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Secular changes in the height of the inhabitants of Anatolia (Turkey) from the 10th millennium B.C. to the 20th century A.D.

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ABSTRACT

We use human-skeleton samples to estimate the height of adults living in Anatolia during the Neolithic period. We also report the results of surveys taken in the 20th century on the height of the Turkish population. Neolithic and the Chalcolithic (5000–3000 B.C.) male heights are estimated as 170.9 cm and 165.0 cm, respectively. Pronounced increases were observed for both sexes between the Chalcolithic and Iron (1000–580 B.C.) periods and sharp decreases among both males and females in the Hellenistic-Roman period (333 B.C. to 395 A.D.). Moreover, recovery to the Iron Age levels was achieved in the Anatolian Medieval period (395–1453 A.D.) for both sexes (169.4 cm for males and 158.0 cm for females). In 1884 the mean height of men was 162.2 cm and by the beginning of the 1930s it increased to 166.3 cm. In the first nationwide survey in 1937 males mean height was 165.3 cm, and females was 152.3 cm, where today current heights are 174.0 cm and 158.9 cm, respectively.

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1. Introduction

The impact of living conditions on height over the course of human history has been well documented (Komlos, 1986; Floud et al., 1990; Larsen, 1997; Bogin, 1999, 2001; Steegmann, 2002; Steckel, 2003; de Beer, 2004). A height decrease accompanied the rise of agriculture near the start of the Holocene period (10,000 B.C.) and was later correlated with urban population density, whereas in the 20th century a gradual height increase could be observed, particularly in urban areas (Gerhards, 2005; Walker and Eng, 2007). Koepke and Baten (2005a) found stagnation in height in Central, Western and Southern Europe throughout the Roman Empire (27 B.C. to A.D. 476). Average height increased dramatically in

the West in the late 5th and 6th centuries and again in the 11th and 12th centuries, which were marked by a rise in temperature as well (Koepke and Baten, 2005a,b). According to Swedish archaeological data (Werdelin et al., 2002), the average height of man living in Europe during the Middle Ages was 172–173 cm. Steckel (2004) reports that between the Middle Ages and the 18th century average heights in Northern Europe decreased by about 6.4 cm. This decrease has been linked with climate changes, socioeconomic inequality, urbanization, the spread of diseases due to increased trade and commerce, nutritional deterioration due to agricultural productivity, and expansionist military conflicts, both imperial and religious in motivation (Steckel, 2004). Koepke and Baten (2005a) showed that population density was a significant negative factor and indicated that the theory of decreasing marginal product and Malthusian theory applied to the pre-19th-century period as well.

Secular increase in height within the developing world has largely been attributed to the well-documented

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Table 1
Detailed chronology of Anatolia.

| Period | Years | Period | Years |
|--------------------|------------------|-----------------------------------|----------------|
| Early Neolithic | 10,000–6000 B.C. | Persian Invasion | 580–333 B.C. |
| Late Neolithic | 6000–5000 B.C. | Hellenistic | 333–30 B.C. |
| Early Chalcolithic | 5000–4500 B.C. | Roman Empire | 30–395 A.D. |
| Late Chalcolithic | 4500–3000 B.C. | Byzantine Empire ^a | 395–1453 A.D. |
| Early Bronze | 3000–2000 B.C. | Seljuk Empire ^a | 1074–1308 A.D. |
| Middle Bronze | 2000–1200 B.C. | Early Ottoman Empire ^a | 1299–1453 A.D. |
| Late Bronze | 1200–1000 B.C. | Late Ottoman Empire | 1453–1923 A.D. |
| Early Iron | 1000–860 B.C. | Republic of Turkey | 1923– |
| Iron | 860–580 B.C. | | |

^a Byzantine Empire, Seljuk Empire and Early Ottoman Empire periods are considered as Anatolian Medieval period.

improved nutrition and health conditions in many industrialized countries during the past two centuries (Eveleth and Tanner, 1990; Ulijaszek, 1996, 1998; Komlos, 1999; Bogin, 1999; Arcaleni, 2006).

In this study we focus on height patterns in populations living in Anatolia from the Neolithic period (10,000–5000 B.C.) to the present day. We aimed to evaluate height changes for Anatolia for the whole settlement history and to establish the secular changes in body height from a prehistorical and historical perspective.

2. Materials and methods

Using the classical Anatolian Chronology (Table 1), we have established average body heights for both sexes during each prehistoric period. This study draws on pre-existing paleoanthropological data beginning the 10th millennium B.C. (Table 2). Heights are estimated on the basis of long-bone measurements, according to the formulas proposed by Trotter and Glesser (1952)¹. The Upper Paleolithic (40,000–20,000 B.C.) and Mesolithic (20,000–10,000 B.C.) periods are characterized by a subsistence-level, hunting-and-gathering way of life. This was followed by the Neolithic Period (10,000–5000 B.C.), and the rise of agriculture (Koca Özer et al., 2008).

¹ Trotter and Glesser (1952) formulae for estimated height are:

| | |
|--|--|
| White males height= | White females height= |
| 3.10 Humerus + 70.00 ± 4.78 | 3.36 Humerus + 60.47 ± 4.45 |
| 4.01 Radius + 74.43 ± 4.97 | 4.74 Radius + 57.43 ± 4.24 |
| 3.81 Ulna + 72.40 ± 4.99 | 4.27 Ulna + 60.26 ± 4.30 |
| 2.61 Femur + 53.76 ± 3.69 | 2.48 Femur + 56.93 ± 3.78 |
| 2.58 Femur _m + 54.79 ± 3.69 | 2.47 Femur _m + 56.60 ± 3.72 |
| 2.79 Tibia _m + 70.81 ± 4.13 | 2.90 Tibia _m + 64.03 ± 3.66 |
| 2.82 Tibia + 72.62 ± 4.15 | 2.95 Tibia + 64.83 ± 3.82 |
| 2.86 Fibula + 67.09 ± 4.17 | 2.93 Fibula + 62.11 ± 3.57 |

The most common and reliable way to estimate stature from human skeletal remains is regression analyses. Long bones have been used in the determination of stature because of given better accuracy in prediction; however they have encountered a small error of estimates.

Former studies were based on Trotter and Glesser (1952) formulae, therefore prior formulae given in the present study's methodology.

Paleodemographical variables constructed through indirect methodological approaches (like date, sex, age and height variables). No direct data available for Anatolian populations (e.g. grave or church records).

Measurements of the adult population (both men and women) in Turkey since the 1880s were collected from several survey reports and compared with a recent data set from a survey conducted in Ankara, the capital city of Turkey between 2004 and 2006 (Koca Özer, 2008), using standard anthropometric protocols (Weiner and Lourie, 1969). The survey's participants comprised 1215 healthy adults (703 males and 512 females) from varied socio-economic backgrounds. With its socio-cultural and economic mixture, Ankara has a varied population. In addition, due to in-migration, Ankara has a good mix of the Turkish population.

3. Results

From the Neolithic Age (10,000–5000 B.C.) to the beginning of the Chalcolithic period (5000–3000 B.C.), mean height decreased by approximately 6 cm among males and by 2.5 cm among females. An increase during the Chalcolithic period and the Iron Age (1000–580 B.C.) was followed by a steep decline during the Hellenistic-Roman period (from the 3rd century B.C. to about A.D. 400). During this period average heights were 165.31 and 155.64 cm for males and females, respectively. Although heights increased during the subsequent Anatolian Medieval period (395–1453 A.D.), they did not attain the mean Neolithic height (Fig. 1).

Sexual dimorphism in the mean height was greatest during the Neolithic period, at approximately 15 cm (Table 3). Height changes for males and for females were in tandem except during the Iron Age (1000–580 B.C.) (Fig. 1). Sexual dimorphism is evident in the modern historical data as well. In 1937 the difference in mean height between males and females was 13 cm; and today it is 15.1 cm similar to the pattern prevailing in the Neolithic period.

Our study indicates that during the Bronze Age (3000–1000 B.C.) mean heights from East Anatolia were lower than the South and Central Anatolian heights. Later in Hellenistic-Roman periods (333 B.C. to 395 A.D.) geographic disparities continued. The population of East Anatolia was the shortest followed by Central Anatolia. Also during the Anatolian Medieval period the mean height for both sexes was less in East than Central and West Anatolia. Because Asia Minor, a land bridge between Asia and Europe, features considerable geographical and topographical diversity, such variations are not unex-

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