Bongaarts 1978). From an evolutionary perspective, this also represents the adaptive resolution of the life history trade-off between reproduction and survival, with resources automatically allocated to somatic maintenance over reproduction when energy is in short supply (Bentley 1999; Ellison 1990). Further evidence that fertility is traded off against maternal health also comes from studies reporting negative correlations between fertility and female longevity (e.g. Gagnon et al. 2009). However, since women need to be healthy to reproduce, those with the highest fertility are often healthier to begin with, and so studies of this kind often suffer from issues of statistical confounding. Perhaps unsurprisingly then, not all studies have detected the hypothetical 'costs of reproduction' (Le Bourg 2007; Sear 2007). Additional research has focused on twinning as a more exogenous measure of fertility, where it is associated with not only an increased risk of maternal death in childbirth but also reduced post-reproductive survival of mothers (Gabler and Voland 1994; Helle et al. 2004; Sear 2007). Likewise, several studies report that mothers who have relatively more sons than daughters are likely to die younger (e.g. Helle et al. 2002; but see Beise and Voland 2002), an effect that has been attributed to a greater physiological cost of carrying male fetuses to term. Thus, overall, while difficult to quantify, there is good evidence that high fertility can reduce maternal health, and that such costs are consequently an important determinant of fertility patterns, particularly in contexts where modern forms of contraception and/or alternative motivations for limited fertility are absent.

Whether or not reproduction has costs to paternal health has less often been studied, and indeed is not anticipated since the physiological costs of reproduction fall on females. In fact, recent evolutionary studies have suggested that reproduction may have positive impacts on male health via more subtle hormonal mechanisms. Testosterone is proposed to mediate resource allocation to mating versus parenting investment in humans and other species, so that males who focus on the mating effort are predicted to maintain elevated testosterone, whereas males who cooperate with a female partner to care for offspring are predicted to reduce testosterone production (Hirschenhauser and Oliveira 2006; Wingfield et al. 1990). Supporting this proposal, testosterone levels have been found to be lower among partnered men compared to single men, and that the transition to fatherhood is associated with a further reduction in testosterone levels (Alvergne et al. 2009a; Gettler et al. 2011; Gray et al. 2002; Muller et al. 2009). Testosterone production is also an immunosuppressant, elevates risks of prostate cancer, and is linked to an increased likelihood of risky behaviour, including alcohol and drug use, at least within Western contexts (e.g. Dabbs and Morris 1990; Parsons et al. 2005). As a result, while healthier men are more likely to marry and have children, a reduction in testosterone levels following family formation may also partially explain why fathers and partnered men are often healthier within populations (Gettler et al. 2011).

5.3.2 *Trade-Offs Between Offspring Quantity and Quality*

Evolutionary anthropologists have conducted much research aiming to test the prediction that, all else being equal, larger family size will disadvantage children because it dictates a dilution of individual shares of parental investment. From a life history theory perspective, parents are anticipated to tolerate such costs because inclusive fitness is maximized by the total, rather than individual, contribution of each offspring to the pool of future descendants (Roff 2002; Stearns 1992). Table 5.1 summarizes the results of prominent studies by evolutionary researchers estimating the effect of family size on child growth or child survival (see also Blurton Jones 1986, on optimal birth spacing). These studies are mostly carried out within specific communities/cultural contexts, rather than based on large-scale national surveys (but see Lawson et al. 2012). Overall, many studies present evidence of a trade-off between offspring quantity and quality in the domain of child health. Yet, in a significant number of studies predicted relationships are absent, and effect magnitude varies between studies (see also Lawson and Mace 2011). Variation between studies may result from issues of residual statistical confounding since in many populations the wealthiest families are also typically the largest. On the other hand, not all studies exclude reverse causality. In particular, fertility–child survival relationships may also be established by ‘replacement’ or ‘insurance’ effects, whereby a mother has additional births to compensate for earlier infant death(s), or expected deaths in the face of predicted extrinsic mortality. As such, the costs of high fertility/large family size are likely to be overestimated in some analyses (Lawson et al. 2012).

Table 5.1 Estimated effect of family size (or close proxy thereof) on child health

Population ^a	Child health outcome		Notes	References
	Growth	Survival		
!Kung of Botswana	n.a.	–		Pennington and Harpending 1988
18th–19th-century Germany	n.a.	↓/–	No. of same-sex siblings reduces infant survival in children of farmers, but not in landless labourers	Voland and Dunbar 1995
Aché of Paraguay	n.a.	↓/–	No. of siblings reduces survival between ages of 5 and 9 years, but not under 5 years	Hill and Hurtado 1996
Dogon of Mali	n.a.	↓		Strassmann and Gillespie 2002
	↓	↓		Strassmann 2011
Shuar of Ecuador	↓	n.a.		Hagen et al. 2006
Rural Gambians	n.a.	↓		Mace 2007
Kipsigis of Kenya	n.a.	↓/–	Negative or n-shaped relationship of no. of brothers to survival to 5 years depending on model specification	Borgerhoff Mulder 2007
19th-century N. America	n.a.	↓		Penn and Smith 2007
18th–19th-century Finland	n.a.	↓		Gillespie et al. 2008
Bimoba and Kusasi of Ghana	n.a.	↓		Meij et al. 2009
Sub-Saharan Africa	n.a.	↓/–	Negative effect in all countries, but significant variation in magnitude both between and within countries	Lawson et al. 2012

^a This table includes only studies specifically addressing the predicted offspring quantity–quality trade-offs from an evolutionary perspective. It does not represent a complete survey of the literature on family size and child health

Key: – no relationship, ↓ negative relationship, ↑ positive relationship, / relationship varies by subgroup (see Notes column for details); *n.a.* not applicable, i.e. study did not explore this outcome

Variation in the magnitude of trade-off effects between studies may also reflect context dependency. For example, quantity–quality trade-offs will logically be weaker when the local determinants of offspring quality are predominantly ‘extrinsic’, i.e. independent of variation in levels of parental investment (Gibson and Lawson 2011; Pennington and Harpending 1988; Quinlan 2007). In the context of many traditional populations, extrinsic risks to health and survival are predicted to be high because environmental factors limit parental ability to protect offspring, including unavoidably high pathogen loads, poor sanitation and health-care access, and significant vulnerabilities to subsistence failure, natural disasters, and violent conflict.

Supporting this assessment, Lawson et al. (2012), through analysis of African DHS, conclude that the cost of high fertility, as estimated by the relative decrease in the odds of child survival per additional birth, tends to be weaker in contexts where child mortality is initially already high due to other factors. Similarly, Desai (1995) reports that having a close-aged sibling is more likely to be associated with poor child health in developing countries with better clean water supply or health service access, suggesting that without these resources parents have limited ability to protect their children through increased investment per child. Such large-scale analyses are undeniably crude in that they lack direct data on associations between parental care and child outcomes, but there is also supporting qualitative evidence that parents in resource-poor settings perceive child deaths and illness to be a largely unavoidable part of life (e.g. Hampshire et al. 2009).

Evolutionary anthropologists also recognize that trade-offs between offspring quantity and ‘quality’ will be influenced by the extent to which children are reliant exclusively on parents. For example, competition between siblings may be reduced when extended kin share the burden of childcare, particularly when such help is given in proportion to need (Sear and Mace 2008, Sect. 5.5). In many societies, children themselves may also offset parental costs of child rearing by directly contributing to subsistence activities or alloparental care (Kramer 2005). However, in general, anthropological studies of food production and consumption have concluded that the net transfer of resources over the life course flows strictly from parents to offspring (Kaplan 1994; Lee and Kramer 2002). This contradicts the persistent view of some demographers that, within much of the developing world, having children is more likely to present a net economic asset to parents (for discussion, see Caldwell 2005).

5.3.3 *Optimising Family Size*

With family size influencing not only maternal but also child health, a final question to consider is the extent to which fertility rates can be understood as adapted to environmental variation. In addressing this question, many studies have focused on the trade-off between fertility and child survival (e.g. Lawson et al. 2012; Meij et al. 2009; Strassmann and Gillespie 2002). This is because child mortality represents a selective bottleneck in human evolution, i.e. many offspring fail to survive the first 5 years of life, but if they do so they are very likely to reach adulthood (Jones 2009; Mace 2000). Furthermore, while there is evidence of later reproductive competition between those that survive childhood, particularly among brothers over marital placements (Borgerhoff Mulder 2000; Gibson and Gurmu 2011; Mace 1996), such effects are not universal (Gibson and Gurmu 2011; Lawson and Mace 2011) and are more often associated with high fertility and biased inheritance systems, rather than reduced fertility (Hrady and Judge 1993). In a review of the literature, Lawson et al. (2012) argue that the cost of fertility on child survival alone is not sufficient to motivate the limitation of reproduction even at the highest fertility levels. Thus, trade-offs between fertility and maternal somatic mainte-

nance, rather than child survival, may be more important in determining variation of pre-demographic transition fertility levels. This conclusion is also consistent with classic demographic accounts of natural fertility, which give primacy to physiological mechanisms such as lactational amenorrhoea, and contend that reproduction in pre-demographic transition societies is rarely (consciously) strategic with respect to its effects on children (Bongaarts 1978; Lloyd and Ivanov 1988; van de Walle 1992).

Why fertility rates almost always fall as societies transition from a preindustrial to postindustrial economy is a source of heated debate for both demographers and evolutionary anthropologists (Borgerhoff Mulder 1998; Mason 1997; Shenk et al. 2013). Paralleling the non-evolutionary demographic literature, evolutionary explanations focus alternatively on (1) the rising conflicts between reproduction and economic productivity, particularly for women, and the increasing socio-economic pay-offs to investing heavily in child education (Kaplan 1996) or (2) shifting patterns of social interaction proposed to modify cultural ideals surrounding reproduction, more or less independently of the costs of child rearing (Newson et al. 2005; Richerson and Boyd 2008). Recent empirical studies suggest that, in general, economic factors provide the best explanation of why fertility falls as populations ‘modernise’ (e.g. Shenk et al. 2013) and that cultural transmission cannot be considered a root cause of preferences for smaller family size because the earliest stages of the transition are inherently reliant on behavioural innovation rather than social diffusion (Alvergne et al. 2011). Modern fertility decline is also clearly maladaptive in an evolutionary sense because those unusual individuals who do have larger families ultimately produce many more long-term genetic descendants (Goodman et al. 2012). Thus, as Kaplan (1996) argues, fertility decline may be best understood as the by-product of evolved, but no longer adaptive mechanisms that motivate human behaviour towards goals of economic and social success (see also Kaplan et al. 2002).

5.3.4 Implications for Policy

1. An evolutionary perspective makes clear from the outset that the mechanisms regulating human reproduction are always likely to tolerate some cost to health in the service of inclusive fitness, and that there will be parent–offspring conflict in ideal reproductive behaviours. Such insight may be useful in improving the design of initiatives aiming to improve family health. For example, building on a conceptual model of evolutionary parent–offspring conflict over breastfeeding decisions, Tully and Ball (2013) argue that public health campaigns will be most successful when mutual benefits to increasing breastfeeding duration for both mother and child are promoted, rather than the child or mother in isolation (see also McDade 2001; Sellen 2007).
2. Variation in fertility in pre-demographic transition societies appears best understood as largely mediated by maternal health. As such, any initiative that

improves maternal wellbeing in resource-poor settings may also inadvertently increase fertility, leading to additional unforeseen negative health consequences as families struggle to care for additional children (Gibson and Mace 2006; Kramer and McMillan 2006). The long-term effectiveness of programmes that improve maternal health may therefore be improved by also integrating family planning and reproductive services (see also Gibson, Chap. 4, this volume).

3. Population policy often assumes that smaller family size will lead to both substantial health and socioeconomic benefits (Bongaarts 1994; Schultz 2007). However, the literature reviewed above also cautions that there is likely to be much context dependency in the health benefits of fertility limitation. Likewise, while high fertility clearly has negative influences on offspring socioeconomic outcomes in modern developed populations (e.g. Goodman et al. 2012), inferring that fertility decline will automatically reap equivalent benefits in the developing world would be erroneous. Indeed, both evolutionary and economic models of the demographic transition understand fertility decline as a response to magnified benefits of low fertility, whereby the effects of family size on human capital generation are conditional on the availability and quality of schools, health facilities, and labour opportunities (Kaplan 1996; for evidence see Maralani 2008). Applied research should prioritise a greater understanding of this context dependency, not only because it greatly influences the projected impact of changes in fertility on population health but also because it may be useful in determining what factors can be targeted to alleviate the costs of large family size where it already exists (e.g. support from kin, child contribution to productive tasks), rather than narrowly focusing effort on the reduction of fertility itself.
4. Finally, policy aimed at reducing fertility in the developing world largely focuses on improving contraception access. Contraception is an important proximate mechanism by which fertility is reduced, but access alone cannot account for why individuals seek to use it, nor why contraceptive use is not ubiquitous even when readily available (see Campbell and Potts 2008 vs. Mace 2008). Evolutionary anthropology's combined focus on proximate mechanisms and ultimate causation of reproductive strategies is therefore instructive. In particular, studies which take an integrated perspective by testing alternative models for the uptake of contraceptive technology may be the most valuable (Alvergne et al. 2011; Alvergne et al. 2013; Borgerhoff Mulder 2009a).

5.4 Polygynous Versus Monogamous Marriage

Polygynous marriage is defined as the marriage of one man to several co-wives, and contrasts with monogamous marriage where a single husband and wife marry. For a recent discussion of polyandrous marriage, i.e. the comparatively rare situation where women marry multiple co-husbands, and its distribution across human societies, see Starkweather and Hames (2012). Polygynous marriage is common cross-

culturally, with Murdock and White (1969) estimating that 82% of preindustrial societies in the ethnographic record allowed men to marry more than one wife. Today, polygynous marriage is most common in sub-Saharan Africa, particularly in West Africa, and is most prevalent in rural areas (Westoff 2003). Within Africa, polygyny is most often nonsororal, i.e. co-wives are not sisters and tend to reside in separate houses; however, in other regions, such as South America, sororal polygyny is more common, and wives typically coreside (White 1988; Winking et al. 2013).

Polygynous marriage is highly relevant to population policy. Its occurrence and legal status has been debated in relation to its potential categorization as a 'harmful traditional practice' argued to infringe on the human rights of women, believed to hold important negative 'emotional and financial consequences' for co-wives and their dependents, and, in some contexts, because it is associated with other harmful practices such as child marriage or female genital mutilation (for recent discussion of these stances, see Gaffney-Rhys 2012; Obonye 2012). Recent large-scale analyses of African DHS data have concluded that polygynous marriage is commonly associated with increased child mortality within countries, bolstering the general view that polygyny is best considered as an important risk factor for poor health (e.g. Amey 2002; Gyimah 2009; Omariba and Boyle 2007). However, rarely do these discussions engage with a consideration of the motivations guiding (male and female) preferences for polygynous marriage. There is also a tendency to prioritise the results of studies based on nationally representative survey data over smaller-scale studies carried out within more specific cultural contexts.

Evolutionary anthropologists have proposed a number of hypotheses for the distribution of human marriage systems across space and time, often embedded in a *sexual selection* framework (Box 5.1b). However, it is important to emphasize from the outset that variation in marriage system generally implies, but does not dictate, patterns of mating and reproduction between the sexes. For example, in populations where serial monogamy is common, men and women may remarry at different rates so that, when the full life course is considered, monogamous marriage equates to polygynous or polyandrous mating (Borgerhoff Mulder 2009b). Furthermore, while monogamous marriage implies that only one wife and her children share resources with a single husband, it does not necessitate that both partners only mate with each other. Indeed, there is considerable historical and ethnographic evidence that, when given the opportunity, men often father children outside of marriage, even in strictly monogamous societies (see references in Fortunato and Archetti 2010). Thus, variation in marriage system may tell us as much about patterns of resource ownership and inheritance as about patterns of sex and reproduction. Below, we introduce alternative evolutionary hypotheses regarding polygynous versus monogamous marriage and by extension how marriage type is anticipated to be associated with health. This section focuses primarily on studies of child health, due to a relative scarcity of studies examining relationships between adult health and polygyny (but see Bove and Valeggia 2009; Sellen 1999). We consider how these models stack up against the empirical evidence from studies examining polygynous marriage within specific communities, rather than across large-scale culturally heterogeneous demographic surveys.

5.4.1 *Why Marry a Married Man?*

From an evolutionary perspective, it is not hard to understand why men may prefer polygynous marriage, with guaranteed sexual access to additional women enabling higher reproductive success (e.g. Borgerhoff Mulder 1987; Cronk 1991; Gibson and Mace 2007). But female motivations for polygynous marriage are less certain. Two main proposals have been entertained—‘female choice’ and ‘male coercion’. Female choice was first speculated to account for polygyny in birds (Orians 1969) before equivalent ideas were adapted to human marriage systems by anthropologists (e.g. Borgehoff Mulder 1992; Josephson 1993), and the idea is very similar to the account of polygyny given by the economist Gary Becker in his landmark *Treatise on the Family* (1981). Briefly put, female choice models argue that it will be in a woman’s interest to marry a married man when the cost of sharing resources with another wife is offset by his overall higher wealth, compared to marrying a relatively poorer man as his single wife. By contrast, other scholars have argued that polygyny is better understood as the consequence of male effort to control females, to the detriment of both co-wives and their children (e.g. Chisholm and Burbank 1991; Strassmann 1997). This does not necessarily imply physical coercion, but rather wider gender norms whereby women have low reproductive autonomy and a subordinate status (Smuts 1995). Like the female choice model, men of higher status are predicted to outcompete lower-status men for polygynous marriages, but in this case such a higher status is not sufficient to offset the costs of resource competition between co-wives.

In its purest form, the female choice perspective predicts that, at equilibrium, all married women should have access to the same resources, and so maternal and child health differentials between polygynous and monogamous families should be negligible. In this sense, there should be no *net* cost to marrying polygynously that would be relevant to a public health policy. Statistical adjustments for differences in wealth between families may however reveal the *hidden* costs of resource competition between co-wives. The male coercion perspective predicts that polygynously married women and their children will suffer *net* costs likely to manifest in their physical health. Table 5.2 summarizes the results of studies carried out within a specific cultural, or relatively small regional contexts that have explored relationships between polygyny and child health and/or survival. On balance, this literature appears superficially supportive of male coercion, in that children of polygynously married women are often at a significant health disadvantage and this effect is robust to at least partial controls for potentially confounding variables (see also Hadley 2005; Sellen 2009 for further discussion).

Yet, the topic remains controversial. It is attractive to conceptualise the choice and coercion hypotheses as mutually exclusive explanations for polygynous marriage, but in reality they are not so easy to distinguish and empirically evaluate as competing hypotheses, especially since wives are added to marriages sequentially and women marrying polygynously may be different to those marrying monogamously to begin with. Moreover, elements of choice and coercion will surely

coexist. For example, Gibson and Mace (2007), measuring both female reproductive success and child nutritional status, report first wives in polygynous marriages in rural Ethiopia appear advantaged relative to both monogamously married women and their higher-order co-wives. Thus, being the early wife of a relatively wealthy polygynous male may be the best scenario for women, while second- and third-order wives are disadvantaged either due to costs of family resource competition or due to patterns of assortment, i.e. lower-‘quality’ women settling for the less desirable position of marrying an already married man (but see Strassmann 2011 for a different pattern of results by wife rank). The failure of many studies to effectively address such issues of wife rank and assortment, along with the reliance on cross-sectional rather than longitudinal studies, leaves much uncertainty about the causality in reported relationships between polygyny and health.

5.4.2 *When Monogamy is Advantageous for Men*

If polygyny is the preferred option for males (at least when wealthy enough to attract multiple wives), a relative absence of polygyny is logically predicted in contexts where male wealth inequality is insufficient for some men to monopolize marriage opportunities (i.e. ‘environmentally imposed monogamy’, Alexander et al. 1979). Indeed, there is some evidence of a positive relationship between regional wealth inequality and the incidence of polygynous marriage (Pollet and Nettle 2009). However, rates of polygyny have also been decreasing throughout sub-Saharan Africa over recent years, and in many countries, polygynous marriage is not legally sanctioned. One classic anthropological argument for why ‘socially imposed monogamy’ may become preferred, not only by females but also by males, is that it reduces within-group competition among men and consequently leads to benefits of greater cooperation reaped at the group level, enabling the cohesion of increasing larger societies (Alexander 1987). However, supporting evidence for such group-level benefits to monogamy has not been convincingly presented. Moreover, the logic of this hypothesis has been challenged because available data suggest that the overall variance in male reproductive success is in fact not significantly lower in monogamous societies, and that cultural norms prescribing monogamous marriage predate the establishment of large nation states (Fortunato and Archetti 2010).

Fortunato and Archetti (2010) present an alternative explanation, arguing that monogamous marriage may be better understood as a system of ‘monogamous transfer’ of inherited resources. They argue, supported by a formal mathematical model, that monogamy will be advantageous for men in specific contexts under two conditions: (1) provided the value of inherited resources is sharply decreased when split between the offspring of multiple co-wives and/or (2) that females strategically guarantee higher paternity to males who marry only a single wife. Thus, in specific contexts, monogamous marriage may be beneficial to both sexes; women benefit from exclusive inheritance transfers to their offspring, while men benefit from increased confidence in the paternity of their (putative) offspring. Supporting

the former condition, available ethnographic and historical data suggest an association of monogamy with shifts to intensive agriculture and conditions of land scarcity, where resource transfers need to be maintained at a high threshold value to ensure the creation of viable productive and reproductive units (Fortunato and Archetti 2010). As an extension to this argument, it is also clear that preferences for polygyny should decrease with the transition to a modern cash economy as reproductive strategies shift in favour of investments in offspring ‘quality’ over quantity (Sect. 5.3). Evidence for the second condition, that monogamous marriage is associated with higher paternity confidence, is less clear. Indeed, there would appear to be some conflict between Fortunato and Archetti’s (2010) model and the dominant view that polygyny is the product of female coercion where men are anticipated to exert dominance over women’s sexuality. Interestingly, many public health studies now speculate a link between polygyny and the transmission of HIV and other sexually transmitted infections (Bove and Vallengia 2009). Hypothetically, this association could be driven by higher levels of promiscuity (and so lower paternity certainty) in polygynous societies. This conjecture however remains to be tested and relevant data on rates of paternity certainty in rural African populations, polygynous or otherwise, are scarce (but see Strassmann et al. 2012).

5.4.3 Implications for Policy

- Is polygyny best considered a risk factor for poor health? The answer to this question depends critically on its intended interpretation. On the one hand, and with respect to child health, studies carried out both at the large and small-scale have consistently demonstrated that growing up in a polygynous household is associated with relatively poor health/survival outcomes and such associations are often independent of other factors such as family size and household wealth (Table 5.2). Such information is valuable to targeted health programmes that seek to identify contexts in which children may be most in need during times of resource stress or food insecurity. It is also valuable to analysts of population health data aiming to isolate other ‘risk factors’ that may confound or interact with polygyny (e.g. ethnicity, maternal education, rural residence).
- However, if we take ‘risk factor’ to imply *causality*, there is little evidence to suggest that polygyny can be meaningfully considered a root cause of poor child health. To date, the literature, mainly relying on cross-sectional analyses, has tackled issues of causation poorly. Moreover, at the ultimate level, any apparent costs of polygyny seem best identified as a *symptom* of male coercion and low female autonomy, without which women would not enter marriages that hold negative health consequences. From a policy perspective, it is far from clear that prohibiting polygyny would reap the protective effects to women and children proposed by some scholars. In this regard, we support Gaffney-Rhys (2012, pp. 58–59), who argues that polygyny itself is not best understood as a ‘harmful traditional practice’ but rather as a cultural norm associated with low gender

Table 5.2 Estimated effect of polygynous relative to monogamous marriage on child health

Population ^a	Child health outcome		Notes	References
	Growth	Survival		
Dogon of Mali	– ↓/–	↓ ↓/–	Growth: children of monogamously married women do better than children of 1st order polygynously married wives, children of 2nd, 3rd & 4th order wives are intermediate Survival: Polygyny associated with lower child survival in 8/9 villages	Strassmann 1997 Strassmann 2011
Datoga of Tanzania	↓ ↓/–	n.a. ↓/–	Growth: Children of monogamously married wives do better than children of first- and second-order polygynously married wives. Growth & Survival: Children of monogamously married wives do better than children of first-order polygynously married wives. Interactions with wealth suggested	Sellen 1999 Sellen et al. 2000
Chad (rural)	↓	n.a.		Begin et al. 1999
Yanomamö of Venezuela	↓/–	n.a.	Negative relationship in boys (tricep skinfold), no relationship in girls	Hagen et al. 2001
Rakai district of Uganda	↓/–	n.a.	Negative relationship in aggregated sample and HIV+, but not in HIV- mothers	Brahmbhatt et al. 2001
West Kiang district, Gambia	n.a.	–		Sear et al. 2002
Tonga of Zambia	↓/–	n.a.	Negative relationship to stunting for boys, but not girls	Gillett-Netting and Perry 2005
Sukuma of Tanzania	↓	n.a.		Hadley 2005
Arsi Oromo of Ethiopia	↓/–	n.a.	Child of first-order polygynously married wives not different from children of monogamously married wives, but do better than children of second- and third-order wives	Gibson and Mace 2007
Kipsigis of Kenya	n.a.	↓/–	Indication that negative effects on survival are limited to poor households	Borgerhoff Mulder 1997, 2007
Bimoba and Kusasi of Ghana	n.a.	↓		Meij et al. 2009
Banfora district, Burkina Faso	n.a.	↓		Diallo et al. 2012

^a This table only includes studies carried out within specific communities/cultural contexts (i.e. large-scale DHS analyses not included). Studies by both evolutionary and non-evolutionary anthropologists and demographers included

Key:—no relationship, ↓ negative relationship, ↑ positive relationship, /relationship varies by subgroup (see Notes column for details); n.a not applicable, i.e. study did not explore this outcome

equality, which is the real threat to health and wellbeing. Attention may thus be better devoted to initiatives that seek to reduce gender inequality rather than to prohibit polygynous marriage. The abolition of polygyny, without tackling the cultural position of women, could lead to unintended negative consequences. For example, one way in which polygyny may be protective to women is through the practice of the levirate, whereby a widow joins the marriage of her deceased husband's brother, without which older widowed women may have difficulty accessing resources required to maintain their own health and welfare.

- We also caution that polygyny may become associated with disadvantage because of culturally insensitive health programmes that neglect its very existence. For example, Bove and Valeggia (2009) consider an initiative in Botswana, where men with HIV+ serostatus were offered free antiretroviral treatment in addition to medication for *one spouse only*. In this case, a well-intentioned policy may actually *create* relative disadvantage in polygynous households simply because they fail to fit the Western norms of monogamous marriage.
- Lastly, we note several reasons why analyses of large-scale nationally representative DHS surveys should *not* be prioritised for policymakers interested in the effects of culturally related variables such as marriage practice. Firstly, there are often important ethnic-related differences in health within countries, and regional boundaries (e.g. Brockerhoff and Hewitt 1998). However, DHS studies have typically neglected to adjust estimates for ethnicity, which will most likely confound with marriage systems (e.g. Amey 2002; Gyimah 2009; Omariba and Boyle 2007). Secondly, anthropological studies have more often been able to utilize longitudinal data and information on wife rank (e.g. Gibson and Mace 2007; Strassmann 2011). The DHS on the other hand are cross-sectional and data on wife rank are generally absent or of poor quality (Omariba and Boyle 2007). Finally, there are important issues with respect to categorization and statistical treatment of polygynous households in the DHS, which are poorly designed to deal with non-nuclear families (Randall et al. 2011). For example, it is unclear how to interpret adjustments for household wealth when men only reside with one wife, while additional wives live in apparently separate but often adjacent and economically co-dependent households.

5.5 The Role of Extended Kin

In both the social and health sciences, most research on family structure is situated in the developed world, particularly Western Europe and North America, seriously biasing the current knowledge base available to population scientists and policymakers alike (Adams 2004; Gyimah 2009; Penn 2012). In these countries, the 'nuclear family' is both the norm and the socially recognized ideal—with wife, husband, and children living in relative isolation and economic independence from other kin. However, in the developing world, nuclear family living is in fact rather rare (Lloyd and Desai 1992; Sear 2011). As we have already discussed, polygynous

marriage is not uncommon. There is also great cross-cultural variation in the role of fathers. Some ‘partible paternity’ cultures in South America even identify multiple fathers for single offspring based on the mother’s sexual relationships during or close to pregnancy (Walker et al. 2010). Moreover, married couples, particularly in rural environments, typically live with, or very close to, the wife’s or husband’s extended family, and resources are generally shared across wider networks. Some cultures tend towards matrilocality (females stay in or near their natal home, and men move at marriage, although often not very far), while patrilocality is generally more common (males stay and females move), especially since the advent of agriculture (Wilkins and Marlowe 2006).

In many parts of the world, rates of fosterage and orphanhood are also high and, due to the HIV/AIDS epidemic, have grown substantially in recent decades. Thus, in sub-Saharan Africa, it has been estimated that one in ten children under the age of 15 have lost at least one parent, while one in six households care for a child with a dead mother or father (Roeland and Ties 2004). In cases where children have lost both parents, they are almost always found in the care of the extended family (Roeland and Ties 2004). How best to deal with rising orphanhood has become a key area of policy relevance, with some arguing that traditional kin-based systems of orphan care have been stretched to breaking point by the impact of the epidemic, and others suggesting the extended family, particularly if supported by appropriate interventions, can still support a large number of orphans (for a discussion, see Abebe and Aase 2007; Mathambo and Gibbs 2009). In addition to the issue of substitute parents, understanding the importance and differing priorities of extended kin is also of broader relevance to population health. This is because as senior family members, both in and outside the presence of biological parents, extended kin are expected to influence patterns of household production and consumption, including patterns of health expenditure (Dupas 2011).

Although rarely directly engaged with the debates above, evolutionary anthropologists have now accumulated a large body of relevant literature on the role of extended kin (Bentley and Mace 2012; Coall and Hertwig 2010; Hrdy 2009; Sear and Mace 2008). Interest in this area is motivated by theories of kin selection, since childcare is an altruistic act predicted to vary in response to genetic relatedness (Box 5.1c). Studies have also sought to elucidate the factors responsible for the unusual features of human life history. In particular, assistance from extended kin is argued to have enabled humans to simultaneously maintain a high reproductive rate and extended juvenile dependency compared to other primates of a similar body size (Hawkes 2003), leading some to categorize humans as ‘cooperative breeders’ (Hrdy 2009; Sear and Mace 2008; but see Strassmann 2011). Furthermore, the influential ‘grandmother hypothesis’ argues that grandmaternal support accounts for why humans are unique among primates in experiencing menopause, i.e. the irreversible cessation of reproductive potential at around 50 years of age. Throughout human evolution, women above this age are proposed to have been better able to enhance their inclusive fitness by assisting existing offspring to care for children than they would by having additional children of their own, due to increased difficulties in childbirth and a reduced chance of surviving long enough to ensure adequate post-natal care (Hawkes 2003; Shanley et al. 2007; Williams 1957).

5.5.1 *Mothers and Others*

Sear and Mace (2008) recently collated data from a large number ($n=45$) of anthropological and demographic studies considering how the presence/absence of alternative categories of kin (usually measured as currently alive or dead) influences child survival in contexts of high child mortality and high fertility. This review provides a useful survey of the relative importance of different family members. Unsurprisingly, children whose mother died before they reached their second birthday had dramatically reduced likelihood of survival, demonstrating that infants are almost exclusively reliant on maternal care. Yet, for children whose mother died after this age, the likelihood of survival was often remarkably high, suggesting that for weaned children maternal care is frequently replaceable, at least with respect to survival outcomes. In most studies, the absence of a father made no difference, and was associated with reduced survival in only one-third of studies with appropriate data. However, in line with expectations from the grandmother hypothesis, around two-thirds of studies reported that the grandmother's presence was associated with improved child survival. Maternal grandmothers were more important than paternal grandmothers, and, in some cases, the presence of paternal grandmothers was negatively rather than positively related to child survival (see also Strassmann and Garrard 2011). With regard to other categories of kin, the presence of grandfathers was generally inconsequential, and, in the few studies with relevant data, the presence of elder siblings was often positively associated with survival confirming that older children can often play an important role as alloparents (see also Kramer 2005). The presence of aunts and uncles was also occasionally correlated with higher child survival, but few studies contained relevant data. Sear and Mace (2008) conclude that help from kin is a ubiquitous feature of human societies, but which kin matter in keeping children alive is highly variable between populations.

The literature reviewed by Sear and Mace (2008) concerns mainly farming and patrilocal populations. This bias however fits the reality of the majority of contemporary rural developing populations. More seriously, correlation in the survival/presence of kin and child survival does not confirm causality. A focus on survival may also obscure more subtle inequalities in health and wellbeing. Some studies have been able to demonstrate the importance of grandmothers more directly. Gibson and Mace (2005), for example, found that the presence of maternal grandmothers in particular was associated with improved child growth and report time allocation data indicating that grandmothers were important in relieving daughters of domestic chores (see also Hawkes et al. 1997). Strassmann (2011), however, cautions that extended kin may not always be beneficial, and that coresident elderly grandparents may be more likely to be net consumers in resource-poor settings. In her long-term study of a Dogon agriculturalist population in Mali, child growth and survival were not improved in the presence of extended kin, and child mortality increased in the presence of paternal grandmothers. Recent studies also emphasize that the benefits of paternal involvement may be underestimated by focusing on early life health outcomes alone. Scelza (2010), for example, reports that in Australian Martu Aborigines, the presence of fathers accelerates the timing of ritual initiations and consequently later social and reproductive success.

5.5.2 *Relatedness and Extended Family Care*

Why do maternal grandmothers more consistently improve child health than paternal grandmothers (Sear and Mace 2008; Strassmann and Garrard 2011)? Kin selection theory presents a strong candidate explanation. When paternity is uncertain, the inclusive fitness benefits of investment will be on average higher for maternal grandparents than paternal grandparents. Although the required genetic data are difficult to come by, there is evidence that paternity is indeed often uncertain to a non-trivial degree in humans (Anderson 2006), supporting the view that paternal relatives are less likely to be genetically related to their putative grandoffspring. There is also evidence that fathers are aware of cues of physical resemblance and alter investment accordingly (e.g. Alvergne et al. 2009b). Furthermore, a number of studies have confirmed similar biases in the investment of maternal and paternal grandparents, as well as aunts and uncles, in more modern populations (Coall and Hertwig 2010; Gaulin et al. 1997).

Alternative, and not necessarily mutually exclusive, explanations have also been presented for the asymmetry between paternal and maternal grandmother effects. Strassmann and Garrard (2011) stress the role of local resource competition, arguing that in patrilocal populations grandparental presence may often be less beneficial or even detrimental to children because they are both consumers of the same pool of family resources. It is also true that in populations where men typically marry and reproduce at a later age, paternal grandparents will be older and so may be simply less likely to be healthy enough to provide support (Strassmann and Garrard 2011). Distinguishing between these hypotheses is difficult on the basis of studies of kin presence and child outcomes alone. More direct data on the care roles and consumption/production activities are therefore required. See also Coall and Hertwig (2010) for a thorough review of the other factors predicted to account for variation in grandparental care, from both evolutionary and non-evolutionary theoretical frameworks.

Recently, it has been argued that investment of paternal and maternal grandmothers will also interact with child sex due to differing relatedness on the X-chromosome, which is estimated to contain approximately 8% of all human genes (Fox et al. 2010). Assuming no paternity uncertainty, X-chromosome relatedness between paternal grandmothers and female grandchildren will be 50%, because fathers transmit the only X chromosome they receive to their daughters, whereas it will be 0% for male children, since they receive a Y rather than an X chromosome. From maternal grandmothers, X-chromosome relatedness to both male and female grandchildren is 25%, since any given X-linked gene has a 50% chance of being passed from grandmother to mother, and again from a mother to either her male or female offspring. Analysing data from seven traditional populations, Fox et al. (2010) found in all populations that boys were more likely to survive in the presence of maternal grandmothers rather than paternal grandmothers, in 4/7 populations girls were more likely to survive in the presence of paternal grandmothers rather than maternal grandmothers, and in 6/7 populations paternal grandmothers

had a more positive influence on female than male survival. The mechanisms behind these findings remain to be investigated, but these initial findings appear supportive of Fox et al.'s predictions. It is also hard to imagine how a non-evolutionary framework could predict such a pattern of results.

5.5.3 *Implications for Policy*

- The most obvious contribution from the anthropological literature on the extended family is that there is nothing 'natural' or intrinsically advantageous about the nuclear family set-up (Bentley and Mace 2012; Hrdy 2009). Yet, as Penn (2012) argues, global health recommendations regarding how children should be raised draw heavily on long traditions of child development research situated in modern Western societies (e.g. WHO 2004). Findings of evolutionary anthropologists therefore deserve to be disseminated widely to an applied audience, contributing to a new synthesis of how best children can be cared for in the developing world where child-rearing environments are often dramatically different.
- What, if anything, can evolutionary anthropology say about the ability of extended kin to absorb the increasing number of AIDS orphans in sub-Saharan Africa? The literature above certainly confirms that extended kin often play an important role in rearing children, father presence is often not related to child mortality, and that even maternal death is often an at least partially recoverable tragedy. However, it also suggests that when conditions are poor, children and extended kin are more likely to be competing for resources (Strassmann 2011; Borgerhoff Mulder 2007). Thus, it is likely that traditional kinship-based care systems can only be considered a meaningful resource for orphans provided a family has not fallen below a certain poverty threshold. Future research should prioritise exploring this interpretation and identifying how such a threshold can be best defined in a way useful for policy design.
- Recent population health literature has rejected a unitary model of household interests, with the effectiveness of health interventions differing depending on which family member is targeted. For example, a number of studies have shown that grandmothers and mothers spend more income improving child health and development than grandfathers and fathers (Dupas 2011). Evolutionary anthropology has much unmet potential as a predictive and interpretive tool with regard to studies of this kind. It also suggests future studies should consider not just differences by sex, but also relatedness. Duflo (2003), for example, finds that the receipt of pension by grandmothers in South Africa improved the health of granddaughters, but had relatively little effect on grandsons. Assuming that most coresident grandmothers are likely to be paternal in this population, this result is intriguingly consistent with the predictions of Fox et al. (2010), i.e. that paternal grandmothers will favour female grandchildren.

5.6 Conclusions

In this chapter, we introduced the evolutionary anthropological perspective on the human family and reviewed its predicted and observed relationship to physical health in the developing world. Where appropriate, we have drawn tentative implications for population policy. What can evolutionary anthropology contribute to population health science? We hope we have been successful at demonstrating at least two major contributions. Firstly, we believe evolutionary anthropology usefully contributes an integrative ‘top-down’ theoretical framework linking thinking about the *causes* of variation in family structure across space and time with current debates on the *consequences* of alternative family structures on physical health and related measures of wellbeing. Secondly, evolutionary anthropologists have amassed a considerable body of quantitatively sophisticated literature on the complex bidirectional relationships between family structure and health. The results of these studies are of raw empirical value regardless of whether or not one subscribes to an evolutionary perspective. Anthropological studies are particularly valuable given their traditional focus on community samples within well-described cultural contexts, complementing the contrasting reliance on large-scale secondary demographic data sets in population health science (David and Haberlen 2005).

The literature reviewed here is also notable in its strong emphasis on context dependency. Indeed, evolutionary anthropologists explicitly argue that the great diversity of human social organization ultimately springs from the very fact that the pay-offs to alternative ways of living are highly contingent on individual and socioecological circumstance (see also Kaplan et al. 2009). This emphasis reinforces traditional anthropological concerns over the inherent dangers of ethnocentrism, i.e. the tendency to judge other cultures by the values and standards of one’s own culture. Furthermore, from a policy perspective, it encourages a healthy scepticism with regard to ‘blanket’ initiatives which implicitly assume equal incentives for behaviour change will apply across a wide range of environments (e.g. nationwide policies spanning both urban and rural contexts). From a more methodological standpoint, the anticipation of high levels of context dependency also presents a strong a priori argument for valuing improved collection and analysis of contextual data at both the family and population level (see also Bock 1999). Large-sample DHS analyses of family structure and health, for example, do not typically include detailed information on the nature of rural livelihoods, often neglect ethnic variation that may confound with variables under study, and rarely sample a sufficient number of households within specific communities that would be required to identify context dependency at the local level. Evolutionary anthropologists, building on a deeper tradition in anthropological demography (e.g. Kertzer and Fricke 1997; Randall et al. 2011), thus have an important role to play in highlighting the limitations of prioritising representativeness and inclusivity at the sacrifice of potentially more meaningful context-specific analyses of population dynamics and health.

Greater exchange with evolutionary anthropology may also provide population health scientists with new knowledge on the existing strategies that disadvantaged peoples in the developing world already use to mitigate risk and uncertainty in the

absence of external intervention. We note, however, that adaptive strategies will be those that prioritise inclusive fitness not personal wellbeing (Hill 1993), and the interests of the individual over the interests of one's partner, children, or wider group. Human behaviour, in any population, may therefore rarely be optimal with respect to maximizing health and minimizing inequality. In any case, a commitment to understanding human adaptation may help us understand why specific initiatives succeed or fail. For example, Hampshire et al. (2009) reflect on the conflict between humanitarian efforts to save the lives of the most-needy children in the context of a severe food crisis in Niger and the efforts of local people to prioritise the preservation of livelihoods and long-term household sustainability. While not taking an explicitly evolutionary perspective, they argue that the efficiency of emergency nutrition programmes, such as the distribution of food supplements to needy households, could be improved by recognizing that parents lack incentives to prioritise the sickest children when overall household survival is maximized by allocating food more equally, or to those most able to engage in the generation of household resources. See also Rende Taylor (2005) for a similar case study regarding parental motivations for child labour in Thailand.

Perhaps the most contentious issue with evolutionary anthropology, both within and outside the discipline, is the extent of maladaptation in human behaviour, particularly in circumstances of environmental novelty (Brown et al. 2011; Nettle et al. 2013). This issue is particularly pertinent to those developing populations undergoing rapid socioeconomic development, where we can expect both genetic and cultural lag to disrupt adaptive responses. Indeed, the universal fertility decline associated with the transition to a developed economy appears to be best understood as a maladaptive product of exceptionally strong trade-offs between fertility and economic investments in self and offspring (Goodman et al. 2012; Kaplan 1996). In this case, adaptive lag is clearly beneficial to population health, even if detrimental in terms of genetic fitness. In other cases, mismatch may be more likely to threaten wellbeing, perhaps particularly for those individuals experiencing rapid social or ecological change within their own lifetime so that the futures they have prepared for fail to materialize (Stevenson and Worthman 2013).

We concede that to an important extent adaptive lag, by removing the assumption that individuals will conform to adaptive expectations, clouds the predictive value of evolutionary anthropology. There is also much debate within the field regarding how much our unique capacity for cultural transmission should lead us away from the conventional framework of optimality modelling (Borgerhoff Mulder 2013). However, the fact that evolutionary anthropology is still working out how best to 'deal with culture' can hardly be seen as a tangible criticism in comparison to population health science, where culture is commonly presented as an explanation for health outcomes and disparities, but rarely defined, measured, nor directly evaluated as a plausible determinant (Hruschka 2009). The primary strength of the evolutionary anthropology paradigm is thus not its marriage to a particular set of assumptions, but rather that it combines a strong commitment to ask the complicated questions about *why people do what they do* with an equal commitment to evaluate alternative hypotheses with the available data. Not doing so is to rely blindly on

rhetoric and implicit assumptions about human nature. We hope this chapter will go some way in drawing an additional audience to the evolutionary anthropological literature and that further exchange with population health scientists will continue to yield both academic and applied insights on the human family.

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