Original Research Article

Preference for Sons and Sex Ratio in Two Non-Western Societies

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ABSTRACT   Moroccan Berbers and the Bolivian Aymara are two unrelated peasant groups living in adverse environments with a still rather traditional agriculture. Precarious life conditions may be responsible for the importance given to male labor and hence for the cultural preference conferred on male descent. This preference, expressed in the social valorization of sons to the detriment of daughters, is more emphasized if the socioeconomic status of the family is lower. Interpreted according to the cost/benefit approach of Fisher ([1958] *Genetical Thoery of Natural Selection*, New York: Dover) of variations in the sex ratio and to its later developments (Trivers and Willard [1973] Science *179:*90–91; Trivers [1985] *Social Evolution*, Menlo Park: Benjamin/Cummings; Hewlett [1991] J. Anthropol. Res. *47:*1–37; Smith [1993] Ethol. Sociobiol. *14:*39–44), these cultural characteristics could determine that parents bias the care allocated to their progeny in favor of sons, to the detriment of daughters. This could eventually affect their respective survival and finally modify the offspring tertiary sex ratio. This study compares differences in survival as indicators of parental care according to a child's sex and across three economic strata: poor, medium, and high. The Moroccan data express no other sex differences in survival than an advantage for daughters during the preweaning period in the medium and high strata. Within the same sex and across economic strata, a greater mortality between age 10–20 years is observed for boys of the poorest stratum. The Aymara data do not show sex differences by economic stratum, except for an advantage to daughters between birth and 5 years in the medium group, and no survival differences within the same sex across economic strata. These results suggest either that despite the social valorization of male progeny no differences in parental care according to sex occur, or that their magnitude is not great enough to contrast the survival of sons and daughters. Am. J. Hum. Biol. 18:325–334, 2006.   © 2006 Wiley-Liss, Inc.

Fisher (1958) proposed a cost/benefit approach to understand the variations of sex ratio in animal species, suggesting that they were ruled by a selective process based on the balance of the expenditure incurred to produce young of each sex vs. the benefit expected from them in terms of reproductive value. Accordingly, when sons and daughters cost different amounts of parental investment, their respective numbers may vary, whereas the investment in both sexes remains equal. In the same cost/benefit perspective, several developments were later proposed, among which were the observations by Trivers and Willard (1973) that the condition of offspring at the end of parental investment is often correlated with the condition of parents during the period of investment, and that in many animal species, the reproductive success of males is more variable than that of females and more dependent on their condition. When these two characteristics are met, natural selection would favor the reproductive strategy in which parents invest more heavily in individuals of the sex that presents the greatest variance in reproductive success in favor-

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able circumstances, and in the opposite sex when circumstances are adverse. The extrapolation of the model by Trivers and Willard (1973) to humans encounters several difficulties: 1) human well-being is probably more dependent on income level than on environmental circumstances, 2) the simultaneous investment in offspring of different ages and sexes is typical of our species, and 3) there is no clear limit to parental investment in societies where resources are heritable (Anderson and Crawford, 1993; Strickland and Tuffrey, 1997). Accordingly, Trivers (1985) insisted on socioeconomic status as an important variable affecting human sex ratio: "Income has a very strong effect on the chance that a man will marry... It has a much smaller effect on the chance of marrying in women... So we expect women at the low end of the socioeconomic scale to have a higher chance of marrying and bearing children than men at the same end of the same scale." Also, "people low on the economic scale have an almost 10% higher chance of producing a daughter. This is probably adaptive since males at the low end of the scale are out reproduced by their sisters."

Hewlett (1991) developed another aspect of the economy of sex ratio, showing that among hunter-gatherers, herders, or primitive agriculturists, factors like the respective contributions of the two sexes to the diet, as well as the existence of differential adult mortality by warfare or through risky activities, could result in correspondingly adjusted differential child care, leading to differential mortality in infancy or childhood, and hence to planed adjustments of sex ratio to meet cultural goals. A model by Smith (1993), which incorporates the return by adult offspring of a part of parental investment in resource contribution or in protection, shows the only behavioral change that would displace an equal parental inversion in both sexes. Later applied to the case of Inuit populations (Smith and Smith, 1994), it offers a plausible explanation of female infanticide. Similarly, Voland (1989) described situations in past European societies in which parental investment was obviously biased toward one sex, on probable account of an expected return investment. These observations fit the "differential payback" hypothesis that Trivers (1985) imagined in the case of patrilinear and patrilocal societies. He postulated that in these societies, male-biased sex ratio and female infanticide could result in a return to the parents by men, to a greater extent than by women, of part of the reproductive investment.

Regardless of theoretical particulars, the generality and magnitude of changes induced in the sex ratio by economic conceptions is still discussed. However, since the 1930s, numerous investigations that explored variations of the human sex ratio and their causes led to contradictory results, probably for the reason expressed by most authors, i.e., that the associations between each factor and sex ratio are very weak. Teitelbaum and Mantel (1971) showed, from large samples of the US population, a significant socioeconomic influence with a decrease of sex ratio in the lowest socioeconomic group only, with the moderate and upper levels unaffected. However, Erickson (1976) and Rostron and James (1977) failed to find significant associations between social class and sex ratio in this same US population (James, 1987).

If quantitative studies on nationwide samples fail to agree, the results of anthropological investigations also do not match. Some studies do not find a relationship between social or economic well-being and biased parental investment (e.g., Essock-Vitale, 1984; Mace, 1996; Borgerhoff-Mulder, 1998). Others indicate either an association between good socioeconomic conditions and higher parental investment in sons (Boone, 1986; Gaulin and Robbins, 1991; Smith et al., 1987; Mealey and Mackey, 1990; Mackey, 1993) or in daughters (Voland et al., 1991; Strickland and Tuffrey, 1997). Reciprocally, a strong female-biased sex ratio expressing probably the better reproductive prospects of women was observed in the underprivileged Mukogodo tribe of Kenya (Cronk, 1991a,b), in 17th century poor Portuguese families (Cowgill and Johnson, 1971), in uniparental families of the US (Gaulin and Robbins, 1991), and in the contents of wills of less wealthy will-writers in the area of Vancouver (Smith et al., 1987).

The present study investigates the eventuality of a cultural molding of sex ratio in two unrelated non-Western patrilineal peasant societies. Notwithstanding their inclusion in a still traditional context, both groups display a variety of economic conditions, ranging from the poorest farm worker to prosperous landowners. Both groups live in adverse environments associated with heavy workload, scarce food resources, low health protection, and an extensive fertility and mortality pattern. These conditions that put preeminent importance on male labor, associated with the patrilineal system of marriage that takes daughters out of the family group, may be responsible for the importance given to male descent (male offspring are the poles of the tent in Berber

popular wisdom, and the eldest son is nick-named "the wall" for the protection that he will provide his old parents). This cultural value is more explicit as the socioeconomic status of the family is lower, and more dependent on adult sons' labor to warrant parents' future resources. This preference could determine that the poor show differences in parental care between sons and daughters, contrasting their probabilities of survival to adulthood, and in consequence, manipulating the tertiary sex ratio. Conversely, the other economic strata, which can eventually afford to employ farm workers, could remain unconcerned by this necessity, and could merely keep the preference for sons in the sphere of sociality.

MATERIALS AND METHODS

The distribution of sex ratios was observed in two traditional peasant societies from southern Morocco and from the Bolivian Altiplano. The Moroccan data were drawn from the Health and Fertility Survey of the Province of Marrakech performed in 1984 by the Faculty of Sciences of the Université Cadi Ayyad and the Centre National de la Recherche Scientifique, in connection with the Provincial Agencies of Public Health and of the Ministry of Planification. The study encompassed a random sample of one tenth of all households of the province (mainly rural), and represented the large environmental diversity of the area: middle to high mountain, irrigated plain, dry plain, or arid hills. Small urban centers (principally administrative and market towns) were also included, with the urban area of the city of Marrakech being excluded. Six thousand and seven hundred households provided detailed social and economic data including education level, occupation, conjugal or extended family dwelling, material conditions (number of rooms in household, presence or absence of latrines, lighting source, water supply, means of transport, radio, or television set), number of persons in the household, number of wage earners, and landed property, as well as personal data of the spouses, including inbreeding and the reproductive histories of all married women (cf. Crognier, 1996, 1997, 1998; Crognier et al., 1992, 1993, 2001).

To maintain the cultural homogeneity of the data, only families living by agriculture are used in this analysis. In 1984 they were still maintaining the tradition of a culture that has existed for a thousand years, and represented by far the major part of the total population. They totaled 15,229 live births (7,902 males and 7,327 females). Their economic diversity was determined by several main factors: level of rural infrastructure (roads, energy, and irrigation), cultivated surface and commercialization rate. Accordingly, three economic strata were individualized (low, medium, and high). They encompassed a wide spectrum of conditions, from the poorest fellah who sells one's labor to a farmer and gets no access to basic standard of well-being, to the owner of a modern farm operating a mechanized agriculture in an irrigated area. Each parental couple was assigned to one of these strata on the basis of its position as supplementary (passive) variable in an analysis of correspondences computed from the pertinent socioeconomic indicators of the district of residence. Separate computations were consequently performed for each of the eight districts of the province, leading to the same classification in each analysis, in low (LES), medium (MES), and upper (HES) economic strata.

The Bolivian data are part of a survey designed by the Bolivian Institute of Altitude Biology of the University Mayor San Andres (La Paz), on behalf of the Ministry of Health, with approval of the Committee of Ethics of the Academy of Sciences of Bolivia. It was developed from August 1998–December 1999. Twelve Aymara peasant communities ("Ayllu") remotely settled at high altitude (4,000 m) on the Altiplano, 30–60 km southwest of the city of La Paz, were studied. The project was principally directed to improve medical research and assistance. From that perspective, a database of social, cultural, and biological information was established in addition to findings of medical examinations, from information collected in 868 families representing the total population of the area surveyed. Reproductive life histories of all women were recorded (Crognier et al., 2002a,b), as well as socioeconomic data, including educational level of both spouses, languages spoken (Aymara or Spanish), number of persons in the household, and material conditions (number of rooms in household, presence or absence of latrines, lighting source, water supply, cooking and heating fuel, means of transport, radio, or television set). Even if, owing to the homogeneity of the natural environment and to the dedication of the whole population to agriculture, economic levels seem less apparent in this group than among Berbers, there are nevertheless marked differences of relative wealth between the families within each "ayllu." The richest may own their farm as well as a house in the nearby town and

TABLE 1. Shift in sex ratio from birth to adulthood estimated from transversal cuts in data of Moroccan offspring

	Birth	12 months	18 months	3rd year	5th year	7th year	10th year	15th year	18th year	20th year
LSES	1.061	1.046	1.023	1.023	1.037	1.053	1.063	1.022	1.057	1.060
MSES	1.088	1.078	1.080	1.087	1.096	1.095	1.083	1.068	1.069	1.079
HSES	1.080	1.028	1.031	1.046	1.071	1.091	1.081	1.087	1.112	1.139
Total	1.078	1.060	1.055	1.062	1.074	1.082	1.077	1.059	1.074	1.085

have access to mechanical farming, whereas farm workers experience miserable living conditions. Three socioeconomic strata (low, medium, and high) could be processed through a single analysis of correspondences, with the superposition of the households as a supplementary variable. In total, 3,629 births (1,929 sons and 1,700 daughters) were recorded.

In both the Moroccan and Aymara data, the distributions of sex ratios were extracted from the reproductive histories by means of a specific program adapted to the SAS statistical package. Right-censored survival analyses employing the Kaplan-Meier estimator (cf. Elandt-Johnson and Johnson, 1980) were also computed with SAS.

RESULTS
Economic stratum and sex ratio in Moroccan peasantry

The sex ratio at birth in the Moroccan sample has a mean value of 1.08 (Table 1). It always remains above 1.0 across successive transversal age cuts, and shows two main inflections: a decrease between birth and the fifth year, followed by an increase from the fifth to the tenth year, suggesting opposite mortality trends among boys and girls during the two periods.

A progressive recovery from the decrease of sex ratio during the early childhood, up to a tertiary sex ratio higher than the sex ratio at birth, was also observed between age 15–19 years in the Italian population (Ulizzi et al., 2001). This apparent pattern of male preponderance could be typical of Mediterranean patrilineal societies. Table 1 shows the economic differences between the three groups, but does not suggest the existence of divergent behaviors. The three groups share the same excess in male mortality from birth to weaning (at age 18–24 months), followed by an excess in female mortality from weaning to the end of childhood. However, transversal cuts express mean values at group level, but do not describe the pattern of survival experienced by individuals.

Offspring survival by economic group. To estimate the conditions of survival met by the offspring in each of the three groups, survival functions were computed by sex using the Kaplan-Meier estimator, for the whole span of youth (from birth to 20 years) and for successive parts of it: from birth to 2 years to encompass the first stage of life dominated by lactation and ending with weaning (which occurs from 18 months to 2 years); from 2–5 years to describe early childhood and juvenile mortality; from 5–10 years to cover late childhood; and finally from 10–20 years to express the maturation to adulthood. The results (Table 2) describe the percentages of survivors for the period considered (each period is independent, i.e., the probability of survival of a particular age cohort at the beginning of each interval is set to 1).

In the lowest economic stratum, there is no significant sex difference in the probability of survival, whatever the period considered, until age 20 years. The percentages of survivors in both sexes for each period, furthermore, are very close.

In the medium and upper groups, there is a significant difference to the detriment of sons in the probability of survival to the end of the first 2 years. As this difference is not compensated for in the subsequent periods, when the probabilities of survival in the two sexes are similar, it remains expressed in the estimates of survival encompassing the whole span (0–20 years).

The survival functions for each sex compared across the three economic strata (Table 2, Fig. 1) show that the probabilities of the survival of daughters are not affected by economic differences, whatever the period. The same is not true for sons: in the age interval 10–20 years, those of the poor stratum are more at risk of death than those of other categories.

In short, the comparison of survival curves across economic strata either negates any sex difference at any period (poorest group), or expresses an advantage for daughters during the preweaning period in the medium and richest groups. The survival curves of the same sex

TABLE 2. *Percentages of surviving offspring by sex within each socioeconomic stratum (I) and percentages of survivors of same sex across economic strata (II), in different periods of life*

	0–2 years	2–5 years	5–10 years	10–20 years	0–20 years
I					
LES					
Sons	84.8	93.8	98.3	96.5	77.4
Daughters	85.8	94.1	98.8	96.8	78.9
P	ns/ns	ns/ns	ns/ns	ns/ns	ns/ns
MES					
Sons	83.4	93.5	98.0	98.3	76.2
Daughters	85.2	94.1	98.1	97.63	78.2
P	**/*****	ns/ns	ns/ns	ns/ns	*/**
HES					
Sons	83.2	94.8	98.0	98.1	76.8
Daughters	87.3	94.7	97.8	96.9	79.9
P	***/******	ns/ns	ns/ns	ns/ns	**/****
II					
Sons					
LES	84.8	93.8	98.3	96.5	77.4
MES	83.58	93.5	98.0	98.3	76.32
HES	83.2	94.8	98.0	98.1	76.8
P	ns/ns	ns/ns	ns/ns	***/******	ns/ns
Daughters					
LES	85.8	94.1	98.6	96.8	78.2
MES	85.2	94.1	98.1	97.6	78.9
HES	87.3	94.7	97.8	96.9	79.9
P	ns/ns	ns/ns	ns/ns	ns/ns	ns/ns

$*P < 0.05$, log-rank test.
$**P < 0.01$, log-rank test.
$***P < 0.001$, log-rank test.
$****P < 0.05$, Wilcoxon test.
$*****P < 0.01$, Wilcoxon test.
$******P < 0.001$, Wilcoxon test.

across economic strata refute the existence of sex differences at any period (daughters), or limit them to the period of adolescence (sons).

Some behavior affecting survival. The differing rates of survival of sons and daughters in the medium and upper strata, whereas no differences appear in the lowest economic group, suggest a behavioral cause. In the period which extends from birth to weaning, the difference could be related to sex distinctions in primary parental care, in particular in feeding or healthcare, whose decisive importance for infant survival was repeatedly noted (Crognier and Zarouf, 1987; Belkeziz, 1989; Baudot and Bley, 1992; Crognier et al., 1992, 1996; Crognier, 1996). In rural Morocco, breastfeeding is the exclusive infant feeding method up to age 4–5 months, and remains an important component of the diet after the introduction of complementary food, until weaning in the age range of 18–24 months. On the one hand, if maternal lactation provides the infant with adequate food and immune defense, and on the other, if the absence of hygiene and of sanitary protection is typical of current conditions in this traditional peasantry, and if it is furthermore noted that the availabil-

ity of animal milk is limited, then the practice and extension of breastfeeding may represent an important factor in infant survival. The only information available on infant feeding is the total amount of lactation in months received by a child up to weaning. These amounts, in months, for sons and daughters, respectively, are 16.9 ± 7.2 (n = 1,979) and 16.8 ± 7.0 (n = 1,895) (LES); 17.0 ± 7.0 (n = 3,919) and 17.0 ± 6.6 (n = 3,635) (MES); and 16.3 ± 6.9 (n = 1,117) and 16.8 ± 6.2 (n = 1,055) (HES).

No difference is significant, either between sexes within each economic group, or within the same sex across economic groups. No difference is observed either in the distribution of breastfeeding patterns (i.e., numbers of infants breastfed at less than 6 months, from 6–11 months, from 12–17 months, from 18–24 months, or more than 24 months) by sex and economic group.

Healthcare is less easy to appraise owing to a lack of relevant statistics, and only the main therapeutic options could be evaluated. The data proceed from interviews of local nurses with each family, complementing the data given by the registry of therapeutic interventions kept in the dispensary. Faced with a son's illness,
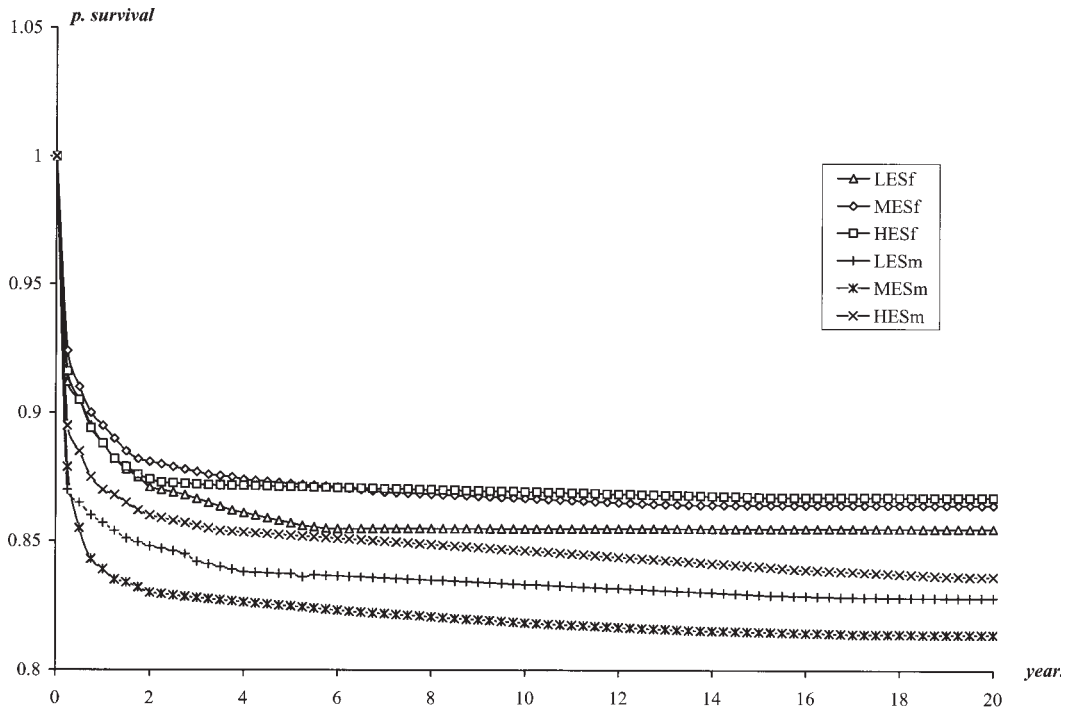
Fig. 1.   Probability (p.) of survival of Moroccan sons (LESm, MESm, and HESm) and daughters (LESf, MESf, and HESf) from birth to adulthood, according to economic level.

43% of LES parents resorted to traditional healing and not to modern medicine, vs. 27% MES and 29% HES. In the event of a daughter's illness, the respective proportions were 41% LES, 31% MES, and 33% HES. These frequencies are not significantly different between sexes, whatever the economic stratum, whereas they are significant within the same sex across the three economic groups (sons: $\gamma_5^2 = 37.7$, $P < 0.001$; daughters: $\gamma_5^2 = 12.0$, $P < 0.05$).

Three principal causes were responsible for infantile death: tetanus (often umbilical tetanus subsequent to a lack of hygiene at birth), gastrointestinal infections accompanying the beginning of food complementation, and other communicative diseases (in particular, infections of the respiratory tract). However, despite an apparent contrast between the high incidence of gastrointestinal diseases among the poor while other infectious diseases predominate in the medium and high strata, the analysis of causes of death does not point at differences between sexes ($\gamma_7^2 = 8.7$ $P < 0.5$), nor at contrasted pathologies that would shape each economic level: $\gamma_{11}^2 = 6.5$, $P < 0.9$, for sons, and $\gamma_{11}^2 = 13.9$, $P < 0.1$, for daughters.

In brief, the behavioral determinants of infant survival do not point at sex-bound variations, either in feeding practices or in healthcare. Some indications given by the results would confirm the contrasting role of economic determinants separating the low economic stratum from the medium and high strata. If behavior is involved in the small differences of infant survival revealed by the analysis, it is not accessible from these data.

Economic strata and sex ratio in Aymara peasantry

The sex ratio at birth is high (Table 3), whatever the economic status. Its only change with age is a drop following birth, expressing the typical higher male infantile mortality. The Aymara pattern is therefore distinct from that of Morocco, lacking the recuperation of the sex ratio seen in Table 1. Here the period posterior to weaning shows opposite trends between low and high groups on the one hand and the medium on the other, whereas the low and medium groups are opposed to the high one during adolescence. These results are not readily under-

TABLE 3. *Shift in sex ratio from birth to adulthood estimated from transversal cuts in data of Moroccan offspring*

	Birth	12 months	18 months	3rd year	5th year	10th year	15th year	20th year
LES	1.143	1.089	1.128	1.129	1.094	1.105	1.136	1.032
MES	1.154	1.077	1.063	1.070	1.078	1.093	1.121	1.166
HES	1.102	1.088	1.116	1.125	1.117	1.067	1.028	1.000
Total	1.136	1.083	1.095	1.1	1.093	1.089	1.099	1.08

TABLE 4. *Percentages of surviving Aymara offspring by sex within each economic stratum (I) and percentages of survivors of same sex and across economic strata (II), in different periods of life*

	LES			MES			HES		
	Sons	Daughters	P	Sons	Daughters	P	Sons	Daughters	P
I									
0–5 years	83.7	86.2	ns	82.9	87.7*/**		85.6	87.5	ns
0–20 years	83.3	86.0	ns	82.0	87.0*/**		84.9	87.1	ns
II									
0–5 years	83.9			82.9			85.6		ns
		86.5			87.7			87.5	ns
0–20 years	83.3			82.0			84.9		ns
		86.0			87.0			87.1	ns

*P < 0.001, log-rank test.
**P < 0.001, Wilcoxon test.

standable, the fluctuations between economic strata probably being the mere effect of limited numbers. The only way to evaluate if economic groups use distinct strategies of parental investment according to an offspring's sex is to analyze the behavior that underlies the probability of survival of sons and of daughters.

As the number of births is much more limited than in the Moroccan sample, survival analyses were only performed for two periods: from birth to the fifth birthday, which virtually encompasses the whole preadult mortality in this population (Crognier et al., 2002a,b), and for the whole span of life preceding age 20 years (Table 4). For both periods, the maximum sex differences in the probability of survival are small: 2.7% for LES, 5.0% for MES, and 2.2% for HES, and significant in the medium economic stratum only. In this group, the discrepancy between sons and daughters, twice that observed in the lower and upper strata, probably reveals a real sex difference. Aymara offspring, like the Moroccans, do not express differences in survival that could suggest a cultural manipulation of sex ratio. This is still more obvious when survival curves of the same sex are compared across economic levels (Table 4, Fig. 2). The differences in probabilities of survival to 5 and 20 years across economic strata do not reach 3% for sons and remain close to 1% for daughters. In both sexes

they are not significant, neither for the Wilcoxon test nor for the log-rank test.

In the Aymara tradition, breastfeeding is as general and as long (mean, 19.6 months; Crognier et al., 2002b) as in Moroccan society. Here too, it is determinant for offspring survival. A comparison of lactation patterns by sex in each economic group does not reveal differences, nor does the mean duration (in months) of lactation by sex, for sons and daughters, respectively: 18.3 ± 8.0 (n = 453) and 18.2 ± 7.5 (n = 408) for LES; 17.5 ± 8.1 (n = 787) and 17.5 ± 7.3 (n = 712) for MES; and 18.4 ± 7.5 (n = 498) and 17.7 ± 7.6 (n = 446) for HES. The difference in survival of sons and daughters of the medium group is consequently not the result of distinct feeding behavior according to sex. As far as causes of death are concerned, infant mortality is high (130‰), and if juvenile mortality is far less prevalent than in Morocco, it has still not been eradicated. Both are produced by the absence of hygiene and of medical support, combined with a particularly harsh environment. The quasitotality of early offspring deaths is associated with a general fever-diarrhea-cough syndrome which does not show a differential sex incidence.

DISCUSSION

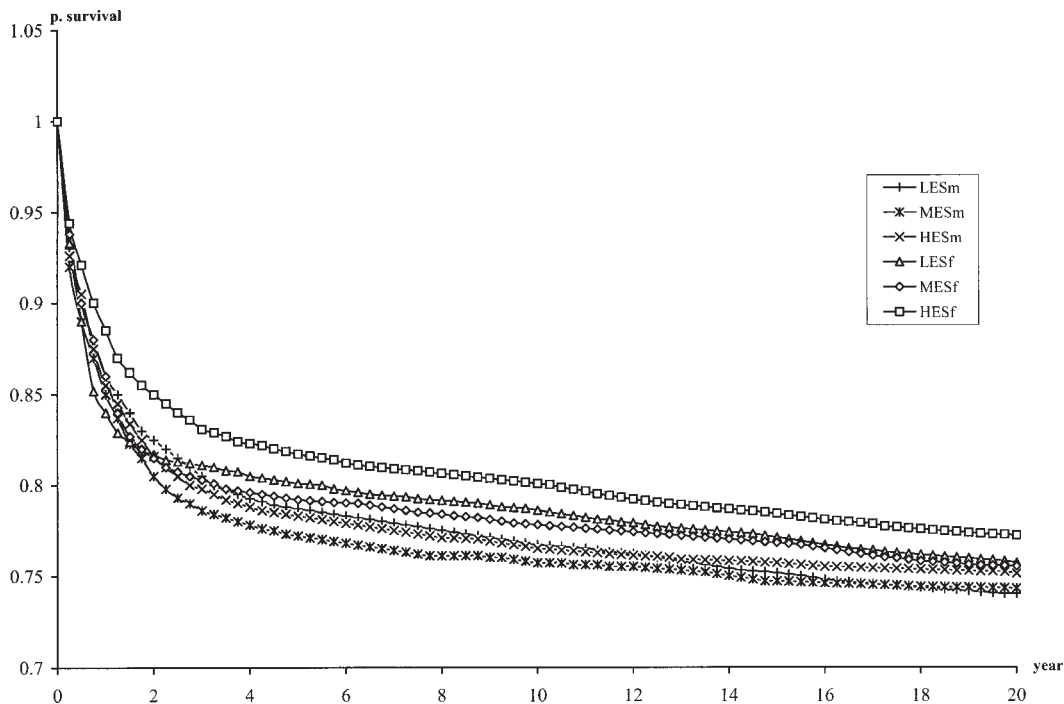Both Berbers and the Aymara present a high sex ratio at birth, which despite the

Fig. 2. Probability (p.) of survival of Aymara sons (LESm, MESm, and HESm) and daughters (LESf, MESf, and HESf) from birth to adulthood, according to economic level.

higher incidence of early male deaths pre-
dicted by the theory of Fisher (1958), is main-
tained throughout preadult life. It is this ob-
servation, in association with the admitted
preference for male progeny, that motivated
the hypothesis that differential parental care
could bias the survival of sons and daughters.

If parental care is a decisive component of
survival in these environments, it is not the
only one. The pattern of morbidity and mortal-
ity of Berbers and Aymara infants and chil-
dren indicates a high incidence of infectious
diseases that might transcend social groups
and level out the differences resulting from
parental care. However, the economic sub-
groups are not equal with respect to illness. In
both populations, medical assistance and bet-
ter food are the first improvements brought by
a rise in the standard of living. Hence it can
be expected that the medium and high strata
will have behavior distinct from the poorest,
in particular when modern medical therapy
can make the difference. It is what would sug-
gest the differences observed between sub-
groups, of medical use as an alternative to tra-
ditional healing.

Insofar as survival rates transcribe differen-
ces in parental care, no bias becomes appa-
rent. In the case of the Berbers, the absence of
any sex difference in infant survival in the low
economic stratum, while sex differences in
favor of daughters are significant at the same
age in the medium and high strata, is bewil-
dering. Many causes other than differences in
parental investment are conceivable, such as
an intrinsic capacity of females to benefit bet-
ter than males, or the relaxation of adverse
living conditions. Another possible factor is
that observed by Hill and Randall (1984) in
the noble Tuareg caste in Mali. Their custom
of fostering infants to servants is associated
with higher infantile and juvenile mortality
rates than those observed among the former
slaves who still follow the tradition of keeping
mothers and infants in close contact. In the
present case, "improved conditions" only ac-
cessible to the medium and high strata (e.g.,
hiring servants to care for offspring) could
result in harm and could perhaps affect males
more than females. Another explanation could
be the practice of bottle-feeding to complement
the diet of male infants, which for a while

became fashionable in urban Morocco, and which could have been adopted by the well-off peasants and turned harmful to infant health in the absence of indispensable hygiene.

Whatever the causes, when probabilities of survival of sons and daughters differ in infancy, it is to the detriment of sons and is related to medium or high economic conditions. It is therefore contrary to expectations that the social preference for sons could entail discrepancies in the amount or quality of child care that offspring receive from parents according to their sex. The trend toward a male preponderance with growing age, as indicated in the transversal cuts in Table 1, is not reflected by the survival curves. This could express diachronic changes in sex ratio at birth during the time lag covered by the reproductive histories, which extends to some 50 years.

The absence of an economic strategy related to sex ratio is also suggested by the comparison of survival curves by sex across economic strata. Heterogeneity is only marked with poor adolescents, who are more at risk of death than those of the other groups. Here, it is the risk associated with the early dedication of young boys to remunerated labor which is probably to blame.

The similarity of Aymara and Berbers catches our attention. Both Berbers and the Aymara present a high sex ratio at birth and maintain it into adulthood. In both groups, the low economic stratum expresses homogeneous survival curves in the two sexes. However, the Aymara, unlike Berbers, do not show a difference in the survival of sons and daughters during infancy in the high stratum, whereas the medium stratum expresses a significant difference that is not compensated for in later life. Here again, no explanation of the results is at hand. A sex difference in the aptitude to derive health benefits from the alleviation of adverse conditions seems the most convincing hypothesis in the Aymara context. Nor do their survival curves by sex across economic strata suggest a cultural intervention in the distribution of sex ratio.

CONCLUSIONS

Parental discrimination in the care allocated to offspring according to sex is not elicited from the survival curves of Berber and Aymara children. Considering the difficult life conditions of these two groups, we cannot exclude the possibility that differences remain unseen on account of the concurrence of other factors affecting survival. It is also imaginable that the magnitude of the difference in parental care is not great enough to affect survival rates. Last but not least, it is possible that the preeminent uncertainty of offspring survival due to environmental factors deterred parents from elaborating a strategy to bias the sex ratio.

On the other hand, there is little doubt that in these societies, a large family is a primary sign of social success. This value placed on family size may run contrary to any strategy to manipulate the sex ratio through practices that raise the mortality rates of one sex. Our results from the Berbers and the Aymara suggest either that the preference for male progeny common in both societies remains confined to the cultural sphere, or that if it results in differential parental care, it does not influence significantly the rates of survival and hence the tertiary sex ratio.

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