Mojgan Stegl and Joerg Baten*

Tall and Shrinking Muslims, Short and Growing Europeans: The Long-Run Welfare Development of the Middle East, 1850-1980

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Mojgan Stegl
University of Tuebingen
Mohlstraße 36
D- 72074 Tuebingen
Germany
e-mail: mojgan.stegl@uni-tuebingen.de

Joerg Baten
(corresponding author)
University of Tuebingen and CESifo
Mohlstraße 36
D- 72074 Tuebingen
Germany
e-mail: joerg.baten@uni-tuebingen.de

Abstract

In this study we examine anthropometric data for eight countries in the Middle East for the period 1850-1910, and we follow those countries until the 1980s. The Middle East had a relatively good position during the mid-19th century, if human stature or real wages are considered, but much less so in terms of GDP per capita. Initially low population densities allowed better anthropometric outcomes. The height advantage was due, among other factors, to easier access to animal products. All indicators suggest that the Middle East lost ground after the 1870s relative to the industrializing Countries.

Keywords: Welfare, Middle East, Anthropometrics, Growth, Living Standards

JEL: I32, N35, O18, O47

Tall and Shrinking Muslims, Short and Growing Europeans: The Long-Run Welfare Development of the Middle East, 1850-1980

1. Introduction

Anthropometric history is a well established method to measure biological aspects of the standard of living. Human stature is determined by the quality of nutrition, minus claims for disease environment and workload during childhood, and those were the major determinants of health and life expectancy in the poor economies of the past. Countries in many continents have been studied with anthropometric methods, including, for example, India, China, Argentina, the United States and certainly many European countries (see also Komlos 1985, Steckel 1995, Steckel and Floud 1997). However, one world region not studied by modern anthropometric historians is the Middle East. A key reason might be that heights were typically not measured by the Ottoman army or in prisons. However, a number of anthropologists measured heights in the Middle East after the late nineteenth century, and although those sources of anthropometric information provide a number of methodological challenges, we use them in the following to reconstruct human stature levels in the Middle East 1850-1910. With those height records, we can study the countries of Turkey, Iraq, Iran, Egypt, Syria, Lebanon, Palestine/Israel, and Yemen.[1]

Was the nutritional situation different in the Middle East, compared to, say, Europe? Would we expect a different level or other developments than in Europe? One difference was certainly the much lower population density in the eight Middle Eastern countries (Table 1).[2] Previous anthropometric research found that populations in sparsely populated countries often

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[1] We will refer to these countries when we write "Middle East" in the following (please note that the Arabian Peninsula is not covered, except for Yemen).

[2] In the Table, population per arable land refers to the number of people relative to land which can be used for agriculture, i.e. excluding deserts, mountains, and other wasteland.

enjoyed “advantages of proximity” to animal husbandry, as a substantial proportion lived in regions specialized in this agricultural activity. Those people were taller than other populations in a situation in which some protein-rich, but less highly valued products of animal farming (offal and milk, for example) could not be shipped at sufficiently low cost (Komlos 1996, Baten and Murray 2000). Based on those previous results, we would expect initially taller heights in the Middle Eastern countries, compared to Europe, because those Europeans who lived in industrial cities sometimes had higher purchasing power of tradable goods, but did not have these proximity advantages. Moreover, the Western urban populations still suffered from “urban penalties” of bad disease environment and hygiene in this period (see, for example, Szreter and Mooney 1998). In the Middle East in contrast, substantial parts of the population lived as Bedouins, who might have initially benefited from those proximity advantages. Low population densities also allowed a benign disease environment in the Middle East of the mid-nineteenth century.

The increase in heights in Europe from the late nineteenth century was so impressive as to suggest a possible reversal of the earlier Middle Eastern height advantage. European urban industrial populations could increasingly buy cheap proteins and benefited from improving disease environments during the twentieth century. Based on this comparison, the present study also increases our understanding of European welfare development. We will assess in the following when the Western industrializing countries started to overtake the Middle Eastern populations, which were lacking sufficient growth and development (Pamuk 2006, Issawi 1995). In particular, we will test the hypothesis that some Middle Eastern populations were taller than Europeans in the mid-nineteenth century, using British, German, Czech, and Italian samples for comparison, and whether this difference disappeared after the late nineteenth century.

In the final part of this study, we contrast heights and purchasing-power oriented welfare measures. How do our height estimates differ conceptually from estimates of real wages and GDP? The strength of GDP per capita is, of course, its comprehensive account of purchasing power and its comparability over time if given in standardized monetary units (such as the 1990 Geary-Khamis dollars). One of the disadvantages of GDP as a welfare measure is its bias against subsistence farming and production within the household. In general, non-traded goods and goods produced and consumed within households are often underreported. Moreover, other forms of informal markets, such as black markets, can often not be captured. Finally, the data requirements for GDP estimates are very large. In contrast, real wages have a better reputation in terms of data quality for long-run studies, as nominal wages and prices were recorded by contemporaries (whereas GDP relies on estimates produced by later generations). From studying real wages, however, we cannot learn about the return to land, capital, or perhaps the return to the exploitative activities of the rulers. Moreover, typical pre-modern subsistence goods or less standardized goods such as housing are again difficult to include in the consumer basket, as those who created the written sources of the past did generally not provide sufficiently detailed information. Finally, both GDP and real wages concentrate on purchasing power and do not include other "biological" living standard components such as health, longevity, and the quality of nutrition, which is the strength of anthropometric techniques (Margo and Steckel 1983). Height studies have the additional advantage of covering many groups of society.

In the next section, we will discuss the main data sources. In section 3, we report regional differences of height in countries on which we have sufficient information, and present a map for Turkey (Figure 1). Section 4 gives an overview of height levels in the Middle East and the economic background, while section 5 discusses differences between the Middle East and the industrializing countries between the 1850s and 1910s. Subsequently, we compare GDP per capita, real wages, and height estimates in section 5. Section 6 concludes the paper.

2. Data and Representativeness

Samples from military and prison samples have allowed scholars to study the anthropometric history of numerous countries in the world. Unfortunately, for the Middle East, military records are not available. Our research in the Ottoman Archive in Istanbul showed that anthropometric measurements in the Ottoman army were only reported as “tall”, “middle”, and “short”, without clear definition of those categories. Another frequently used source of height records are prison measurements, but those were only exceptionally recorded for the Middle East by Western anthropologists. If available, we included those in our sample. But overall, most of our height information on the Middle East stems from anthropological studies. During the late nineteenth and early twentieth century many European and American anthropologists went to the Middle East in order to study the physical characteristics of the local population. We could find some of the resulting measurements of height as individual height data, for example in the archives of the British Anthropological Collection. Sometimes anthropologists also published their individual data (for example, Chantre 1895 and Field 1956, see Table 2). However, this (ideal) individual data accounted only for 1,476 observations in total. Another way presenting data in the anthropological studies was to organize height data aggregated by 10-year age groups. This information can also be analyzed without major methodological problems, as long as the samples were drawn representatively for the underlying population, like Inan (1939) did for 28,992 Turkish heights. Finally, the third type is height averages for which we can only reconstruct the birth decade in which most individuals were born. We will explain in section 4 below how we incorporated this type of data.

In the following, we will discuss in detail those cases where we can compare the height development based on individual cases on the one side, and grouped cases on the other, for example for Egypt and Turkey. Including the grouped data, the total number of underlying cases was 47,797, after discarding height and age extremes (in the following, we will only use ages 20-50, with the one exception of Turkey where we also used the 50-59 year-olds, as this age range was reported in one aggregated group, see below).[3] We concentrate on male heights only in this study, as the aim will be to compare them to heights in the industrializing countries in the nineteenth century, which are almost exclusively male (due to the predominant data generating institutions being the military, prisons, and so forth).

To what degree is our data set representative? Are the economic sectors represented by similar shares in our samples as in the overall population? The Inan (1939) dataset, which accounts for 28,992 underlying observations (or some 60 percent of our data), was representatively drawn from the Turkish population, also with respect to occupation (Inan 1939, p. 62). Inan (1939, p. 56-58) describes in great detail how he in cooperation with the Turkish Statistical Office made sure that adequate numbers of measurements were performed in each individual district. Without the direct support of Atatürk and his influence with the Turkish authorities, these large-scale measurement activities could not have been realized. Hence, for this part of our dataset, we do not expect strong selectivity biases. For our individual samples, we have occupations recorded for a smaller subset, namely 445 out of our 1,476 individual observations, of which 71 percent were engaged in the agricultural sector. For those we can compare the occupational composition with the overall population. Given Issawi's (1982, p.118) estimate that about four fifths of the Middle Eastern population were engaged in occupations related to agriculture, our best guess is that our sample might include a slightly lower share of rural people relative to the overall population. The rural population might have enjoyed a better nutritional status because of easier access to food and lacking

[3] We excluded extreme heights above 185 and below 140. When the measurement year was not reported, we assumed it to be the publication date of the survey minus three years. This increases the measurement errors – but concerns only 0.75 percent of our sample. Our robustness tests suggested that the impact is marginal and that the broad trends are unaffected. We also tested different criteria for the exclusion of outliers and found the results consistent with our findings.

market integration, and might thus have been relatively tall on average, but the difference between "four fifths" and 71 percent is not a very large difference.

Were there unrepresentative subgroups or regional biases in the dataset? Among the grouped samples, most of them were drawn randomly for a certain region of a country, hence we will need to control for regional composition in the following. Sometimes the anthropologists were particularly interested in desert tribes or in the Jewish part of the population. That is why we need to look out for those characteristics. All of the height measurements were taken within the country of origin. We excluded all migrants, with the one exception of 23 Yemenite Jews, who were measured in Israel. We included those 23 cases to fill the gap in the 1880s.[4] Those will deserve special attention in the following and will be controlled for using a dummy variable, even if they account only for a negligible 0.05% of our sample. Another group with potential social bias is prisoners. For Egypt, Craig (1911) collected height data of criminals in Cairo in 1905.[5] He argued that the anthropometric information is representative for the underlying Egyptian population because of the relatively broad social spectrum of Egyptian prisoners. He argued that the elite groups within the Egyptian society, the wealthy merchant strata of Alexandria and similar cities, were not represented in this prison sample, but given that most had foreign origins, he did not consider them a part of the Egyptian people anyway. We have some doubts about his arguments. It might well be that the sample was slightly biased towards the lower income groups of Egypt, compared with the samples taken by anthropologists, who aimed at representative data collection. However, in the following paragraph we will find that the Egyptian samples were probably not downward biased in terms of numeracy, which would support Craig's

[4] Otherwise the 1880s would have been dropped for not reaching the minimum inclusion number of 30 height observations.

[5] Our Egyptian data stem from five different sources: Ammar (1944), Chantre (1904), Craig (1911), Field (1952a).

hypothesis. Apart from those social groups, no other special subgroups were recorded in our data. But we certainly need to control for regional composition, religion, age, and migrant status below.

One strategy to assess the representativeness of historical samples is to compare the age heaping behaviour in the sample and in the underlying Mid-Eastern population. The idea of an age heaping analysis is that people who are not able or willing to state their exact age often report an age rounded to multiples of five, and those persons are typically less educated than people who report their age exactly (Baten et al. 2008). Age heaping indices such as the "Whipple Index" tend to be strongly negatively correlated with other human capital indicators such as literacy, and even stronger – in modern times – with measures of mathematical skills (as reported in the PISA survey, see A'Hearn et al. 2008). Normally those indices require large individual samples of 500 or more persons reporting their age, which we do not have for each birth cohort and country (Table 3). Nevertheless, on average the Whipple index of 309 for our individual samples is quite similar to corresponding census values of 281. The total number of our individuals with age statements is almost 600; hence this overall value is quite informative.[6] Even if sample sizes are probably too small, we also compared individual countries and birth cohorts with at least 30 observations for which matching census data could be obtained. In some cases, the Whipple index is slightly higher for our samples (such as Iraq and Iran), and the samples of Turkey and Egypt in 1850 and 1870 have lower index values than apparent in the representative census data. But on average the difference is quite modest, especially when compared to the large differences of Whipple indices in the world, reported on the bottom of the table. We should note the possibility that assuming a negative correlation between Whipple indices and heights, our Iraq and Iran estimates might be slightly overestimated, and the Egyptian and Turkish estimates slightly underestimated, although the

[6] We cannot use all our individual observations, as not for all countries and birth decades corresponding census data is available

individual country differences might also be influenced by small sample size. We conclude that the average Middle Eastern level seems quite representative for the underlying population.

To sum up, we find that the dataset is broadly representative for the underlying population.[7] The large share of the agricultural population is reflected in the dataset. While a small number of special subgroups is contained in our sample, these can be controlled for with dummy variables. Last but not least, the age heaping analysis suggests that our samples were overall quite representative in terms of human capital.

Which of the countries have larger numbers of cases overall, and for individual and grouped height figures? With 687 observations Iraq has the largest number among the individual samples (Table 4). The case numbers of the individual samples are relatively small in comparison with typical military and prison samples that have been used for Western anthropometric history. Among our grouped samples with more than 10 cases, the Turkish one is by far the largest, being based on almost 29,000 observations between the 1880s and 1910s.

The second-best documented country among the grouped cases is Egypt, again for the early cohorts from the 1850s, and the 1870s birth cohort is particularly well-documented. The grouped rates for Egypt concentrate on earlier birth decades. In Iraq we have numbers for the later cohorts based on both individual and grouped cases. The other countries' (Iran, Palestine, Lebanon, Syria, Yemen) grouped samples are concentrated in the 1850s and 1860s, allowing at least a first impression of the height levels in those countries in the 19th century.

[7] This reflects the efforts of many anthropologists who studied Mid-Eastern populations and attached great importance to a representative social mix of their data (for example, Craig 1911, p. 67 states that "it may be concluded, that the statistics are representative of the Egyptian and Nubian races with their local variations.").

We now study the two best-documented countries separately, Turkey and Egypt, in order to assess the measurement quality of those two samples. In particular, we consider the question as to whether subsets of the available heights show similar height developments.[8] It turns out that there was very little trend for the grouped Turkish sample (Figure 2). The 1880s birth cohort might be slightly underestimated due to shrinking -- perhaps by 0.98 cm, as the Sorkin et al. (1999) analysis showed.[9] On the other hand, selective mortality counteracts this bias, as taller individuals tend to be healthier and hence more likely to survive up to this age. The youngest birth cohort might contain some individuals who did not yet reach their final adult height; hence this value might be underestimated. Given that the number of cases is quite small, not too much importance should be attached to the slightly taller individual data points before the 1870s. Only the 1860s have 63 cases and might allow a substantive height estimate. Moreover, the similar values of those born in the 1850s and 1870s might improve the credibility of the 1860s height level.[10] In conclusion, the level of the small individual Turkish height samples (1870s and before) and the large aggregated samples (1880s and thereafter) was relatively similar.

Egypt is another large country in the region, which is relatively well-documented in our sample. We can, for example, compare one well-documented individual province to the overall Egyptian development. This avoids any risk that a development over time might be

[8] The grouped Turkish heights were recorded in 1937 and refer to those aged 20-24 (i.e. born 1913-17), those aged 25-29, 30-39, 40-49, and 50-59. The latter persons were mostly born in the 1880s, although a smaller share was also born in the 1870s. We assigned birth decades by taking the one during which the majority was born. Hence, one drawback that needs to be mentioned is the imprecision of birth cohorts for Turkey.

[9] Sorkin et al. (1999) estimate the effect for North Americans in 1980 to be 0.98 cm for the age group 50-59.

[10] The individual cases reflect mostly Erzurum-Kars province (with a share of 43 percent), and five other provinces with smaller shares. The map of Turkish heights for the birth cohorts of the 1880s-1910s shows that this region (Erzurum-Kars) had about average heights (Figure 1). Hence, the height of the first Turkish birth cohorts are unlikely to have a strong regional bias.

caused by adding different regions for different birth cohorts and then arriving at a misleading impression of development over time. We did this for the best documented province in Egypt, Sharqia (see appendix Table available from the authors). We found that the trend in this province was very similar to the overall trend, hence suggesting that the movement of the time series was not caused by pooling heterogeneous regions.

Now, we could continue and go through all the countries and different samples individually, but this would take too much space. Instead, we consider the average heights jointly, and turn to consider the raw heights first (Table 5). We find that those raw heights were relatively similar across Middle-Eastern countries (for example those of the birth decade of the 1850s), except Yemen that had substantially lower average anthropometric values. The trend over time of those countries with sufficient data seems relatively stable. However, during the 1880s there was apparently a temporary decline of heights in the Middle East, which is supported by data on Egypt, Iran, and Turkey. Before comparing those raw results with the results of regression analyses, we will first consider potential regional differences.

3. Regional height differences

Regional differences of living standards were quite substantial in other countries of the world (on the U.S., see, for example, Margo and Steckel 1983). In order to ascertain spatial variations in the levels and trends in physical stature for the Middle Eastern countries, we estimate heights at the regional level. This will also prove useful in the following trend regressions, which will include control variable for regional differences. A detailed analysis of the determinants of spatial height differences remains a subject of future research though.

Iraq

Reasonably good regional information is available for Iraq. The north and northeast of Iraq are mountainous and most inhabitants are Kurdish. The regions around Mosul (Ninawa) are treeless uplands and highly dependent on irrigation from smaller rivers and rivulets. The central districts of Baghdad, Babil, and Karbala are hot flatlands. Crop cultivation was only possible by using irrigation systems. At the onset of the eighteenth century, systematic cultivation was established and controlled by Ottoman garrisons, in particular around Basra, Diyala, Arbil, and Mosul. The rest of Iraq was inhabited by tribal groups (*dira*[11]) who were self-sustaining and only under limited control by the government in Istanbul. Having large areas at their disposal, the tribesmen made use of shifting cultivation and stock-breeding (Issawi 1966, p. 129f.). The cattle herding tribesmen consumed relatively large quantities of milk, meat, and offal. In contrast, the settled inhabitants in the cities and agricultural areas relied more on starches and proteins from vegetables. Moreover, they eventually suffered from insufficient rainfalls and the devastating annual flood of the Tigris and Euphrates (Issawi 1988, p.105). In Iraq, there is a height advantage for the population living in deserts (Table 6). Those desert inhabitants were on average 0.85 cm taller than the urban dwellers in large cities such as Baghdad or Basra. Desert populations had an even stronger height advantage over Iraqis from other rural regions, such as the irrigated land along the Tigris and Euphrates rivers. Hence, it will be important to pay attention to desert regions in the following regressions. In a separate WLS regression analysis of height we found that rural inhabitants not living in the desert were 1.25 cm shorter than desert inhabitants (significant at the 0.01 level, see appendix available from the authors) after controlling for birth periods and other variables, whereas urban dwellers were 0.46 cm shorter, but not statistically significant. Over time, the share of nomadic Iraqis in the total population fell considerably, as population increased, from 35 percent in 1867 to 5 percent in 1947 (Issawi 1966, p. 158). This would support the hypthesis that initially low population densities allowed better anthropometric levels, and that this height advantage was partly due to easier access to animal products.

[11] The *dira* is the area claimed by the tribe (Issawi 1995 p. 163).

Turkey

For Turkey, heights were reported by ten regions (Figure 1). Unfortunately, Inan (1939) also included very old Turks born in the 1850s to 1870s, for whose shrinking bias he did not adjust in his regional averages.[12] Therefore the height levels for the regions are downward biased. Hence we do not consider the regional height levels, but only the ranking between the regions, assuming that the share of old people was more or less equal across regions. The shortest populations were from the Dardanelles in the northwest of Turkey and the Aegeis, whereas the tallest Turks could be found in central Anatolia. An important part in the economic life of Turkey was livestock breeding. This was done mainly by nomads outside of the cultivated areas. Issawi (1980, p. 270) analyzed tax returns and reported that animal husbandry was prevalent primarily in the relatively dry inland while it did not figure as a common occupation in the moist coastal regions. Stock-breeding was also widespread in the European provinces of Turkey, but per capita values were not as high. Issawi (1980, p. 8) reported that the Turkish peasants of the nineteenth century ate meat very rarely, whereas milk was available in considerable quantities. While Turkey did not have as strong a desert advantage as Iraq, a similar pattern emerges for the dry inland region of central Anatolia, which had high anthropometric values, low population density, and quite a strong nomadic element.

Egypt

The third of the large countries for which we can document regional inequality is Egypt. Because of Egypt's aridity, most of the population lived along the Nile valley and delta. For agriculture, irrigation is a necessary precondition. Only the northern coast has sufficient rainfall, which might have made life somewhat easier in this region – heights were greatest in the coastal regions of Egypt (Table 6). Egypt again had a height advantage for its

[12] It is an average of both adult height and the height of persons who had already started to shrink.

desert population over the urban population, although the coastal population was even taller than the desert inhabitants in this case ("other rural" being equal). Some coastal and river delta inhabitants might have benefited from the strategy that provided a substitute for drinking water during the inundation months of the Nile: In Cairo and perhaps other cities of this region, cow milk was consumed in quite large quantities, substituting unavailable water during this period (Kuhnke 1990, p. 25). In a similar WLS regression analysis as for Iraq, we included birth decade, age, religion, and regional dummy variables (see appendix available from the authors). The constant refers to the desert population. Urban dwellers were 1.04 cm shorter than desert inhabitants (significant at the 0.01 level) after controlling for birth periods and other variables.

4. Height development (or non-development) in Middle Eastern countries 1850-1910

We will incorporate our findings from the spatial pattern analysis into our national trend analysis. Controlling for age, region, migration, and religion in a regression, we pool all height data and assign dummy variables to each country and birth cohort (Table 7, Col. 1).

When studying height trends, one frequent problem regarding anthropological surveys is the paucity of the information given on birth cohorts, as many anthropologists of the late nineteenth and early twentieth century assumed no change in height over time. Hence, we had to find out when most of the measured individuals were born, and we had to accept the fact that a smaller part of the measured individuals was born before or after the most strongly represented birth decade. The time trend which results from these estimated birth cohorts resembles moving averages insofar as it smoothes the height development. For example, if there was a height decline in the 1880s but only 70 percent of the respective individuals were born in the 1880s and 30 percent in the 1870s, the decline would be smoothened. Koepke and Baten (2005, 2008) have suggested estimating these grouped and individual data jointly with Weighted Least Square Regressions (WLS). They applied this method to populations for which we otherwise do not have any way of studying their anthropometric development, given the data which are obtainable. For the Middle-Eastern, this scarcity of data is also clearly given. Hence, we will also apply WLS regression techniques for pooled individual and grouped data here as no large-scale individual height data from archival records can be expected for future research. We follow Dickens (1990) and weight each observation by the square root of its group size.

In the following regressions, we included an age dummy for those of age 20, as there might have been late adolescent growth at this age.[13] Since the human body is subject to a shrinking process at advanced ages, we restricted our sample to individuals who were not older than 50 (except for Turkey in the 1880s). We also inserted a control variable for the Jewish minority within those mostly Islamic countries. The reason for this could be different religious food consumption rules, or possibly occupational and education differences (and discrimination). Lastly, we pay attention to regional variation. The resulting time coefficients are reported in Table 7 and graphed for each country (Figure 3).

We also checked the distribution of height for normality (Figure 4); the overall height distribution appears normal, which confirms the validity of the estimation procedure. Heaping on round numbers is very mild, which might be caused by the fact that the height measurements of our sample were performed by well-qualified anthropologists. The first regression controls for age, regions, migrant and religious characteristics, the second only for migration and religion (Table 7, Col. 1 and 2). The third regression controls only for age (Col. 3). Apparently, those who reported age 20 were consistently shorter than older Mid-Easterners. This might be either caused by the fact that they were still growing at age 20, or that less educated persons reported a rounded age and came from lower strata families with shorter stature (or both). Among the regional dummies, the desert region variable is positive

[13] Additional dummies for ages 21 and 22 were not significantly negative and hence they were excluded from the regressions.

and significant, although the coefficient is not very large. Coastal and urban dwellers were not significantly different from the other rural population of the whole sample. The results for the country-decade dummies are not very sensitive to including or omitting the dummy variables for region, migrant and religion. Only the Iranian decline of the 1880s looks erroneously large if religion is ignored (many Iranian Jews were born during the decade), and the Yemenites of the 1880s would appear too tall without attention to migrant status. We graph the dummy variable coefficients of birth decade and country reported in Table 7, Column 1, in Figure 3. In the Middle East, most populations tended to be fairly tall in the 1850s-1870s by 19th century standards, especially the Turkish, Iraqi, and Palestine/Israel population, whereas Yemenites were much shorter (Figure 3). This confirms the results we found by studying the raw height data. The development over time was mostly stagnant between the 1850s and 1910s.

What was the background for this stagnation of height in most countries? To take one relatively well-documented example, we will first describe the general economic history trends of Egypt, before comparing it with the anthropometric results. Under the reform policy of Muhammad Ali (1805-49) between the 1820s and the 1840s, Egypt's GDP rose (Issawi 1982, p. 104). However, we do not know whether this GDP growth was also translated into a height increase, as Ali accepted quite large costs for the population in pursuing his aims – for example, he required 12 percent of the population to serve in forced labor institutions, and 3 percent to serve terms of military conscription. Export activities and the corresponding profits were gained by a small group of foreigners (Issawi 1966, p. 359). However, Ali slightly improved the catastrophic educational situation in Egypt by creating new schools. For example, while less than 5 percent of Egyptians reported their exact age in the 1820s, this share had slightly risen to 15 percent by the 1860s – a value which was still much lower than that for Turkey with its 45 percent (Crayen and Baten 2008). He also improved the Public Health system dramatically, by introducing smallpox vaccination, for example, and by training former slaves as mid-wives (Kuhnke 1990, p.14, 123 and 132). Better perennial irrigation increased both agricultural production and cultivation area by a large amount. Yet due to the heavy burden of taxation, the situation of the peasant population did not ease; Issawi (1966, p. 377) reports that the Egyptians did not consume much meat in this period, which also might indicate a low standard of living. Nevertheless, GDP growth, Public Health progress, and marginal educational development might have prepared the ground for some welfare increase during the subsequent period of the 1860s (Figure 3). Between the 1850s and 1860s, Egyptian heights increased by 1.34 cm (Table 7). Moreover, in this period, the conscription burden declined and the Crimean war boom is reported as having had a beneficial effect even for the Egyptian peasants (Issawi 1982, p. 104). In the early 1860s, the cotton boom which resulted from a supply shortage during the American Civil war provided additional income for the Egyptian peasants, although it did not last long. Already in the late 1860s and especially in the 1870s prices for Egyptian products began to fall, and taxes rose (Issawi 1982, p. 105). Hence, it is not surprising that heights in Egypt declined in the 1870s. For Egypt, the decline during the 1880s might have been exaggerated due to small sample size, although the fact of a decline is supported by similar height decreases in the other countries (Figure 3). Iran also experienced a temporary height decline during the 1880s, whereas the decline in Turkey might partially be caused by changes of the sample and ageing effect (see section 2 above).

What might have caused the 1880s decline? At the current state of research, not much can be said about it. One potential candidate is the cattle plague, which wiped out 80-90% of the cattle in neighboring Ethiopia and Somalia (and consequently one third of the human population) during the late 1880s before it continued its way south to Africa (Barrett and Rossiter 1999). Ethiopia and Somalia are situated just to the South of Yemen, and it is likely that the cattle plague epidemic moving slowly from Central and East Asia to Africa had reduced Middle Eastern cattle stocks before coming to Africa, albeit with less severe mortality impact, as the epidemic had been around in Asia for centuries.

Nevertheless, the evidence on the causes of this temporary decline during the 1880s is not very conclusive. Cattle plague was always a relatively poorly documented epidemic, as it affected remote nomadic tribes the most and those typically left very few written records due to their illiteracy (Barrett and Rossiter 1999). The contribution of our study is rather to document that there was not an upward trend after the 1870s in the Middle East, when heights in Europe and the other industrializing countries started to grow continuously and substantially.

Iran also did not show improvements in physical stature. Gilbar (1986) argues that in Iran, the increasing cultivation of crops such as grain, opium, cotton, and fruits implied a structural development away from animal farming. However, given the similarity of stagnation tendencies in other countries, we would argue that the opium and cash crop trade might not have been the most important driving force. Moreover, Okazaki (1986) found that only a relatively small area was affected (on the opium trade, see also Hansen 2001).

Average anthropometric values were prevalent in Syria and Lebanon in the 1850s and 1860s. In general, purchasing power was relatively high in this economic core region of the Ottoman Empire (Issawi 1982, p. 106-7). Being one of the commercial centers of the Middle East, Lebanon developed a wealthy mercantile sector early on which demanded high quality food from the surrounding countryside and invested in the silk (and later fruit) exports from this region. This might have been one of the reasons for the relatively tall population in neighboring Palestine/Israel.

In contrast, the Yemenite population displayed catastrophically low anthropometric values. Since antiquity when Yemen was reportedly remarkably rich, population density was high and the economy specialized in spices, coffee, and other cash crops. One can speculate whether Yemen fell into a kind of Malthusian trap in the mid- to late nineteenth century, as conflicts did not allow the maintenance of the irrigation systems which would have been necessary for generating sufficient income for such a dense population. In the years around 1900, Yemen's territory was split into many small centers of power and its political situation was very instable due to tribal attacks against the Ottoman leadership in 1872. Those conflicts and other factors led to severe famines (Dresch 2000, p. 4).

5. An overall height trend of the Middle East

We now combine all country estimates into a Middle Eastern trend, weighted by population size and interpolated wherever necessary with the growth rate of height of a country with relatively robust height trend estimates (following Baten 2006). For the early half of the period, we used the Egyptian development to interpolate, and for the latter half we used the Turkish development, always using a real measurement for an individual country as a level benchmark (results in Figure 5). The levels are therefore relatively close to the true values. For the period after the 1910s, we join the trend estimates of Baten (2006) which are mainly based on the Demographic and Health surveys (DHS) for the Middle East, as well as a variety of other sources and studies on the industrializing countries (which include North America and the Asia/Pacific countries of Australia, New Zealand, and Japan). We updated this trend estimate for the Middle East with recently recorded data on Iran (Janghorbani et al. 2007), again with appropriate population weights. Finally, we used linear interpolation for the 1920s and 1930s, as most world region height estimates indicate a rather smooth upward trend for this time period. The most recent birth cohort in these series is the decade after 1980, that is, our study covers a range of individuals from those born in the 1850s to those living today.

Compared with the industrializing countries, height values in the Middle East were quite favourable until the 1870s. But was this difference actually significant? In order to test the statistical significance, we compiled anthropometric data from three different industrializing European countries and regions (see Table 8), namely Germany, Northern

Italy, and the Czech lands (part of Austria-Hungary at the time), which we will compare with the United Kingdom below. We took care not to include the very extreme cases of the height distribution of industrializing countries, such as Sweden, the United States or other New World economies on the one hand (with tall heights), or Japan, Spain, and Portugal on the other hand (short heights) in this particular regression. The Middle Eastern "old world" populations were clearly shorter than the former, but taller than the latter. In contrast, we took comparable "old world" economies of Central and Southern Europe, which were closer to the average of the industrializing societies of the 19th century. We also took heights from different institutional backgrounds in order to make sure that any statistical difference was not caused by one of those institutional factors: The first sample was drawn from North Italian soldiers and deserters (Meineke 2008). A'Hearn (2003, p. 370) has shown that Northern Italians were not exceptionally short before mid-century (his sample ends with the 1840s birth cohort). The second source of information comes from Southeast German male convicts of the 1850s and 1860s. We also compared military conscripts from Southwest and Southeast Germany (districts of Frankenthal and Brueckenau, respectively, see Baten 1999). Finally, we included Czech prison height data (Hodinova 2007). All those data sets are publicly available on the IEHA data hub.[14] The Italian data were the only ones which required a truncated regression estimate, given the minimum height requirement of the Italian army at that time. In contrast, the German conscripts were measured before the minimum height requirement was applied (hence the lists included also the rejected ones). We pooled those samples with our individual Middle Eastern height data, and tested whether a Middle East dummy variable was statistically significant, regressing each birth decade separately (Table 8). It turned out that in almost all cases, the Mid-Eastern heights were significantly larger than those of European countries during the 1850s and 1860s - only the German prisoners in the 1850s were not statistically different from the Middle Eastern populations (Table 8). We can also speak of

[14] http://www.uni-tuebingen.de/uni/wwl/dhheight.html, accessed May 2nd, 2008

economic significance for those decades, as the height differential was always larger than one centimeter, which is a substantial amount. For example, Baten and Komlos (1998) estimated that one centimetre of height corresponds to 1.2 years of life expectancy (as already mentioned in section 2), which most people would consider to be a substantial addition to biological welfare. For the UK, Floud et al. (1990) arrive at similar height levels as the Middle Eastern populations, although there has been some debate about the absolute level of height as estimated by different truncated regression models (see Komlos 1998). Also, apart from the Minimum Height Requirement, the English Army was a volunteer army, hence it is not clear whether the army had a positive height selection compared to the civilian population.

During the 1870s and 1880s, the difference between Middle Eastern and European populations vanished and there were neither statistical nor economic differences (Table 8). The era after the 1870s was characterized by similar anthropometric values for both world regions. Only from the 1910s did the industrializing European countries overtake the Middle East (Figure 5). The Middle East was probably one of the very few world regions which had a height advantage in comparison with Central European countries during the mid-nineteenth century (Baten 2006).

6. Comparison of GDP per capita, real wages, and height

How do those height trend estimates compare with existing GDP and real wage estimates? In general, both GDP per capita and heights diverged in the course of the twentieth century (Figure 5 and 7). However, the picture for the nineteenth century is fundamentally different. During the 1850s and 1860s, when the Middle Eastern countries still had a height advantage over the Western world, GDP per capita was already higher in the industrializing countries. The reason for this could be hypothesized to be distributional, as income inequality was perhaps higher in the West (Williamson 1998). Given that heights are quite sensitive to the well-being of the lower income strata, low inequality might ceteris paribus result in greater heights. The real wage of unskilled laborers relative to GDP might give a first impression. Allen (2001) calculated real wage estimates for a number of cities, including London, Amsterdam, Antwerp, Milan, and Madrid, for almost every decade of the 19th century. Comparing Allen's estimates with Özmucur and Pamuk (2002) for Istanbul, it turns out that in terms of real wages, the West was also ahead of Istanbul in the 1870s, with real wages for the Western cities being almost twice as high (Figure 7). However, this applies mainly to London and Amsterdam. If we consider the Western countries without those cities, Istanbul had in fact a real wage advantage in the early nineteenth century and wages were more or less equal in the period between the 1850s and the 1890s. If we remember that the UK and the Netherlands accounted for only 10.7 percent of Europe's population in 1890 (Maddison 2001), we might conclude that real wages in most of Europe and the Middle East were not particularly different. Could this have been a result of the fact that we considered until now only wage data for the large city of Istanbul? The answer is probably negative, as Özmucur and Pamuk (2002) showed that wages in Istanbul were in fact quite representative of Middle Eastern cities, with some cities (such as Edirne, Bursa, Damascus, and Jerusalem) having higher and other cities having lower estimated real wages.

Is the result for GDP per capita similar if we exclude the richest decile of Europe? When comparing Belgium, Italy, and Spain with the Middle East, we found no country composition effect: those three countries from the poorer part of Europe were still much richer than the Middle East (Figure 8). Assuming that both real wages and GDP estimates reflect the purchasing power of the respective social strata, we thus conclude that Western Europe must have had much stronger income inequality. The Middle East had some proximity advantages which made its population taller during the pre-1880 period. But its urban lower classes had similar purchasing power as those in the poorer four fifths of Europe. In contrast, urban merchants, factory owners, large land-owners, highly qualified engineers, other professionals, and similarly well-to-do persons who might have increased GDP per capita in

Western Europe were probably substantially poorer in the Middle Eastern regions in relative terms. And what happened after 1950? The Middle East had a substantial increase of GDP per capita particularly from 1950 to 1970, but the economic development in the industrializing countries was even stronger (Figure 6).

Conclusion

This study enlarges our understanding of the Middle Eastern biological standard of living in the nineteenth and early twentieth centuries by providing anthropometric estimates for eight countries of this world region. We have to admit that the data might potentially contain more measurement errors than height studies from industrializing countries, as we had to rely partly on anthropological surveys which reported heights in an aggregated way. Unfortunately, for the Middle East, military records are not available. Our research in the Ottoman archive in Istanbul showed that heights in the Ottoman military were only recorded as "tall-middle-short" without clear definition of those categories. Heights of prisoners were only exceptionally recorded by Western anthropologists and included in our sample. Hence no large-scale individual height records from archival records can be expected from the typical sources. Here the choice is between either leaving a large blank spot on the anthropometric history world map or else undertaking a challenging exploration into these important world regions. We clearly suggest the latter strategy. Moreover, our dataset also has strengths, as for example half of the underlying data comes from a Turkish study which was drawn representatively for the whole population. Robustness tests showed that also the anthropometric estimates of the other countries might be quite reliable, at least for obtaining an idea of the general level of heights. Also, the development over time was quite similar in the main countries under study, which again suggests relatively robust estimates.

In general, Middle Eastern height values were higher than those of industrializing countries in the mid-nineteenth century. During the early stages of modern economic growth, the Middle Eastern regions enjoyed some of the well-known "advantages of proximity" to animal husbandry, as a substantial proportion lived in regions specialized in this agricultural activity. Those people were taller than other populations in a situation in which some protein-rich, but less highly valued products of animal farming (offal and milk, for example) could not be shipped at sufficiently low cost. It fits into this picture that desert inhabitants in Iraq were 1.3 cm taller than those from other rural regions. Moreover, in Egypt desert populations had a 1 cm advantage over urban dwellers, and for all eight countries the height advantage of desert people was 0.6 cm (significant at the 0.10 level). The share of nomadic people in Iraq declined from 35 percent to 5 percent, suggesting that the share of people enjoying those "advantages of proximity" declined between 1867 and 1947 (Issawi 1966, p. 158). This is important for the understanding of the industrializing economies as well, because inhabitants of industrializing cities sometimes had higher purchasing power of tradable goods, but did not have these proximity advantages (Komlos 1998, Baten 1999, Baten and Murray 2000). In the Middle East, substantial parts of the population lived as Bedouins, who initially benefited from those advantages, but after the late nineteenth century European urban industrial populations could buy cheap proteins and were advantaged by improving disease environments during the twentieth century. This was the period when the Western industrializing countries overtook the Middle Eastern populations, especially so, as its urban populations could not benefit sufficiently, because industrial development and income growth took place much later (Pamuk 2006, Issawi 1995). During the late nineteenth century the industrial countries started to overtake the Middle East in terms of net nutritional status. Afterwards, a strong divergence was observable. In this study we have been able for the first time to identify the point in time when the Middle East fell back relative to industrializing countries.

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Table 1: Population densities in selected European and Middle Eastern countries

	Population density			Population per arable land		
	1820	1870	2003	1820	1870	2003
Germany	70	110	231	199	314	681
Italy	67	93	192	153	212	698
United Kingdom	87	129	247	295	436	981
Czechoslovakia	97	129	199	236	314	496
Iraq	2	4	56	24	34	448
Yemen	5	5	37	205	225	1,344
Middle East (8 countries)	8	10	99	79	110	996

Note: “Middle East (8 countries)” is weighted with population size. „Arable land“ refers to 1961 for 1820 and 1870, and to 2003 for 2003. Source: Maddison (2001), World Bank (1995), www.worldbank.org, accessed May 5th, 2008.

Table 2: Anthropometric data sources for the birth decades of the 1850s to 1910s

Country	Height sources
Egypt	Ammar (1944), Chantre (1904), Craig (1911), Field (1952b), Orensteen (1915)
Iran	Weissenberg (1913), Field (1939), Pardini (1975)
Iraq	Field (1929, 1931, 1936, 1940, 1951, 1952a, 1956)
Palestine/Israel	Genna (1938), Gloor (1950), Vallois (1964),
Lebanon	Seltzer (1936, 1940), Shanklin (1935, 1946)
Syria	Seltzer (1940), Shanklin (1936, 1938), Weissenberg (1911)
Turkey	Inan (1939), Chantre (1895), Wagenseil (1925), Crowfoot (1900), Field (1956)
Yemen	Weissenberg (1909), Cipriani (1938), Thomas (1929, 1931, 1932)

Table 3: Whipple Indices of our sample in comparison with census data

Country	Birth decade	Sample	Census	N (sample)
Iraq	1900	325	237	231
Iraq	1910	300	226	30
Iran	1890	367	228	60
Iran	1900	308	239	99
Iran	1910	228	198	46
Turkey	1850	297	361	37
Turkey	1860	315	315	54
Egypt	1870	330	451	47
Mean		309	282	
For comparison:				
United Kingdom	1850		115	
Poland	1850		149	
Dominican Rep.	1910		221	
Nigeria	1910		304	
India	1910		367	
Pakistan	1910		412	

Note: Iraq 1910 and Iran 1910 refer to age 20-49 (otherwise observations would be less than 30).

Source: we thank Dorothee Crayen and Joerg Baten for friendly providing the Whipple Indices based on censuses (males). See also Table 2. Abbreviations: see Table 2.

Table 4: Number of height observations by country, birth decade, and individual versus grouped data

	1850	1860	1870	1880	1890	1900	1910	Total
Egypt	738	109	9447					10,294
	22	145	28	36				231
Iraq					1733	740		2473
			20	78	165	394	30	687
Iran	119							119
			30	50	61	99	46	286
Israel/Pal.	381	640						1021
								0
Lebanon	1066	415						1481
								0
Syria	1581	282						1863
								0
Turkey				4402	5098	7014	12,478	28,992
	39	63	37	23	28	2		192
Yemen	38	40						78
			22	30	10	18		80
	3984	1694	9584	4619	7095	8267	12,554	47,797

Notes: Grouped data are grey-shaded. Sources: Table 2.

Table 5: Raw height average by country and birth decade

Country	1850	1860	1870	1880	1890	1900	1910
Egypt	166.44	167.82	166.92	163.55			
Iraq				168.55	166.52	168.85	165.73
Iran	165.34		165.82	163.44	165.44	166.83	166.08
Israel/Palestine	168.42	168.63					
Lebanon	166.58	167.23					
Syria	166.35	168.03					
Turkey	168.82	168.94	168.34	167.39	168.41	168.40	167.70
Yemen	162.45	161.30		158.80			

Note: Height averages are weighted by the number of observations. Only cases with N>30 shown.

Sources: Table 2.

Table 6: Height averages by region type and country

Country	Coast	Desert	Other rural	Urban	Desert minus urban
Egypt	167.03	166.92	166.99	165.79	1.13
Iraq		168.78	166.71	167.92	0.85
Iran			166.03	164.59	
Israel/Palestine	168.06		168.00	168.73	
Lebanon	166.76				
Syria	167.16		165.93	168.10	
Turkey	168.12		167.95		
Yemen	161.45				

Note: Height averages are weighted by the number of observations. Only cases with N>30 shown.

Sources: Table 2.

Table 7: Weighted Least Square regressions of heights in the Middle East

	(1)	p-value	(2)	p-value	(3)	p-value
Coast	0.18	0.66				
Desert	0.56*	0.09				
Large urban	-0.11	0.81				
Jews	-2.56***	0.00	-2.47***	0.00		
Age 20	-0.52***	0.00	-0.52***	0.00	-0.51***	0.00
Migrant	-0.24	0.63	-0.33	0.29		
Syria 1850	-1.61**	0.01	-1.61***	0.01	-1.60***	0.01
Syria 1860	0.03	0.96	0.07	0.88	0.08	0.86
Lebanon 1850	-1.50***	0.00	-1.38***	0.00	-1.37***	0.00
Lebanon 1860	-0.79**	0.03	-0.73***	0.00	-0.72***	0.00
Iran 1850	-2.62**	0.02	-2.62**	0.02	-2.61**	0.02
Iran 1870	0.31	0.81	0.33	0.80	-2.13*	0.07
Iran 1880	-2.76***	0.00	-2.84***	0.00	-4.51***	0.00
Iran 1890	-1.97**	0.01	-2.03**	0.01	-2.51***	0.00
Iran 1900	-0.48	0.54	-0.55	0.46	-1.12	0.13
Iran 1910	-0.76	0.38	-0.83	0.32	-1.63**	0.04
Iraq 1870	0.93	0.51	1.31	0.34	1.32	0.34
Iraq 1880	0.42	0.50	0.60	0.32	0.61	0.31
Iraq 1890	-1.35***	0.00	-1.30***	0.00	-1.43***	0.00
Iraq 1900	0.61	0.12	0.95***	0.01	0.96***	0.01
Iraq 1910	-1.80	0.11	-1.91*	0.07	-1.91*	0.07
Yemen 1850	-5.69***	0.00	-5.51***	0.00	-5.50***	0.00
Yemen 1860	-6.83***	0.00	-6.66***	0.00	-6.65***	0.00
Yemen 1880	-7.18***	0.00	-7.01***	0.00	-9.15***	0.00
Yemen 1890	-5.23***	0.00	-5.06***	0.00	-5.05***	0.00
Yemen 1900	-5.96***	0.00	-5.78***	0.00	-5.78***	0.00
Yemen 1850	0.71	0.41	0.86	0.29	0.87	0.28

Turkey 1860	1.11	0.14	1.22*	0.08	1.00	0.16
Turkey 1870	2.13**	0.03	2.15**	0.02	0.49	0.57
Turkey 1880	-0.56***	0.00	-0.56***	0.00	-0.56***	0.00
Turkey 1890	0.46***	0.00	0.46***	0.00	0.46***	0.00
Turkey 1900	0.45***	0.00	0.45***	0.00	0.46***	0.00
Israel/Pal. 1850	1.11***	0.00	1.08***	0.00	0.47	0.22
Israel/Pal. 1860	0.90***	0.01	0.90***	0.00	0.68***	0.00
Egypt 1850	-1.60***	0.01	-1.51**	0.01	-1.50**	0.01
Egypt 1860	-0.26	0.51	-0.14	0.73	-0.13	0.75
Egypt 1870	-1.07***	0.00	-1.04***	0.00	-1.03***	0.00
Egypt 1880	-4.96***	0.00	-4.41***	0.00	-4.40***	0.00
Constant	167.95***	0.00	167.96***	0.00	167.95***	0.00
N (Original)	47,797	0.00	47,797	0.00	47,797	0.00
R-squared	0.32		0.31		0.30	

Notes: Robust p-values in parentheses. ***, **, * significant at the 0.01 , 0.05 level, 0.10 level respectively. Intercept represents a 20-50 year old male who was born in Turkey in 1910 (Col. 1-3), in a “other” rural province (Col. 1), and who was not migrant or Jewish (Col. 1 and 2). N(Original) refers to the underlying, originally measured persons. The number of different height figures (counting grouped data as 1) is 1,595, 1,476 individual and 119 grouped. Sources: Table 2.

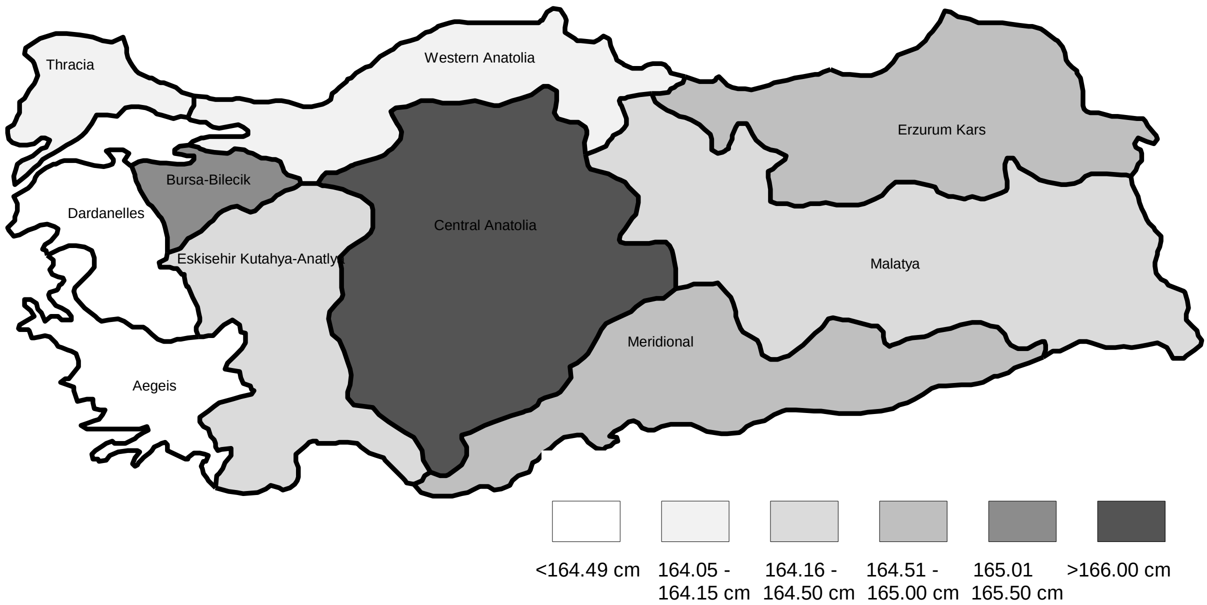
Table 8: Was the difference between the Middle East and various European countries statistically significant?

Comparison sample	Italy	Italy	Germany-SE (prison)	Germany-SE (prison)	Germany-SW (cons.)	Germany-SW (cons.)
Birth decade	1850s	1860s	1850s	1860s	1850s	1860s
Middle East	2.086***	3.487***	1.338	2.279***	2.742***	3.627***
	(0.81)	(0.47)	(0.89)	(0.66)	(0.91)	(0.57)
Constant	165.9***	165.2***	166.2***	166.4***	164.8***	165.1***
	(0.11)	(0.17)	(0.52)	(0.47)	(0.55)	(0.34)
Observations	4241	2157	241	369	182	556
R-squared	.	.	0.01	0.03	0.05	0.07

Comparison sample	Germany-SW (cons.)	Germany-SW (cons.)	Germany-SE (cons.)	Czech lands	Czech lands	Czech lands	Czech lands
Birth decade	1870s	1880s	1850s	1850s	1860s	1870s	1880s
Middle East	0.560	-0.178	1.386*	2.906**	3.217***	0.587	-0.683
	(0.58)	(0.69)	(0.80)	(1.30)	(0.80)	(0.82)	(1.06)
Constant	165.7***	165.0***	166.2***	164.7***	165.5***	165.6***	165.5***
	(0.31)	(0.55)	(0.35)	(1.08)	(0.66)	(0.66)	(0.97)
Observations	562	337	429	98	293	254	262
R-squared	0.00	0.00	0.01	0.05	0.05	0.00	0.00

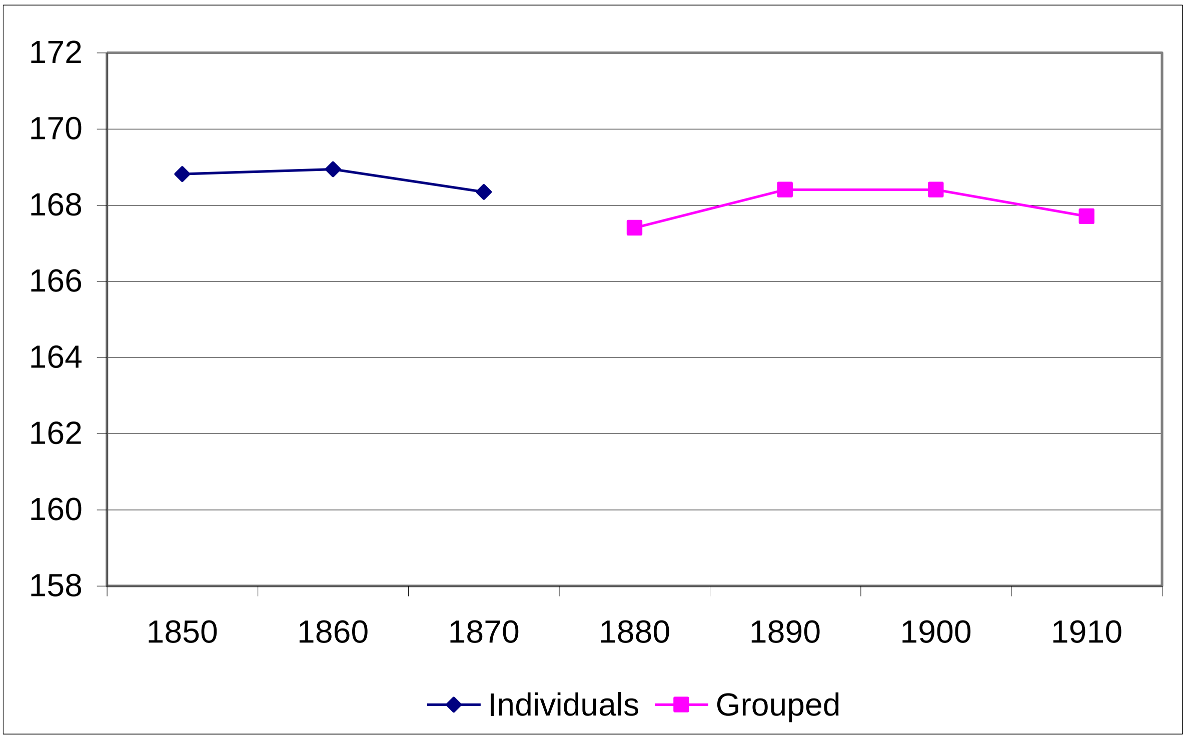
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; Notes: the standard deviations of Italy in the truncated regression model are estimated -- quite plausibly -- as 5.784 (1850) and 6.006 (1860). R-square for Italy is not reported, as this cannot be calculated for this truncation model. The number of cases refers to both Middle East and European comparison samples, for the number of cases on the Middle East, see Table 4. Abbreviation: “cons.”= conscript. Reported is always the coefficient for Middle East (ME) in pooled samples of Middle East and European samples. For sources on European heights, see http://www.uni-tuebingen.de/uni/wwl/dhheight.html

Figure 1: Regional mean stature of Turkish males, 1850-1910



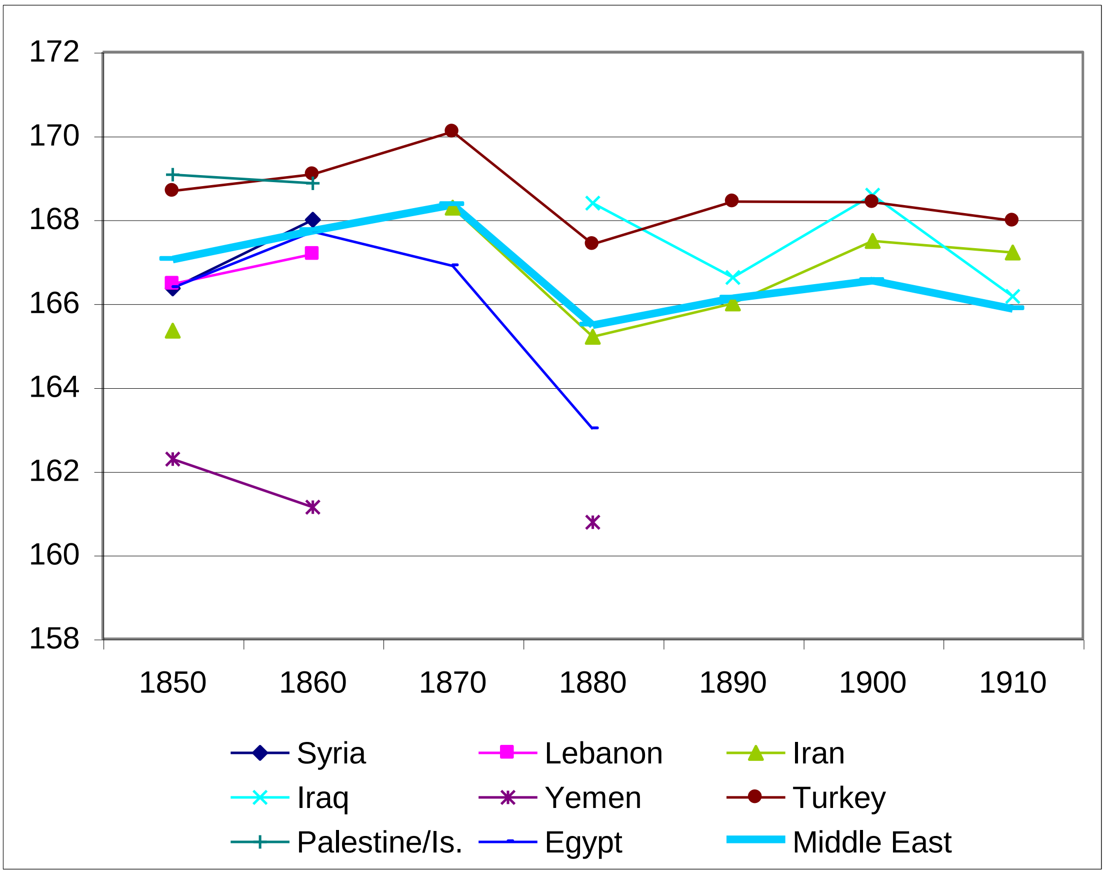
Note: due to the inclusion of elderly persons, the height levels are too low. Only the ranking between regions is informative. Source: processed from Inan (1939).

Figure 2: Individual and grouped data for Turkey



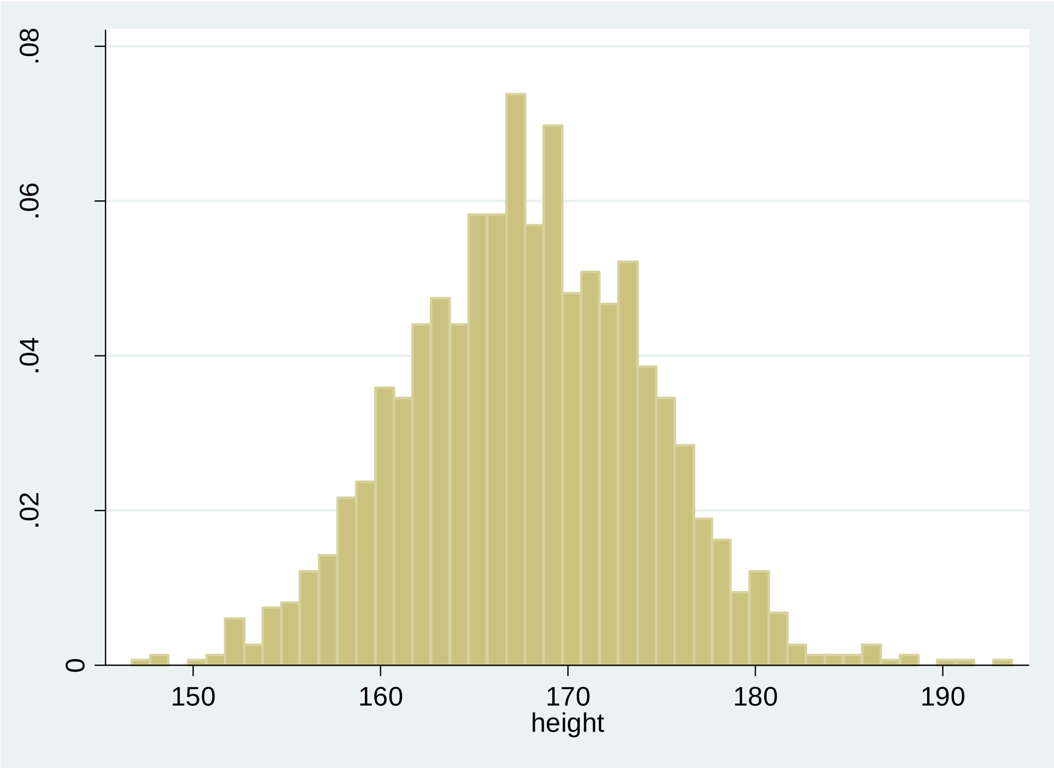
Notes: for the vertical axis, the same height interval is taken as in Figure 3. Only cases with N>30 are reported. Source and Abbreviations: Table 2.

Figure 3: Height Development in the Middle East (regional, migratory, and religious controls included)



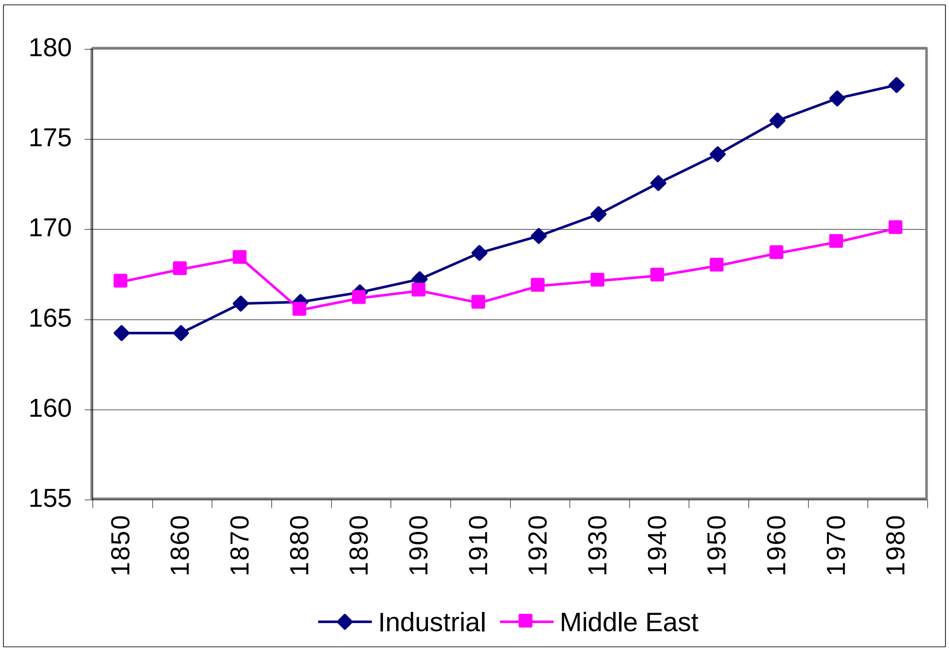
Notes: Source and Abbreviations: Table 2. Iraq 1870, Yemen 1870, 1890 and 1900 is not shown, because N is less than 30.

Figure 4: Distribution of individual height (males)



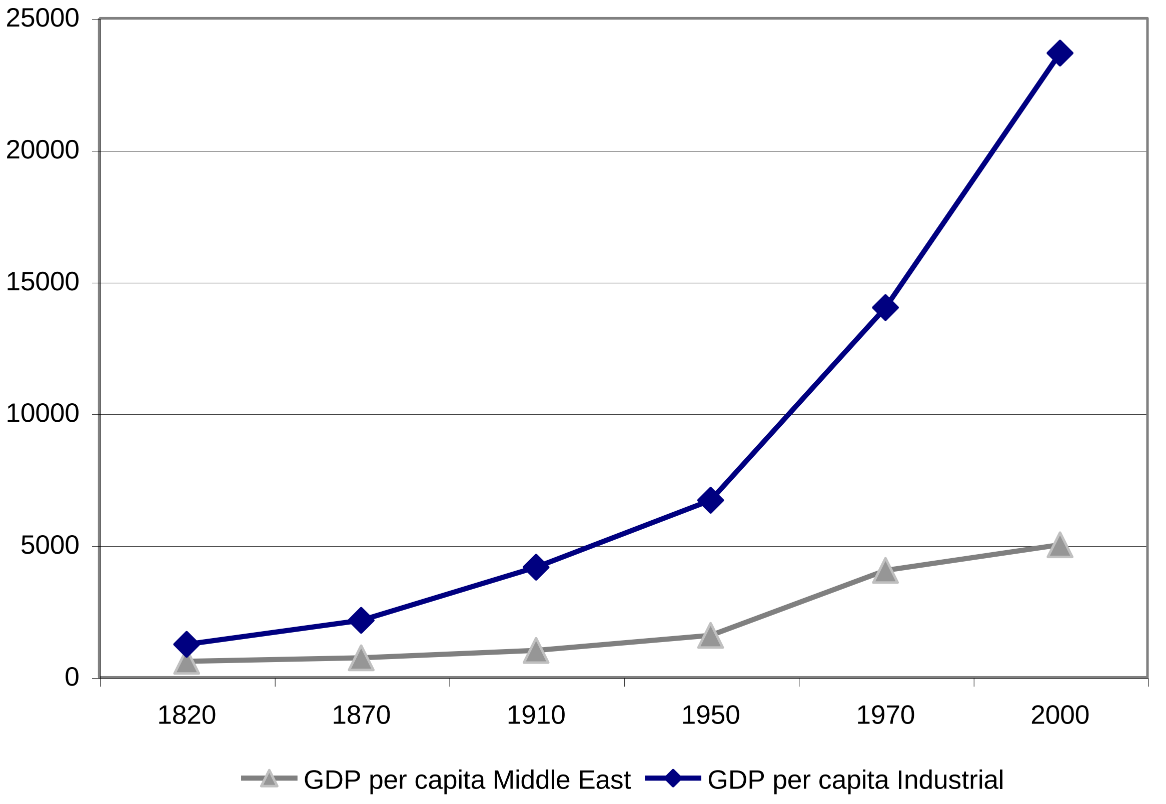
Sources: see Table 2

Figure 5: Heights trend in the Middle East and industrializing countries (weighted by population size)



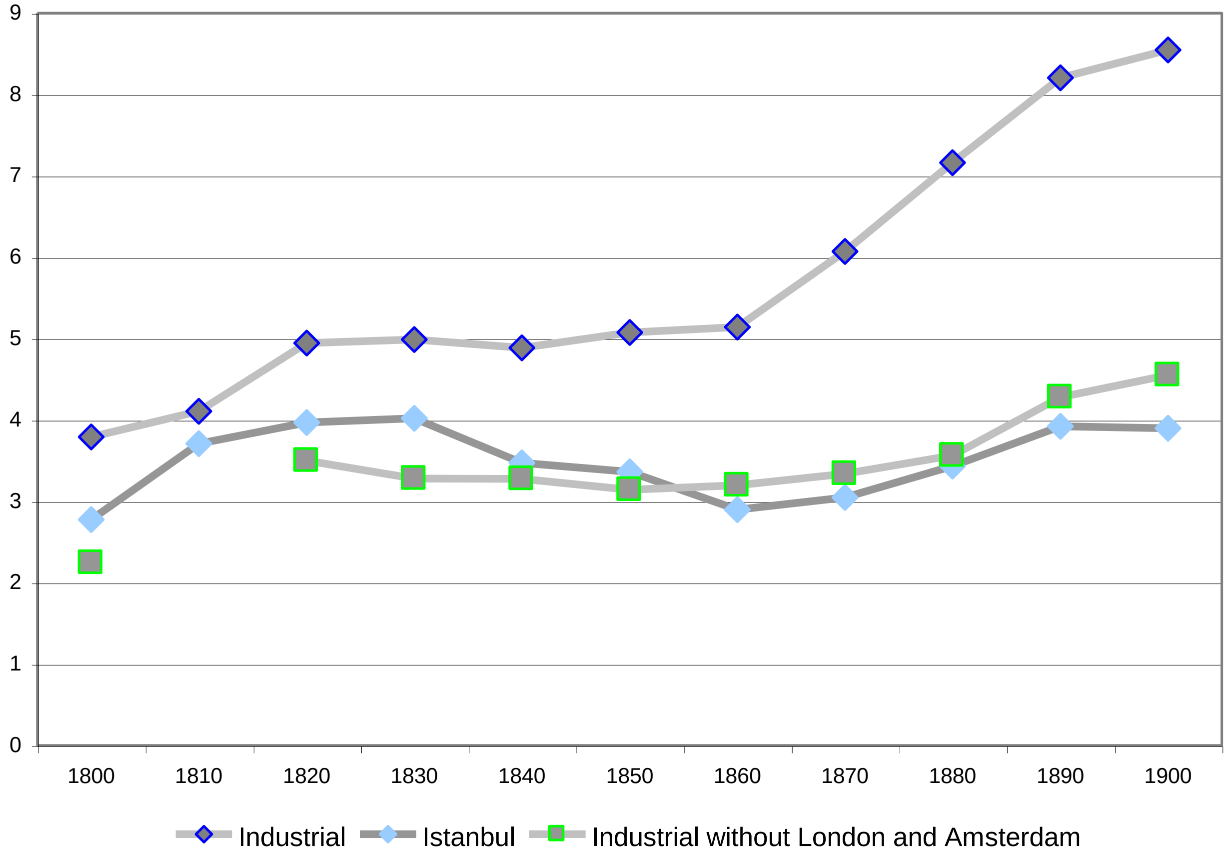
Sources: for 1850-1910: see Table 2; for 1940-1980: Baten (2006), based on Demographic and Health surveys (DHS); Janghorbani et al. (2007). The 1920s and 1930s for Middle East are interpolated.

Figure 6: GDP per capita in 1990 PPP Dollars (weighted by population size)



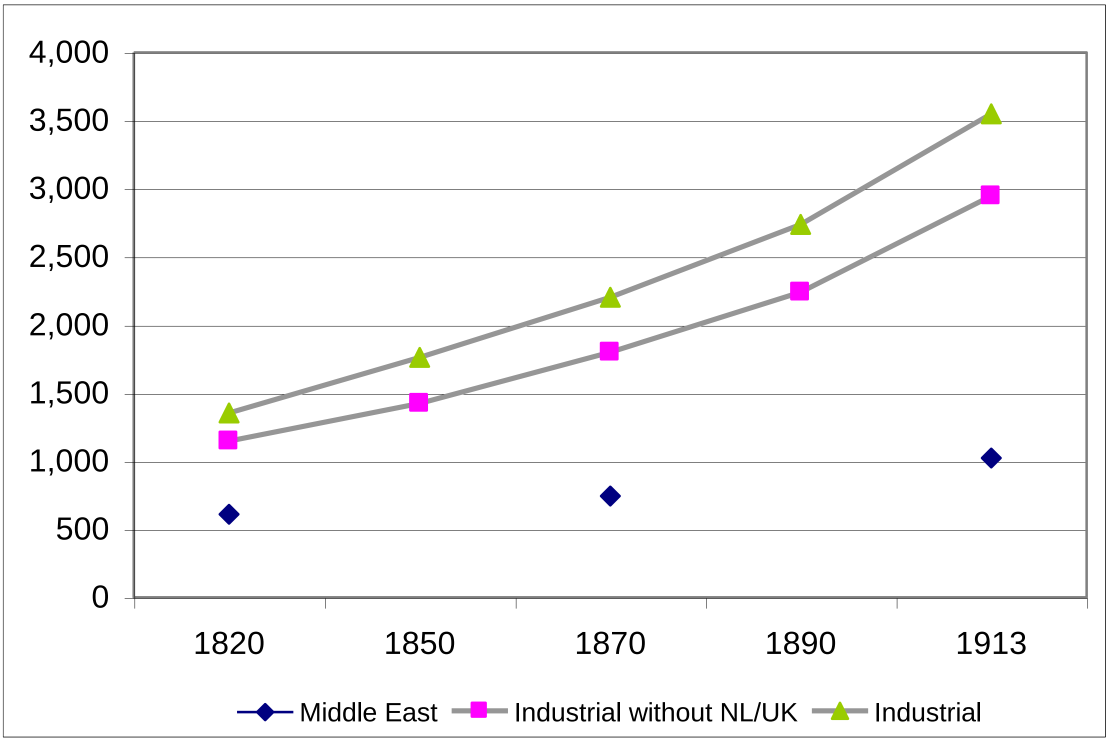
Source: S. Pamuk (2006)

Figure 7: Real wages in Istanbul and industrializing countries in grams of silver per day (weighted by population size)



Sources: Istanbul: S. Özmucur, S. Pamuk (2002), industrializing countries: Allen (2001)

Figure 8: GDP per capita (1990 International Geary-Khamis dollars)



Source: Maddison (2001); Pamuk (2006).