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Human osteological database at the Israel Antiquities Authority

Overview and some examples of use

Yossi Nagar
Department of Excavations and Surveys,
Israel Antiquities Authority,
P.O.B. 586, Jerusalem, 91004 Israel
email: yossi@israntique.org.il

Abstract: *The Israel Antiquities Authority (IAA) has a department of osteology that is based in Jerusalem and is in charge of the study of past human skeletal remains found in IAA excavations. The human osteological database was first created by the IAA in 1994 and includes basic demographic, metric, and descriptive data of the archaeological skeletons found in present-day Israel. Over the years, these data have been routinely collected using standardized criteria that are presented here in detail. This standardization allows reconstruction of a comprehensive anthropological profile of ancient local populations and comparison of bioarchaeological data from various periods and geographic regions. Examples of use are given along with selected data from various periods and populations.*

Key words: osteological database; metric measurements; non-metric traits; fractures; Israel

Introduction

With over 30,000 registered archaeological sites and 1.5 million years of human history, archaeology and anthropology in Israel attract great interest. The Israel Antiquities Authority (IAA) is responsible for the majority of the salvage excavations conducted in modern Israel, an average of 300 each year. In the past 20 years, the IAA anthropological laboratory, based in Jerusalem, was involved in all IAA excavations where human skeletal remains were found, from periods spanning the fifth millennium BCE to present times. The IAA anthropologists are responsible for publishing preliminary data reports of the human remains recovered in all the excavations, all of which are included in the IAA archives, while selected quantitative data are also stored in a computer database in the IAA anthropological laboratory.

Despite this IAA policy, many political restrictions hinder both the excavation of human remains and their study. Since July 1994, the Israeli Antiquities Law (first issued in 1978) stipulates immediate reburial of human bone found in archaeological excavations. Human skeletal remains cannot therefore be taken for further study in the laboratory. In addition, an extreme religious group Athra Kaddisha, which vehemently opposes the excavation of human bone, often attempts to terminate excavations before their conclusion. These restrictions further impede the ability to reconstruct fully anthropological parameters, forcing rapid fieldwork and systematic documentation of all available information (Nagar 2002a, 2011a).

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The majority of the human skeletal remains excavated each year are fragmentary, and the osteological data recovered are therefore limited. The systematic recording of the skeletal state of preservation between 1993 and 1999 revealed that the bones in a great majority of the sites were poorly preserved (**Table 1**). The same trend was noticed for human remains excavated more recently; however, this trend was not systematically surveyed. These relatively limited data are usually cited in archaeological reports in IAA related journals such as *Hadashot-Arkheologiot* (online since 2008 as *Excavations and Surveys in Israel*) and *'Atiqot* (e.g., Dahari & Ad 1998; Nudel 1999; Sonntag 1999; Stern 1995; Van Den Brink 2009). Better preserved or relatively large skeletal assemblages are published independently in *'Atiqot* or *IAA Reports* (e.g., Getzov & Nagar 2002; Nagar 1998, 2002b, 2006, 2010), whereas conclusive studies or special pathological case studies are published in the relevant international literature (e.g., Mitchell et al. 2006; Nagar & Arensburg 2000; Nagar & Eshed 2001; Nagar & Sonntag 2008; Nagar et al. 1999). Unpublished preliminary reports stored in the IAA are freely available to any reader, with the agreement of the excavator. Publications in *Hadashot-Arkheologiot* and *'Atiqot* are now available online (see www.antiquities.org.il for details).

Table 1. General state of preservation[1] of human skeletal remains excavated in Israel between 1993–1999, presented as the number of sites in each category.

	Number of sites / State of preservation			
Year	**Total**	**Poor**	**Average**	**Good**
1993	40	30	8	2
1994	28	23	3	2
1995	51	48	2	1
1996	48	46	2	0
1997	35	28	6	1
1998	34	30	3	1
1999	20	16	3	1
Total	256	221 (86%)	27 (11%)	8 (3%)

[1] Data based on visual examination by osteologists in the field.

The list of excavations, available on MS Excel file, holds approximately 450 items. It can be sorted by name, license number, name of excavator, and period. Data regarding craniofacial measurements and non-metric (epigenetic) traits are stored on a specific separate MS Excel file. This data is classified by period and ethnicity, when possible (see **Tables 2, 4, 6** for a selection of records). However, postcranial measurements (mostly femoral measurements), and selected pathological conditions of the skull (cribra orbitalia and porotic hyperostosis) and of the long bones (trauma and periostitis), although systematically recorded, are usually stored in the excavations' files. These data are combined and sorted by parameters such as geography or chronology according to the research demands, as is the example presented in **Table 5**.

The following is a detailed description of the methods used in the collection of skeletal data for the database (e.g., age estimation, sex determination, and metric and non-metric trait scoring).

Age and sex assessment

The reconstruction of age-at-death and sex determination of an individual is the basis of anthropological fieldwork. While numerous publications are known to have dealt with age and sex estimation methodologies, close reliance on the most common anthropological literature (e.g., Bass 1987; Buikstra & Ubelaker 1994) reduces the effect of inter-observer error, which is necessary when collecting data for the establishment of a database (for further details see Nagar 1999:13-14; Nagar & Hershkovitz 2004). The use of several methods renders it possible to estimate the age and determine the sex of most of the skeletal remains even in poorly preserved cases. When well-preserved anatomically articulated skeletons are considered, however, a multifactorial age determination is employed for each skeleton, with a calculation of 'summary age' and 'revised age' (Lovejoy et al. 1985).

Since adult age estimation is most often based upon tooth wear stages, age estimation tables were modified from Hillson (1993) and Lovejoy (1985) to create standardized criteria for local populations (Nagar & Winocur, forthcoming). Sex estimation is based upon skull and pelvic morphology (Bass 1987). Since these skeletal elements tend to be very fragmentary after long term interment, measurements of the vertical diameter of the femoral head and the distal humerus are more commonly used. Several other criteria (Bass 1987:151, 219) were found applicable to the study of local populations as well (Nagar, forthcoming a).

Skull measurements

Metric measurements of bones, especially of the skull, are a basic practice in characterizing skeletal populations. Although numerous skull measurement lists using various techniques and skeletal landmarks have been published, virtually all include the same division into chords, arcs, and angles (see discussion in Howells 1973; Hursh 1976).

Several scholars have discussed the importance of skull morphometry as a discriminative factor between populations (Hershkovitz et al. 1990; Rightmire 1976), and which measurements should be preferred (Buikstra & Ubelaker 1994; Gill et al. 1988; Hershkovitz et al. 1990; Howells 1969; Rightmire 1976; Paleopathology Association 1991). When working in the field under time constraints, it is necessary to construct a standardized list of measurements that is short but still informative. In constructing this list for the intensified fieldwork of the IAA, the following criteria were considered:

1. Independence and minimum correlation between the selected measurements.
2. The validity of various measurements for the purpose of comparison. For example, measurements of the face are better for this purpose than measurements of the vault (Krogman 1967; Kobyliansky et al. 1980; Sjøvold 1995). Therefore, it is accepted that face measurements are better indicators in characterizing populations than are vault measurements (Gill et al. 1988; St. Hoyme & Iscan 1989).
3. The desired index directed the choice of specific measurements.

The measurement form routinely used by the IAA anthropological laboratory is presented in the **Appendix**. Measurements were collected following Howells (1973). Also presented are the selected indices and angles and their method of computation. Indices were preferred by the IAA anthropologists since they are independent of size per se. However, while comparing between populations, basic linear measurements (maximum cranial length; maximum cranial breadth; upper facial height; biauricular breadth) and angles (frontal, parietal, occipital, zygomaxillary, and mandibular) are used, in addition to the indices.

Non-metric traits

Non-metric traits of the skull entered into the IAA database were divided into two categories i.e., continuous and discontinuous (following Anderson 1968). The following criteria were considered during the construction of the standardized list of discrete traits to record:

1. Traits with substantial genetic basis, and minimum environmental influence (Bergman 1993; Finnegan & Faust 1974; Hauser & De Stefano 1989).
2. Traits which are independent of each other (Hertzog 1968).
3. Traits free of age and sex influence (Perizonius 1979a).
4. Traits which are easy to identify visually, in order to eliminate inter-observer error.

The list of discrete traits that are routinely recorded is presented in the **Appendix**. Traits are recorded following Hauser and De Stefano (1989). The frequency of bilateral traits is counted as the number of sides exhibiting the trait, rather than the number of specimens (Perizonius 1979b). This technique also allows the recording of frequencies of discrete traits from very fragmentary skeletal material.

Examples of use

Since 1994, over 400 anthropological reports of various extents were composed by the IAA anthropological laboratory. Standardization of data collection, as detailed above, enabled comparisons between different periods and geographical areas. Because different pronunciation of site names might cause confusion, and because some sites are known by several names, excavation license numbers (in brackets) are also given. The location of Chalcolithic and Bronze Age sites mentioned in the text is presented in **Figure 1** whereas the locations of sites dating after the Bronze Age are shown in **Figure 3**. It is to be noted here that the author is aware of the disputes over the dating of early periods, therefore only general dates are provided (Bar Yosef & Garfinkel 2008).

The Chalcolithic period (5300–3700 BCE)

Spanning about 1500 years (not including the Wadi Rabah culture), about 30 burial sites from the Chalcolithic period have been found during the last 20 years, with skeletal remains in varying degrees of preservation. Key burial sites from this period (**Figure 1**) include Peqi'in (A-2297/95; Nagar, forthcoming a), Sha'ar Efrayim (A-3577/02; Nagar 2011b), Horvat Zur (A-4511/05), and Horvat Karkar (A-4635/05).

Paleodemographic study of these populations revealed a phenomenon of age-dependent burial practice: infants and children under three years old were absent from Chalcolithic cemeteries or burial caves. Instead, they were permanently interred in the dwelling areas (Nagar & Eshed 2001; Nagar 2011b). Morphometric study (craniofacial measurements) of well-preserved adult skulls from the Chalcolithic period sites of Peqi'in (northern Galilee;

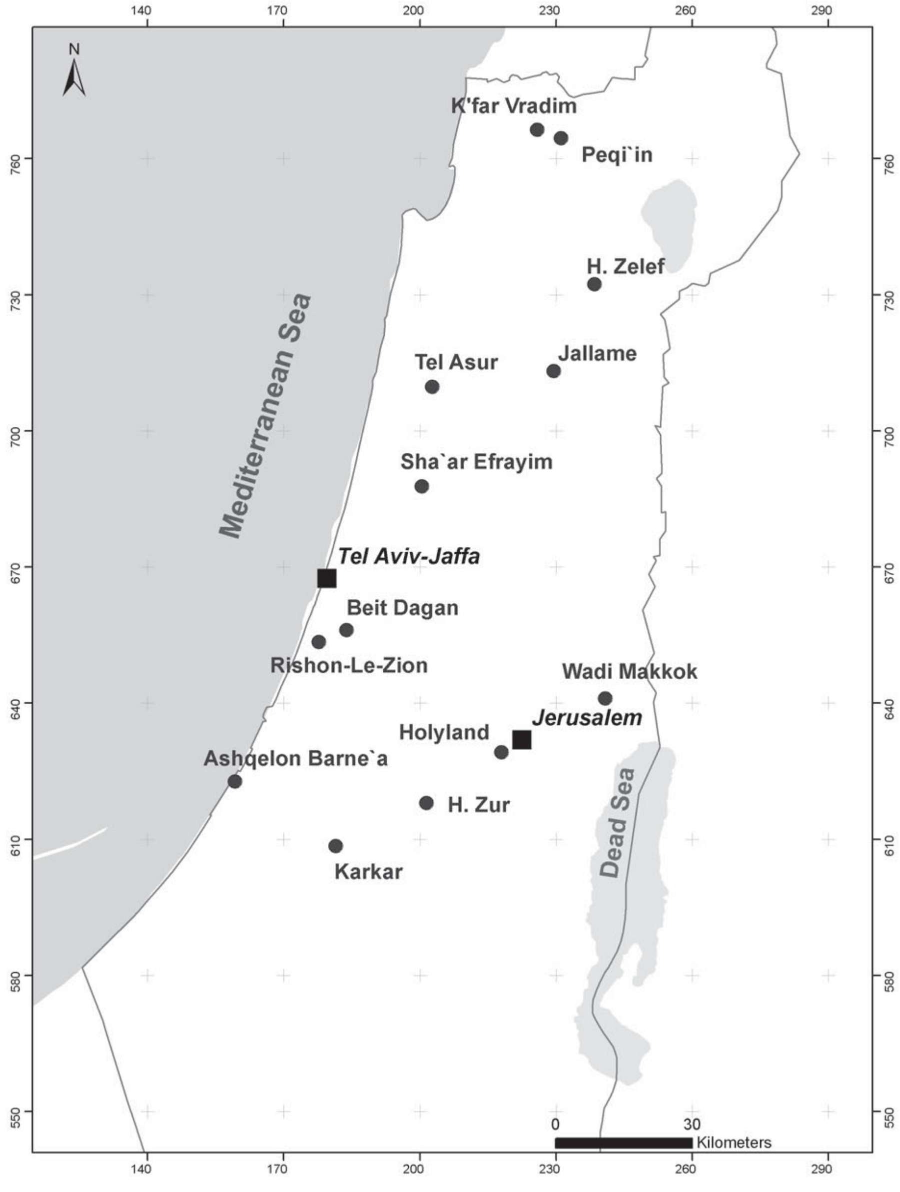

Figure 1. The location of key sites from the Chalcolithic period and the Bronze Age.

Table 2) and Wadi Makkokh (northern Judah desert) manifested their resemblance to present day Bedouins (Nagar, forthcoming a). The comparison was made by means of a cluster analysis, using SPSS statistical application, and presented as a dendrogram (**Figure 2**). These results, obtained through the use of the IAA database, were crucial in the reconstruction of local population history (see Nagar 2003). They highlight the morphological resemblance between the Chalcolithic period populations and the Bedouins, attesting for the ancient local roots of the latter ones, as was postulated by earlier scholars (Arensburg 1973).

Table 2. Selected skull measurements and indices of the Chalcolithic skeletal population in Peqi'in cave (Northern Galilee).

Measurement	Males			Females		
	n	mean	SD	n	mean	SD
cranial index	19	75.7	2.8	15	74.8	2.5
cranial module index	8	154.4	3.8	10	149.7	4.2
mean height index	8	82.8	5.1	11	88.5	17.2
vault height index	5	85.0	3.0	8	87.0	3.0
frontoparietal index	17	67.5	3.3	13	69.2	3.7
bregma angle (na-ba)	7	47.5	3.2	9	47.2	1.6
frontal angle	18	130.0	3.0	17	126.9	4.0
parietal angle	19	132.5	5.1	16	133.4	3.4
occipital angle	11	120.0	5.1	16	122.3	6.1
glabella projection	19	2.1	0.9	31	0.3	0.5
orbital index	17	78.6	5.3	23	83.5	5.8
interorbital breadth index	14	22.3	2.6	17	24.1	2.0
eye size index	12	53.9	2.8	20	57.2	2.9
maxillofrontal index	12	35.5	5.0	16	35.4	5.8
palatine index	14	81.4	10.3	15	80.3	6.7
nasal index	15	49.1	5.7	22	50.5	5.8
cheek height index	12	33.6	3.4	16	34.1	3.4
upper facial index	5	53.4	2.3	7	49.7	2.7
zygomaxillary angle	10	126.2	4.7	13	126.1	5.7
foramen magnum index	8	89.3	7.1	14	87.1	10.6
basion angle (na-pr)	6	40.8	1.2	10	37.7	2.3
maximum length	21	186.2	5.1	19	179.8	5.4
maximum breadth	20	141.5	4.6	15	134.5	6.5
biauricular breadth	11	118.5	5.4	14	114.8	4.2
upper facial height	13	68.8	4.0	23	57.8	18.5

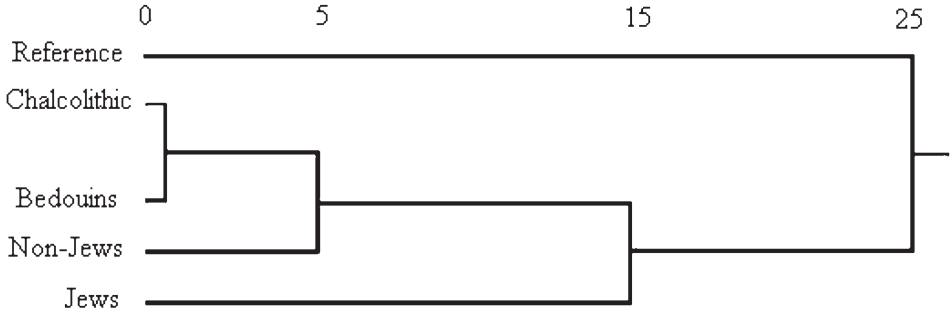

Figure 2. The relative Euclidean distance between the Chalcolithic period population and later local populations (after Nagar, forthcoming a). Reference sample: skulls from India stored in the Tell Aviv University anthropological laboratory.

The Bronze Age (3700–1200 BCE)

Several burial sites of the Bronze Age are found and excavated each year, of populations that are generally termed Cana'anites. However, the skeletal remains from this period are usually very fragmentary. Relatively large and important sites (**Figure 1**) include Tel Asur (A-2235/93, A-4005/03; Nagar 2010; Nagar & Winocur, forthcoming), Ashqelon Barne'a (A-4177/04; Golani & Nagar 2011), Beit Dagan (A-4243/04; Yannai & Nagar, forthcoming), Holyland (A-5385/08), K'far Vradim (A-2160/94; Getzov & Nagar 2002), Horvat Zelef (A-2555/96; Nagar 2011c), and Jallame (A-4124/04). Using paleodemographic data accumulated from various sites and stored in the IAA database, it was possible to plot a mortality graph typical of the Early and Middle Bronze Ages (3700–2200, 2000–1550 BCE respectively), and to calculate the life expectancy of several populations during these periods (**Table 3**). Craniofacial measurements of a small sample available from the Intermediate Bronze period (2200–2000 BCE) revealed that the population inhabiting the southern Levant during this short period was much different from the local populations of this area in previous and subsequent periods (Yannai & Nagar, forthcoming). Through using information stored in the IAA database it was possible to prove the foreign identity of the Intermediate Bronze population in Israel/Cana'an, as had been postulated by several archaeologists (e.g., Kenyon 1966).

Table 3. Life expectancy in selected Bronze Age sites.

Period	Site	Sample Size	Life Expectancy at Birth (e^0_x)	Life Expectancy at the Age of 10 (e^{10}_x)
Early Bronze	Tel Asur Barkai	142 93	25 24	28 22
Middle Bronze	Rishon-Le-Zion	213	24	26
Late Bronze	Horvat Zelef	100	24	27

Iron Age and Persian periods (1200–332 BCE)

In both the Iron Age and Persian periods, the geographical area is grossly divided between the populations of the hilly regions, and those along the Mediterranean coast. Excavating graves dating to the Iron Age is problematic, due to strong objection by various religious groups. Being the capital of the Israelite/Judahite kingdom, many burial caves are located in Jerusalem (e.g., Kloner & Davis 1994). However, these were either empty due to later re-use, or excavated in the past without satisfactory anthropological examination. In contrast, in the rest of the hilly regions of the country, the paucity of graves may be related to the religious beliefs in that period (Kletter 2003). This leaves us with skeletal samples mainly from the coastal regions, related to non-Israelite populations (Phoenicians, 'Sea Peoples', Cana'anites). The most prominent cemeteries (**Figure 3**) were excavated at Yavne (A-3286/00) and Azor (A-3422/01, 3660/02; Buchennino & Yannai 2010).

Shortly after the destruction of the Israelite/Judahite kingdoms at the end of the Iron Age II, the region was conquered by the Persian Empire. Yet, the situation concerning the Persian period is even worse than during the Iron Age. As the region appears to have suffered demographic decline, limited skeletal remains have been found in the hilly regions and most have not yet been published. In recent years, however, excavations along the coast have yielded samples large enough to characterize the burial practices of the local population (Nagar, forthcoming b). Still, anthropological parameters such as morphology, pathology, and demography, are scant.

A map showing the location of key sites dating from the Iron and Persian periods to the Modern Age is presented in **Figure 3**.

The Classical Antiquity

During the Hellenistic (332–63 BCE), Roman (63 BCE – 324 CE), and Byzantine (324–638 CE) periods, the land of Israel was initially divided between Jews and Pagans, and later between Jews and Christians. Differentiating between these populations is relatively easy based upon their burial practices (e.g., Stern & Getzov 2006).

Excavation at Jewish burial sites usually provokes demonstrations by extremist religious groups which often cause premature closure of the excavation. Nevertheless, the few sites that were excavated and studied yielded enough information to characterize demographic and pathological aspects of the Jewish population. As reported by Nagar and Torgeë (2003), life expectancy of Jews during the Hellenistic and Roman periods was estimated as 24 years at birth, 26 years by the age of 10. The average stature, based upon this part of the database, was 166cm for males, 147cm for females. These data are in accordance with earlier studies conducted by Tel Aviv University and the Hebrew University (Arensburg et al. 1980; Arensburg & Smith 1983; Goldstein et al. 1980; Smith et al. 1980), which refer to most of the skeletal remains of Jews excavated in Israel.

Unlike Jews, numerous burial sites associated with the desert dwellers known as Nabateans have been excavated and the skeletal remains have been extensively studied. The largest site was Horvat Ma'aravim (A-2541/96; Nagar 2006). However, data from the large Roman-Byzantine cemetery of Rehovot-in-the-Negev, although excavated by the Hebrew University (Tsafrir & Holum 1988), are also incorporated into the IAA database. Combining these and

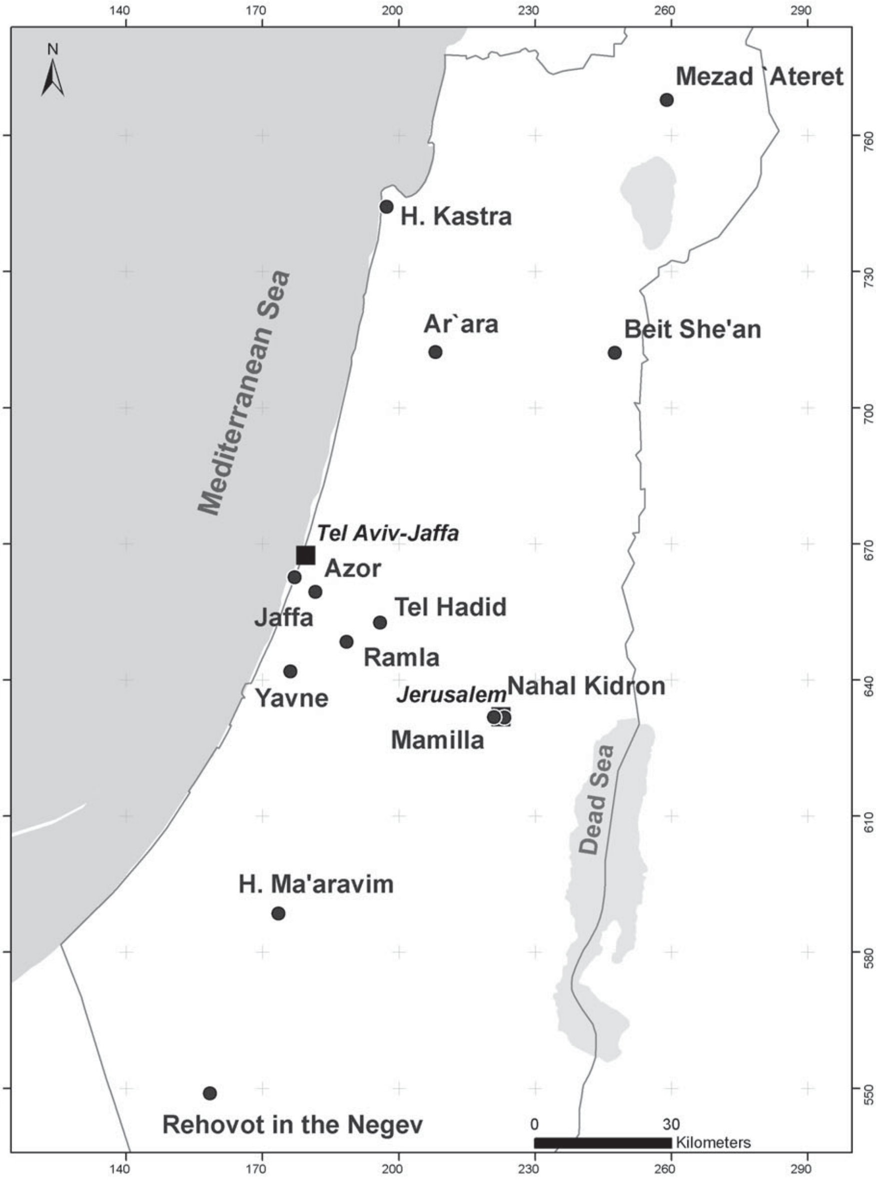

Figure 3. The location of key sites from the Iron Age and later.

other, smaller sites around the Be'er Sheva region, conclusions were drawn as to the demography, morphology, and pathology characteristic of the Nabateans (Nagar & Sonntag 2008). As was shown by Nagar (1999), this population manifested a close resemblance with the recent Bedouin population that today inhabits the same geographic areas.

North of the desert regions, small samples of pagan populations dating from the Roman period were also studied (e.g. Nahal Kidron A-2240/00; Horvat Kastra A-2207/95). As an application of data in a database, these samples were compared with larger skeletal assemblages of Christians from the Byzantine period in the same areas, such as Mamilla in Jerusalem (G-1/92; Nagar 2002b) or from Horvat Kastra near modern Haifa (A-2207/95). The difference in sample sizes (minimum number of individuals) is by itself a confirmation for the demographic bloom recognized by some archaeologists has having occurred in Israel during the Byzantine period (see Shereshevski 1991). A summary of non-metric traits of Jews, Nabateans, and other local populations (Pagan or Christian) during the classical periods is presented in **Table 4**. A matrix of relative distances, published and discussed by Nagar (1999:79-85), did not show significant differences between these three population groups. However, the raw data presented in **Table 4**, though not statistically processed yet, is wider and includes newly retrieved information. Detailed morphometric data (craniofacial measurements) of these populations, based upon the lists in the **Appendix**, can be found in Nagar (1999:48-71), while the incidence of common pathological conditions such as trauma and periostitis in adult long bones is provided in **Table 5**.

Muslims and Crusaders

Muslim and other skeletal remains from the Early Islamic period are numerous, especially those dating from the Arab conquest in 638 CE to the arrival of the Crusaders by the end of the 11th century. The majority of the skeletal remains derive from excavations associated with large urban centers of this period such as Ramla (A-4503/05), or Beit She'an (G-42/98). Most of the data are presented in preliminary reports in the IAA anthropological laboratory, but a comprehensive study of the large skeletal sample from Beit She'an, focusing on demography and pathology is underway (Nagar & Hershkovitz, forthcoming).

During the 12th century CE and the first half of the 13th century, the southern Levant was under Crusader rule. Unfortunately, a few skeletal remains from this period have been recovered. Several skeletons from the Crusader fort of Vadum Iacob in the eastern Galilee (A-2334/01), excavated by the Hebrew University, were studied by the IAA anthropological laboratory and entered into the database. This sample represents a foreign military population of European origin (Mitchell et al. 2006). Skeletal remains of local populations from this period are sporadically found within large later cemeteries (e.g., in the lower levels of the Mamilla site, Jerusalem). A unique case was the excavation of a burial cave at Ar'ara (Nagar & Eshed 2009), where the remains of at least 40 skeletons were found. Some of the skeletons exhibited pathological conditions such as periostitis in the tibiae and caries sicca in the skull vaults, conditions that are characteristic of treponematosis. Dated to the 12th century CE (despite the mistaken title of the publication which reads "Mamluk-period", Nagar & Eshed 2009), these finds shed new light on the origin of the 16th century epidemic of syphilis in Europe.

In recent years, large assemblages of Muslim skeletal remains postdating the Crusaders (Mameluk and Ottoman periods) have also been studied. The largest collections originate

Table 4. Frequency of non-metric traits in selected local populations from the classical (Hellenistic-Roman-Byzantine) periods.

Population / Trait	Jews		Nabateans		Other local populations[1]	
	n	%	n	%	n	%
Metopic suture	163	8.6%	90	5.6%	74	4.0%
Supraorbital foramen	246	30.5%	143	30.8%	101	27.8%
Accessory infraorbital foramen	108	3.7%	114	5.3%	41	4.9%
Supratrochlear notch	189	21.2%	131	18.3%	83	10.8%
Parietal foramen	108	75.9%	65	78.5%	30	86.7%
Frontotemporal articulation	165	0.0%	104	4.8%	53	0.0%
Ossicle at lambda	115	10.4%	63	9.5%	35	14.3%
Inca bone	127	7.9%	86	3.5%	53	3.8%
Condylar canal	136	55.1%	97	58.8%	33	57.6%
Foramen of Huschke	223	11.7%	140	10.7%	120	4.2%
Mandibular torus	62	11.3%	98	8.2%	52	0.0%
Mylohyoid bridge	85	5.9%	130	9.2%	91	12.1%
Mandible, M3 agenesis	51	11.8%	63	9.5%	22	22.7%
Maxilla, M3 agenesis	44	4.5%	61	6.6%	19	5.3%
Humerus, septal apperture	215	26.0%	138	20.3%	142	19.0%
Suprascapular foramen	18	0.0%	58	0.0%	14	7.1%
Tibia, squatting facet[2]	11	72.7%	73	69.9%		
Atlas, posterior bridge	106	11.3%	133	8.8%	65	6.2%
Atlas, lateral bridge	100	0.0%	131	0.0%	66	0.0%
Atlas, spina bifida occulta	48	6.3%	59	0.0%	31	0.0%
Atlas, incomplete fusion of the transverse process	76	6.6%	107	11.2%	42	11.9%
Axis, incomplete fusion of the transverse process	57	7.0%	105	1%	61	5.0%
Sacrum, spina bifida	64	6.3%	50	4%	29	6.7%

[1] During the Byzantine period these were mostly Christians.

[2] See comment in the appendix, Table 3.

from the urban centers of Jerusalem (Mamilla site, A-4658/05, B-332/09) and Jaffa (Beit Eshel St., A-4034/04; Kishle, A-5037/07). Since most of the skeletal remains were only recently excavated, published data so far includes only one sample of skeletal remains from Jaffa (Nagar 2011d), and a sample from the cemetery of the Ottoman period village at K'far Sava (A-4123/04; Gorzalczani 2007). However, these data suggest a relatively low life expectancy and low resilience to pathological conditions, as was shown by other investigators analysing smaller samples from the past 500 years (Smith & Horwitz 2009). The incidence of common pathological conditions such as trauma and periostitis in adult long bones is given in **Table 5**, while a summary of non-metric traits is presented in **Table 6**. Both were recorded from the central cemeteries of Jerusalem and Jaffa that are attributed to a Muslim (Palestinian) popula-

Table 5. Frequency of fractures and periostitis in adult long bones in two local populations differing by chronology and geography: Nabatean (Roman-Byzantine town in the Negev desert) and Palestinian (Ottoman period Muslims in Jaffa and Jerusalem).

Population / Bone	Nabatean				Palestinian			
	Fractures		Periostitis		Fractures		Periostitis	
	n	incidents	n	incidents	n	incidents	n	incidents
Humerus	59	1	59	0	130	2	130	0
Ulna	55	0	55	0	90	3	90	0
Radius	53	0	53	0	94	2	94	1
Femur	58	1	58	0	205	3	204	3
Tibia	60	1	60	2	179	2	179	5
Fibula	43	0	43	1	58	3	58	0

Table 6. Frequency of non-metric traits in two large Muslim skeletal populations: Mamilla cemetery (Jerusalem) and the Kishle compound (Jaffa).

	Trait	Jerusalem – Mamilla		Jaffa – Kishle	
		n	%	n	%
Skull	Metopic suture	130	4.6%	31	6.5%
	Supraorbital foramen	91	18.7%	28	28.6%
	Supratrochlear notch	56	23.2%	16	12.5%
	Accessory infraorbital foramen	20	0.0%	15	6.7%
	Parietal foramen	10	90.0%	5	100.0%
	Frontotemporal articulation	7	14.3%	4	0.0%
	Foramen of Huschke	135	10.4%	24	4.2%
	Condylar canal	14	21.4%	5	60.0%
	Ossicle at lambda	29	0.0%	8	0.0%
	Inca bone	51	0.0%	7	0.0%
Mandible and maxilla	Mylohyoid bridge	180	8.9%	39	10.3%
	Mandibular torus	107	3.7%	11	0.0%
	Mandible, M3 agenesis	228	15.4%	20	10.0%
	Maxilla, M3 agenesis	62	11.3%	11	18.2%
Postcranium	Humerus, septal apperture	309	23.9%	62	16.1%
	Suprascapular foramen	2	0.0%	9	11.1%
	Tibia, squatting facet	65	43.1%	10	30.0%
	Atlas, posterior bridge	29	6.9%	39	15.4%
	Atlas, lateral bridge	34	2.9%	40	0.0%
	Atlas, spina bifida	14	7.1%	22	0.0%
	Atlas, incomplete fusion of the transverse process	16	0.0%	35	5.7%
	Axis, incomplete fusion of the transverse process	45	0.0%	35	0.0%
	Sacrum, spina bifida	14	0.0%	15	0.0%

tion. Excavations in these sites continue in the present, and new data accumulate each year and would be added to the database.

Conclusion

Since human skeletal remains are reburied shortly (and sometimes immediately) following excavation, it is necessary to systematically use the same methods and to collect the same sort of data in all excavations. Repeated use of the above-mentioned methods enables an efficient, relevant and useful data collection (Nagar 2002a), thus partially overcoming the many obstacles hindering anthropological study in Israel. As a result, over 400 reports of various extents have been published by the IAA anthropological laboratory in the past 20 years, accumulating a tremendous amount of valuable information.

Quantitative data from various geographical areas and different periods were digitally stored in the anthropological laboratory, some were presented in **Tables 2-6**, and relevant references to some others were provided. Much of these data were used for comparative purposes in the research of the ancient local populations and conclusions were drawn as to their life quality and their affinity to each other (for a conclusive summary see Nagar 2003). The readily available demographic and morphological data, as well as reported pathological conditions, burial practices, and other general information published by the IAA, provides scholars interested in the bioarchaeology of ancient Near Eastern populations with a valuable source of information, and with a large and reliable amount of data for comparison.

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Appendix

1. List of measurements routinely recorded by the IAA anthropological department. In brackets are Howells' acronyms (1973).

Vault measurements: maximum cranial length (GOL); maximum cranial breadth (XCB); biauricular breadth (AUB); porion – bregma height[1]; minimum frontal[2]; frontal chord (FRC); frontal angle (FRA); parietal chord (PAC); parietal angle (PAA); occipital chord (OCC); occipital angle (OCS); basion – bregma height (BBH); glabella projection (GLS)[3].

Face and skull base: orbital breadth (OBB; right); orbital height (OBH; right); interorbital breadth (measured to maxillofrontale)[4]; biorbital breadth (EKB); nasal height (NLH); nasal breadth (NLB); naso-maxillofrontal subtense[4]; upper facial height (NPH); bizygomatic breadth (ZYB); zygomaxillary angle (SSA); basion – prosthion (BPL); basion – nasion (BNL); cheek height (WMH); foramen magnum, length (FOL); foramen magnum, breadth[5]; palate breadth; palate length; palate depth at M1 – M2.

Mandible: maximum length; body length; ramus height (vertical)[3]; ramus length (diagonal)[3]; ramus, minimum width[3] ; mandibular angle; bicondylar breadth.

[1] po-br; Bass 1987:72.
[2] Between frontotemporal points; Bass 1987:74.
[3] Not used in the comparative analyses.
[4] After Gill et al. 1988.
[5] ba-o; Bass 1987:65.

2. Formulae for selected indices and angles.

Index	Formula
cranial index	(max. breadth x 100) / max. length
cranial module index	[length+breadth+height(ba-br)] / 3
mean height index	[height(ba-br) x 100] / [0.5(lengtn+breadth)]
vault height index	porion-bregma height x 100 / basion - bregma height
frontoparietal index	min. frontal x 100 / max. breadth
bregma angle (Na-Ba)	inverse cosinus [(br-na) vs. (br-ba)]
upper facial index (1)	height nasion-prosthion x 100 / bizygomatic breadth
upper facial index (2)[1]	height nasion-prosthion x 100 / height basion-bregma
cheek height index	cheek height x 100 / upper facial height (na-prost.)
nasal index	nasal breadth x 100 / nasal length
orbital index	orbital height x 100 / orbital length
interorbital breadth index	interorbital breadth x 100 / biorbital breadth
eye size index[2]	1/2(eye height+breadth) x 100 / upper facial height
maxillofrontal index[c]	nasomaxillofrontal subtense[3] x 100 / maxillofrontal breadth
palatine index	palate breadth x 100 / palate length
basion angle (nasion-prosthion)	inverse cosinus [(ba-na) vs. (ba-prost)]
foramen magnum index	foramen magnum breadth x 100 / foramen magnum length
mandibular index	bicondylar breadth x 100 / maximu mandibular length

[1] The zygomatic bone is usually found broken in the archaeological record; therefore 'basion-bregma' height is also used, to check for the upper facial index.
[2] Devised to check the eye size for differences in the size of the skull.
[3] After Gill et al. 1988.

3. List of non-metric traits routinely recorded by the IAA anthropological laboratory.

Cranium: metopic suture; supraorbital foramen; accessory infraorbital foramen; supratrochlear notch; parietal foramen; frontotemporal articulation; ossicle at lambda; Inca bone; condylar canal; foramen of Huschke;

Mandible and postcranial skeleton: mandibular torus; mylohyoid bridge; mandible, M3 agenesis; maxilla, M3 agenesis; humerus, septal aperture; suprascapular foramen; tibia, squatting facet[1;]

Vertebrae: atlas, posterior bridge; atlas, lateral bridge; atlas, spina bifida occulta; atlas, incomplete fusion of the costal element of the transverse process; axis, incomplete fusion of the costal element of the transverse process; sacrum, spina bifida.

[1] This trait is exceptional, since it probably does not have a genetic basis but its frequency deviates between populations.

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