

ADULT SEX RATIO IN THE NECROPOLIS OF SHAHR-I SOKHTA, BRONZE AGE BACTRIA MARGIANA, AND INDUS VALLEY SITES

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Abstract: A common observation in skeletal samples discovered during archaeological excavations is that male adult skeletons significantly outnumber female ones, while in living adult populations, the adult sex ratio (m/f) is close to 1. Male-biased archaeological sex ratios could partly be due to the rapid degradation of the more delicate female skeletons. In a large sample of necropolises from Southern Mediterranean, Northern Africa, and Middle East countries ranging from Neolithic to Middle Ages, we observed a mean sex ratio of 1.40. On the contrary, samples of adult skeletons from the necropolis of Shahr-i Sokhta, sexed by different authors using different methods, constantly show an overrepresentation of females (about 42% males and 58% females), i.e., a sex ratio of 0.72. Similar values have been observed in necropolis from chronologically close sites in the Bactria-Margiana and Indus Valley cultures (Gonur Depe, Mohenjo-Daro, Djarkutan, Rakhigarhi). We speculate that the most likely interpretation of this particular observation could be the uxorial settlement pattern in these populations.

Keywords: Bronze Age, Shahr-i Sokhta, Bactria Margiana Archaeological Complex, Indus Valley, Necropolis, adult sex ratio, mobility, matrilocality.

چکیده: از مشاهدات معمول و رایج در بقایای اسکلتی به دست آمده از کاوش‌های باستان‌شناسی آن است که اسکلت افراد بالغ مذکر به صورت معناداری بیشتر از نمونه‌های مربوط به افراد مؤنث است، در حالی که در جمعیت‌های افراد زنده بالغ، نسبت جنسیت افراد بالغ (مذکر/مؤنث) نزدیک به ۱ است. سوگیری در مورد نسبت جنسیت مردان در مطالعات باستان‌شناسی تا حدی به خاطر فرسایش سریع استخوان‌های شکننده‌تر زنان است. ما در نمونه بزرگی از تعدادی قبرستان، از مدیترانه جنوبی، آفریقای شمالی و کشورهای خاورمیانه، از دوره نوسنگی تا قرون وسطی، شاهد نسبت میانگین جنسیت ۱٫۴۰ بودیم. در مقابل، نمونه‌های اسکلت‌های افراد بالغ در قبرستان شهر سوخته که محققان مختلف با استفاده از روش‌های متفاوت آن‌ها را تعیین جنسیت کرده‌اند، به صورت مکرر، وجود بیش از حد جنس مؤنث را نشان می‌دهد (حدود ۴۲٪ مردان و ۵۸٪ زنان)، یعنی ۰٫۷۲ درصد نسبت جنسیت. از گورستان محوطه‌هایی با گاهنگاری نزدیک به فرهنگ‌های باختری-مرویی و دره سند (گنور تپه، موهنجو دارو، جارکوتان، راخیگاری) مقادیر مشابهی مشاهده شد. حدس و گمان بر این است که محتمل‌ترین تفسیر در این مورد مشاهده شده خاص می‌تواند ناشی از الگوی سکونت در موطن همسر (زن) در این جمعیت‌ها باشد.

کلمات کلیدی: عصر مفرغ، شهر سوخته، مجموعه باستان‌شناسی باختر(بلخ)-مرو، دره سند، گورستان، نسبت جنسیت افراد بالغ، جابجایی، محل سکونت مادرزادی.

I. Introduction

A common observation in skeletal series coming from archaeological excavations is that male adult skeletons significantly outnumber female ones producing a sex ratio (m/f) >1, while in living adult populations sex ratio is close to 1. Weiss (1972) assembled a large (n=12,064) worldwide sample of adult archaeological skeletons and found that the sex ratio was 1.19, that is about 54.5% males and 45.5% females, on the contrary, in pre-industrial living people (n=39,843) the sex ratio is 0.98, that is 49.6% males and 50.4% females. Halstead (1977) studying demography in Bronze Age Crete observed (page 108) that "...men usually outnumber women by a wide margin. This might be interpreted as, for example, an indication of systematic female infanticide, but might simply result from the better preservation of the more robust male skeleton...". Bennike (1985) agreed that male biased archaeological sex ratios could partly be due to rapid degradation of the more delicate female skeletons. This cannot be taken as a general rule; Walker *et al.* (1988) noticed that young adults of both sexes were equally

well preserved as compared with older or younger individuals in the skeletal collection of the Mission La Purisima. Nonetheless, skeletal preservation in elderly women is significantly lower than in men as can be seen in the case of Saint Bride's church where the sex was based on the coffin plates (Walker, 1995). Male overrepresentation could also be partly due to the tendency of sexing as male and female individuals from robust prehistoric populations as in many older studies skull features were commonly used in sex determination. By taking into account the year in which the anthropological study took place as well as the methods applied to the sex determination in each site, Bone (1993) observed that male overrepresentation tends to disappear in more recent works (1972–1993) in pelvis sexed samples. Although rare, the overrepresentation of females can be found in some cases, Triantaphyllou (2000), observing it in several skeletal samples from Northern Greece, proposes three interpretations: matrilocality residence; long-distance travel for men who were more likely to die and be buried abroad; female-biased parental investment.

II. Materials and methods

We collected from published anthropological studies a sample of 34 necropolises (6,368 adult individuals of both sexes) from a broad geographical area (Southern Europe, Egypt, Middle East) ranging from Neolithic to Middle Ages, Appendix Table 1.

We then collected data from three different anthropological samples issued from the necropolis of Shahr-i Sokhta: Macchiarelli and Passarello, 1988; Shadmehr *et al.*, 2017; Ascalone and Fabbri, 2019. Data regarding anthropological samples from Bronze Age sites ascribed to Bactria Margiana Archaeological Complex (BMAC) and Indus Valley (IV) are available for Dzharkutan, Farmana, Gonur Depe, Harappa, Mohenjo Daro, and Rakhigarhi, see appendix information for references.

Ref.	m/f	unsexed	m	f	tot	%m	%f
Ascalone and Fabbri, 2019	0.66	-	19	29	48	39.6	60.4
Macchiarelli and Passarello, 1988	0.84	-	48	57	105	45.7	54.3
Shadmehr <i>et al.</i> , 2017	0.69	409	143	206	349	41.0	59.0
Shahr-i Sokhta total	0.73	409	191	263	454	42.1	57.9

Table 1. Sex ratio in different adult samples from Shahr-i Sokhta.

We grouped the necropolises data in the reference sample on a chronological basis, regardless of their geographical origin, Table 2, the mean sex ratio ranges between 1.15 (pre-Bronze Age) and 1.64 (Medieval) in the chronological subsamples. In the total sample, we observe a mean sex ratio of 1.42 (range 0.80-2.70).

We also considered the Chalcolithic necropolis of Mehrgarh where cranial and dental measures and features are closely similar to those observed in the Bronze Age necropolis of Harappa (Hemphill *et al.*, 1991).

III. Sex ratio

Considering three different skeletal samples from the necropolis of Shahr-i Sokhta, Table 1, we observe that in all of them, female skeletons outnumber male ones and that in the total sample, the sex ratio is 0.73, i.e., 42.1% males and 57.9% females.

We then took into account a sample of necropolises from BMAC and IV Bronze Age and Shahr-i Sokhta, and we found a significantly lower sex ratio, a mean of 0.69 and a narrower range (0.61-0.73) outside the range observed in the comparison sample. Interestingly the Chalcolithic sample from Mehrgarh is within SiS-BMAC-IV's range.

	n (individuals)	n (necropolises)	m (m/f)	sd (m/f)	min (m/f)	max (m/f)
SiS-BMAC-IV	1,558	10	0.69	0.0405	0.61	0.73
Mehrgarh	48	1	0.71			
pre-Bronze Age	702	4	1.36	0.8168	0.86	2.58
Bronze Age	809	8	1.15	0.5019	0.80	2.36
Iron-Historic preMed.	3,174	8	1.35	0.3730	0.95	2.00
Medieval	1,683	14	1.64	0.5267	1.00	2.70
Total	6,368	34	1.42	0.5404	0.80	2.70

Table 2. Sex ratio in the necropolises from Shahr-i Sokhta, BMAC, and IV Bronze Age (Shahr-i Sokhta, Mohenjo Daro, Farmana, Harappa, Dzharkutan, Rakhigarhi, and Gonur Depe), Mehrgarh and reference sample (see appendix Table 1).

As previously noted, Bone (1993) observed that due to improvement in sex determination, male overrepresentation is less marked in recent papers (1972–1993). Our reference sample is generally recent (31 out of 36 have been issued after 2000 and coxal bone sex determination is by far the most frequently used and there is no correlation between sex ratio and year of issue ($r^2=0.029$). Nevertheless, males are overrepresented as the total m/f is 1.43. Regarding Shahr-i Sokhta, BMAC, and IV Bronze Age sites, published between 1962 and 2019, the sample where males are mostly underrepresented is the earliest published one

from Harappa (1962). We can conclude that male overrepresentation in reference samples and male underrepresentation in Shahr-i Sokhta and BMAC and IV sites are not related to methods of sex determination or year of publishing.

The shortage of males in Indus Valley sites has long been noticed. Ghosh *et al.* (1962) observed that in the total sample from Harappa, males were 44% and females the 56% of sexed adult skeletons. Their interpretation of the find is surprising: “The sex proportions, except in the Mound Area, are abnormal. The excess or shortage of females may be explained by

supposing that as Harappa was a central city – one of the joint capitals, the structure, both age structure and sex ratio, was artificial. Normally there would be a shortage of females; but if females are employed as slaves or impressed as laborers in certain periods, there would be an excess”, pag.7. Women should be few in places where power was exerted, as power is a male business, but if there were many women they could only have been laborers or slaves. It seems more a product of sexism than a sound archaeological interpretation. Regarding BMAC sites, Babakov *et al.* (2001) observed the predominance of women in the necropolis of Gonur Depe, m/f=0.64 in their sample, supposing that “.. a portion of the women (about 36%) could be included in the population from outside or else that a group of some newcomers came to the new territory, pressed out some of the local men and incorporated local women into their composition.

IV. Mobility

The common basis in studies addressing mobility and patrilocality versus matrilocality is that the sex showing higher variability is assumed to be the more mobile.

Greater male variability means greater male migration and thus should indicate matrilocality, greater female variability should indicate patrilocality. This can be investigated in morphological traits of the skeleton and, more often, of the dentition (Stojanowski and Schillaci, 2006), in stable isotope analysis in dental enamel (Bentley *et al.*, 2012), in mtDNA and Y-chromosomal haplotypes (Bentley *et al.*, 2005).

Narasimhan *et al.* (2019) analyzed aDNA in some human samples from Shahr-i Sokhta and Gonur Depe. Out of 22 individuals from Shahr-i Sokhta, 8 (36.4%) are genetically classified as outliers, among them, five are males and three females.

Anthropological studies on cranial and dental measures and morphology in Harappa (IV) suggest that women could have been related to each other by descent, while men were not (Hemphill *et al.* 1991). Biodistance studies indicate that females in Harappa retain closer genetic affinity to each other than to males,

a feature that has been interpreted as evidence for matrilocality (Kennedy, 2000). In a human sample from Sanauli (IV), Valentine (2013) notes that females are relatively robust and of slightly greater stature than males, concluding that this could suggest a genetic distance between the sexes.

Moreover, isotopic data from Farmana and Harappa indicate that Integration Era cemeteries were reserved for immigrants who left their natal groups at a young age, and the isotopic distinction between the sexes agrees with distances studies of population affinity at Harappa that suggests a genetic distance between males and females (Hemphill *et al.*, 1991; Kennedy, 2000).

V. Nutritional stress indicators

In previous analyses, sex based differences in nutritional stress indicators have not been investigated in Shahr-i Sokhta and the data we collected are still not enough for meaningful conclusions.

In Harappa lines of enamel hypoplasia are more frequent in women than in men (Hemphill *et al.*, 1991; Lukacs, 1992).

Hemphill *et al.* (1991) suppose that the higher dental enamel hypoplasia prevalence in women could result from generally lower parental investment in girls. In Gonur Depe, the frequency of enamel hypoplasia among adults shows no significant differences between the sexes (Babakov *et al.*, 2001).

VI. Dwelling

Collecting data on mean habitation floor area (MFA) in samples of matrilocal and patrilocal traditional societies, Ember (1973) was the first to note that the former have significantly higher MFA than the latter. Apart from the exceptionally high MFA observed in patrilocal Nootka (227.6 m²), in Table 3, patrilocal societies range between 2.8 and 45.1 m², while matrilineal ones range between 45.0 and 209.8 m².

Ember proposes that MFA could be a simple archaeological indicator of Matri- versus patrilocality. Subsequent papers confirmed Ember’s observation (Divale, 1977; Porcic, 2010; Hrcncir *et al.* 2020).

		n	mean	sd	min	max
Ember, 1973	Matrilocal sample 1	4	80.6	16.6	55.7	90.3
	Matrilocal sample 2	5	114.8	75.6	45.0	209.8
	Patrilocal sample 1	18	30.3	50.8	2.8	227.6
	Patrilocal sample 2	10	21.6	13.0	5.2	45.1
Biscione <i>et al.</i> , 1977	Shahr-i Sokhta				90	150

Table 3. Mean habitation floor area (MFA), m², in ethnographical samples from Ember (1973) compared to the MFA range in Shahr-i Sokhta’s Period 2 from Biscione *et al.* (1977).

MFA range in Shahr-i Sokhta's Period 2 was 90-150 m², Biscione *et al.* (1977), would place the site society between the matrilocal ones.

VII. The social role of women

Following Clark (2003), pag.318, "In any case, the figurines may lend support to Kenoyer's (1998: 133) suggestion that, "some women of the cities may have had important social and ritual positions," which may be corroborated by possible matrilocal burials in the Harappan period cemetery at Harappa. Regarding Shahr-i Sokhta, Ameri (2020) has shown the important role of women in administrative sealing. A strong social role and prestige for women in BMAC Bronze Age societies has been suggested by Luneau (2008).

VIII. Long-distance trade

Indications of intense trading activities connecting Shahr-i Sokhta and BMAC and IV Bronze Age sites as well as Mesopotamian ones come both from anthropological and archaeological studies (Piperno and Salvatori, 1982, 1983; Hemphill *et al.* 1995; Cortesi *et al.*, 2008). The burial of a monkey, *Macaca mulatta*, has been recently discovered in the necropolis of Shahr-i Sokhta (Minniti and Sajjadi, 2019), as no non-human primate species are native to Iran and *Macaca mulatta* inhabits South and South-East central Asia, this is further and indisputable proof of long-distance trade.

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IX. Conclusions and perspectives

The shortage of adult males in anthropological samples is a constant observation in Shahr-i Sokhta and Bronze Age sites from BMAC and IV sites. In all of these samples, we observe a male-to-female ratio ranging from 0.61 to 0.73, in a large reference sample dating from the Neolithic to the Middle Ages the male-to-female ratio range is 0.86 to 2.70. Genetic data point to the high frequency of outliers among Shahr-i Sokhta individuals. Several papers on Indus Valley sites suggest a closer genetic relationship among women than between women and men and a more frequent local origin for the former. Nutritional stress indicators do not show lower parental investment in boys as compared to girls. The mean habitation floor area in Shahr-i Sokhta, 90-150 m², would place the population of the site among matrilocal societies. A high social role and prestige for women has been observed in many of the sites under examination comprising Shahr-i Sokhta. These observations lead us to the hypothesis that the shortage of men in the necropolis of Shahr-i Sokhta could be the result of different factors affecting an exogamic, matrilocal, and possibly uxorilocal society where men, coming from abroad and married to local women, were involved in long-distance travel and a significant percentage of them died far from the site itself and hence were not buried in the necropolis. Archaeological and anthropological indicators seem to support our hypothesis which, we hope, we shall be able to test in the next years.

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Appendix
Necropolises. BA Bronze Age; I-H-PM Iron-Historical premedieval ; M Medieval; P-BA pre-Bronze Age

Site	m/f	Country	Ref.	Unsexed	m	f	tot	% m	% f	% unsexed	Period
Harappa,	0.61	Pakistan	Ghosh <i>et al.</i> , 1962	-	36	59	95	37.9%	62.1%	-	BA
Harappa, R37C	0.66	Pakistan	Hemphill <i>et al.</i> 1991	42	19	29	48	39.6%	60.4%	46.7%	BA
Shahr-i Sokhta	0.66	Iran	Ascalone and Fabbri, 2019	-	19	29	48	39.6%	60.4%	-	BA
Mohenjo Daro	0.68	Pakistan	Hemphill <i>et al.</i> , 1991	55	57	84	141	40.4%	59.6%	28.1%	BA
Djarkutan	0.69	Uzbekistan	Hemphill, 1998	-	46	67	113	40.7%	59.3%	-	BA
Rakhigarhi	0.70	India	Shinde <i>et al.</i> , 2018	16	7	10	17	41.2%	58.8%	48.5%	BA
Gonur Depe	0.72	Turkmenistan	Kufterin <i>et al.</i> , 2013	-	142	196	338	42.0%	58.0%	-	BA
Farmana	0.73	India	Mushrif-Tripathy <i>et al.</i> 2012	1	11	15	26	42.3%	57.7%	3.7%	BA
Shahr-i Sokhta	0.73	Iran	Ascalone and Fabbri, 2019; Macchiarelli and Passarello, 1988; Shadmehr <i>et al.</i> , 2017	409	191	263	454	42.1%	57.9%	47.4%	BA
Dzharkutan	0.73	Uzbekistan	Luneau 2008	-	117	161	278	42.1%	57.9%	-	BA
Mehrgarh	0.71	Pakistan	Sellier, 1989	25	20	28	48	41.7%	58.3%	34.2%	P-BA
VBQ	0.98	Italy	Bernabò Brea <i>et al.</i> , 2010	11	44	45	89	49.4%	50.6%	11.0%	P-BA
Early-Dynastic	2.58	Egypt	Castillos 1982	-	111	43	154	72.1%	27.9%	-	P-BA
Tepe Hissar I-III	1.02	Iran	Afshar, 2014	28	172	168	340	50.6%	49.4%	7.6%	P-BA
Naga ed-Der	0.86	Egypt	Podzorski 1990	146	55	64	119	46.2%	53.8%	55.1%	P-BA
Macedonia	0.80	Greece	Triantaphyllou 2000	52	61	76	137	44.5%	55.5%	27.5%	BA
Luristan	0.93	Iran	Riesle and Dastugue, 1983	14	13	14	27	48.1%	51.9%	34.1%	BA
Canaan LBA	0.94	Palestine	Kennedy, 2013	-	89	95	184	48.4%	51.6%	-	BA
Buston VI	0.97	Uzbekistan	Avanesova <i>et al.</i> , 2010	-	34	35	69	49.3%	50.7%	-	BA
Tell Tweini	1.00	Syria	Ricaut, 2008	34	6	6	12	50.0%	50.0%	73.9%	BA
Urkesh (Tell Mozan)	1.00	Syria	Kharobi, 2015	36	15	15	30	50.0%	50.0%	54.5%	BA
Demircihöyük-Sarket	1.21	Turkey	Massa, 2014	-	105	87	192	54.7%	45.3%	-	BA
Tell al-Judiadah, Anatolia	2.36	Turkey	Krogman, 1940	-	111	47	158	70.3%	29.7%	-	BA
San Nicolàs (Murcia)	0.95	Spain	Sánchez-Aparcero <i>et al.</i> 2020	60	206	216	422	48.8%	51.2%	12.4%	I-H-PM
Timmari Montescaglioso (MT)	1.09	Italy	Marchi and Borgognini Tarli, 2002	25	25	23	48	52.1%	47.9%	34.2%	I-H-PM

Timarghara	1.10	Pakistan	Bernhard, 1967	20	44	40	84	52.4%	47.6%	19.2%	I-H-PM
Rome (varia)	1.13	Italy	De Angelis <i>et al.</i> 2015	-	1236	1092	2328	53.1%	46.9%	-	I-H-PM
Apollonia Pontica	1.27	Bulgaria	Keenleyside <i>et al.</i> , 2011	-	33	26	59	55.9%	44.1%	-	I-H-PM
Himera	1.78	Italy	Lonocce <i>et al.</i> , 2018	-	57	32	89	64.0%	36.0%	-	I-H-PM
Mégara Hyblaea	2.00	Italy	Duday and Gras, 2018	-	36	18	54	66.7%	33.3%	-	I-H-PM
North-West (Estark, Liarsangbon, Shahne Poshte, Qareh Tepe, Mersin)	1.50	Iran	Soltysiak <i>et al.</i> 2016; 2017; 2019a, b, c, d	25	54	36	90	60.0%	40.0%	21.7%	I-H-PM
San Juan de Momoitio (Vizcaya)	1.00	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	14	24	24	48	50.0%	50.0%	22.6%	M
La Torrecilla (Granada)	1.04	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	50	50	48	98	51.0%	49.0%	33.8%	M
Xarea (Almería)	1.22	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	3	101	83	184	54.9%	45.1%	1.6%	M
San Peré (Barcelona)	1.24	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	4	62	50	112	55.4%	44.6%	3.4%	M
S. Pietro di Cavallermaggiore (CN)	1.35	Italy	Barbiera, 2008	6	81	60	141	57.4%	42.6%	4.1%	M
Santa Eulalia (Álava)	1.40	Spain	Sánchez-Aparcero, <i>et al.</i> 2020	0	28	20	48	58.3%	41.7%	0.0%	M
St John's Divinity School	1.48	UK	Inskip <i>et al.</i> , 2019	-	80	54	134	59.7%	40.3%	-	M
Roma, Palazzo della Cancelleria	1.54	Italy	Barbiera, 2008	2	97	63	160	60.6%	39.4%	1.2%	M
Dueville	1.60	Italy	Carrara, 2013	-	40	25	65	61.5%	38.5%	-	M
Monte d'Argento, Minturno (LT)	1.79	Italy	Barbiera, 2008	2	70	39	109	64.2%	35.8%	1.8%	M
Castro dei Volsci	1.80	Italy	Barbiera, 2008	0	101	56	157	64.3%	35.7%	-	M
Maro (Málaga)	2.21	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	8	188	85	273	68.9%	31.1%	2.8%	M
South Greece	2.55	Greece	Bourbou, 2003	117	84	33	117	71.8%	28.2%	50.0%	M
Fuerte de Santiago (Cádiz)	2.70	Spain	Sánchez-Aparcero <i>et al.</i> , 2020	28	27	10	37	73.0%	27.0%	43.1%	M

Table 1. Necropolises. BA Bronze Age; I-H-PM Iron-Historical premedieval ; M Medieval; P-BA pre-Bronze Age.

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