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Major correlates of male height: A study of 105 countries

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ABSTRACT

The purpose of this study is to explore the main correlates of male height in 105 countries in Europe & overseas, Asia, North Africa and Oceania. Actual data on male height are compared with the average consumption of 28 protein sources (FAOSTAT, 1993–2009) and seven socioeconomic indicators (according to the World Bank, the CIA World Factbook and the United Nations). This comparison identified three fundamental types of diets based on rice, wheat and milk, respectively. The consumption of rice dominates in tropical Asia, where it is accompanied by very low total protein and energy intake, and one of the shortest statures in the world (~162–168 cm). Wheat prevails in Muslim countries in North Africa and the Near East, which is where we also observe the highest plant protein consumption in the world and moderately tall statures that do not exceed 174 cm. In taller nations, the intake of protein and energy no longer fundamentally rises, but the consumption of plant proteins markedly decreases at the expense of animal proteins, especially those from dairy. Their highest consumption rates can be found in Northern and Central Europe, with the global peak of male height in the Netherlands (184 cm). In general, when only the complete data from 72 countries were considered, the consumption of protein from the five most correlated foods ($r = 0.85$) and the human development index ($r = 0.84$) are most strongly associated with tall statures. A notable finding is the low consumption of the most correlated proteins in Muslim oil superpowers and highly developed countries of East Asia, which could explain their lagging behind Europe in terms of physical stature.

1. Introduction

In our previous study (Grasgruber et al., 2014), we identified nutrition and genetics as the strongest correlates of height among contemporary young men from 42 European and three overseas countries (Australia, New Zealand and the USA). Out of all the socioeconomic factors that were examined, only children's mortality approached the significance of nutrition and genetics, which points to the importance of a disease-free environment. Improved nutrition and better healthcare are direct consequences of improving living standards that accompanied the process of the industrial revolution (Hatton, 2013).

In the present study, we aim to extend this research to North Africa, Asia and Oceania. These regions include mostly developing countries, but Muslim oil superpowers (Bahrain, Brunei, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates/UAE) and some developed countries of East Asia (Japan, Singapore, South Korea, Taiwan) currently belong to the wealthiest in the world, with the gross domestic product (GDP) per capita higher than 30,000 USD (World Bank, 2013), not to mention the semi-independent territory of Hong Kong. Interestingly, male height in some of these regions (Arab countries of North Africa and the Near East) was once similar or even higher than in Europe, but after the 1880s it started to lag

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behind considerably (Stegl and Baten, 2009). On the other hand, wealthy nations of East Asia are still known for their surprisingly small stature, despite very high values of the GDP per capita (Baten and Blum, 2014). Therefore, it would be important to identify the main factors that currently distinguish these regions from Europe.

As we did similarly in our previous study, we plan to explore the correlation of factors such as nutrition, healthcare and national wealth with the height of contemporary young men. Genetic factors (frequencies of Y haplogroups) are included as well, but in a supplementary function, because no Y haplogroup is shared in appreciable frequencies across the whole area of Europe, North Africa, Asia and Oceania.

2. Methods

2.1. Collection of anthropometric data

The selected regions of North Africa, Asia and Oceania encompass 63 countries (including three semi-independent territories–American Samoa, French Polynesia, Hong Kong), for which data on body height were researched. In Oceania, only more populous countries with a population size exceeding 50,000 inhabitants were considered, because statistics were not available for small island nations. Preferably, we searched for anthropometric data on young, mature men aged 18–30 years (but ideally 20–25 years) from the time after the year 2000. Only surveys that incorporated at least 50 individuals were used, but whenever possible, nationwide surveys with more than 200 individuals were preferred. The only samples with fewer than 100 individuals were from Guam ($n = 59$) and Algeria ($n = 55$)[1]. By far the most representative data (regular measurements of recruits) were available from Israel, but paradoxically, they were the most problematic due to the inclusion of young immigrants, who were not born and raised in Israel[2].

The majority of surveys included in our study are nationwide health surveys incorporating all social groups. Some other surveys had certain limitations. Six of them (from Bhutan, Laos, Libya, Oman, the Maldives and Syria) incorporate an urban population from a single city. The sample from Libya consists of patients visiting a hospital in Derna. Three surveys (from Saudi Arabia, the United Arab Emirates and the Federative States of Micronesia) come from a specific region of the country. The sample from North Korea includes refugees. In the case of Afghanistan, Kyrgyzstan, Pakistan, Tajikistan and Turkmenistan, the male height was estimated, based on highly representative studies of local women. The height in Kazakhstan (175.6 cm) was computed from the data of Facchini et al. (2007). (See Appendix: Methods for a more detailed discussion.)

Due to the scarcity of information from some countries, certain compromises needed to be made. This especially concerns the STEPS surveys (Noncommunicable Disease Risk Factor Surveys) performed by the World Health Organization (WHO), which rarely include people younger than 25 years and routinely start with the age category of 25–34 years. Nevertheless, it is unlikely that the inclusion of older subjects would markedly distort our results, because the pace of the secular trend in the majority of the examined countries is very slow or almost non-existent.

Besides that, some means of male height from our previous study were updated. This update relates to Bosnia and Herzegovina, Bulgaria, the Czech Republic, Georgia, Moldova and Ukraine (see Appendix: Methods and Appendix Table 1). Recent anthropometric data were even obtained from Armenia, but they did not seem to be sufficiently representative. Nevertheless, they indirectly supported the accuracy of our male estimate based on DHS 2005 (171.9 cm)[3].

Altogether, information on body height was collected from 61 out of 63 targeted countries (Table 1). Only data from Macau and New Caledonia were missing[4]. Our list also includes the Maori, but considering that they make up a minority in New Zealand, this sample was not useable.

2.2. Collection of nutritional and sociodemographic data

The information about the average daily protein consumption (in grams) was computed from FAOSTAT.org[5]. The statistics on the gross domestic product (GDP) per capita (by purchasing power parity/PPP, in current international USD), health expenditure per capita (by PPP, in constant 2005 international USD), urbanization (% of urban population), children's mortality under 5 years (per 1000 live births) and total fertility rate (births per woman) were taken from the World Bank[6], and the Gini index of social inequality from the CIA World Factbook[7]. In addition, we included the human development index (HDI) that is regularly calculated by the United Nations[8]. Since 2010, the HDI has been computed

[1] Large samples of young men from Algeria, Morocco and Tunisia were recently measured within the epidemiological survey ETHNA, but the authors were reluctant to share the data.

[2] A large sample of 2.1 million Israeli men born between 1950 and 1993 included only 5.7% men born in Israel, but 53.1% of the men came from Africa or Asia (Meydan et al., 2013).

[3] According to "Tables for evaluation of physical development of 16–25 years old boys and girls in the Republic of Armenia (guidance for medical doctors)" published in 2010 (A. Tadevosyan—pers. communication), the average height in the age category 21–25 years was 176.1 cm in men ($n = 157$) and 162.9 cm in women ($n = 210$). However, the average height of Armenian women aged 20–24 years in DHS 2005 was only 159.2 cm ($n = 1066$). This strongly suggests that we are dealing with the data of university students, which was also indicated by other surveys provided by A. Tadevosyan that examined students from elite educational institutions. More importantly, the male/female ratio in the above mentioned survey was 1.081, which agrees with the ratio 1.08 that was used in our previous study for the estimation of male height in Armenia.

[4] The most recent sample from New Caledonia that we were able to find came from 1991. A sample of 495 men aged 30–32 years reached 171.0 cm (A. Cournil—pers. communication).

[5] FAOSTAT, http://faostat3.fao.org/download/FB/CC/E.

[6] The World Bank, http://data.worldbank.org/topic. Statistical data of GDP per capita from Taiwan (Republic of China) were specially requested from the World Bank.

[7] The CIA Factbook, https://www.cia.gov/library/publications/the-world-factbook/fields/2172.html.

[8] Human development statistical annex (2011), http://www.undp.org/content/dam/undp/library/corporate/HDR/2011%20Global%20HDR/English/HDR_2011_EN_Tables.pdf