Am J Hum Genet 31:324–340, 1979

Analysis of Genetic Data on Jewish Populations I. Historical Background, Demographic Features, and Genetic Markers

BATSHEVA BONNÉ-TAMIR,[1] SAMUEL KARLIN,[2] AND RON KENETT[3]

SUMMARY

Part I describes the data sets on which the analysis of Part II is based. This covers the nature of the populations sampled, the extent to which the samples are representative, and a brief review of historical and demographic facts on the populations involved.

INTRODUCTION

The subject of the "origin of the Jews," or the existence of a Jewish race, has been prominent in the recent anthropological-genetic literature [1–3]. A tendency to seek differences between Jewish communities was given impetus when differences in the incidence of various diseases were found among the various immigrant communities in Israel in the 1950s [4, 5]; survey results of that time highlighted the differences rather than the similarities between the communities. Our studies differ from earlier ones on the subject [6–8] in emphasis as well as in methodology; they are based not on phenotypic variables and morphological observations such as height, facial features, and hair or eye color, but on simple genetic traits such as blood groups [9–11]. Better genetic data were available by 1973, when an international conference was held in Israel to discuss theoretical population genetic issues regarding these migrant and isolate populations [12]; and today we have still better data.

Moreover, advances in technology, notably in serological and electrophoretic procedures, have made it possible to determine variation on many new genetic markers

Received July 24, 1978; revised November 28, 1978.

This study was supported in part by grant 219 from the Chief Scientist's Office, Ministry of Health, The American Joint Distribution Committee, a joint U.K.—Israel collaborative project, grant GM 10452-15 from the National Institutes of Health, Volkswagen Foundation grant AZ:1122274, National Science Foundation grant MCS76-80624-A01, and Israel Benational Science grant 573175.

[1] Department of Human Genetics, Sackler School of Medicine, Tel-Aviv University, Ramat-Aviv, Israel.

[2] Department of Mathematics, Stanford University, Stanford, California 94305.

[3] Department of Mathematics, Weizmann Institute of Science, Rehovot, Israel.

[13]; and various new descriptive and multivariate statistical concepts have made it possible to assess the variability of polymorphic markers *within* populations rather than *between* populations [14, 15]. Through large-scale screening programs investigating Tay-Sachs, phenylketonuria, and other genetic defects, information has been collected on the distribution and frequency of monogenic diseases among various Jewish groups [16–18].

With the benefit of these advances, and with a critical eye toward some earlier data that served as working material for both "old" and "new" hypotheses, data on a whole range of polymorphic characteristics—including blood groups, allozymes serum groups, and histocompatibility antigens (HLA)—were obtained on the major Israeli ethnic groups between 1971 and 1976. The primary objective of this undertaking was a comprehensive and systematic study of genetic polymorphic systems. Among the questions addressed are the following: How different or similar are the various Jewish historical-geographical groups? How do Jewish populations compare to non-Jewish populations with respect to genetic composition? Which loci best discriminate inter- and intra-Jewish groupings? Some HLA frequency and blood group data on individual populations have been published [19–23], their emphasis being on unusual variants and comparisons with other samples from the same populations.

Our purpose in studying the differences and similarities between various Jewish populations was not to determine whether a Jewish race exists, nor was it to discover the original genes of "ancient Hebrews," or to retrieve genetic characteristics in the historical development of the Jews. Rather, it was to evaluate the extent of "heterogeneity" in the separate populations, to construct a profile of each population as shaped by the genetic data, and to draw inferences about the possible influences of dispersion, migration, and admixture processes on the genetic composition of these populations. A new methodology has been introduced and applied to the data; it is described and elaborated in the accompanying paper by Karlin, Kenett, and Bonné-Tamir [24].

The present article reviews some pertinent historical facts about the Jewish people, describes relevant demographic parameters, and discusses the nature of the data on which the subsequent statistical analysis is based.

HISTORICAL BACKGROUND

The populations in this study are grouped into four major divisions. Three of them are the standard categories: the Ashkenazi, Sephardi, and Oriental Jewish communities [25, 26]. The fourth group is composed of three Middle Eastern and non-Jewish populations that have resided in Palestine for several hundred generations. These four major groups are subdivided as follows: Ashkenazi Jews—Polish, Russian, German, and Rumanian; North African (Sephardi) Jews—Moroccan and Libyan; Oriental Jews—Iraqi, Yemenite, and Cochin; and Middle Eastern Populations—Arabs, Armenians, and Samaritans.

The histories of these communities have been detailed in other publications [27–29]. An abbreviated historical account of the major Jewish populations is presented in table 1 [30–35]. Only events which may be relevant to the genetic context are discussed, including origin of community, length of existence, temporal variation in size,

TABLE 1

HISTORICAL SKETCH OF JEWISH POPULATIONS

Time	Ashkenazi	North-African	Babylonian	Yemenite	Cochin
721 BC			*721* BC Arrival of first deportees.		
586 BC			*586* BC Destruction of Jerusalem. Exile of Judeans to Babylon.		
300 BC		*300* BC Egyptian king Talmai transferred 100,000 J. from Palestine to Egypt, Cyrenaica & Libya.			Jews probably reached India in about 175 BC. They travelled across Persia or Persian Gulf, both as traders & refugees. Their earliest large settlement was in Bombay.
70 AD			*70* AD Destruction of 2nd Temple. More J. joined community in Mesopotamia.		
87 AD		*87* AD J. revolt against Romans.			
		2nd cen. Epigraphic evidence of presence of J. in Morocco in towns along coast.			
			300 A small J. community in Baghdad.	*300* Archeological findings confirm existence of J. communities in Himyar (Yemen).	
321 AD	*321* AD J. in Cologne (Germany).				
	First J. in Germany, tradesmen who followed Roman legions & settled in towns along Rhine Valley.				
				*4*th cen. J. tribes jointly with non-J. residents fought invading Ethiopians. Judaization of royal house.	
			500 Scholars of Sura & Pumbeditha Academies compiled Babylonian Talmud.	*526* Fall of Jewish Kingdom & death of its king, Joseph Dhu Nuwas.	Origin of J. association with Cochin and Malabar coast obscure.
533 AD		*533* Byzantines conquered N.A. J. forced to settle among Berbers in mountains & desert regions.			
			J. settled in hundreds of towns and villages all over Mesopotamia.		

TABLE 1 (*continued*)

		7th cen. Moslem conquest of N.A. resulted in additional waves of J. into Libya from Syria and Arabia; brought with them Arabic language.	*634* Moslem conquest.	*7th* cen. Islam obstructed process of Judaization; forbade further J. migration to Yemen.	
800 AD	*800* Total Ashkenazi population estimated about 1000 families.		*800* Heavy taxation, restrictions of residence. *850*		
		Under Islamic rule, J. became subordinated; oppressive and discriminatory decrees. In most towns J. had to live in separate quarters.		Period of subjugation & persecution. Yemenite J. lived in isolation, but maintained contacts with J. communities in Palestine, Babylonia, and Egypt.	*974–1020* Earliest historical document on settlement of J. in Malabar coast.
1096 AD	*1096* Crusaders exterminate entire communities; migration of J. to Austria.	*11th* cen. Large J. community flourished in the town of Tripoli. Important centers of J. learning in Fez, Meknes and Aghmat (in Atlas mountains).			
				12th cent.	
			1170 Benjamin of Tudela reports on large flourishing communities numbering thousands of J.	*1172* Maimonides epistle to Yemenite J.—source of comfort and support.	*1170* Benjamin of Tudela reported about 1,000 J. in Quilton.
1298 AD	*1298* 140 communities in S. Germany completely destroyed.		*1258* Mongol conquest of Iraq.		
			1333 Synagogues of Baghdad destroyed.		
1350 AD	*1350* Migration to Eastern Europe began.			*1366* J. moved from Egypt to Sana.	
1400 AD	*1400* First 5 established communities in Lithuania.				

TABLE 1 (*continued*)

Time	Ashkenazi	North-African	Babylonian	Yemenite	Cochin
		1492–1497 During expulsion from Spain, J. left for African coast & settled in Morocco & Libya.		*1489* Ovadiah Bartenura reports: "many large J. communities in Aden & Yemen."	
1500 AD	*1500* J. expelled from Lithuania; fled to Poland.		*1508* Alternate Persian & Ottoman rule.		*1506* German traveller referred to Cochin J. as a foreign element among pagan population.
1580 AD	*1580* Scatter of J. communities; largest three: Cracow, Lublin, Poznan.	*16th* cen. Ottoman Empire.	J. maintained relations with Palestine, Syria & other neighboring countries. Commercial relations with Turkey, Persia, Syria, and India.	*1546* Turkish regime brought further suffering and degradation.	*16th* cen. Two waves of J. immigration into Cochin: 1. from original settlement on Malabar coast, and 2. from Spain & Portugal.
1648 AD	*1648* Cossack massacres, mass slaughter, many communities completely destroyed.	*17th* cen. Jews from Italy (Livorno) joined Libyan communities.			*1502–1663* Portuguese rule 900 Jewish households.
				1678 Expulsion of Turks by local rulers. Deportation of all J. from capital, Sana, to coastal regions.	*1663–1795* Dutch Period. Complete cultural autonomy and religious freedom. Break of isolation from rest of J. world. Contacts with Amsterdam Jews.
		1727 Beginning of European intervention in North Africa, resulting in departure of village J. toward urban centers.			
1769 AD	*1769* Cossack massacres in Ukraine.			*1781* J. allowed to return to city, but compelled to build special quarters outside city boundaries. A few rare and brief interludes of peace and respite from threats and persecution by ruling emirs. Period of intensive physical suffering.	*1781* 422 families.
1793 AD	*1793* Partitioning of Poland between Russia & Prussia.				
1815 AD	*1815* Autonomous kingdom of Poland. Large J. population in Warsaw.	Rabat, Safi, and Marrakesh replaced Fez & Meknes as rabbinical centers.	*1824* 1500 families in Baghdad.		
1835 AD	*1835* Boundaries of "Pale" established.	*1858* Some wealthy families from Morocco established themselves in Palestine.	*19th* cen. "Golden Age" of J. Controlled country's commerce, exerted considerable influence in governmental circles.		

TABLE 1 (*continued*)

1871 AD	*1871–1881* Pogroms & mass exodus from Russia to US began.	*1900* Epidemic of plague in Morocco.		*1880* First J. from Yemen settled in Palestine. First diaspora to leave land of their dispersion.	Leaders of Cochin community maintained close contacts with J. communities outside India (Yemen, Babylonia) as well as with J. settlement within India.
		1911 Libya conquered by Italians.		*1907–1915* Second major wave of migrants.	
1925 AD	*1925* No. of German J. estimated: 564,000.		*1917–1932* Further improvement of J. conditions under British Mandate.	*1918–1948* 15,838 came to Israel.	
1925 AD	*1925–26* Several thousand J. migrated from Poland to Israel.				
1930 AD	*1930* Ashkenazi J. comprised 90% of total Jewry.	*1931* 21,000 Jews in Libya, 15,000 of them in Tripoli.	*1932–1948* Overt hostilities; harsh laws; thousands of J. fled illegally to Iran and Israel.		
1937 AD	*1937* Until now, ¼ of German J. left Germany; of these, 130,000 to Israel.				
1939 AD	*1939–40* 2nd World War. 3 million J. in Poland.	*1939–1943* Moroccan J. suffer persecutions.	*1947* 125,000 J. in Iraq 80,000 in province of Baghdad.		
1948 AD		*1948* 285,000 J. in Morocco, & 29,000 in Libya. Mass migration to Israel of some 260,000 J. (almost all Libyan J.).	*1948* Mass exodus: 110,000 J. left for Israel.		
			1948–1951 123,500 Iraqi-born J. settled in Israel.	*1950* "Magic Carpet" operation carried to Israel about 50,000 Yemenite Jews.	*1950–1970* 2,200 J. left Cochin for Israel, settled in agricultural settlements throughout the country.
1959 AD	*1959* 30,000 J. remained in Poland.				
1968 AD	*1968* More than 2.5 million J. still in Russia as a cut-off diaspora, concentrated in large cities of Moscow, Leningrad and Minsk.				

NOTE. — Based on the following references: [27, 28, 29, 30, 31, 32, 33, 34, 35, 36]. "Jewish" and "Jews" often abbreviated "J."

relationships with neighboring non-Jewish groups and other Jewish communities, and the extent of residency and/or movements.

During the pre-Christian and early Christian period, there appears to be no special subjugation or persecution of Jews in any of the Eastern or North African communities. Indeed, a number of indigenous populations were converted to Judaism: around the Mediterranean in the Hellenistic period [25]; in Ethiopia during the pre-Christian period; in Yemen in the 4th century, culminating in a Jewish Kingdom in the 5th century; among indigenous North African tribes, the Moroccan Berbers; and at the beginning of the 8th century in Khazaria in South Russia [27]. The extent of these conversions—whether they encompassed members of the royal families only or included tribal segments as well, is not known. Any persecution the converts may have experienced was not directed at their new faith, as such. Some Yemenite Arabs, who embraced Judaism in pre-Islamic days, may have found the threats and persecutions of the zealous Moslem rulers too much for them, and they adopted Islam [30, 36].

In short, even if some of these historical references have been embellished by Jewish historians, Jewish life in these lands in this early period seems to have been peaceful. Moreover, in several communities, Jews wielded substantial political and social influence. But with the Moslem conquest in the 7th century in Yemen, and somewhat later in Babylonia and in North Africa, there commenced a new epoch in Jewish life. The histories of Jewish settlements from that time on record a succession of misfortunes and oppressions, with only brief interludes of tranquility under particular political regimes.

Sometimes Jews were confined to separate enclosed quarters or specific areas (the Mellah in Morocco in 1438, the Chamulah in Yemen in 1781, the "Pale" in Russia in 1835). Some Jewish populations were expelled; others were driven to migrate; others were brutalized, or in some cases, exterminated. Understandably, quantitative reports on these events up to the 19th century do not exist. It is also possible that during all these periods, a significant amount of intermarriage and assimilation occurred. Exactly how much and what kinds we do not know; any evaluation of the genetic effects of such relationships is accordingly somewhat speculative (Patai and Patai-Wing [1] and Sheba [37]).

In recent times Ashkenazi Jews have greatly outnumbered all other Jewish communities. Because of their geographical distribution, most of their contacts with other Jews were limited to other Ashkenazi communities in Europe. In contrast to the history of the Oriental and North African communities, Ashkenazi history has seen repeated expulsions and large scale migrations. The direction of the early migrations was from west to east; but early in the 19th century there began a large scale migration, mostly of German Jews, from east to west. According to Ruppin [38], from 1880 to 1929 some 35% of an estimated 11.25 million Ashkenazi Jews emigrated from their homelands. The figures for Poland are particularly striking. From 1821 to 1925 about 70% of all Polish Jews left Poland, and in 1926, 40% of the remaining Jews emigrated.

The oldest and largest of the Oriental Jewish communities is the Iraqi community. For the first 1500 years of their 2500-year existence, the Iraqi Jews provided the scholastic center of Judaism throughout the world. Ties between Babylonian academics and the Jewish communities in Persia, Syria, Palestine, Egypt, North Africa, and Spain

gradually strengthened until Iraq was overrun by the Mongols in the 13th century.

The other two Oriental communities are the Cochin and Yemenite Jews. Of the individual populations studied here, the Cochin Jews are the smallest community and geographically the most distant. Accurate documentation on them refers only to the last 200 years or so, during which they broke their isolation and "announced" their existence.

The Yemenite Jews, more than any other group, regarded themselves over the centuries as being in exile, in both the literal and the religious sense [36]. Many of them were traveling craftsmen, an occupation that brought them into constant contact with the local Arabs. Yet throughout Yemen, Jews lived in separate villages and quarters [36], and even in Sana they were confined to suburbs outside the main city.

The two North African Sephardi communities, the Moroccan and Libyan Jews, had similar histories; however, there are no written records of the extent of contact between the two. There have been about ten times as many Moroccan Jews as Libyan Jews.

The impression gleaned from this brief historical sketch is of continuity of each group coupled to expulsions and migrations. There were several population "bottlenecks" (i.e., significant reductions in size), which may be of some importance in interpreting the population frequency data.

DEMOGRAPHIC BACKGROUND

Until about the 9th–10th centuries, the center of gravity of the Jewish population remained in the East. Jewish penetration into the West was very slow. Although there is evidence of Jews in Rome and near the Rhine River in the first centuries, their numbers are very small. Substantial Jewish migrations westward occurred after the Moslems conquered Spain in the 7th century. When the cultural supremacy and leadership passed from Babylonian Jews to Sephardi, the number of Western Jews increased constantly. When the Jews were expelled from Spain in 1492, the numbers of Eastern and Western Jews were about equal [38], and this balance was maintained until the end of the 17th century. A rapid increase of European Jews during the 18th century altered the scale in favor of the West. At the same time, the Jews began their expansions beyond European boundaries, across the ocean, especially to America. Only rough estimates are available for the size of Jewish populations before the 19th century [39].

Prior to World War II, the Jewish Bureau of Statistics in Berlin was an active center for the collection and analysis of data obtained from statistical censuses. The demographic features described below are based on these data as summarized in the *Encyclopedia Hebraica* [39]. The demographic description is confined to Ashkenazi Jews, since demographic data for the Sephardi and Oriental communities before their migration to Israel are very sparse.

Until the 18th century, the demographic picture of most Jewish communities in Europe was similar to that of their neighboring host non-Jewish populations, namely, relatively slow growth due to low fertility rates coupled with high mortality rates. In the late 19th and early 20th centuries, when social, economic, and cultural progress, along with advances in medicine, resulted in lowered mortality rates, there was a rapid growth of European Jewry.

Ruppin estimates roughly that within the world Jewish population, Ashkenazi Jews increased from 60% in 1800 to about 92% in 1930, when there were approximately 14 million Ashkenazi and 1.4 million Sephardi and Oriental Jews [38]. With the trend toward birth control at the beginning of the 20th century, and an increase in the number of Western European Jews lost through conversion, the growth of the Ashkenazi population slowed.

The Holocaust, during which about one-third of the Jews were lost, produced a distorted age and sex composition of the Jewish demographic profile. Ashkenazi Jews decreased in numbers, while Sephardi and Oriental Jews increased as a result of lower mortality, especially after great numbers of them migrated to Israel in the 1950s. Today there are about 11.5 million Ashkenazi Jews, and all other communities together number about 2.5 million. A rough estimate of the total number of Jews on the various continents in 1973 is given in table 2.

Since the establishment of the state of Israel in 1948, the ethnic composition of the population has changed markedly (table 3). In 1971, 53% of the Israeli population was still foreign-born [40]. Among the foreign-born, as table 3 shows, there was a sharp decrease in those born in Europe and America, from 85% in 1948 to 51% in 1970, and an increase in those born in Asia and Africa, from 15% to 48.5%. As late as 1971, only 18% of Israeli children were born to parents who were born in Israel (1974 census [40]).

A breakdown of these figures into country of birth (table 4) shows that among Libyan, Iraqi, and Yemenite Jews (communities that migrated en masse), the numbers of those born in Israel in 1972 surpassed those born abroad; among European and Moroccan Jews, the majority in 1972 were still born abroad. High fertility rates in the former communities (see tables 5 and 6), and possibly the younger average age of their immigrants to Israel in 1948, are responsible for this phenomenon.

There are outstanding demographic differences between those born in Europe and America, and those born in Asia and Africa (table 5). The main one is that the Oriental and North African Jews marry at a younger age and produce far more children per family. Another is their high child mortality rate, more than twice that of Ashkenazi and European Sephardi Jews. Statistical records for later periods, however, indicate a

TABLE 2

ESTIMATE (IN THOUSANDS) OF TOTAL JEWISH POPULATION IN 1973

	ASIA & OCEANIA		AFRICA		EUROPE		AMERICA		
DIVISION	Israel	Other	North	South	USSR	Other	North	South	TOTAL
Ashkenazi	1300	70	...	110	2500	1100	5890	570	11540
Sephardi	800	50	40	10	...	250	210	180	1540
Oriental	600	100	...	...	80	20	90	30	920
Total	2700	220	40	120	2580	1370	6190	780	14000

NOTE.—Computed by Dr. A. Adam (1973).

TABLE 3

PERCENT CHANGE IN POPULATION COMPUTED IN ISRAEL ACCORDING TO COUNTRY OF BIRTH

Birthplace	% in 1948	% in 1971
Asia-Africa:		
Iraq	2.0	8.1
Yemen-Aden	3.5	4.1
Persia	0.8	3.7
Morocco (Algeria/Tunisia)	1.1	20.7
Libya	0.3	2.2
Egypt	1.0	2.4
Others	6.4	7.3
Total	15.1	48.5
Europe-America:		
USSR, Poland, Rumania	58.8	36.4
Greece, Bulgaria	4.7	3.0
Others	21.4	12.1
Total	84.9	51.5

TABLE 4

TOTAL POPULATION ESTIMATES FOR GROUPS INCLUDED IN THE STUDY IN 1972

Nationality of origin	Born in Israel	Born abroad
Polish	151,000	209,000
Russian	64,500	102,000
German	42,000	53,000
Moroccan	154,000	225,000
Libyan	39,000	29,000
Iraqi	125,000	114,000
Yemenite	97,000	57,000

TABLE 5

DEMOGRAPHIC CHARACTERISTICS IN VARIOUS JEWISH COMMUNITIES BEFORE MIGRATION TO ISRAEL

	% MEN MARRYING BELOW AGE 19		% WOMEN MARRYING BELOW AGE 19		MEAN NO. CHILDREN/ WOMAN	% CHILDREN DYING BELOW AGE 5
ETHNIC COMMUNITY	Before 1946	1946–61	Before 1946	1946–61		
Ashkenazi	3.8	1.8	5.6	3.8	1.8	12.3
Sephardi (Balkan)	3.0	2.6	8.3	6.3	2.2	13.5
Turkey, Syria, Lebanon, Egypt	7.9	6.3	20.2	13.8	4.4	21.8
Iraqi and Kurdish	16.1	14.8	41.7	24.4	6.4	29.5
Persian	23.0	22.8	56.1	45.4	7.1	26.5
Libyan	23.7	17.3	42.5	26.2	7.5	28.9
North-African (mixed)	32.4	14.7	56.9	36.8	7.5	35.1
Yemenite	48.6	45.2	67.3	55.1	6.8	45.5

NOTE.—From population census, 1961.

TABLE 6

PERTINENT DEMOGRAPHIC OBSERVATIONS IN SAMPLE POPULATION STUDIED

Ethnic community	No. families	No. children per family*	% First-cousin or closer marriages	% First-cousin or closer in 1955/57 (Goldschmidt et al. 1960)	% Interethnic marriages (Cohen, 1971)
Polish	213	†	0	1.6	17
Russian	125	†	0	0.3	
German	94	2.12 = 1.15	1	1.1	
Libyan	150	6.18 = 3.11	15	6.7	26
Moroccan	not known	not known	not known	7.1	
Iraqi	not known	not known	not known	17.5	52
Yemenites	230	4.90 = 2.67	10	8.6	34
Samaritans	75	4.70 = 2.06	33	...	...
Armenians	84	3.89 = 1.99	24	...	...
Arabs	68	‡	19	...	...

* Families in which the mother reached 40 years.
† All subjects were young and recently married.
‡ Data collected by Sarah Nevo.

reduction, depending on length of stay in Israel, in both fertility rates and child mortality rates among North African and Yemenite Jews.

Table 6 summarizes several pertinent demographic observations on the ethnic groups of this sample. Here again we see a marked difference between European Jews and the other groups. First-cousin marriages among Libyan and Yemenite Jews were still relatively common in the 1970s; our sample showed even higher rates than were estimated for 1955–57 [41]. Interestingly enough, Iraqi Jews, with 17.5% first-cousin marriages, also have the highest percentage of interethnic marriages (52%) [42].

These figures indicate that there still may be so-called sub-isolates or distinct divisions within the various Jewish communities, in which different and sometimes contradictory trends prevail. Unfortunately, our data do not permit us to explore this possibility.

THE POPULATION SAMPLE

A total of 1,625 individuals were included in this investigation (table 7). Personal interviews were conducted with most subjects in which detailed demographic data were obtained, including age, sex, birthplace of parents and grandparents, consanguineous relationships, and number of children. The following is a short description of each sample. Additional details can be found in the references cited.

Ashkenazi Jews

German Jews. These subjects came from various villages in Israel. Most were adults who immigrated in the 1930s from Germany, and whose four grandparents were known to be Jews. Their families had lived in Germany for at least 3–4 generations, and came from about 11 different geographical regions within Germany, about half from the north and east, and the other half from the south and west [43, 44].

TABLE 7

SEX DISTRIBUTION AND TOTAL NO. SUBJECTS TESTED IN EACH COMMUNITY

	ASHKENAZI JEWS				SEPHARDI JEWS		ORIENTAL JEWS			MID-EASTERN		
SUBJECTS	Polish	Russian	German	Rumanian	Moroccan	Libyan	Iraq	Yemenite	Cochin	Samaritan	Armenian	Arab
Males	123	59	58	...	180	74	148	80	...	72	110	...
Females	90	66	54	...	16	101	40	142	...	52	56	...
Total	213	125	112	130	196	175	188	222	84	124	166	104

Russian and Polish Jews. Most of these subjects were chosen from a large screening survey for Tay-Sachs disease. All were young, recently married couples, born in Israel, whose parents and grandparents were born in Poland or in Russia as defined geographically in 1945. The Russian sample can be divided roughly into two major geographical regions: north and central (including Lithuania and Latvia), and Southern Russia. Unfortunately, the total numbers in each of our sub-samples are too small to allow separate treatment [44–46].

Rumanian Jews. These subjects are people whose Rumanian ancestry could be ascertained for at least three generations; Rumania was defined by its post-World War II boundaries and thus included the Jewish communities of the provinces of Moldavia, Wallachia, and Transylvania [47]. In this group only the HLA antigens were determined. The blood group results used in the analysis were obtained from an unpublished study of male civil servants in Israel conducted by Levin et al. in 1963.

North African (Sephardi) Jews

Libyan Jews. This sample is based on 107 different Libyan families representing proportionately the entire Libyan Jewish population in Libya. Most are adults who immigrated to Israel after 1948. More than 80% are from the town of Tripoli, where most Libyan Jews resided [22, 48].

Moroccan Jews. This group consists of young, healthy blood donors, hospital personnel, and army recruits, who were either themselves born in Morocco, or born in Israel of parents both born in Morocco. No distinction was made in the sample between urban and rural Jews, and no attention was paid to the subjects' specific geographic origin within Morocco [49, 50].

Oriental Jews

Iraqi Jews. This group, too, consists of young blood donors, hospital personnel, and army recruits. Most were born in Israel, but both their parents were born in Iraq, generally in or around the two major cities of Baghdad and Bazra [51, 52].

Yemenite Jews. Our sample of Yemenite Jews was drawn from a town of about 12,000 Yemenite residents at the time of the study, almost all of whom arrived in Israel in 1949–50. They represent the major towns and villages in Yemen where Jewish population was concentrated [19].

Cochin Jews. The 84 people included in this analysis were obtained from a larger sample of related Cochin Jews living in an agricultural settlement near Jerusalem. The blood markers were determined by Brautbar et al. [21].

Non-Jewish Middle-Eastern Populations

Armenians. The sample consists of schoolchildren 12–18 years old, and students of the Armenian Theological Seminary in Jerusalem. The total community of Armenians in Jerusalem numbers about 2,000. All relatives of subjects selected were excluded from the sample [53].

Samaritans. This is a non-random sample comprising about 25% of the total Samaritan community. The data were obtained during their Passover celebration on

their holy mountain, when all Samaritans gather together. The subjects represent the five major patrilineages comprising this isolate [54, 55].

Arabs. The subjects were 68 couples from Western Galilee, randomly selected, most of them drawn from maternity wards. They came from several neighboring villages in which the founders and their descendants have been living continuously for several generations [20].

We are aware that the above described populations do not exhaust the various Jewish communities. Among the important groups missing are Persian and Kurdistani Jews, Balkan and Turkish migrants representing "classical" Sephardi Jews, and Ashkenazi Jews from Hungary, Austria, and Czechoslovakia. Still, the data represent the majority of the present-day Jewish communities in Israel and the vast majority of the population. If conclusive statements based on these data are impossible, it should nonetheless be possible to throw light on the question posed in the introductory section.

THE DATA

The genetic markers that were investigated in these individuals (only loci that were determined in all groups) are listed here.

Blood groups: ABO, MNSs, Rh, Duffy, P, Kell, and HLA, A and B loci. *Serum proteins:* haptoglobins and transferins. *Enzymes:* Acid phosphatase—AP (3.1.3.2.), Adenylate kinase—AK (2.2.4.3.), Adenosine deaminase—ADA (3.5.4.4.), Phosphoglucomutase, locus 1—PGM_1 (2.7.5.1.), 6 Phosphogluconate dehydrogenase—6PGD (1.1.1.44.), Glutamate pyruvate transaminase—GPT (2.6.1.2.), Glucose-6-phosphate dehydrogenase—G6PD (1.1.1.49.), Lactate dehydrogenase—LDH(1.1.1.27.), Malate dehydrogenase—MDH (1.1.1.37.), Phosphoisomerase—PHI (5.3.1.9.), and Peptidase A_1B_1—$Pep^{A, B}$ (3.4.11.).

The methods of all red cell antigen typings, determination of the enzyme variants, and the HLA antigens are described elsewhere [43, 51]. Gene frequencies of the HLA were calculated by the maximum-likelihood iteration procedures [56], and those of the red cell antigens either by direct counting or by the iterative counting method developed by Ceppellini et al. [57]. Scanning through the data, eight markers appeared almost completely monomorphic, with frequencies of the common allele exceeding 99%. These are: GPT, G6PD, LDH, MDH, PHI, Pep^A, Pep^B, and transferin. We confined our analysis to the polymorphic loci, thus largely eliminating the influence of possible rare mutations.

Unfortunately, gene frequencies for all these genetic markers among non-Jewish North African, Yemenite, Saudi Arabian, and Iraqi populations are not available. Therefore, for comparative purposes, only three non-Jewish European populations were included in the analysis: Poles, Russians, and Germans [58–61].

The complete data set of gene frequencies, which was the basis of the analysis in the accompanying paper by Karlin et al. [24], was recorded with the American Document Service, archived with the ASIS/NAPS c/o Microfiche. They can be obtained by writing to Microfiche Publications, 305 East 46th St., New York, N.Y. 10017.

ACKNOWLEDGMENTS

The assistance of Mrs. S. Efrati and Mrs. F. Zetland in the preparation of the material is gratefully acknowledged. We would also like to thank Sarah Ashbel from the Department of Human Genetics of Tel-Aviv University for her careful laboratory determinations of most blood groups and allozyme variants in these populations.

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