Four Empirical Essays on the Economics of Height

INAUGURAL-DISSERTATION

zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München

2008

vorgelegt von
Martin Hiermeyer

Referent: Prof. John Komlos, Ph.D.
Korreferent: Prof. Dr. Ekkehart Schlicht
Promotionsabschlussberatung: 4. Februar 2009

Four Empirical Essays on the Economics of Height

INAUGURAL-DISSERTATION

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of
Doctor oeconomiae publicae (Dr. oec. publ.)
at the Ludwig-Maximilians-University Munich

2008

Martin Hiermeyer

Thesis Supervisor:	Prof. John Komlos, Ph.D.
Thesis Co-Supervisor	Prof. Dr. Ekkehart Schlicht
Final Committee Consultation:	February 4th, 2009

To Milenka

Acknowledgements

First and foremost, I would like to thank my supervisor, Professor John Komlos, for his outstanding support and academic guidance. I am deeply indebted to him for taking such an extraordinary amount of time to comment on each of my papers. I cannot imagine better support.

I am also very grateful to Professor Ekkehart Schlicht for his feedback and for kindly accepting to be co-supervisor. Furthermore, I would like to thank Professor Joachim Winter for agreeing to complete my thesis committee as third examiner.

Special thanks go to my former and current colleagues Ariane Breitfelder, Francesco Cinnirella, Arne Kues, Marco Sunder, Gordon Winder, and Matthias Zehetmayer for valuable comments and for providing me with a very pleasurable work and research environment. I would also like to thank the participants of various research workshops at the University of Munich, in particular Jörg Baten, Roberto Cruccolini, Helmut Küchenhoff, Elmar Nubbemeyer, and Christoph Stoeckle.

I am grateful to Detlef Kaltwasser (Statistisches Bundesamt), Rainer Lüdde (Institut für Wehrmedizinalstatistik und Berichtswesen), Steve McClaskie (US Bureau of Labor Statistics), and Heribert Stolzenberg (Robert-Koch-Institute) for helping me to fully understand the data sets used in this dissertation.

Parts of this doctoral thesis were written during my research stay at the University of Cambridge. I am particularly indebted to Sheilagh Ogilvie who served as my supervisors there. I also owe gratitude to Christian Grisse, Gisela Jäger, Cherie Lee, and Craig Peacock. Financial support from Deutscher Akademischer Austauschdienst (DAAD), grant no. D/07/41734, is gratefully acknowledged.

Last but certainly not least I would like to thank my whole family.

Table of Contents

1.	Introduction	12
1.1	The Economics of Height	13
1.2	References	16
2.	The Correlation between Height and Wages, a Conundrum Explored	18
2.1	Abstract	19
2.2	Introduction	19
2.3	Data	21
2.4	The relationship between height and wages in the NLSY 97	31
2.5	Parental income during adolescence and adult height	32
2.6	Channels	34
2.7	Conclusion	38
2.8	References	39
2.9	Appendix	48
3.	The Trade-off between a High and an Equal Biological Standard of Living – Evidence from Germany	50
3.1	Abstract	51
3.2	Introduction	51
3.3	Data	53
3.4	Level of the biological standard of living in East and West Germany before and after unification	56
3.5	Regional height convergence in East and West Germany	68

3.6 Inequality in the biological standard of living in East and West Germany before and after unification 72

3.7 Regional equality convergence in East and West Germany 83

3.8 Conclusion 84

3.9 References 86

3.10 Appendix 93

4. The Height and BMI values of West Point Cadets after the Civil War 95

4.1 Abstract 96

4.2 Introduction 96

4.3 Data 97

4.4 Results 98

4.5 Conclusion 106

4.6 References 108

4.7 Appendix 113

5. Height and BMI values of German conscripts in 2000 and 2001 117

5.1 Abstract 118

5.2 Introduction 118

5.3 Data 119

5.4 Results 122

5.5 Historical comparison 129

5.6 Conclusion 137

5.7 References 139

5.8 Appendix 143

Eidesstattliche Versicherung 146

Curriculum Vitae 147

List of Tables

Table 2.1: Characteristics of the NLSY sample 22

Table 2.2: OLS estimates, dependent variable: log hourly wage of US-born individuals who worked 1,000 hours or more in 2004, age 19-24 31

Table 2.3: OLS estimates, dependent variable: adult height of US-born individuals, age 19-24 32

Table 2.4: OLS estimates, dependent variable: adult height of white US-born females, age 19-24 36

Table A2.1: Survey year and NLSY code for variables used in the paper 48

Table 3.1: OLS estimates, dependent variable: adult height of 1930-79 birth cohorts 59

Table 3.2: Pre-unification OLS estimates, dependent variable: adult height of 1940-69 birth cohorts 63

Table 3.3: Post-unification OLS estimates, dependent variable: adult height of 1980-1983 birth cohorts 64

Table 3.4: Separate OLS estimates for West and East Germany, dependent variable: adult height of 1940-69 birth cohorts 67

Table 3.5: OLS estimates, dependent variable: difference in average height between the 1946-49 and the 1976-79 birth cohorts 71

Table 3.6:	OLS estimates, dependent variable: difference in the coefficient of variation for height between the 1946-49 and the 1976-79 birth cohorts	83
Table A3.1:	Characteristics of the sample after excluding all observations without height information	93
Table 4.1:	OLS estimates, dependent variables: height and BMI of West Point cadets (age 16-21) born 1860 to 1884	99
Table A41:	Characteristics of the combined and new sample	113
Table 5.1:	OLS estimates, dependent variables: adult height and BMI of German recruits, 2000 and 2001	122
Table A5.1:	Characteristics of the sample	143
Table A5.2:	Provinces of the German Empire and today's states and regions	144

List of Figures

Figure 2.1:	Scatter diagram between height at age 14 and adult height for white, US-born individuals	25
Figure 2.2:	Histogram of female (left panel) and male (right panel) height, 14-year old, US-born individuals	27
Figure 2.3:	Histogram of female (left panel) and male (right panel) adult height, US-born individuals only	28
Figure 2.4:	Comparison of NLSY 97 and NHANES 1999-2004 growth profiles, US-born individuals only	29
Figure 2.5:	Average adult height of white US-born females with parents of average height as a function of parental yearly gross household income during adolescence	34
Figure 2.6:	Average adult height of white US-born females with parents of average height and average income as a function of doctor visits	37
Figure A2.1:	US Census Regions	49
Figure 3.1:	Comparison of Mikrozensus and Bundesgesundheitssurvey average adult height, by year of birth, East and West Germany	54
Figure 3.2:	Male-to-female height ratio, by year of birth, East and West Germany	55
Figure 3.3:	Average height by state, 1960-67, 1968-75, and 1976-83	56
Figure 3.4:	Regional differences in height after controlling for demographics, average town size and average income, 1930-79 birth cohorts	61
Figure 3.5:	Comparison of adult height of East and West German females who grew up before and after unification assuming average income and urbanization	65

Figure 3.6: Height difference between West and East Germans as a function of town size (1940-69 birth cohorts) 68

Figure 3.7: Height convergence in East and West Germany, 1946-79 to 1976-79 birth cohorts, 88 sub-regions 69

Figure 3.8: Regional differences in equality, as measured by the coefficient of variation of height, 1930-79 birth cohorts 73

Figure 3.9: Average coefficient of variation by state, 1960-67, 1968-75, and 1976-83 74

Figure 3.10: Male-to-female coefficient of variation ratio, by year of birth, East and West Germany 77

Figure 3.11: Pre-unification coefficient of variation for height in West and East Germany (1940-69 birth cohorts) 78

Figure 3.12: West-East difference in the pre-unification coefficient of variation for height as a function of income (1940-69 birth cohorts) 79

Figure 3.13: West-East difference in the pre-unification coefficient of variation for height as a function of town size (1940-69 birth cohorts) 80

Figure 3.14: Post-unification coefficient of variation for height in West and East Germany 81

Figure A3.1: Coefficient of variation for height in West and East Germany, by year of birth 94

Figure 4.1: Average final heights of American male populations 101

Figure 4.2: Height of 20 year old West Point candidates (cm) born 1875-79, by region 102

Figure 4.3: Trend in BMI for 20-year old West Point cadets and Citadel students 103

Figure 4.4: BMI of 20 year old West Point candidates (cm) born 1875-79, by region 104

Figure 4.5: BMI values of 20-year old West Point cadets and Citadel students born in the 1870s, by region 105

Figure 4.6: Weight of West Point cadets and Citadel students born in 1870-85, by age 106

Figure A4.1: Histograms of regression error terms (plus constant) 115

Figure 5.1: Height and BMI distribution of German males (age 18-22) in 2000 and 2001 121

Figure 5.2: Height and BMI of German males as a function of education, 2000/01 124

Figure 5.3: Height and BMI of German males as a function of health, 2000/01 125

Figure 5.4: Height and selected geographic environmental correlates of German males in 2000 and 2001 by region, rank 127

Figure 5.5: BMI and selected geographic environmental correlates of German males in 2000 and 2001 by region, rank 128

Figure 5.6: Height of German males in 1906, by region 130

Figure 5.7: Male height in Germany 1906 and 2000/2001, by social status and region 131

Figure 5.8: Male adult height in Germany, birth cohorts of 1938 to 1976 and of 1981/1982, by region 132

Figure 5.9: Average adult height (1938 birth cohort) and increase in average adult height (1938-1982 birth cohorts), by region 133

Figure 5.10: Increase in height by region, 1906-1950 and 1951-2000 134

Figure 5.11: Male BMI in Germany, birth cohorts of 1938 to 1976 and of 1981/1982 135

Figure 5.12: Height and BMI, 1973-76 birth cohorts, by urbanization (selected areas) 136

Chapter 1: Introduction

1.1 The Economics of Height

Economists are interested in height for at least four reasons. One reason is that a correlation between heights and wages exists: On average, taller men and women earn more than their shorter peers (Ekwo et al. 1991, Averett and Korenman 1993 and Persico et al. 2004[1]). Because of that, height is usually an important control variable in any well-specified wage equation[2]. Several explanations for the correlation between heights and wages have been discussed in the literature. For example, it has been suggested that, because of interpersonal dominance derived from height, taller people can extract a premium during wage negotiations (Klein et al. 1972). Additionally, it has been argued that taller workers are preferred by employers because they consider them to be more self-confident and assertive (Martel and Biller 1987). Furthermore, according to Persico et al. (2004), tall adults are also relatively tall during adolescence, and because of that are more likely to participate in high school activities in which they obtain skills that are later rewarded in the labor market. Case and Paxson (2006), finally, suggested that taller people have better cognitive ability, and thus their higher income is a return on human capital. In the first essay, we explore another channel. We show that white high-income parents can nourish their daughters in a way so that they become relatively tall adults. With social mobility being limited, these relatively tall daughters will later, like their parents, earn relatively more, generating – at least in part – the positive correlation between heights and wages for this group.

---

[1] For a more complete list of references, see Chapter 2 of this dissertation.

[2] More recently, Mankiw and Weinzierl (2007) have also argued that because of the correlation, "one must either advocate a tax on height, or […] reject, or at least significantly amend, the conventional Utilitarian approach to optimal taxation". Their argument is that in optimal taxation theory, a Utilitarian social planner aims to transfer income from high-ability individuals to low-ability individuals, but is not able to distinguish between income earned because of ability and income earned because of effort. Since taxing income discourages effort, the planer is deterred from the fully egalitarian outcome. Only by taxing attributes that are positively correlated with ability – such as height –, the planner can get closer to the optimal solution. Based on simulations, Mankiw and Weinzierl show that the optimal tax on height is substantial. A tall person making $50,000 should pay about $4,500 more in taxes than a short person making the same income.

Authoritarian regimes such as the former GDR tend to report unreliably conventional standard of living indicators, such as income (von der Lippe, 1996, Feshbach and Friedly 1992, Morgan 1999). Accurate height information, however, is frequently available (Pak 2004). As height reflects not only nature but also nurture, the latter can serve as a proxy for conventional indicators. This is a second reason for why economists are interested in height, which in turn has been used to monitor, for example, the decline in the health of the Soviet population during the last decades of its existence, the condition of Taiwan under Japanese occupation (Olds 2003) as well as the suffering of the Chinese population during Mao-Tse Tung's 'Great Leap Forward' policy of the late 1950s and early 1960s (Komlos and Kriwy 2003). In the second essay, we use height to compare the former GDR to West Germany. We show that before unification, the GDR had a lower but more equally distributed biological standard of living than the West. On average, East Germans were shorter than their West German peers (-0.81 cm for females and -0.50 cm for males); however, their heights were distributed more equally in terms of the coefficient of variation (-0.10% for females and -0.06% cm for males). This finding is in contrast to Komlos and Kriwy (2003) who found on the basis of a different data set that height inequality was about the same. With the adoption of the West's system following re-unification, East Germany rapidly caught up in terms of efficiency (heights), but also in terms of inequality. This implies that a trade-off exists between efficiency and equality not only for conventional indicators (as has often been shown to be the case) but also for the biological standard of living.

For most of human history, conventional indicators of living standards are not available at all. National accounts, for example, were only developed during the Great Depression of the 1930s (Ruggles 1983). Information on height, on the other hand, is available as far back the 18th century[3]. Many hundreds of thousand of records from nearly all continents of the globe have been examined by now (Komlos 1991). One of the most striking findings of this research is that adult stature in the United States began to decline among the birth cohorts of the 1830s and recovered only in the 1860s. This is surprising and puzzling because according to conventional indicators the American economy was expanding rapidly during the antebellum decades (Komlos 1987, Gallman 1966). In the third paper, we use archival data on West Point cadets born just subsequent to this period in 1860-84 in order to examine the timing and the characteristics of the recovery process. We find that West Point cadets born in the 1880s were taller than those born in the 1860s (+1.46 cm) and had significantly higher BMI values (+0.85). The cadets were on average under-nourished by modern standards, with today's average reference values being about 5 BMI units higher than those of the cadets.

Well-being is inherently multidimensional, encompassing more than the mere command over goods and services (Komlos and Snowdon, 2005). Even today, height can thus contribute to a more nuanced view of the quality of life by documenting developments above and beyond the material well being of a population. This is a fourth reason why economists are interested in height. In the fourth paper, we examine the height and weight of 320,000 German 18-22 year old conscripts born between 1979 and 1982. We find that height is associated with socio-economic differences such as education. A West-East and a North-South gradient in both height and BMI is found. Today, German recruits are about 5 cm taller than their peers 40 years ago and about 12.5 cm taller than those 100 years ago, reflecting a substantial improvement in the biological standard of living. To this day, however, individuals of high socio-economic status are able to reach an above-average height.

---

[3] In general, the sources are surviving military records. Armies all over the world tended to record the height of their recruits. Similarly, some universities also collected biometric data of their students (e.g. Harvard University for parts of the 19th century, Roche, 1979)

1.2 References

Averett, S. and Korenman, S. (1993). “The Economic Reality of the Beauty Myth.” Journal of Human Resources 31: 304-30.

Case, A. and Paxson, C. (2006). “Stature and Status: Height, Ability, and Labor Market Outcomes”, NBER Working Paper No. 12466.

Ekwo, E., Gosselink, C., Roizen, N. and Brazdziunas, D. (1991). “The effect of height on family income.“ American Journal of Human Biology 3: 181-88.

Feshbach, M. and Friedly, A. (1992). “Ecocide in the USSR: Health and Nature under Siege.” Harper Collins, New York.

Gallman, R.E. (1966). “Gross National Product in the United States, 1834-1909.” In Output, Employment, and Productivity in the United States After 1800. New York: National Bureau of Economic Research.

Klein, R. E., Freeman, H. E., Kagan, J., Yarbrough, C. and Habicht, J.P. (1972). “Is big smart? The relation of growth to cognition.” Journal of Health and Social Behavior 13: 219-25.

Komlos, J. (1991). “On the Significance of Anthropometric History.” Revista di Storia Economica 11: 97-111.

Komlos, J. and Kriwy, P. (2003). “The Biological Standard of Living in the Two Germanies.” German Economic Review 4: 493-507.

Komlos J. and Lauderdale, B.E. (2007). “Spatial Correlates of U.S. Heights and BMIs, 2002.” Journal of Biosocial Science 39: 59-78.

Komlos, J. and Snowdon, B. (2005). “Measures of Progress and Other Tall Stories.” World Economics 6: 87-135.

Lippe, P. von der (1996). “Die politische Rolle der amtlichen Statistik in der ehemaligen DDR”, Jahrbücher für Nationalökonomie und Statistik 215: 641-73.

Mankiw, N.G. and Weinzierl, M (2007). “The Optimal Taxation of Height: A Case Study of Utilitarian Income Redistribution.“, unpublished.

Martel, L.F. and Biller, H.B. (1987). “Stature and Stigma: The Biopsychosocial Development of Short Males.” Lexington, Mass.: Lexington Books.

Morgan, S. (1999). “Biological Indicators of change in the standard of living in China during the 20th century.” In: Komlos, J. and Baten, J., ed., “The Biological Standard of Living in Comparative Perspective.” Vol. 1. Stuttgart: Franz Steiner.

Olds, K. (2003). “The Biological Standard of Living in Taiwan under Japanese Occupation.” Economics and Human Biology 1: 1-20.

Pak, S. (2004). “The biological standard of living in the two Koreas.” Economics and Human Biology 2: 511-18.

Persico, N., Postlewaite, A. and Silverman, D. (2004). “The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height.” Journal of Political Economy 112: 1019-53.

Roche, A.F. (1979). “Secular Trends in Stature, Weight, and Maturation.” Monographs of the Society for Research in Child Development 44: 3-27.

Ruggles, N.D. (1987). "Social accounting," The New Palgrave: A Dictionary of Economics, pp. 377-82.

Chapter 2: The Correlation between Height and Wages, a Conundrum Explored

2.1 Abstract

Taller workers earn more. We argue that this is in part because high-income parents can provide sufficient nourishment for their children so that they become relatively tall adults. With limited social mobility, relatively tall children subsequently, like their parents, earn more than average, generating - at least in part - the positive association between height and income. We test this hypothesis by regressing the children's adult height on their parents' income at the time the former were adolescents. We find evidence for this hypothesis for white females.

2.2 Introduction

That taller workers earn more is well known. A typical estimate for the wage premium is about 2.5% for every additional inch in height among 30 to 40 year old males and about 2.9% for every additional inch in height among 30 to 40 year old females[1]. Much effort has

[1] Persico et al. (2004), using data from the National Longitudinal Survey of Youth 79, show for the US that every additional inch in adult height is associated with a 2.5% increase in wages at age 31 to 38 for white male workers. Case and Paxson (2006), using data from the National Health Information Survey, estimate that every additional inch in adult height is associated with a 2.9% increase in wages at age 33 for females. Also for the US, Behrman and Rosenzweig (2001), using data from the Minnesota Twin Registry and exploiting the variation in height between monozygotic twins, estimate that every additional inch in adult height is associated with a 1.7% increase in wages for female workers. Judge and Cable (2004) report that an individual who is 72 inch tall could be expected to earn $5,525 more per year than someone who is 65 inch tall, even after controlling for gender, weight, and age. For the UK, Case and Paxson (2006), using the 1970 cohort of the National Cohort Study, estimate that every additional inch in adult height is associated with a 1.5% increase in wages at age 30 for male workers, and with a 2.8% increase in wages at age 30 for female workers. Heineck (2005), using data from the German Socio-Economic Panel Study, finds that above-average height West German males have gross monthly earnings which are about € 750 higher than those of below-average height West German males. To a lesser extent, the same is true for West German females. Other studies include Averett and Korenman (1993), Cawley (2000), D'Hombres (2007), Ekwo et al. (1991), Heineck (2006), Mirta (2001), Mankiw and Weinzierl (2007), Ribero (2000), Soumyananda et al. (2006), Thomas and Strauss (1997) and in particular Huebler (2006), who finds that the individual height effects on wages are curvilinear rather than linear.

been made to explain what underlies this empirical relationship: (1) Case and Paxson (2006) suggested that taller people have better cognitive ability, and thus their higher income is a return on human capital. (2) According to Persico et al. (2004), tall adults are also relatively tall during adolescence, and because of that are more likely to participate in high school activities in which they obtain skills that are later rewarded in the labor market. (3) Martel and Biller (1987), Loh (1993) and Magnusson et al. (2006) argue that taller workers are preferred by employers because they consider them to be more self-confident and assertive. (4) Klein et al. (1972), Frieze et al. (1990) and Hensley (1993) suggest that taller people can extract a premium during wage negotiations thanks to interpersonal dominance derived from their height.

We propose a complementary reason for the association: higher socio-economic status families nourish their children better so that they become relatively tall adults, but also endow them with more human capital than average. In such a society the social structure reproduces itself with limited social mobility, and the relatively tall children earn more than average, thus generating - at least in part - the positive association between height and income. This hypothesis is not meant as a substitute for the other explanations mentioned above but rather as an additional reason why taller people usually earn a greater income.

The inquiry is thus based on two assumptions – social mobility being limited, and high-income parents being able to nourish their children in a way so that they become relatively tall. We do not test whether social mobility is limited, as this issue has already been studied extensively. According to research by Blanden (2005), Perruci and Wysong (2003) and Wysong and Perrucci (2006), only 9% of sons whose fathers were in the lowest quartile of the income distribution ended up in the top quartile during the second half of the 20th century in the US[2]. Some authors even suggest that over recent years, social mobility has become

[2] See also Borjas (1992, 1994), Bowles and Gintis (2004), Menchik (1979), Mulligan (1996), Neal and Johnson (1996), Solon (1992), Tomes (1981), and Zimmerman (1992), in a wider sense also Blank (1991), Cutler and Katz (1991, 1992), Hanratty and Blank (1990), Lerman and Yitzhaki (1985, 1989, 1991) and Stark et al. (1986).

more limited. Perucci et al. (2007), partly drawing on data contained in Featherman and Hauser (1978), show that in 1973 49 percent of adults were upwardly mobile compared to only about 30 percent of adults in 1998[3].

Many studies have shown that a relationship between social status and height has existed in all societies and at all times even as far back as the 18th century (Komlos et al. 1992), or even in such unexpected places as the former German Democratic Republic (Komlos and Kriwy 2003). However, data on parental income is mostly unavailable so that current adult income has to be used as a proxy for parental income (Komlos and Lauderdale 2007). A study that does use parental income finds that it is positively correlated with children's height until about a family income of about $80,000. For example, between an annual family income (for a family of four) of c. $10,000 and $80,000 the height of a 17-year-old increases by nearly one inch (2.3 cm) and the height of whites is considerably more sensitive to family income than that of blacks (Komlos and Breitfelder 2007). We explore this relationship further on another data set that contains family income, children's height, and parental height, examining whether children of wealthier parents attain a higher nutritional status and become relatively tall adults in contemporary America. To do so, we regress adult height of children on the income of their parents during the time the children were adolescents. As a control variable, we use parental height.

2.3 Data

We use data from the National Longitudinal Survey of Youth 97 (NLSY 97) collected by the Bureau of Labor Statistics of the US Department of Labor and designed to gather information on significant life events in a sample of the US population. It is a nationally representative sample of 8,984 youth who were 12 to 16 years old as of December 31, 1996. The

[3] See also Schmitt (2005). The evidence on change in the extent of social mobility is disputed (see Solon and Lee

respondents were interviewed every year since then. The NLSY 97 includes information not only on height and wage of the respondents but parental income and height as well. All in all, we use 25 variables from the NLSY 97. Table A2.1 of the appendix lists the variables together with their NLSY identification code. Table 2.1 presents descriptive statistics for the most important variables. Four response items – "total income from wages and salary in 2003", "parental household income in 1998", "height of mother", and "height of father" – have a large share of missing values (50.0%, 72.7%, 25.7 and 50.7%, respectively, see Table 2.1). This is partly because the questions are not applicable to all respondents (i.e. not all individuals have already worked in 2003 at age 18-24, for example) and partly because the NLSY does not pose all questions to all individuals. The data set can be accessed at the NLSY website (http://www.bls.gov/nls/nlsy97.htm).

Table 2.1: Characteristics of the NLSY sample

Gender of respondent			**Ethnicity of respondent**	
Female	49.4%		Black	33.2%
Male	50.6%		White	66.8%
Census region of residence in 1997			**Total hours worked in 2003**	
Northeast	17.7%		Less than 1,000 hours	48.5%
North Central	26.8%		1,000 to 2,000 hours	12.2%
South	40.7%		2,000 hours or more	18.7%
West	14.8%		Missing	20.6%
Total income from wages and salary in 2003			**Respondent covered by health insurance**	
Less than 10,000 dollar	19.7%		Yes	75.4%
10,000 dollar or more	30.3%		No	12.1%

2006, Mayer and Lopoo 2005, and Levine and Mazumder 2002).

Missing	50.0%		Missing	12.5%
Respondent visited a doctor for routine check-up in the last two years			**Respondent lived in urban area in 1997**	
Yes	71.7%		Yes	22.6%
No	12.0%		No	73.3%
Missing	16.3%		Missing	4.1%
Height of mother			**Height of father**	
Between 4 and 5 feet	2.4%		Between 4 and 5 feet	0.1%
Between 5 and 6 feet	70.7%		Between 5 and 6 feet	34.0%
Between 6 and 7 feet	1.2%		Between 6 and 7 feet	15.2%
Other or Missing	25.7%		Other or Missing	50.7%
Age at 2003 interviews			**Age at 1998 interviews**	
18 years old	0.6%		13 years old	0.6%
19 years old	14.7%		14 years old	15.5%
20 years old	15.7%		15 years old	16.4%
21 years old	15.2%		16 years old	16.6%
22 years old	15.2%		17 years old	17.0%
23 years old	12.7%		18 years old	13.9%
24 years old	0.9%		19 years old	1.2%
Missing	11.8%		Missing	5.7%
Years of education, residential mother			**Years of education, residen-tial father**	
7 years or less	5.3%		7 years or less	4.3%
8 years	2.0%		8 years	1.3%
9 years	2.9%		9 years	2.1%
10 years	4.2%		10 years	2.2%
11 years	5.8%		11 years	3.1%
12 years	31.9%		12 years	21.3%

13 years	7.1%		13 years	3.8%
14 years	11.1%		14 years	8.0%
15 years	2.8%		15 years	1.8%
16 years	10.0%		16 years	8.7%
17 years	1.8%		17 years	1.3%
More than 17 years	4.2%		More than 17 years	5.5%
Missing	10.8%		Missing	36.5%
Parental household income in 1998				
Less than 10,000 dollar	6.6%			
10,000 to 49,999 dollar	7.3%			
50,000 to 100,000 dollar	10.5%			
More than 100,000 dollar	3.0%			
Missing/Not part of sub-sample	72.6%			

Note: Number of observations is 5,936. Respondent heights are reported in Figures 2.1-2.4.
Source: NLSY 97.

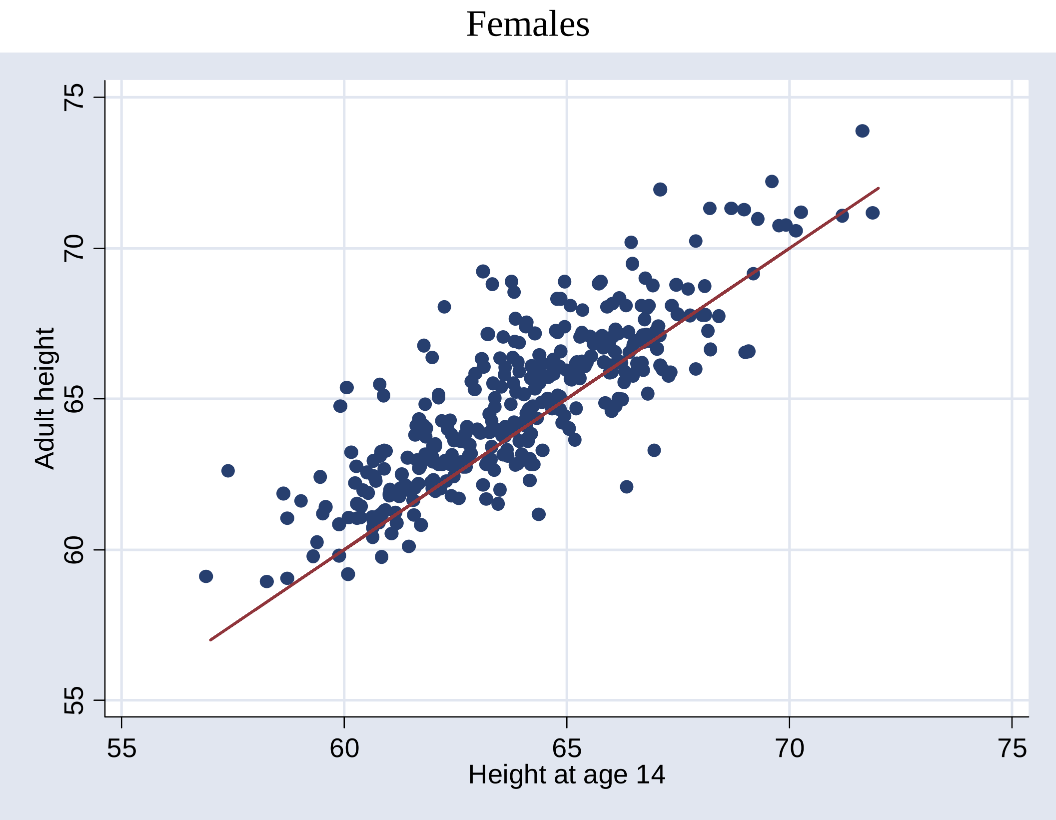
To avoid confounding the effects of race and gender discrimination, Persico et al. (2004) focus on white men only. We use a similar strategy. In a first step, we restrict our sample to those 5,936 respondents who were born in the US and who are classified as either black or white[4]. In a second step, we then run separate regressions by race and gender for these individuals.

A limitation of our data is that height is self-reported to the nearest inch. The resulting measurement error is to some extent even evident in the data. For example, about 13% of white females (N=2,932) and 2% of white males (N=3,004) report an adult height that is less than what they reported at age 14, with the error being in the range of one inch in about 85%

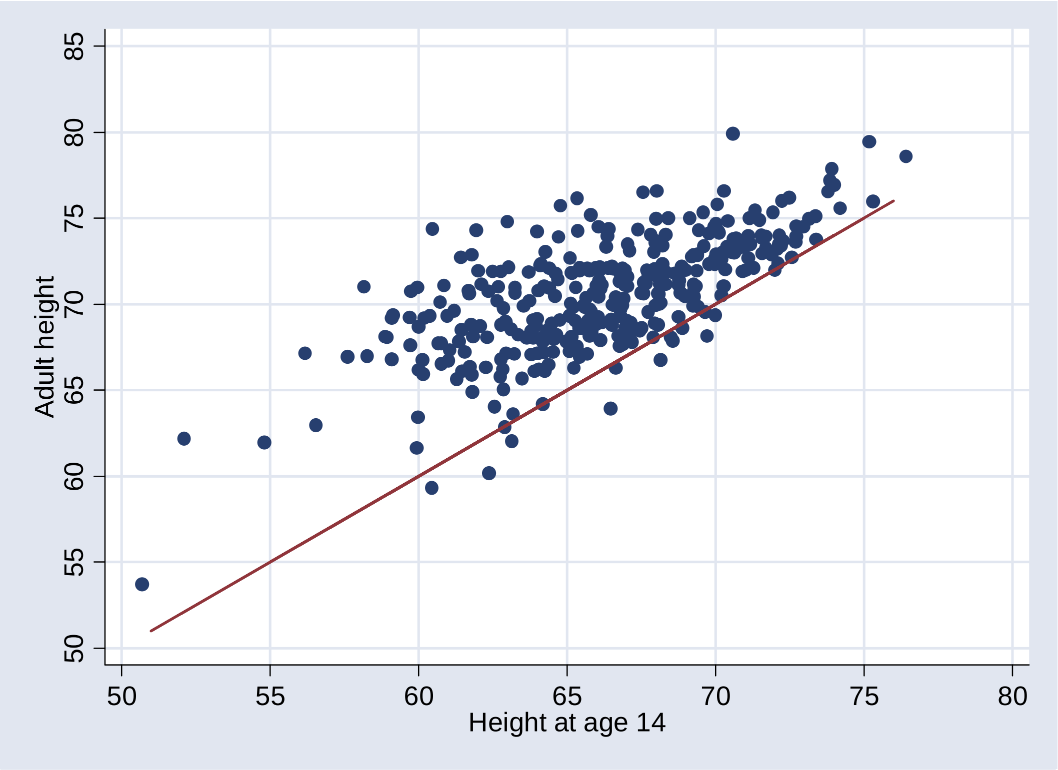
[4] This relatively large decline in the number of observations is due to the fact that minorities are over-sampled in the NLSY 97.

of cases (Figure 2.1; observations below the 45 degree line reflect an adult height that is less than what the respondent reported at age 14).

Figure 2.1: Scatter diagram between height at age 14 and adult height for white, US-born individuals



Males



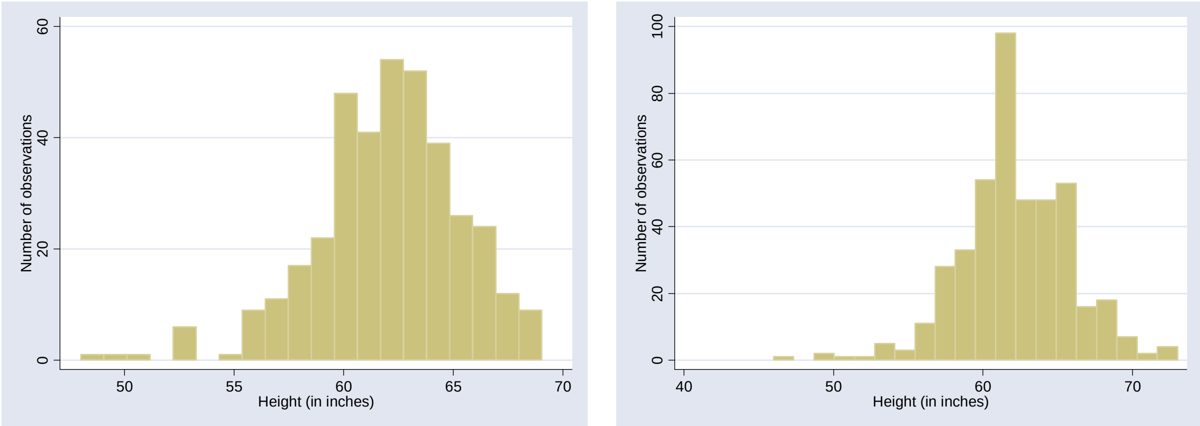
Note: The sample is restricted to respondents who were 14 years old at the time of the 1997 survey round. Adult height is defined as height at the time of the 2003 survey round when the respondents shown in the diagram were approximately 20 years old. The line shown in the diagram is a 45 degree line. Observations below this line imply that the individual has reported an adult height that is strictly less than what they reported at age 14.
Source: NLSY 97.

After controlling for gender, age, and race, height should be distributed normally. In our data, this is not the case for younger respondents, pointing to some misreporting (Figure 2.2). The D'Agostino et al. (1990) and Royston (1991) skewness and kurtosis tests reject the null of normality for all distributions (p<0.01 in all cases, N=382, N=397, N=223 and N=245 respectively)[5]. However, the adult height distributions are normally distributed for whites (Figure 2.3, p=0.2 for females and 0.3 for males) and nearly normal for blacks (p=0.1 for females and males, N=1,959, N=2006, N=974 and N=997, respectively).

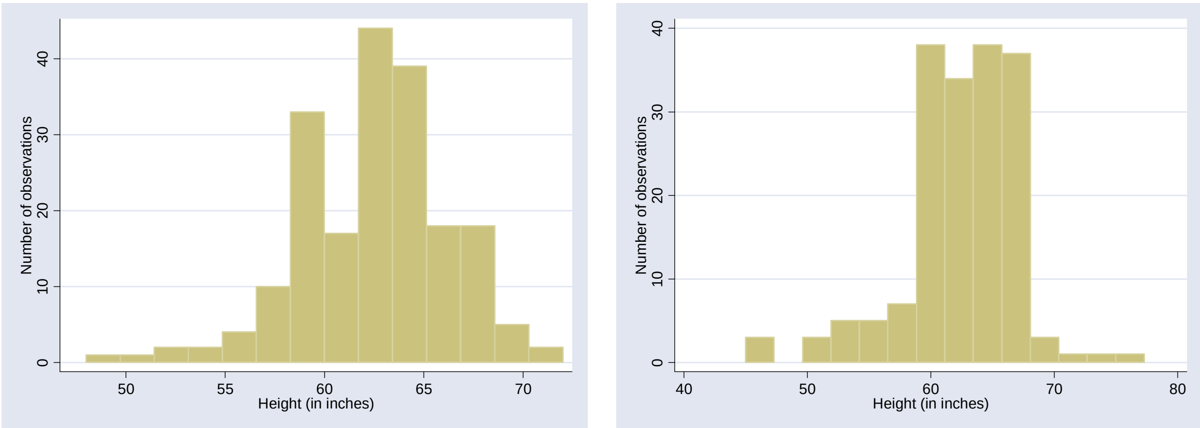
[5] While height is generally assumed to be normal for adults of a specific race and gender, it is not entirely clear whether this is also true for children, where different growth tempos may lead to distortions.

Figure 2.2: Histogram of female (left panel) and male (right panel) height, 14-year old, US-born individuals

Whites



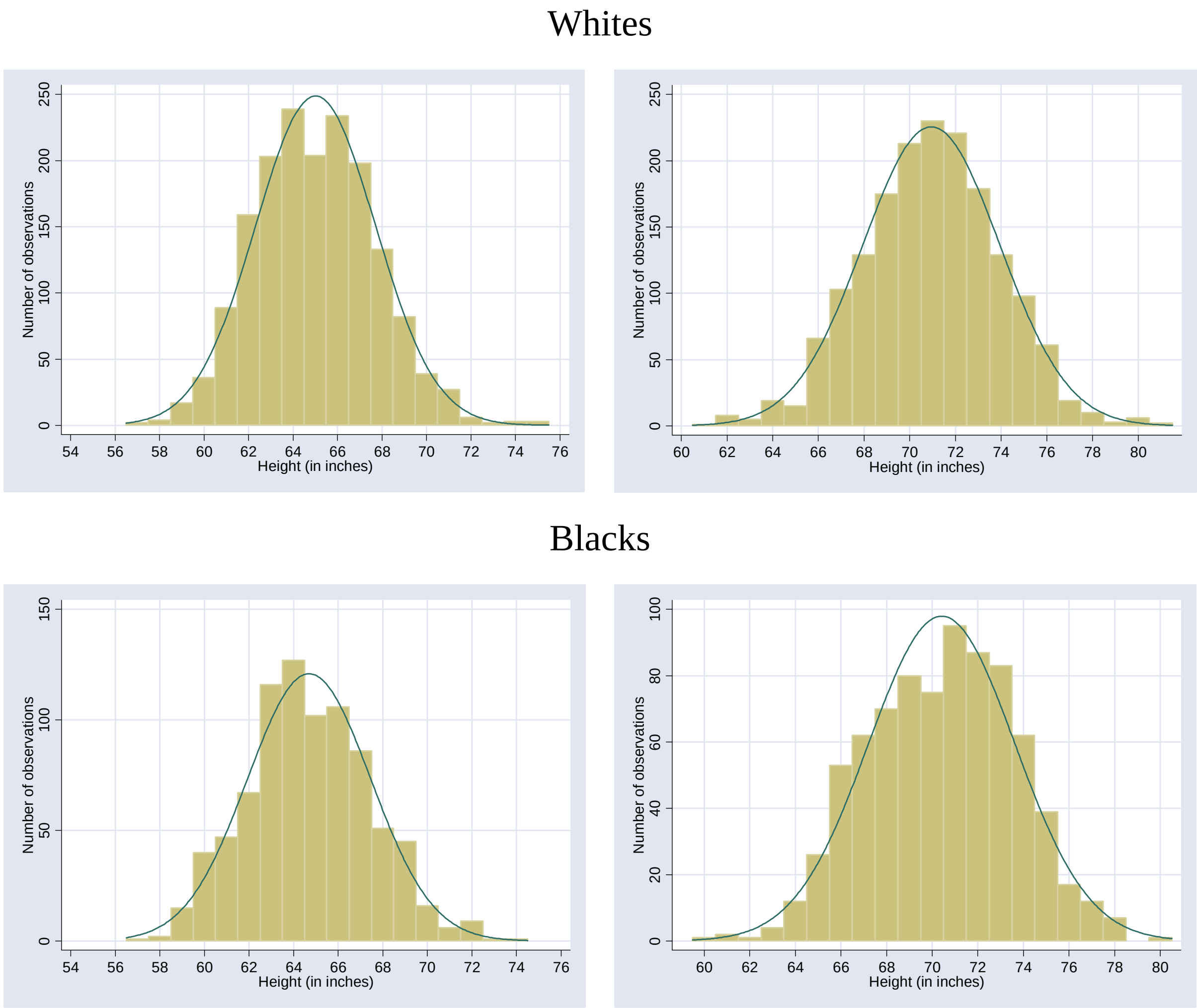
Blacks



Note: Height is measured at the time of the 1997 interview.

Source: NLSY 97.

Figure 2.3: Histogram of female (left panel) and male (right panel) adult height, US-born individuals only



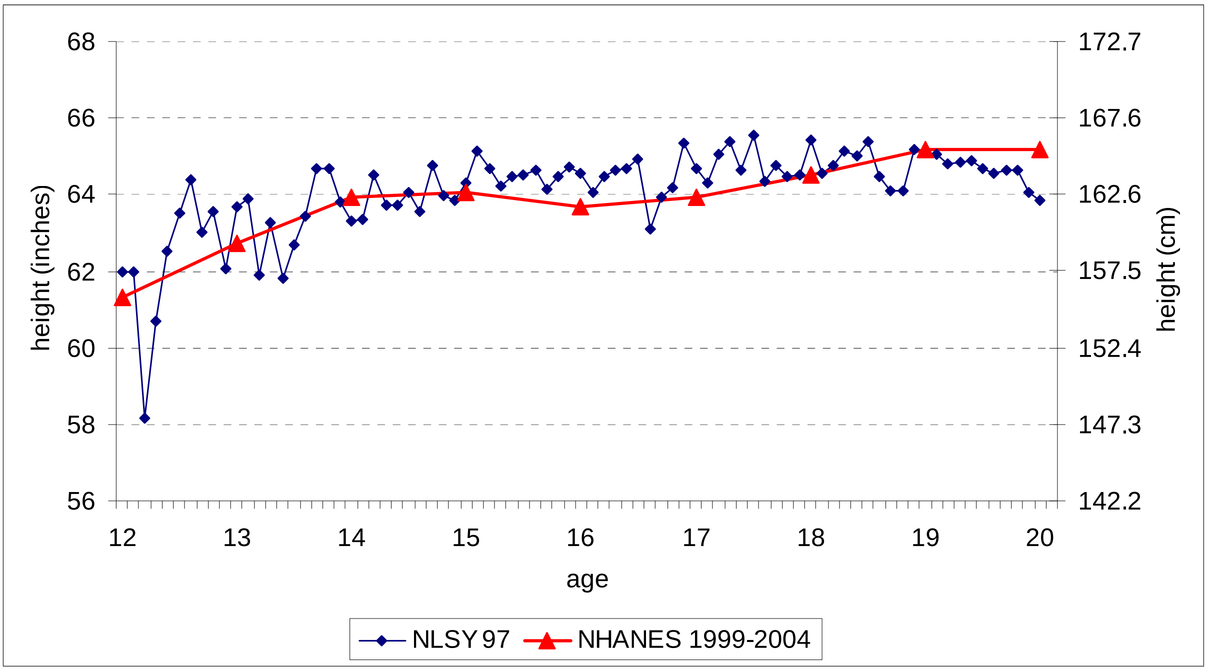
Note: Adult height is height of the respondents at the time of the 2003 interview.

Source: NLSY 97.

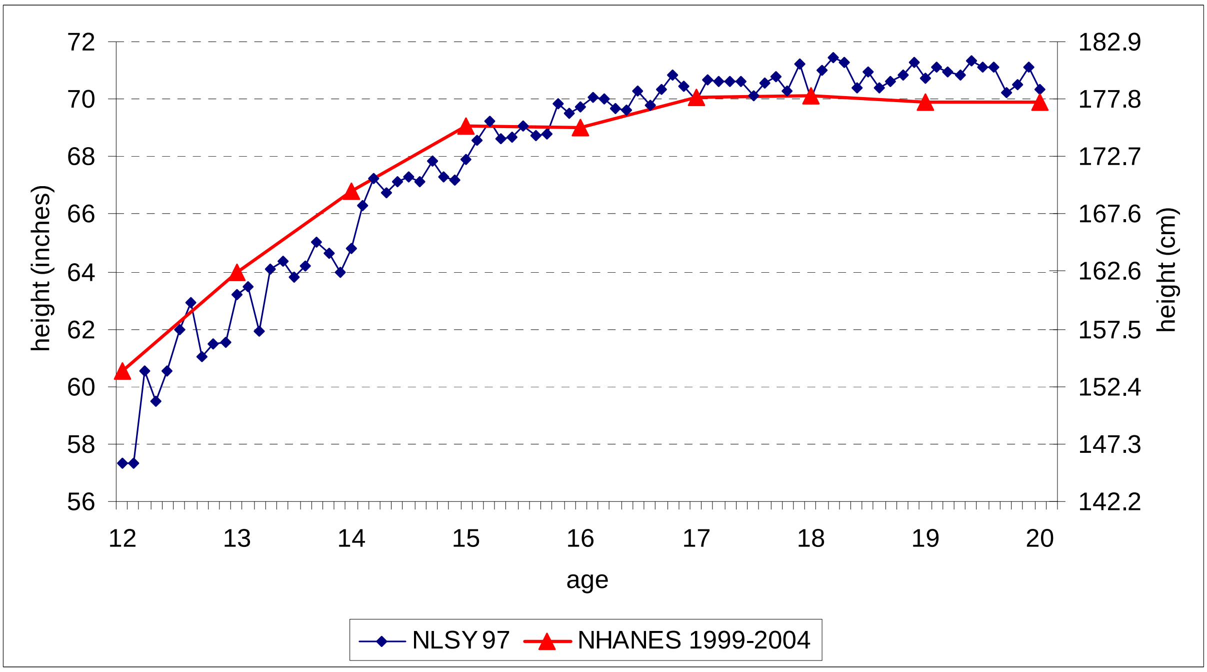
In the National Health and Nutritional Examination Survey 1999-2004 (NHANES 1999-2004) height is carefully measured[6]. This data set has been recently examined by Komlos and Breitfelder (2006) and in Figure 2.4 we use their growth profiles as benchmark (N=9,965). Average deviation is 0.5 inches (1.32 cm) for white females, 0.78 inches (1.98 cm) for white males, 0.91 inches (2.31 cm) for black females and 0.97 inches (2.46 cm) for black males.

Figure 2.4: Comparison of NLSY 97 and NHANES 1999-2004 growth profiles, US-born individuals only

White females

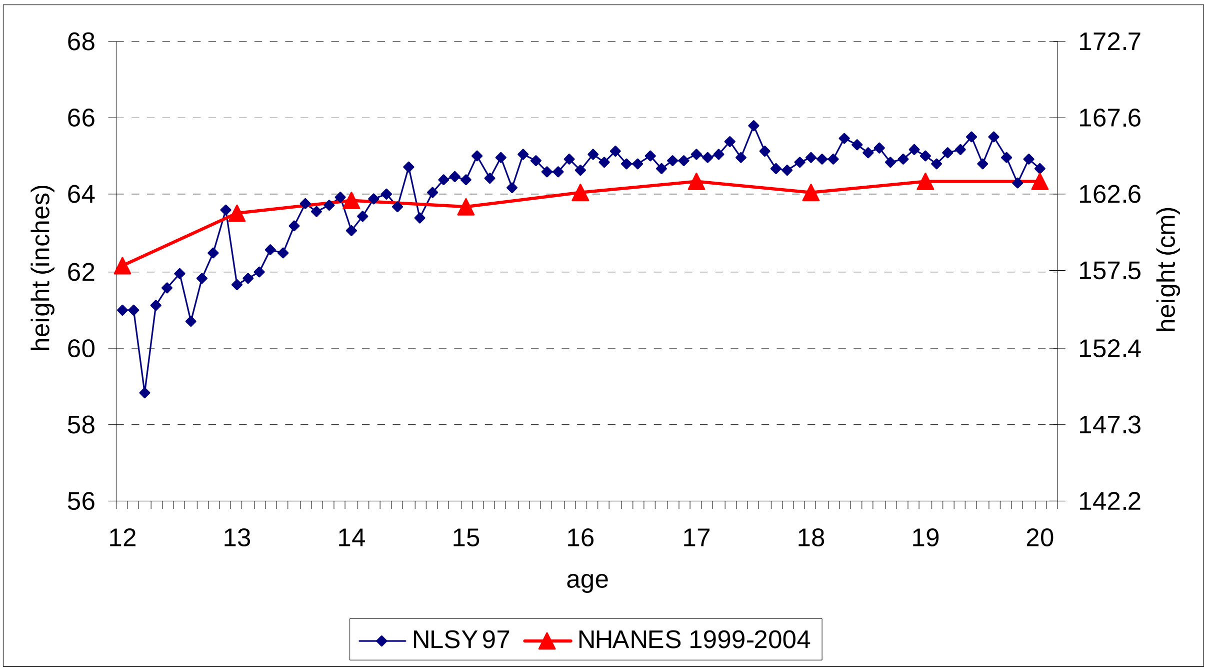


White males

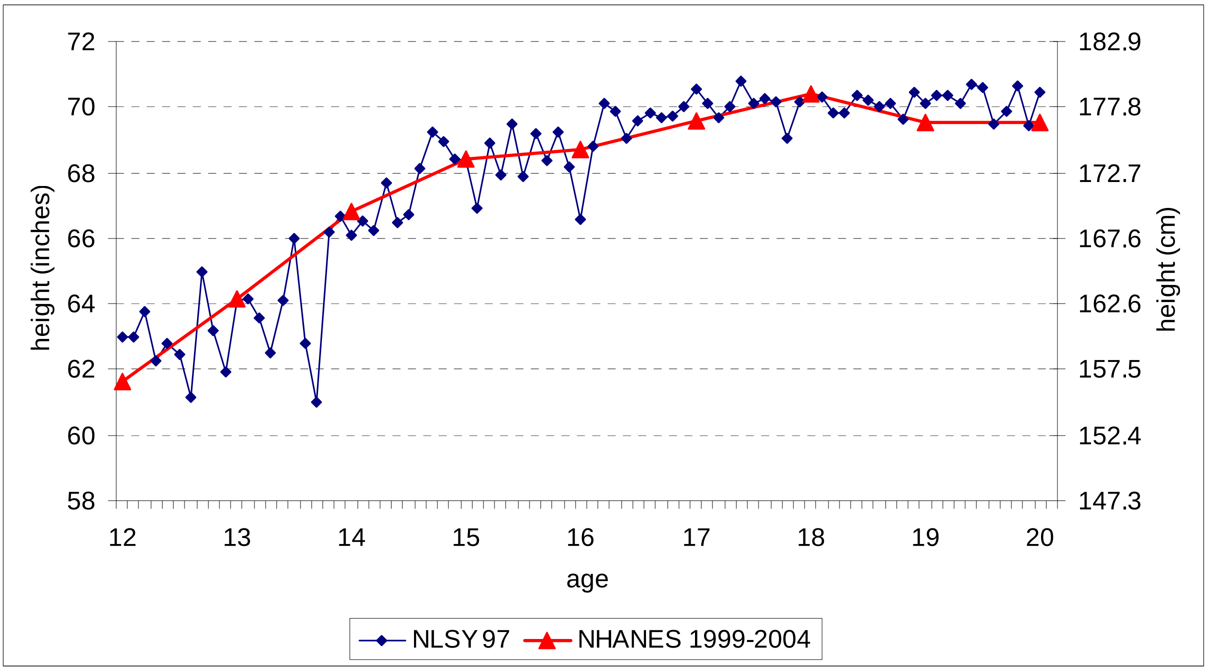


[6] One might ask why we do not use this data set in the first place. The answer is that the NHANES data set does not include information on parental height and parental income while the child grew up. These variables are, however, key to our analysis.

Black females



Black males



Note: NLSY 97 data is on a monthly basis, while the NHANES 1999-2004 data is on an annual basis.
Source: NLSY 97, Komlos and Breitfelder (2006).

The NLSY profiles in Figure 2.4 are closer to the NHANES profiles for ages 17-20 than for ages 12-16 in all cases. Given this evidence, it seems safer to focus on adult height than on teenage height. Teenage heights, which nonetheless may provide some important insights, must await future research.

2.4 The relationship between height and wages in the NLSY 97

Like Persico et al. (2004), we regress the log hourly wage of US-born individuals who worked 1,000 hours or more in 2004 on height (Table 2.2)[7]. Age ranges from 19 to 24. We find a significant positive association between heights and wages only for white females (Table 2.2, column 1). For them, one additional inch in height is associated with a 1% increase in the wage. Together with some measurement error, the relatively small number of observations may partly explain why no significant association exists for the other groups studied. Alternatively, it is also possible that many tall, high-potential individuals are in college at age 19-24. This might also explain why the white female wage premium is relatively small when compared to prior estimates.

Table 2.2: OLS estimates, dependent variable: log hourly wage of US-born individuals who worked 1,000 hours or more in 2004, age 19-24

	Females		Males	
	White	Black	White	Black
Height	0.01*** (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Constant	9.25*** (0.20)	9.50*** (0.17)	10.04*** (0.09)	10.06*** (0.21)
Adjusted R-squared	0.01	0.00	0.00	0.02

[7] Results are robust for adults who worked more than 1,500 or more than 2,000 hours (tables omitted). Also following Persico et al., we do not include in our models the usual Mincer (1974) control variables - schooling, experience, squared experience. These variables "are endogenous, that is, choice variables that may be influenced by height. This approach [i.e. leaving out the endogenous variables] is consistent with the strategy taken by Neal and Johnson (1996), who, along with Heckman (1998), provide detailed arguments against accounting for differencesin decision variables when estimating the effect of labor market discrimination." (Persico et al. 2004).

F-statistic	7.3***	2.3	0.5	1.5
Number of observations	476	157	623	161

Note: Dependent variable is the log hourly wage at the time of the 2004 interview when respondents were aged 19-24. Observations below the federal minimum wage were deleted. The sample is restricted to individuals who worked 1,000 hours or more. Height is taken from 2004 and measured in inches. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are in parenthesis.
Source: NLSY 97.
* significant at 10%; ** significant at 5%; *** significant at 1%

2.5 Parental income during adolescence and adult height

To test our hypothesis, we regress the height of adults on both gross household income of parents during adolescence and parental height (Table 2.3). The model has a number of useful econometric properties. Firstly, misreported heights are less of a problem if height is used as the dependent variable. Provided that the measurement error is not correlated with any of the independent variables, coefficients can be expected to be unbiased (Wooldridge 2005 and Schneeweiss et al. 2006). Secondly, simultaneity is not an issue in this case. Causality runs only from parental income to adolescent height but not the other way round. We thus do not depend on, often imperfect, instrumental variables for identification. Finally, with parental height in the regression equation, the main potential source of omitted variable bias is eliminated.

Table 2.3: OLS estimates, dependent variable: adult height of US-born individuals, age 19-24

	Females		Males	
	White	Black	White	Black
Gross household income of parents during adolescence, 1998 (in 100,000 dollars)	0.68** (0.32)	-0.14 (0.10)	0.00 (0.34)	-0.18 (1.38)
Height of mother	0.36***	0.25*	0.44***	0.31**

	(0.06)	(0.13)	(0.07)	(0.14)
Height of father	0.30*** (0.05)	0.34*** (0.12)	0.36*** (0.06)	0.31** (0.12)
Constant	20.47*** (5.35)	25.33*** (10.78)	17.16*** (6.49)	28.73*** (10.32)
Adjusted R-squared	0.35	0.24	0.35	0.20
F-statistic	26.8***	5.0***	23.2***	5.9**
Number of observations	212	54	201	35

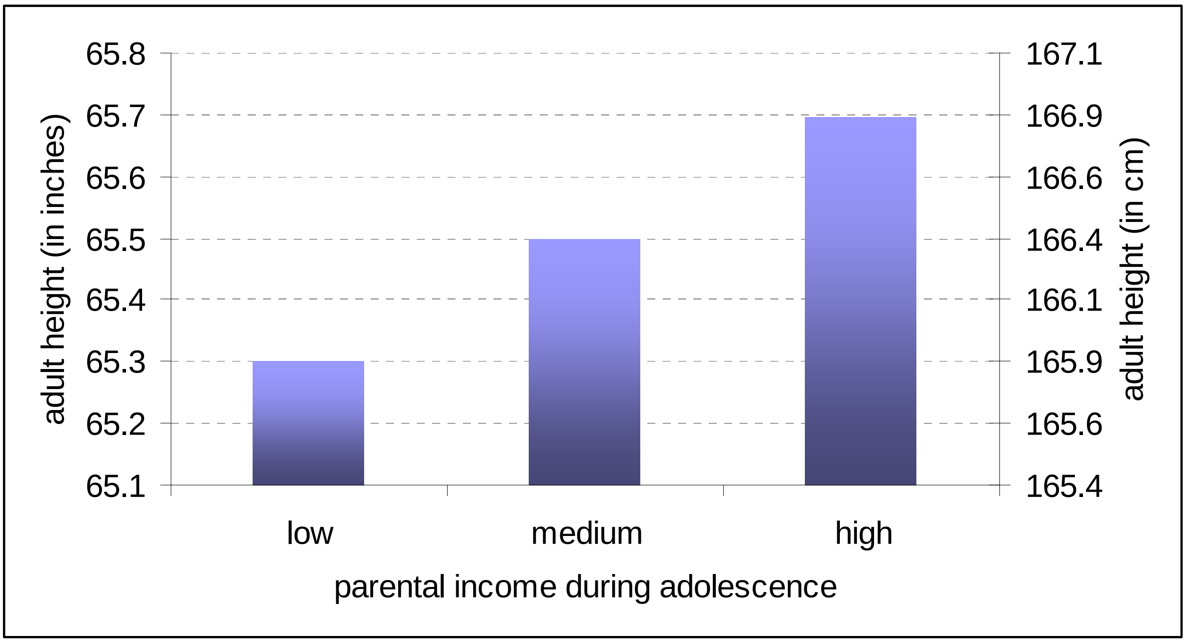
Note: Dependent variable is height at the time of the 2004 interview when respondents were adults aged 19-24. Height is measured in inches. Gross household income of parents is for 1998 when respondents were still growing. Height of parents is in inches and refers to the height of biological parents. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are in parenthesis.
Source: NLSY 97.
* significant at 10%; ** significant at 5%; *** significant at 1%

For white females, the coefficient is significantly positive at the 5% level (Table 2.3, column 1). An increase in yearly parental gross household income by $100.000 leads to an increase in the adult height of children of 0.68 inches (1.73 cm). On average, daughters of low-income ($20,000) parents reach an adult height of 65.3 inches (165.9 cm), while those of medium-income ($49,000) parents reach an adult height of 65.5 inches (166.4 cm), and those of high-income ($78,000) parents reach an adult height of 65.7 inches (166.9 cm) (Figure 2.5). If social mobility is limited, these relatively tall children will later, like their parents, earn more relative to their shorter peers, generating in part the positive association between height and income[8]. The "parental income height premium" exists only for females. This makes sense given that most of the other explanations discussed in the introduction pertain to men only while the height premium is actually comparable in size for males and females. There is also evidence from historical studies that shows that the height of females reacts

[8] The result is robust to gross household income being used in logarithmic form.

stronger to an exogenous shock in the biological standard of living than male height (Sunder 2007).

Figure 2.5: Average adult height of white US-born females with parents of average height as a function of parental yearly gross household income during adolescence



Note: The figure is based on the regression results of Table 2.3, column 1. In the figure, a low (medium, high) parental income during adolescence is defined as an income of $20,000 ($49,000; $78,000). The effect of parental income during adolescence is significant at the 5% level.
Source: NLSY 97.

2.6 Channels

Why parental income influences female height is not obvious, given that the food budget is a relatively small part of total expenditures today. To learn more about the transmission channels, our data set affords a rich set of variables.

In a first step, we add a dummy variable for whether a respondent visited a doctor for a routine check-up in the last two years. Children, who did not see a doctor for a routine check-up in the last two years are on average about 1.33 inch (3.4 cm) shorter than children who have visited a doctor for a routine check-up in the last two years (column 1 of Table 2.4 and Figure 2.6). The coefficient on income of parents is reduced from 0.68 to 0.64, suggesting that about 6% of the parental income height premium can be explained by being able to make doctor visits. The generally good education of high-income parents might also help their children in becoming relatively tall, for example, because they can weigh better the risks associated with neglecting doctor visits. We control for this by adding the educational achievement of the mother and the father (Table 2.4, column 2). Unlike our control for health consciousness, parental education is not significant in this model[9]. Adding dummy variables for the four US Census regions reduces the coefficient of interest by more than 10% to 0.59 (column 3 of Table 2.4)[10]. While self-selection (some regions may attract high-income and tall people with, for genetic reasons, tall children) may explain part of the result, this nevertheless suggests that the "parental income height premium" is partly transmitted by high-income parents living in regions where their children have better access to advanced medical facilities, clean air and fresh fruit, all of which help growth as height depends positively on gross nutritional intake and negatively on claims on the human body such as illness (Komlos 1989). Adding controls for whether a respondent lives in an urban or rural area also mediates the initial parental income height premium (-6% to 0.65, column 4 of Table 2.4). If all variables discussed so far are included in the model, the initial coefficient on income (column 1) is reduced by about 20% (column 5 of Table 2.4)[11].

[9] Results are qualitatively unchanged if we control only for mother's or father's education. Only if we leave out parental income and parental height, does education have the expected positive effect. The same is true when we add controls for the education of the respondent herself/himself instead of controls for the education of parents (results omitted).

[10] Information on the composition of the four Census regions (Northeast, North Central, South and West) is contained in Figure A2.1 in the Appendix.

[11] There are other channels that might be worth exploring. Studies show that cost is the most significant predictor of dietary choice (Foley and Pollard 1998, Mackerras 1997). Hence, poorer people consume cheaper food, which may also be less healthy. Furthermore, poor neighborhoods in the U.S. have limited access to supermarkets, which offer a wide variety of healthy food (Morland et al. 2002), making dietary change difficult to achieve. Smoking parents, no health insurance, little social safety and psychosocial stress may also adversely affect the height of children (Fogelman and Manor 1988, Sunder 2003, Steckel 2008, Woitek 2003, Sunder and Woitek

Table 2.4: OLS estimates, dependent variable: adult height of white US-born females, age 19-24

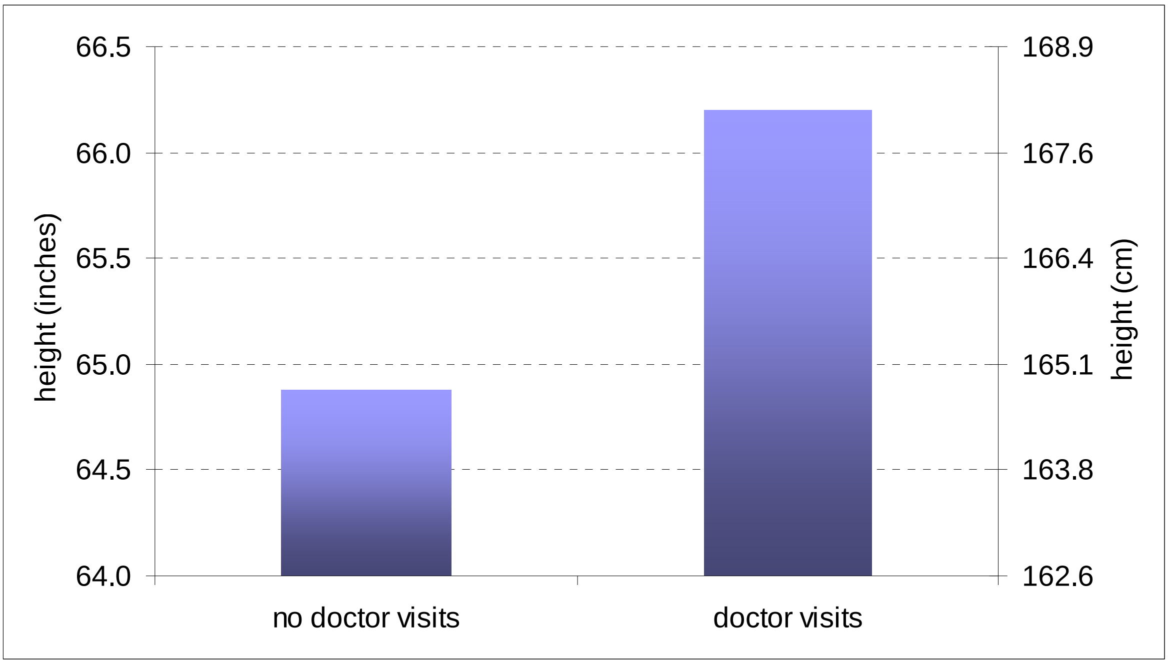
	(1)	(2)	(3)	(4)	(5)
Gross household income of parents during adolescence (in 100,000 dollars)	0.64** (0.32)	0.65* (0.35)	0.59* (0.32)	0.65* (0.33)	0.55 (0.36)
Height of mother	0.36*** (0.06)	0.36*** (0.06)	0.36*** (0.06)	0.36*** (0.06)	0.36*** (0.06)
Height of father	0.30*** (0.05)	0.30*** (0.05)	0.30*** (0.05)	0.30*** (0.05)	0.30*** (0.05)
Respondent has not visited a doctor for a routine check-up in the last two years	-1.33** (0.62)				-1.25* (0.65)
Respondent has visited a doctor for a routine check-up in the last two years	Reference				Reference
Years of education, mother		-0.02 (0.07)			-0.02 (0.07)
Years of education, father		0.03 (0.07)			0.01 (0.07)
South			Reference		
Northeast			0.39 (0.53)		0.33 (0.54)
North Central			0.51 (0.37)		0.47 (0.34)
West			0.18 (0.43)		0.05 (0.49)
Rural				-0.07 (0.92)	-0.25 (0.93)
Urban				0.11 (0.92)	-0.01 (0.91)

2005, Wadsworth et al. 2002, Peck and Lundberg 1995, Montgomery et al. 1997, Silventoinen et al. 1999, Davey-Smith et al. 2000). Due to small sample size, we can not examine these channels with our own data in a meaningful way.

Other than rural or urban				Reference	Reference
Constant	20.33*** (5.36)	20.35*** (5.53)	20.44*** (5.40)	20.10*** (5.51)	20.18*** (5.71)
Adjusted R-squared	0.32	0.31	0.32	0.31	0.31
F-statistic	21.3***	16.4***	13.0***	16.2***	7.7***
Number of observations	212	212	212	212	212

Note: Dependent variable is height at the time of the 2004 interview when respondents were adults aged 19-24. Height is measured in inches. Gross household income of parents is for 1998 when respondents were still growing. Height of parents is in inches and refers to the height of biological parents. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are in parenthesis.
Source: NLSY 97.
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 2.6: Average adult height of white US-born females with parents of average height and average income as a function of doctor visits



Note: The figure is based on the regression results of Table 2.4, column 1. The effect is significant at the 5% level.
Source: NLSY 97.

2.7 Conclusion

Several explanations have been offered for why employers pay a wage premium for taller workers. Either taller people have more human capital, or employers have a preference for taller people for managerial positions. We add an additional explanation by arguing that taller people earn more because high-income parents can nourish their children in a way so that they become relatively tall adults. If social mobility is limited, these relatively tall children later earn more, like their parents, generating - at least in part - the positive association between heights and wages. We test this hypothesis by regressing children's adult height on the income of their parents during the time the former were still growing, controlling for parental height. We find evidence for our hypothesis only for white females. The white female "parental income height premium" is partially mediated through health conscious behavior, parental education and geographical location choice. We show that children who have not visited a doctor for a routine check-up in the last two years are on average about 1.33 inch (3.4 cm) shorter than children who have visited a doctor for a routine check-up in the last two years.

This result contributes to the growing literature on the "biological standard of living" (Floud 1994, Fogel 1994, Komlos 1985, 1989, Steckel 2008, Waaler 1984). According to this literature, conventional standard of living measures should be complemented by measures like health status, body-mass index, longevity, or average height, as "well being encompasses more than just the command over goods and services" (Komlos and Snowdon, 2005). Average height is the variable most often used in this literature. Reflecting the net nutritional status of a population, average height is sensitive to many socio-economic influences. The paper adds to this literature by showing that parental income and health consciousness affect the height of adolescent girls.

2.8 References

Averett, S. and Korenman, S. (1993). “The Economic Reality of the Beauty Myth.” Journal of Human Resources 31: 304-30.

Beard, A.S. and Blaser, M.J. (2002). “The Ecology of Height: The Effect of Microbial Transmission on Human Height.” Perspectives in Biology and Medicine 45: 475-99.

Behrman, J. and Rosenzweig, M. (2001). “The Returns to Increasing Body Weight.” Working paper. Philadelphia: University of Pennsylvania.

Blanden, J. (2005). “International Evidence on Intergenerational Mobility.” Working Paper, Department of Economics, University College London.

Blank, R.M. (1991). “Why Were Poverty Rates So High in the 1980s?” NBER Working Paper 3878.

Bobak, M., Kriz, B., Leon, D.A., Danova, J. and Marmot, M. (1994). “Socioeconomic factors and height of preschool children in the Czech Republic.” American Journal of Public Health 84: 1167-70.

Borjas, G. (1992). “Ethnic capital and intergenerational mobility.” Quarterly Journal of Economics 107: 123-50.

Borjas, G. (1994). “Long-run convergence of ethnic skill differentials: the children and grandchildren of the great migrations.” Industrial & Labor Relations Review 47: 553-73.

Bowles, S. and Gintis, H. (2004). “The Inheritance of Inequality.” Journal of Economic Perspectives 16: 3-30.

Case, A. and Paxson, C. (2006). “Stature and Status: Height, Ability, and Labor Market Outcomes”, NBER Working Paper 12466.

Cavelaars, A. E., Kunst, A. E., Geurts, J. J., Crialesi, R., Grotvedt, L., Helmert, U., Lahelma, E., Lundberg, O., Mielck, A., Rasmussen, N. K., Regidor, E., Spuhler, T. and Mackenbach, J. P. (2000). “Persistent variations in average height between countries and between socio-economic groups: an overview of 10 European countries.” Annals of Human Biology 27: 407-21.

Cawley, J. (2000). “Body Weight and Women's Labor Market Outcomes.” NBER Working Papers 7841.

Cutler, D.M. and Katz, L.F. (1991). “Macroeconomic Performance and the Disadvantaged.“ Brookings Papers on Economic Activity 2: 1-74.

Cutler, D.M. and Katz, L.F. (1992). „Rising Inequality? Changes in the Distribution of Income and Consumption in the 1980's.“ The American Economic Review 82: 546-51.

D'Agostino, R. B., Balanger, A. and D'Agostino R. B., Jr. (1990). “A suggestion for using powerful and informative tests of normality.” American Statistician 44: 316-21.

D'Hombres, B. (2007). “Does body height affect wages?” Economics and Human Biology 5: 1-19.

Davey-Smith, G., Hart, C. and Upton, M. (2000). “Height and risk of death among men and women: aetiological implications of associations with cardiorespiratory disease and cancer mortality.” Journal of Epidemiology and Community Health 54: 97-103.

Ekwo, E., Gosselink, C., Roizen, N. and Brazdziunas, D. (1991). “The effect of height on family income.“ American Journal of Human Biology 3: 181-88.

Floud, R. (1994). “The heights of Europeans since 1750: a new source for European economic history.” In: Komlos, J. (Ed.), Stature, Living Standards, and Economic Development: Essays in Anthropometric History. The University of Chicago Press, Chicago, 9–24.

Fogel, R.W. (1994). “Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy.” American Economic Review 84: 369–95.

Fogelman, K.R. and Manor, O. (1988). “Smoking in pregnancy and development into early adulthood.” British Medical Journal 297: 1233-36.

Foley, R.M. and Pollard, C.M. (1998). “Food cent$ - implementing and evaluating a nutrition education project focusing on value for money.” Australian and New Zeeland Journal of Public Health 22: 494-501.

Frieze, I.H., Olson, J.E. and Good, D.C. (1990). “Perceived and Actual Discrimination in the Salaries of Male and Female Managers.” Journal of Applied Social Psychology 20: 46-67.

Hanratty, M.J. and Blank, R.M. (1990). “Down and Out in North America: Recent Trends in Poverty Rates in the U.S. and Canada.” NBER Working Papers 3462.

Heckman, J.J. (1998). “Detecting Discrimination.” Journal of Economic Perspectives 12: 101-16.

Heineck, G. (2005). “Up in the skies? The relationship between height and earnings in Germany.” Labour: Review of Labour Economics and Industrial Relations 19: 469-89.

Heineck, G. (2006). “Height and weight in Germany, Evidence from the German Socio-Economic Panel, 2002.” Economics and Human Biology 4: 359-82.

Hensley, W.E. (1993). “Height as a Measure of Success in Academe.” Psychology, Journal of Human Behavior 30: 40-46.

Huber, P. J. (1967). “The behavior of maximum likelihood estimates under nonstandard conditions.” Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability. Berkeley, CA: University of California Press, vol. 1: 221-23.

Huebler, O. (2006). “The Nonlinear Link between Height and Wages: An Empirical Investigation.” IZA Discussion Papers 2394. Institute for the Study of Labor (IZA). Bonn.

Judge, T.A. and Cable, D.M. (2004). “The Effect of Physical Height on Workplace Success and Income: Preliminary Test of a Theoretical Model.” Journal of Applied Psychology 89: 428-41.

Klein, R. E., Freeman, H. E., Kagan, J., Yarbrough, C. and Habicht, J.P. (1972). “Is big smart? The relation of growth to cognition.” Journal of Health and Social Behavior 13: 219-25.

Kleinman, J.C. and Madans, J.H. (1985). “The effects of maternal smoking, physical stature, and educational attainment on the incidence of low birth weight.” American Journal of Epidemiology 121: 843-55.

Komlos, J. (1985). “Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development.” American Historical Review 90: 1149-61.

Komlos, J. (1989). “Nutrition and economic development in the eighteenth century Habsburg monarchy.” Princeton: Princeton University Press.

Komlos, J. (1991). “On the Significance of Anthropometric History.” Revista di Storia Economica 11: 97-111.

Komlos, J. and Breitfelder, A. (2006). “Improvements in the most recent CDC height growth charts for the US.” Unpublished.

Komlos, J. and Breitfelder, A. (2007). “The height of US-born non-Hispanic children and adolescents ages 2-19, born 1942-2002 in the NHANES Samples.” American Journal of Human Biology, forthcoming.

Komlos, J. and Kriwy, P. (2003). “The Biological Standard of Living in the Two Germanies.” German Economic Review 4: 493-507.

Komlos, J. and Lauderdale, B.E. (2007). “Underperformance in Affluence: the Remarkable relative decline in American Heights in the second half of the 20th-Century.” Social Science Quarterly 88: 283-304.

Komlos, J. and Snowdon, B. (2005). “Measures of Progress and Other Tall Stories.” World Economics 6: 87-135.

Komlos, J., Tanner J.M., Davies P.S.W. and Cole, T. (1992). “The Growth of Boys in the Stuttgart Carlschule, 1771-93.” Annals of Human Biology 19: 139-52.

Lerman R.I. and Yitzhaki, S. (1985). “Income Inequality Effects by Income Source: A New Approach and Applications to the United States.” The Review of Economics and Statistics 67: 151-56.

Lerman R.I. and Yitzhaki, S. (1989). “Improving the accuracy of estimates of Gini coefficients," Journal of Econometrics 42: 43-47.

Lerman R.I. and Yitzhaki, S. (1991). “Income Stratification and Income Inequality.” Review of Income and Wealth 37: 313-29.

Levine, D.I. and Mazumder, B. (2002). “Choosing the right parents: changes in the intergenerational transmission of inequality between 1980 and the early 1990s,” Working Paper Series WP-02-08, Federal Reserve Bank of Chicago.

Lindgren, G. (1976). “Height, weight and menarche in Swedish urban school children in relation to socio-economic and regional factors.” Annals of Human Biology 3: 501-28.

Loh, E.S. (1993). “The Economic Effects of Physical Appearance.” Social Science Quarterly 74: 420-38.

Mackerras, D. (1997). “Disadvantaged and the cost of food.” Australian and New Zeeland Journal of Public Health 21: 218.

Magnusson, P.K.E., Rasmussen, F. and Gyllensten, U.B. (2006). “Height at Age 18 Years is a Strong Predictor of Attained Education Later in Life: Cohort Study of Over 950000 Swedish Men.” International Journal of Epidemiology 35: 658-63.

Mankiw, N.G. and Weinzierl, M. (2007). “The Optimal Taxation of Height: A Case Study of Utilitarian Income Redistribution.“, unpublished.

Martel, L.F. and Biller, H.B. (1987). “Stature and Stigma: The Biopsychosocial Development of Short Males.” Lexington, Mass.: Lexington Books.

Mayer, S.E. and Lopoo, L.M. (2005). “Has the Intergenerational Transmission of Economic Status Changed?” Journal of Human Resources 40: 169-185.

Menchik, P.L. (1979). “Inter-generational transmission of inequality: an empirical study of wealth mobility.” Economica 46: 349-62.

Mincer, J. (1974). “Schooling, Experience and Earnings.” New York: National Bureau of Economic Research.

Mirta, A. (2001). “Effects of Physical Attributes on the Wages of Males and Females.” Applied Economics Letters 8: 731-35.

Montgomery, S., Bartley, M. and Wilkinson, R. (1997). “Family conflict and slow growth.” Archives of Disease in Childhood 44: 326-30.

Morland, K., Wing, S., Diez Roux, A. and Poole, C. (2002). “Neighborhood characteristics associated with the location of food stores and food service places.” American Journal of Preventive Medicine 22: 23-29.

Mulligan, C.B. (1996). “Parental Priorities and Economic Inequality.” Chicago: University of Chicago Press, forthcoming.

Neal, D.A. and Johnson, W.R. (1996). “The role of premarket factors in black-white wage differences.” Journal of Political Economy 104: 869-95.

Peck, M. and Lundberg, O. (1995). “Short stature as an effect of economic and social conditions in childhood.” Social Science and Medicine 41: 733-38.

Peck, A. M. and Vagero, D.H. (1987). “Adult body height and childhood socioeconomic group in the Swedish population.” Journal of Epidemiology and Community Health 41: 333-37.

Perrucci, R. and Wysong, E. (2003). “The New Class Society.” 2nd ed. Landham, Maryland: Rowman and Littlefield.

Persico, N., Postlewaite, A. and Silverman, D. (2004). “The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height.” Journal of Political Economy 112: 1019-53.

Ribero, R. (2000). “Adult morbidity, height and earnings in Colombia.” In: Savedoff, W. and Schultz, T.P., ed., “Wealth from Health.” Latin American Research Network. Inter-American Development Bank. Washington, D.C.

Royston, P. (1991). “sg3.5: Comment on sg3.4 and an improved D'Agostino test.” Stata Technical Bulletin 3:19. Reprinted in Stata Technical Bulletin Reprints 1: 110-12.

Schneeweiss, H., Komlos, J. and Ahmad, A.S. (2006). “Symmetric and Assymetric Rounding.” Discussion Paper 479, Sonderforschunsbereich 386, LMU Munich.

Silventoinen, K., Lahelma, E. and Rahkonen, O. (1999). “Social background, adult body-height and health.” International Journal of Epidemiology 28: 911-18.

Solon, G.R. (1992). “Intergenerational income mobility in the United States.” American Economic Review 82: 393-408.

Solon, G.R. and Chul-In, L. (2006). “Trends in Intergenerational Income Mobility.” NBER Working Paper No. W12007.

Soumyananda, D., Gangopadhyay, P.K., Chattopadhyay, B.P., Saiyed, H.N., Pal, M. and Bharati, P. (2006). “Height, weight and earnings among coalminers in India.“ Economics and Human Biology 4: 342-50.

Stark, O., Taylor, J.E. and Yitzhaki, S. (1986). “Remittances and Inequality.” Economic Journal 96: 722-40.

Steckel, R.H. (2008). “Biological Measures of the Standard of Living.” Journal of Economic Perspectives 22: 129-152.

Sunder, M. (2003). “The Making of Giants in a Welfare State: The Norwegian Experience in the 20th Century.” Economics and Human Biology 1: 267-76.

Sunder, M. (2007). “Passports and Economic Development: An Anthropometric History of the U.S. Elite in the Nineteenth Century.” Unpublished manuscript. University of Munich.

Sunder, M. and Woitek, U. (2005). “Boom, Bust, and the Human Body: Further Evidence on the Relationship between Height and Business Cycles.” Economics and Human Biology 3: 450-66.

Thomas, D. and Strauss, J. (1997). “Health and Wages: Evidence on Men and Women in Urban Brazil.“ Papers 97-05, RAND.

Tomes, N. (1981). “The family, inheritance, and the intergenerational transmission of inequality.” Journal of Political Economy 89: 928-58.

Waaler, H. (1984). “Height, weight, and mortality: the Norwegian experience.” Acta Medica Scandicana (Supplement) 679: 1–56.

Wadsworth, M., Hardy, R., Paul A., Marshall, S. and Cole, T. (2002). “Leg and trunk length at 43 years in relation to childhood health, diet and family circumstances; evidence from the 1946 national birth cohort.” International Journal of Epidemiology 31: 383-90.

White, H. (1980). “A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity.” Econometrica 48: 817-30.

Woitek, U. (2003). Height cycles in the 18th and 19th centuries, Economics and Human Biology 1: 243-57.

Wooldridge, J.M. (2005). “Econometric Analysis of Cross Section and Panel Data.” MIT Press.

Zimmerman, D.J. (1992). “Regression toward mediocrity in economic stature.” American Economic Review 82: 409-29.

2.9 Appendix

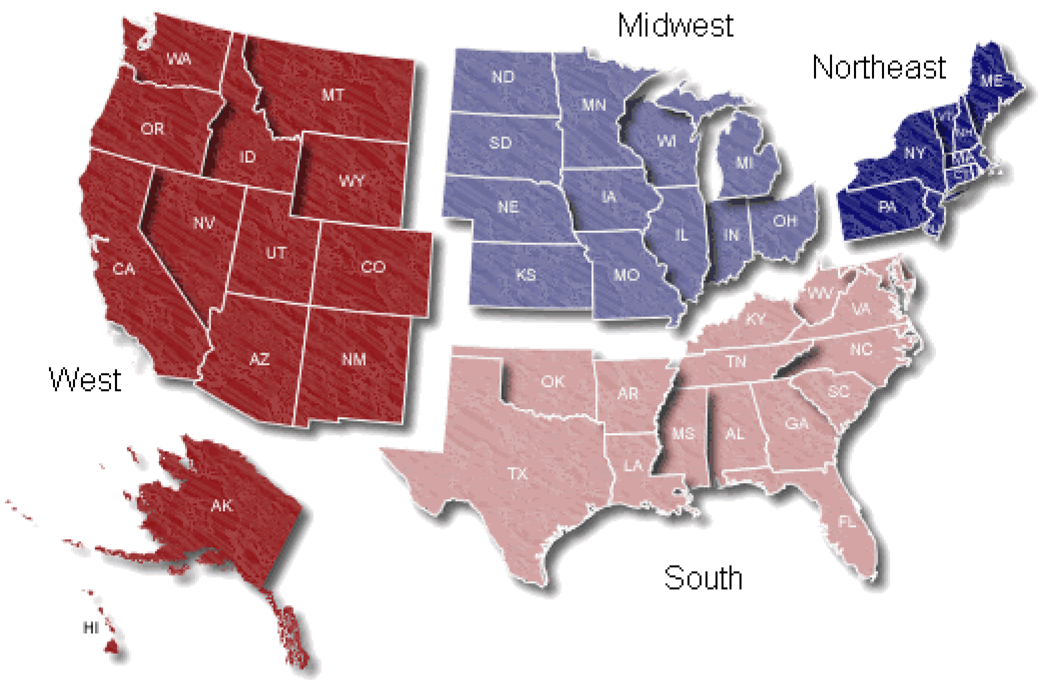
Table A2.1: Survey year and NLSY code for variables used in the paper

No.	Variable	Survey year	NLSY code
1	Height in 1997	1997	R0322500, R0322600
2	Height in 1998	1998	R2164100, R2164200
3	Height in 1999	1999	R3482000, R3482100
4	Height in 2000	2000	R4880200, R4880300
5	Height in 2001	2001	R6497600, R6497700
6	Height in 2002	2002	S0905500, S0905600
7	Height in 2003	2003	S2978200, S2978300
8	Height in 2004	2004	S4677000, S4677100
9	Total income from wages and salary in 2003	2004	S4799600
10	Total hours worked in 2003	2004	S3817100
11	Parental household income in 1998	1998	R2563300
12	Height of father	1997	R0608200, R0608300, R0608500, R0608600, R0608900, R0609000
13	Height of mother	1997	R0608200, R0608300, R0608500, R0608600, R0608900, R0609000
14	Gender identification biological parents	1997	R0733700, R0734200, R0735100, R0734800
15	Gender of respondent	1997	R0536300
16	US-born	1997	R5821400
17	Ethnicity of respondent	1997	R1482600
18	Exact age during 1998 interview	1998	R2553400
19	Exact age during 2003 interview	2003	S2000900
20	Years of education, residential father	1997	R1302600
21	Years of education, residential mother	1997	R1302700
22	Respondent covered by health insurance	1997	R0686800

23	Respondent visited a doctor for routine check-up in the last two years	2003	S1240500
24	Respondent lived in urban area in 1997	1997	R1217500
25	Census region of residence in 1997	1997	R1200300

Source: NLSY 97.

Figure A2.1: US Census Regions



Note: Northeast: CT=Connecticut, ME=Maine, MA=Massachusetts, NJ=New Jersey, NH=New Hampshire, NY=New York, PA=Pennsylvania, RI=Rhode Island, and VT=Vermont. North Central: IL=Illinois, IN=Indiana, IA=Iowa, KS=Kansas, MI=Michigan, MN=Minnesota, MO=Missouri, NE=Nebraska, ND=North Dakota, OH=Ohio, SD=South Dakota, and WI=Wisconsin. South: AL=Alabama, AR=Arkansas, DE=Delaware, DC=District of Columbia, FL=Florida, GA=Georgia, KY=Kentucky, LA=Louisiana, MD=Maryland, MS=Mississippi, NC=North Carolina, OK=Oklahoma, SC=South Carolina, TN=Tennessee, TX=Texas, VA=Virginia, and WV=West Virginia. West: AK=Alaska, AZ=Arizona, CA=California, CO=Colorado, HI=Hawaii, ID=Idaho, MT=Montana, NM=New Mexico, NV=Nevada, OR=Oregon, UT=Utah, WA=Washington, and WY=Wyoming.
Source: Map by the Indiana Business Research Center, Kelley School of Business, Indiana University.

Chapter 3: The Trade-off between a High and an Equal Biological Standard of Living – Evidence from Germany

3.1 Abstract

Following German re-unification, East Germany moved from a state-socialist to a market-based economic system. Using West Germany as a “control group”, we examine how the change affected the level and the equality of the biological standard of living. We find that before unification, East Germany had a lower but somewhat more equally distributed biological standard of living than the West. After unification, East Germany rapidly caught up in terms of height but at the expense of equality. This suggests that a trade-off exists between a high and an equally distributed biological standard of living. Unlike previous research, we find that West Germany’s pre-unification height advantage was smallest in towns with 5,000 to 20,000 inhabitants and largest in cities with 20,000 to 100,000 inhabitants (females) or in cities with more than 100,000 inhabitants (males). Between regions, height converged both in East and West Germany, but particularly markedly among East German males. Equality convergence, like height convergence, is significantly larger for East than for West German males.

3.2 Introduction

Biological welfare indicators such as health, longevity and height are useful complements to conventional indicators of welfare as they reflect the socioeconomic and environmental circumstances experienced by a population (Bogin, 1999; Floud, 1994; Fogel, 1994; Komlos, 1985, 1989; Steckel, 1995, 2008; Sunder, 2003; Waaler, 1984). As Komlos and Kriwy (2003) point out, this is particularly true for comparisons between countries with different economic and political systems such as the two Germanies prior to unification. After all, in such cases, conventional welfare measures are limited in their usefulness as it is hard to control for differences in the way prices are determined, in the quality and availability of goods, and in the reliability of official data. Apart from that, it is questionable to what extent conventional indicators can capture all dimensions of the quality-of-life. “How, for example, should one interpret the fact that East German employees earned about half of their Western counterparts in 1980, and their travel was restricted, but had full employment and a more equal distribution of income?” (Komlos and Kriwy 2003). With surveys of contentment also unavailable, biological welfare indicators are useful for comparing well being in East and West Germany before unification (Komlos and Baur 2004 and Heineck 2006).

From a social point of view, not only a high but also an equally distributed standard of living is desirable. In Germany, a “just and equal income distribution” is a goal actually mandated by a law enacted in 1963 (Kämper 1992, Krupp 1985, Moeller 1968, Schiller 1978)[1]. It is often suggested that the goals of a high living standard and an equally distributed living standard are to some extent conflicting. As Browning and Johnson (1984) argue: “Income redistribution is not a socially costless endeavor because the policies required to accomplish it generally produce misallocations of resources” (Aghion et al. 1999, Baumol and Fischer 1979, Benabou 1994, 1996, 2000, 2005, Blyth 1997, Lee 1987, 1993, Niggle 1997, 1998, Okun 1975, Persson and Tabellini 1994, Vallentyne 2000; see, however, also Lindert 2007). Empirical evidence for a trade-off between equality and efficiency (in Germany) comes from Hauser (1992), Loetsch (1991, 1993) and Dathe (1998). They show that after unification, average income in East Germany increased together with the number of poor households. In 1990, only 3% of East German households had an income of less than half of the average per capita income. By 1997, about 8% did. Despite much research on the biological standard of living, little is known about to what extent such a trade-off exists.

[1] This makes sense in view of the so called Easterlin Paradox of Happiness Economics, which states that the effectiveness of income as a generator of well-being is greatly diminished once income reaches a certain level (Easterlin 1974). The reason is that aspiration increases along with income and after basic needs are met, relative rather than absolute levels of income become important for well-being (“hedonic treadmill”, Brickman and Campbell 1971, Clark et al. 2006, Diener 2005, Di Tella 2001, 2004, Frank 1997, Frey and Stutzer 2000, 2002, Hepburn and Eysenck 1989, Layard, R. 2005, Phelps 2001, Sen 1970, 1985, 1992, 1995, 1999).

3.3 Data

The German Mikrozensus is a yearly survey of 1% of households, which is about 370,000 households or about 820,000 persons[2]. For the survey, districts are selected in which all persons are interviewed. The public use files are 70% subsamples of the original Mikrozensus, designed to better ensure the anonymity of respondents. We restrict our analysis to the Mikrozensus rounds 1999 and 2003, as these rounds are the only ones which include a question on the height of respondents. We exclude all implausible observations. For the sake of comparability, we exclude immigrants. Throughout the paper, both rounds of the Mikrozensus are pooled together to increase sample size. Descriptive statistics of the sample are available in Table A3.1 of the Appendix.

Since height is self-reported in the Mikrozensus, we should be aware of potential bias. We compare the trend in height calculated from the Mikrozensus data to similar profiles for the 1998 Bundesgesundheitssurvey (BGS, "Federal Health Survey"), in which height is measured by professionals (Stolzenberg 2000). On average, we have 2,003 female observations per annual birth cohort in the Mikrozensus but only 82 in the BGS. For males, the respective numbers are 2,012 and 77. In the Mikrozensus, East and West German female height is on average 0.3 cm above the BGS trend (Figure 3.1)[3]. Deviations are larger for older than for younger individuals (0.7 cm in the West and 0.8 cm in the East at age 50 to 80 versus 0.2 cm and 0.1 cm at age 20 to 49), suggesting that respondents are not fully aware of age-related shrinking. Males show less over-reporting than females. Average deviation is 0.6 cm in the West and 0.5 cm in the East. Again, deviations are larger for older than for younger respondents, though only slightly (0.6 cm at age 50 to 80 and 0.5 cm at age 20 to 49).

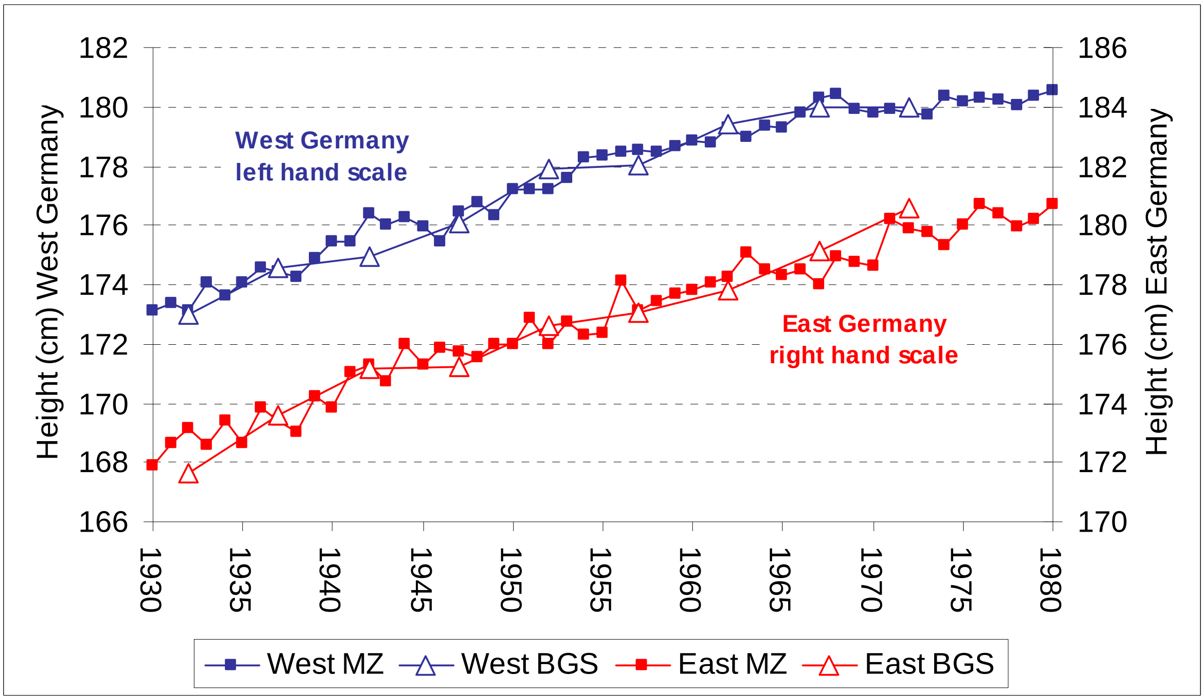
---

[2] The survey is conducted by the Bundesamt für Statistik (Federal Statistical Office) jointly with the statistical offices of the 16 individual German states. Most items in the Mikrozensus questionnaire are subject to compulsory response. The data can be ordered under the following address: http://www.gesis.org/en/social_monitoring/GML/data/mc/index.htm.

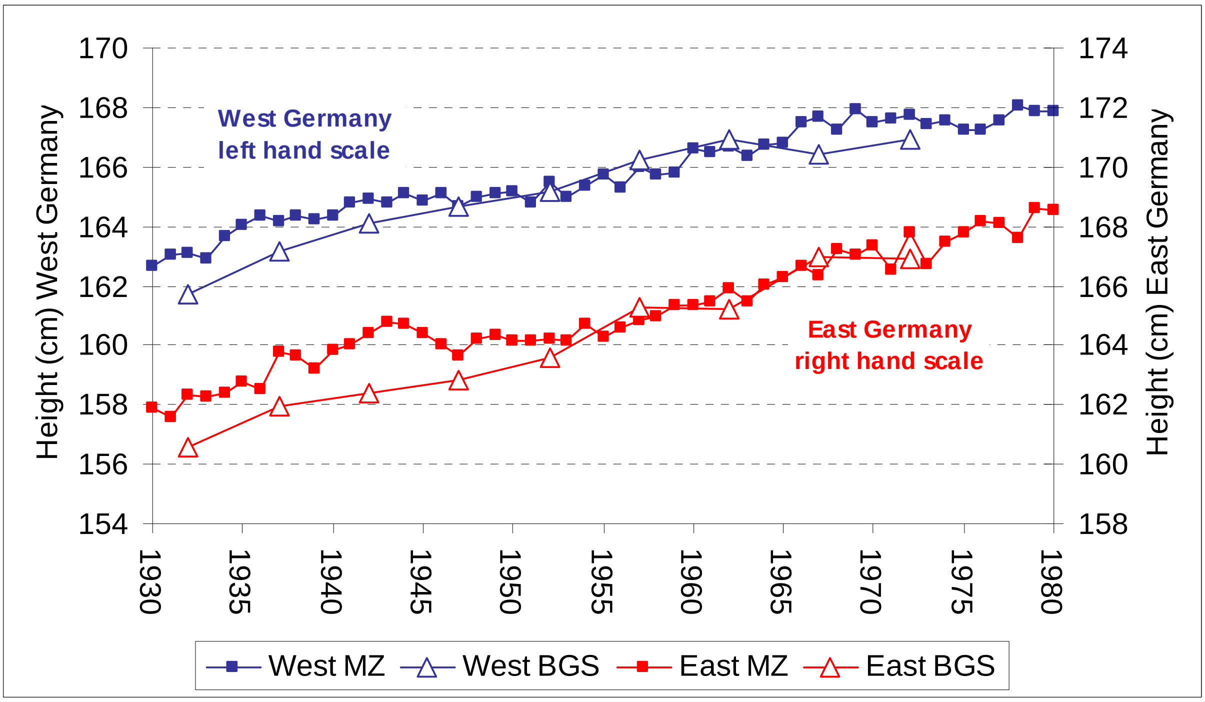
[3] We refer to people living in regions that once belonged to the German Democratic Republic as East Germans, and to people living in areas that belonged to the Federal Republic of Germany as West Germans.

Figure 3.1: Comparison of Mikrozensus and Bundesgesundheitssurvey average adult height, by year of birth, East and West Germany

Females



Males

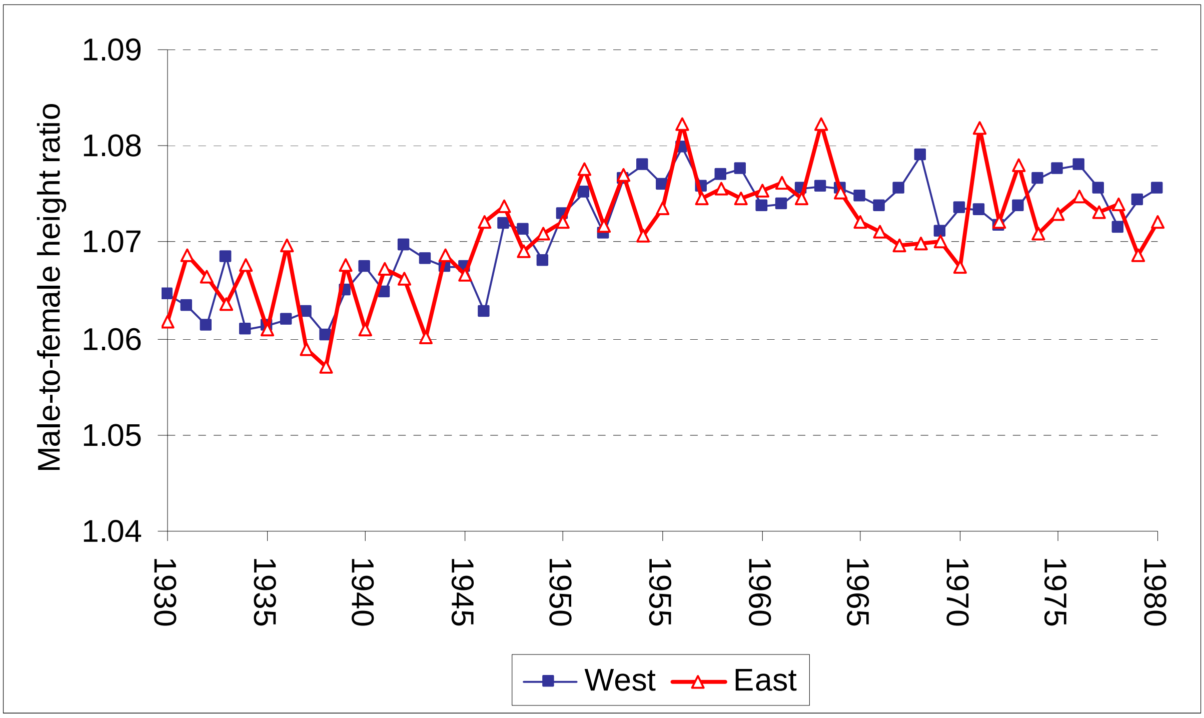


Note: Mikrozensus data is on a yearly basis, while the BGS data reflects 5-year averages. Height in the Bundes-gesundheitssurvey is measured by professionals.

Source: Mikrozensus 1999 and 2003, Bundesgesundheitssurvey 1998

The male-to female height ratio was similar in East and West Germany throughout the period under consideration (Figure 3.2). In both parts of Germany, the male height advantage increased beginning with the birth cohorts of the 1950s.

Figure 3.2: Male-to-female height ratio, by year of birth, East and West Germany



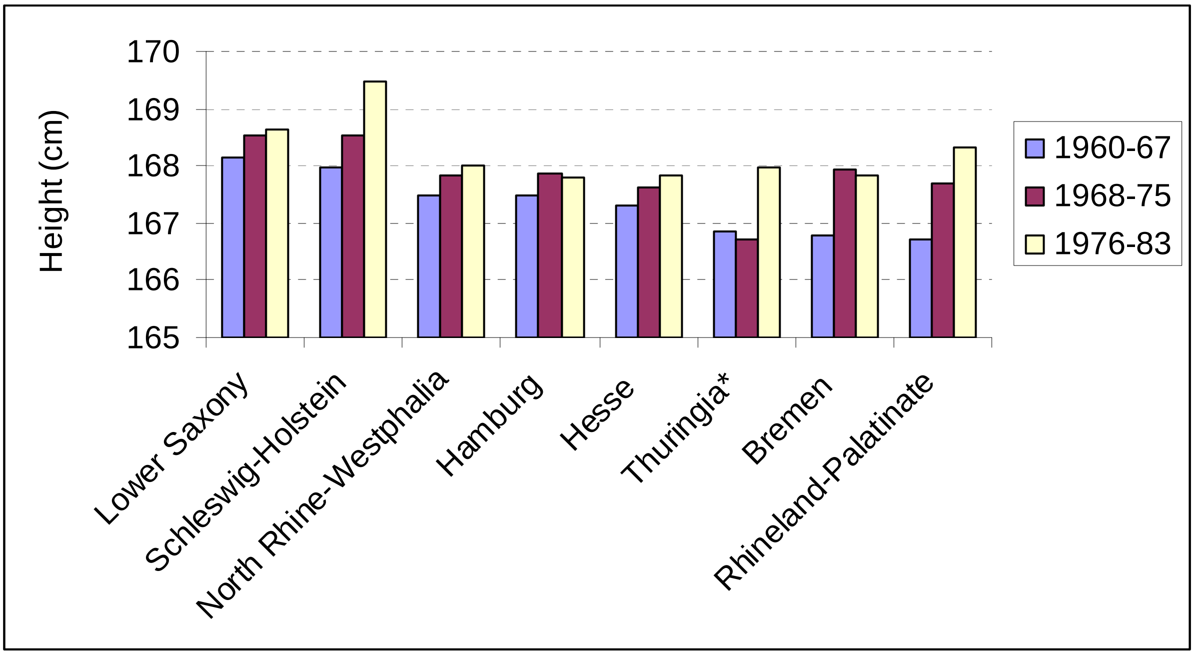
Source: Mikrozensus 1999 and 2003

3.4 Level of the biological standard of living in East and West Germany before and after unification

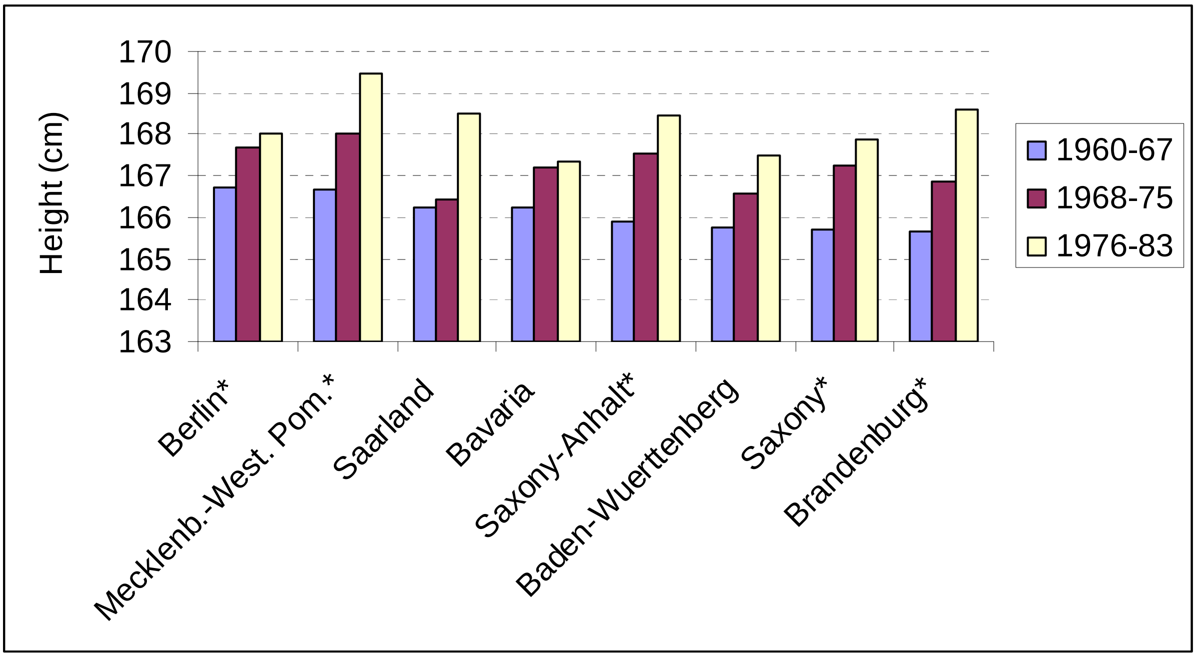
Using the BGS data set, Komlos and Kriwy (2003) showed that, despite their genetic similarity, West Germans were significantly taller than East Germans before unification. They conclude that the mixed economy in the West led to a higher biological standard of living than the state-socialist system in the East. They found, moreover, that East German males (unlike East German females) have started to catch up to their West German counterparts after unification. At the level of the 16 individual German states, average adult height generally increased from the period 1960-67 to 1976-83 for both genders (Figure 3.3). The only exception is the state of Saarland, which saw a slight decline in male average height (-0.1 cm). Only one East German state made it in the top 8 of the states with the greatest female height in 1960-67 (Thuringia). Among males, the top 8 is even more dominated by West German states, with no East German state represented.

Figure 3.3: Average height by state, 1960-67, 1968-75, and 1976-83

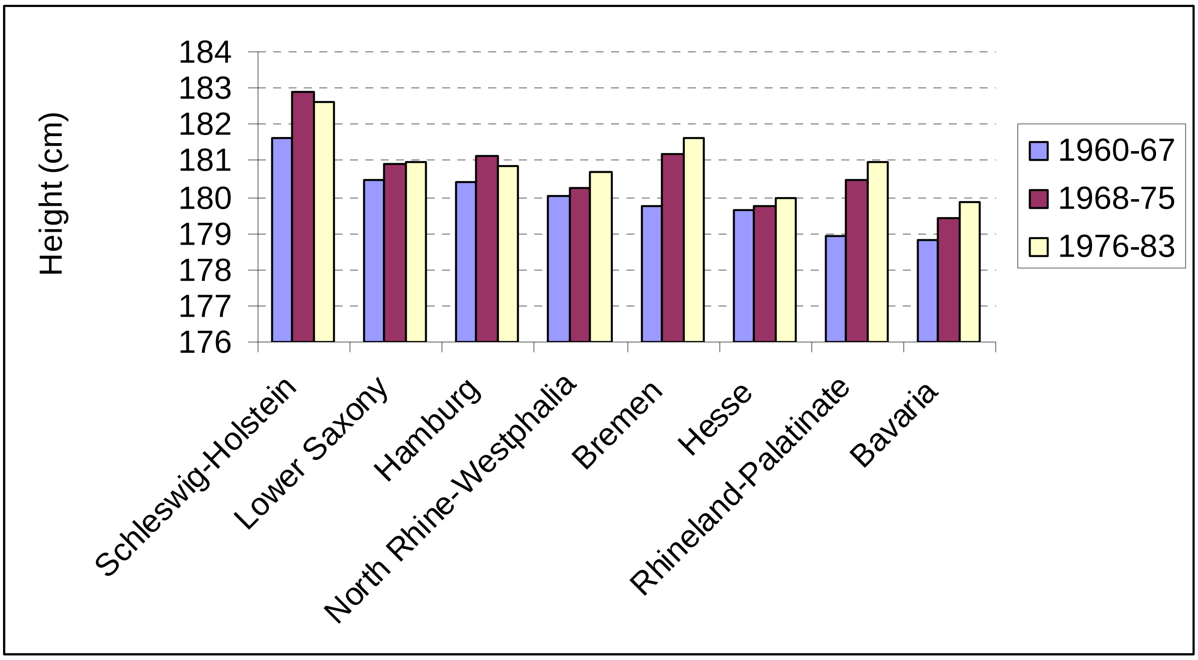
Females, Top 8 States



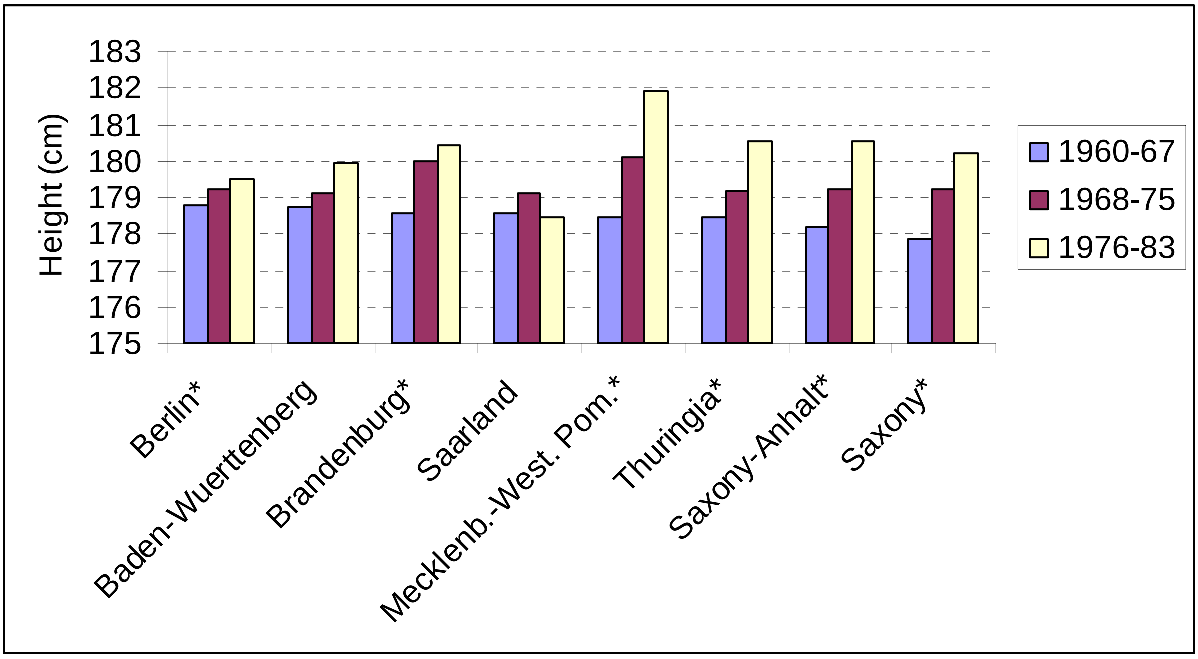
Females, Bottom 8 States



Males, Top 8 States



Males, Bottom 8 States



Note: States ordered by height in 1960-67. An asterisk denotes an East German state.
Source: Mikrozensus 1999 and 2003.

We regress the height of Germans born 1930-79 on dummy variables for the Bundesland (state) in which the individuals lived in the survey year (Table 3.1). In most cases, this state is also the state in which the individual grew up as regional mobility is low in Germany (Buch 2006). In addition to birth cohorts and state of residence, in columns 2 and 4 we also control for town size and net monthly income. The former is a useful predictor of height outcomes in so far as the supply of medical services is often more efficient in metropolitan areas than in rural ones. Moreover, income is usually found to be an important determinant of height, as richer parents often have superior consumption skills (Komlos and Kriwy, 2003)[4].

Birth cohorts are significant in all specifications, reflecting a general upward trend in the biological standard of living for both genders. Income is also significant for both females and males, reinforcing previous research (e.g. Heineck 2006, Thomas 1994) insofar as height

[4] Here the assumption is that the subject's own income is positively correlated with his/her parents' income.

is associated with socio-economic differences. Urbanization is generally not significant in contrast to the findings of Komlos and Kriwy.

Significant regional differences exist (Table 3.1 and Figure 3.4). There is a North-South and West-East gradient, as reported by Heineck (2006) using data from the German Socio-Economic Panel.

Table 3.1: OLS estimates, dependent variable: adult height of 1930-79 birth cohorts

	Females		Males	
	(1)	(2)	(3)	(4)
Birth cohorts				
30-39	-1.84***	-1.64***	-3.72***	-3.33***
40-49	-0.56***	-0.50***	-1.83***	-1.71***
50-59	Reference	Reference	Reference	Reference
60-69	1.62***	1.64***	1.46***	1.51***
70-79	2.56***	2.70***	2.36***	3.02***
Urbanization				
Less than 5,000 inhabitants		0.23***		-0.04
5,000-20,000 inhabitants		0.08		-0.01
20,000-100,000 inhabitants		Reference		Reference
More than 100,000 inhabitants		0.02		0.16**
Net monthly income				
Less than € 900		Reference		Reference
€ 900 - € 1,300		0.45***		0.64***
More than € 1,300		1.36***		2.23***
Federal states				
Baden-Wuerttemberg	-1.24***	-1.27***	-1.20***	-1.19***
Bavaria	-1.15***	-1.19***	-1.09***	-1.01***
Berlin	-0.89***	-0.98***	-0.33***	0.01
Brandenburg	-1.40***	-1.41***	-1.27***	-0.43***

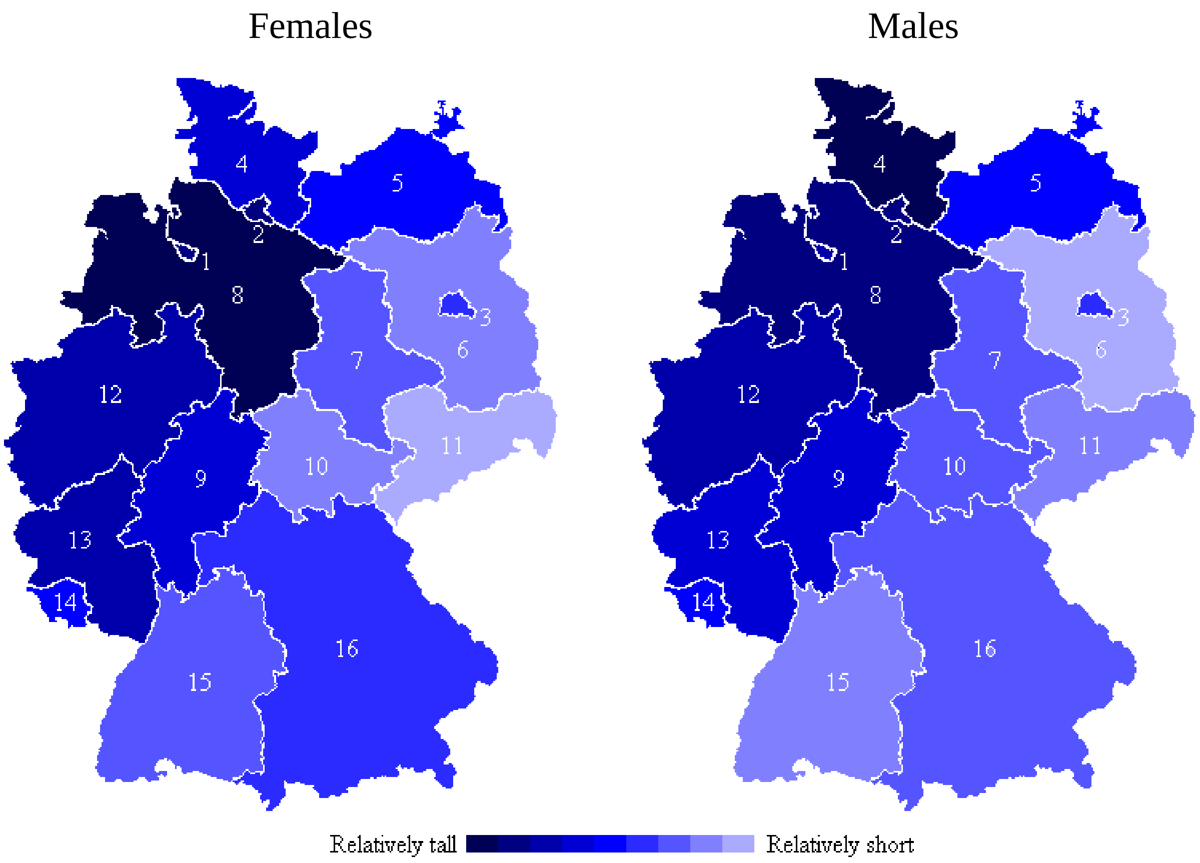
Bremen	0.14	0.13	0.12	0.19
Hamburg	0.15	0.01	0.51***	0.54***
Hesse	-0.46***	-0.48***	-0.40***	-0.32***
Lower-Saxony	0.27***	0.28***	0.42***	0.52***
Mecklenburg-Western Pomerania	-0.83***	-0.73***	-0.97***	-0.02
North Rhine-Westphalia	Reference	Reference	Reference	Reference
Rhineland-Palatinate	-0.39***	-0.44***	-0.67***	-0.58***
Saarland	-0.78***	-0.71***	-1.36***	-1.21***
Saxony	-1.41***	-1.36***	-1.54***	-0.76***
Saxony-Anhalt	-1.33***	-1.22***	-1.63***	-0.78***
Schleswig-Holstein	0.53***	0.45***	1.09***	1.20***
Thuringia	-1.15***	-1.11***	-1.66***	-0.79***
Constant	166.04***	165.51***	178.42***	176.56***
Adjusted R-squared	0.06	0.07	0.09	0.11
F-statistic	355.7***	313.1***	619.0***	576.8***
Number of observations	98,204	98,204	110,000	110,000

Note: Height is measured in cm. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used.

Source: Mikrozensus 1999, 2003

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3.4: Regional differences in height after controlling for demographics, average town size and average income, 1930-79 birth cohorts



Note: The figure is based on the regression results of columns 2 and 4 of Table 3.1. 1=Hamburg, 2=Bremen, 3=Berlin, 4=Schleswig-Holstein, 5= Mecklenburg-Western Pomerania, 6=Brandenburg, 7=Saxony-Anhalt, 8=Lower-Saxony, 9=Hesse, 10= Thuringia, 11=Saxony, 12=North Rhine-Westphalia, 13=Rhineland-Palatinate, 14=Saarland, 15= Baden-Wuerttemberg, 16=Bavaria. States 5, 6, 7, 10 and 11 comprise East Germany, Berlin (3) was divided.

Source: Mikrozensus 1999, 2003.

We next limit the analysis to those born in the years 1940-69 (Table 3.2). These individuals grew up before unification. Then, we repeat the analysis for people born 1980-1983, who grew up after unification (Table 3.3)[5].

[5] We also consider the birth cohorts of 1970-83 and 1990-96. All results are qualitatively unchanged (results omitted). This is also true if we control for education rather than for net monthly income (results omitted). In Table 3.2, the height of those born before 1953 is not equal to their adult height insofar as people start to shrink

East German females who grew up in a divided Germany were 0.81 cm shorter and males 0.50 cm shorter than their West German counterparts (Table 3.2, column 1 and 3 and Figure 3.5)[6]. The coefficients are somewhat smaller than the ones calculated by Komlos and Kriwy (2003), who found height advantages of 1.16 and 0.7 cm respectively using BGS data for the birth cohorts of 1946-80. The height difference is significant for all birth cohorts (Table 3.2, columns 2 and 4).

To be sure, that East Germans were shorter than West Germans before unification does not prove that the state-socialist system in the East led to a lower biological standard of living then the mixed economy in the West. Even larger differences exist between some West German states – despite the same economic and political system (Figure 3.4). However, German re-unification provides us with a "natural experiment" in which to test whether system-driven differences in the biological standard of living exist: Over a very short period, the East's economic and political system changed. We therefore consider the height of East Germans after unification. We find that relative to the West German "control group", East Germans are no longer significantly shorter than their West German peers (Table 3.3 and Figure 3.5) and that East German males are even taller now (by 0.66 cm). This indicates that the differences were system-driven and that the mixed economy in the West led to a higher biological standard of living than the state-socialist system in the East.

Our results might be influenced by migration. Immediately after unification, considerable numbers of West Germans moved to the East. In general, they were either government officials dispatched to help with the transformation process, or company representatives developing the new markets. While they were too old to be included in the birth cohorts of 1980-83 (Table 3.3), their children may be. At the same time, many East Germans moved to

---

after about the fifth decade of life (e.g. Komlos and Kriwy, 2003). However, for the purpose of East-West comparisons this does not matter as the shrinking tempo should be comparable in East and West Germany.

[6] Wherever we compare East to West Germany in the paper, we exclude Berlin as the data set does not distinguish between East and West Berlin.

the West, looking for more promising opportunities there. This flow became more important over time when East Germany's economic development remained behind expectations.

Table 3.2: Pre-unification OLS estimates, dependent variable: adult height of 1940-69 birth cohorts

	Females		Males	
	(1)	(2)	(3)	(4)
Birth cohorts				
40-49	-1.68***	-1.62***	-2.94***	-2.78***
50-59	Reference	Reference	Reference	Reference
60-69	0.47***	0.21*	0.30***	0.02
40-49*West		0.46***		0.59***
50-59*West		1.11***		0.77***
60-69*West		1.02***		0.29***
West	0.81***		0.50***	
East	Reference		Reference	
Urbanization				
Less than 5,000 inhabitants	0.06	0.08	-0.32**	-0.30*
5,000-20,000 inhabitants	-0.03	-0.02	-0.19	-0.17
20,000-100,000 inhabitants	Reference	Reference	Reference	Reference
More than 100,000 inhabitants	0.08	0.08	-0.07	-0.08
Less than 5,000 inhabitants*West	-0.13	1.97***	0.00	1.88***
5,000-20,000 inhabitants*West	-0.15	1.97***	-0.14	1.75***
20,000-100,000 inhabitants*West	0.01	2.11***	-0.14	1.75***
More than 100,000 inhabitants*West	0.00	2.03***	0.31	2.18***
Net monthly income				
Less than € 900	Reference	Reference	Reference	Reference
€ 900 - € 1,300	0.57***	0.54***	0.28***	0.45***
More than € 1,300	1.22***	1.37***	1.43***	1.93***
Constant	165.45***	165.49***	177.68***	177.52***
Adjusted R-squared	0.02	0.04	0.04	0.05

F-statistic	191.5***	226.7***	385.5***	379.9***
Number of observations	78,254	78,254	90,493	90,493

Note: Height is measured in cm. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used.

Source: Mikrozensus 1999, 2003

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.3: Post-unification OLS estimates, dependent variable: adult height of 1980-1983 birth cohorts

	Females		Males	
	(1)	(2)	(3)	(4)
Birth cohorts				
1980	0.27	-0.01	0.16	-0.75
1981	Reference	Reference	Reference	Reference
1982	0.18	0.10	-0.47	-1.44**
1983	-0.29	-0.39	-0.59	-1.15*
1980*West		0.65		0.07
1981*West		0.39		-0.12
1982*West		0.44		0.06
1983*West		0.62		0.03
West	0.56		-0.02	
East	Reference		Reference	
Urbanization				
Less than 5,000 inhabitants	0.00	0.00	-1.01	-1.03
5,000-20,000 inhabitants	1.76***	1.76***	-0.54	-0.56
20,000-100,000 inhabitants	Reference	Reference	Reference	Reference
More than 100,000 inhabitants	0.89	0.90	-0.38	-0.37
Less than 5,000 inhabitants*West	0.22	0.77	1.66*	0.97
5,000-20,000 inhabitants*West	-1.54**	-0.99	0.34	-0.36
20,000-100,000 inhabitants*West	0.00	0.55	0.00	-0.73
More than 100,000 inhabitants*West	-0.83	-0.29	0.15	-0.6

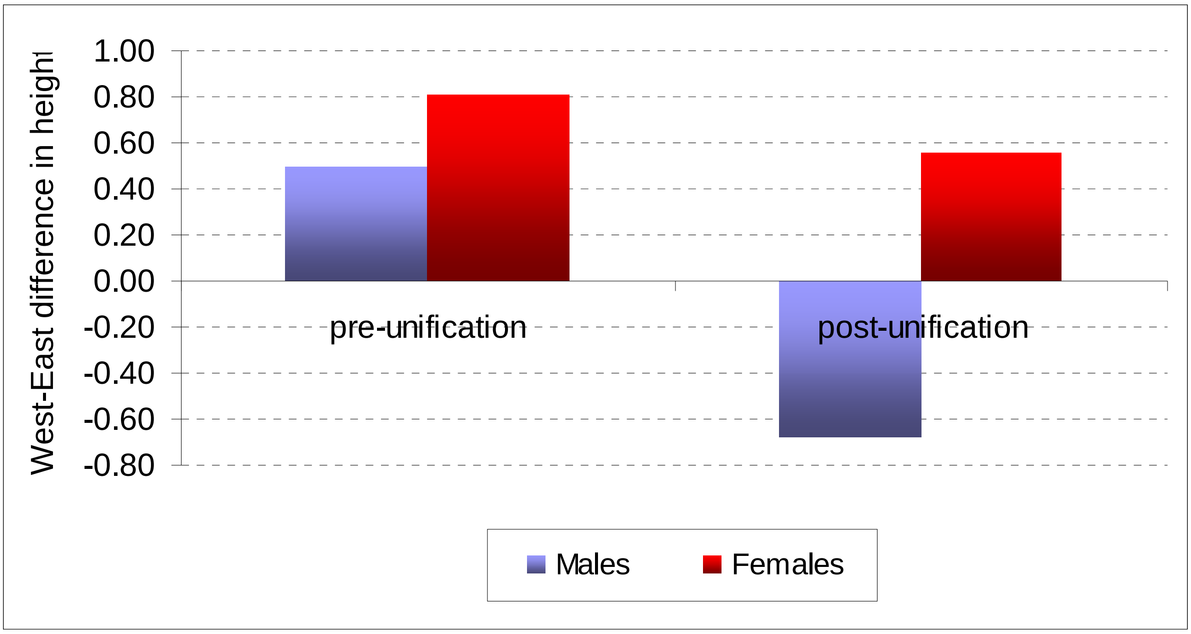
Net monthly income				
Less than € 900	Reference	Reference	Reference	Reference
€ 900 - € 1,300	0.22	0.23	0.05	0.03
More than € 1,300	1.62***	1.61***	0.07	0.08
Constant	167.20***	167.31***	181.51***	182.12***
Adjusted R-squared	0.01	0.01	0.01	0.01
F-statistic	2.05	1.7	1.13	1.14
Number of observations	3,836	3,836	3,741	3,741

Note: Height is measured in cm. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used.

Source: Mikrozensus 1999, 2003

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3.5: Comparison of adult height of East and West German females who grew up before and after unification assuming average income and urbanization



Note: Positive values mean that West Germans were on average taller than East Germans. Pre-unification refers to an individual born between 1950-59 of average urbanization and income (columns 1 and 3 of Table 3.2), while post-unification refers to an individual born 1981 (again of average urbanization and income, columns 1 and 3 of Table 3.3).

Source: Mikrozensus 1999, 2003

While urbanization plays little or no role in regressions using post-unification cohorts (Table 3.3), it is significant in some specifications concerning the pre-unification cohort (Table 3.2). This is an indication that the spatial distribution of goods and services became more uniform after unification. Notably, urbanization is consistently significant in the specifications with interaction terms, but not in the other specifications. To learn more about this phenomenon, we ran separate regressions for East and West Germans (Table 3.4).

In our data, the spatial distribution of biological living standards in Eastern and Western Germany is different (Table 3.4 and Figure 3.6). For females, the West-German height advantage increases with urbanization, while for males, the pattern is U-shaped. Both for females and males, West Germany's relative height advantage is smallest in towns with 5,000-20,000 inhabitants and largest in cities with 20,000 to 100,000 inhabitants (females) or more than 100,000 inhabitants (males). In the study by Komlos and Kriwy, the West-German height advantage compared to the East-German population was particularly large in towns with fewer than 2,000 inhabitants and decreased with increasing urbanization.

The difference between our finding and the Komlos and Kriwy finding may be partly explained by the choice of control variables. Komlos and Kriwy use a composite indicator which is available in their data set to control for socioeconomic status[7], while we control for net monthly income. Another possible explanation for the difference pertains to the period under investigation. While Komlos and Kriwy examine the years 1946-80, we focus on the years 1940-69.

[7] The composite indicator is determined on the basis of four criteria: general education, vocational education, occupation and income. Each variable obtains a score from 1 to 7 points. The sum is then divided into three equal parts: lower, middle and upper socioeconomic status (Winkler, 1998).

Table 3.4: Separate OLS estimates for West and East Germany, dependent variable: adult height of 1940-69 birth cohorts

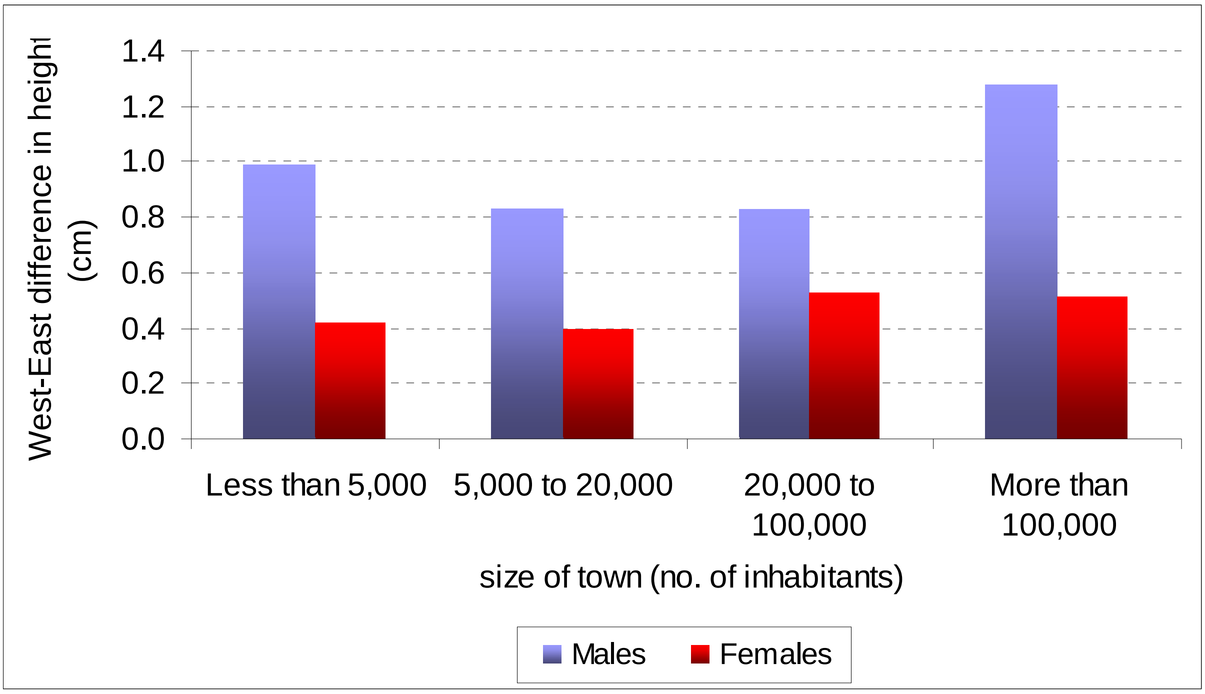
	Females		Males	
	West	East	West	East
Birth cohorts				
40-49	-1.71***	-1.65***	-2.96***	-2.77***
50-59	Reference	Reference	Reference	Reference
60-69	0.53***	0.25**	0.37***	0.01
Urbanization				
Less than 5,000 inhabitants	-0.07	0.04	-0.16*	-0.32**
5,000-20,000 inhabitants	-0.18**	-0.05	-0.18**	-0.18
20,000-100,000 inhabitants	Reference	Reference	Reference	Reference
More than 100,000 inhabitants	0.07	0.09	0.37***	-0.08
Net monthly income				
Less than € 900	Reference	Reference	Reference	Reference
€ 900 - € 1,300	0.59***	0.47***	0.01	0.91***
More than € 1,300	1.38***	0.49***	1.21***	1.88***
Constant	166.20***	165.67***	178.22***	177.39***
Adjusted R-squared	0.02	0.02	0.04	0.04
F-statistic	221.9***	45.2***	452.6***	116.4***
Number of observations	60,764	17,490	72,294	18,199

Note: Height is measured in cm. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used.

Source: Mikrozensus 1999, 2003

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3.6: Height difference between West and East Germans as a function of town size (1940-69 birth cohorts)



Note: Positive values indicate that West Germans were on average taller than East Germans. The figure is based on the regression results of Table 3.4.
Source: Mikrozensus 1999, 2003

3.5 Regional height convergence in East and West Germany

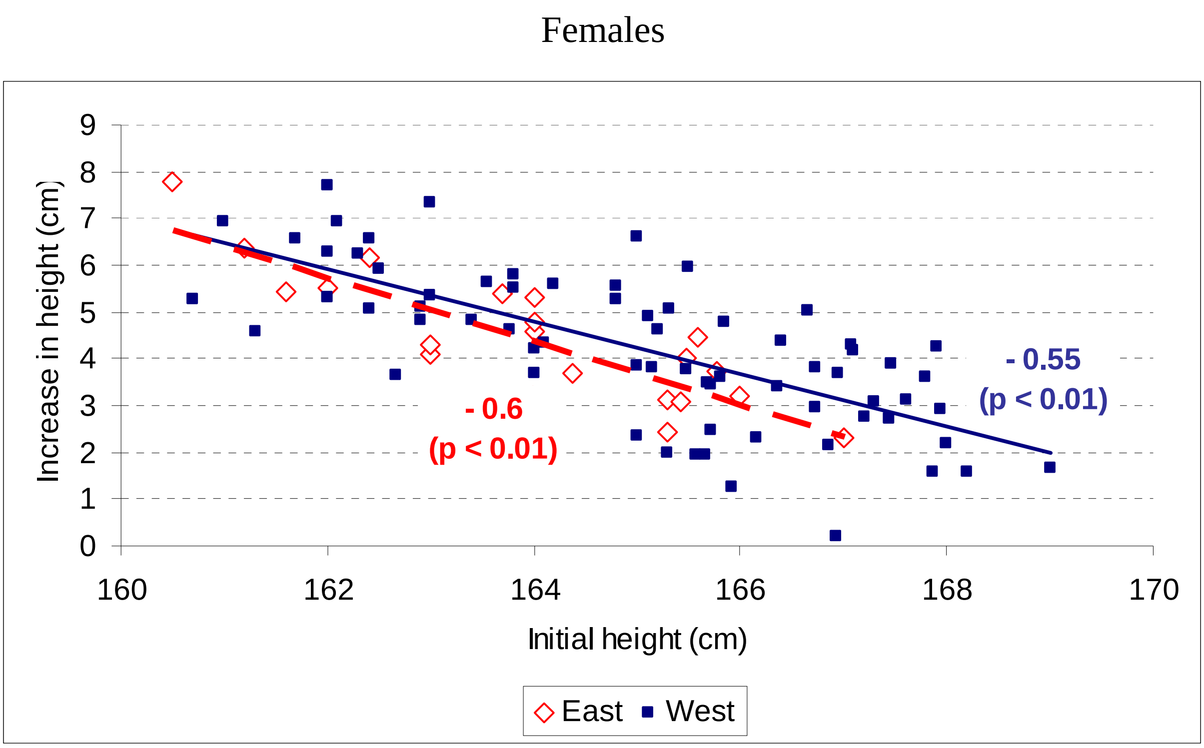
To test for income convergence on a cross-section of economies, the average rate of income growth for a given period can be regressed on the initial income (Baumol 1986, Barro 1991, Barro and Sala-i-Martin 1992, 1995). A negative sign on the coefficient of the initial income is interpreted as evidence of income convergence. This kind of regression analysis can also be used to consider spatial convergence of biological living standards (Komlos 2007). In the following, we therefore regress the difference in height between the birth cohorts of 1946-49 and 1976-79 on the height of the initial birth cohorts (1946-49) at the sub-regional level

(N=88)[8]. To avoid short-term cyclical effects, we use periods of four years (1946-49, 1976-79) to calculate robust average heights for the individual sub-regions.

Convergence is significant in East and West Germany for both genders (Figure 3.7). If female mean height of an East German sub-region was only 162 cm in 1946-49, it increased on average by 5.5 cm over the next 30 years. In contrast, if the mean height in 1946-49 was already 166 cm, it increased only by 3 cm, as reflected by the slope of regression line of –0.6[9].

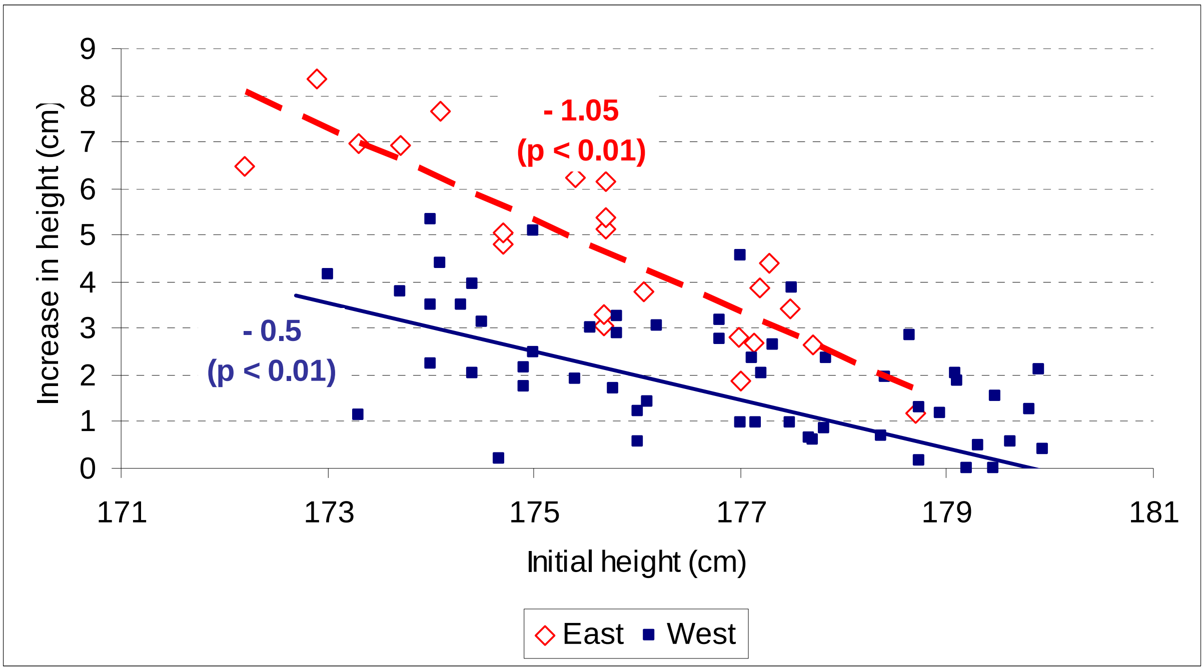
Similar values apply to West German females and East and West German males, though convergence is particularly strong for East German males (slope of –1.05).

Figure 3.7: Height convergence in East and West Germany, 1946-79 to 1976-79 birth cohorts, 88 sub-regions



[8] Alternatively, we could consider states. However, sample size would be only 15.
[9] On average, the increase is 3.9 cm.

Males



Note: Significance is evaluated using heteroscedasticity-robust Huber-White (1967, 1980) standard errors. For females, the average for 1946-49 is calculated from 9,650 observations and for the 1976-79 average from 9,430 observations. For males, the respective numbers are 9,702 and 9,456.
Source: Mikrozensus 1999, 2003.

To test for East-West differences in height convergence between sub-regions, we include an interaction term between West Germany and average height of the 1946-49 birth cohort in another regression (Table 3.5). To capture convergence in the biological standard of living rather than convergence in the degree of urbanization, or income, we also include controls for birth cohorts, urbanization and net monthly income.

Our previous convergence results are qualitatively confirmed (significant negative association of average height with subsequent height gains, Table 3.5). For East German males, unlike for females, convergence is significantly larger than for their West German peers (significant interaction term, Table 3.5).

Table 3.5: OLS estimates, dependent variable: difference in average height between the 1946-49 and the 1976-79 birth cohorts

	Females	Males
Average height, 1946-49 birth cohorts	-0.60***	-1.24***
West*Average height, 1946-49 birth cohorts	0.05	0.11***
West	-8.36	-14.71***
East	Reference	Reference
Share of population living in a town with…		
... less than 5,000 inhabitants	-0.55	-1.36
... 5,000-20,000 inhabitants	-0.24	-1.70
... 20,000-100,000 inhabitants	Reference	Reference
... more than 100,000 inhabitants	0.99	-0.40
Share of population with a net monthly income of…		
... less than € 900	Reference	Reference
... € 900 - € 1,300	1.45	9.64**
... more than € 1,300	0.76	7.19**
Constant	100.18***	215.13***
Adjusted R-squared	0.39	0.55
F-statistic	12.3***	8.5***
Number of observations	88	88

Note: Height is measured in cm. Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used. The average for 1946-49 is calculated from 9,650 observations for females and 9,702 observations for males. The respective numbers for the 1976-79 average are 9,430 and 9,456.

Source: Mikrozensus 1999, 2003.

* significant at 10%; ** significant at 5%; *** significant at 1%

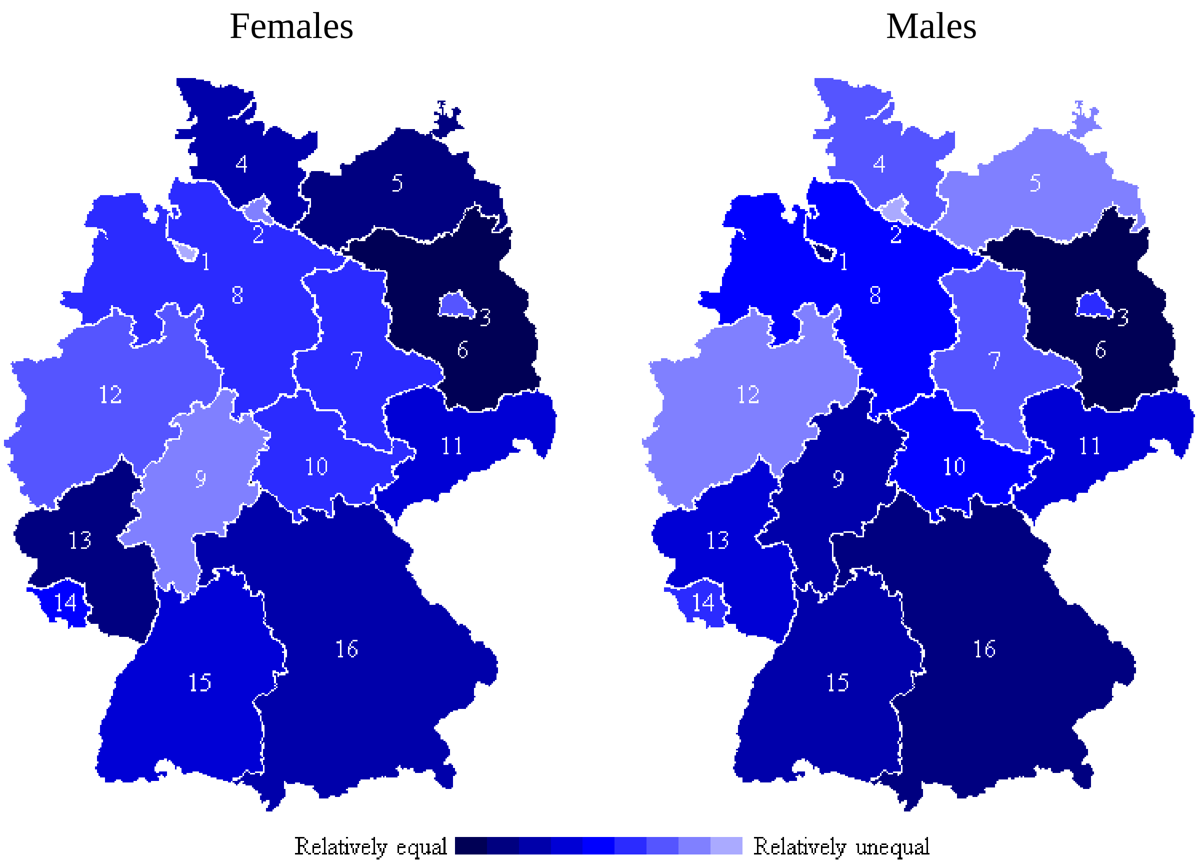
3.6 Inequality in the biological standard of living in East and West Germany before and after unification

The coefficient of variation (CV) for height is widely used in the literature to measure equality in the biological standard of living (Baten 2000, Baten and Murray 2000, Godoy et al. 2005, Morady and Baten 2005, Komlos 2007). It is defined as the standard deviation of a distribution divided by mean height[10].

We present the 1930-79 average of this coefficient at the level of the 16 individual German states by gender (Figure 3.8). Major differences exist. The states of Schleswig-Holstein and Mecklenburg-Western Pomerania are among the most equal ones for females but among the least equal ones for males; the opposite is true for Hamburg. We did not find similar gender-based differences for mean height.

[10] Usually, the coefficient of variation is multiplied by 100 and reported as a percentage.

Figure 3.8: Regional differences in equality, as measured by the coefficient of variation of height, 1930-79 birth cohorts



Note: 1=Hamburg, 2=Bremen, 3=Berlin, 4=Schleswig-Holstein, 5= Mecklenburg-Western Pomerania, 6=Brandenburg, 7=Saxony-Anhalt, 8=Lower-Saxony, 9=Hesse, 10= Thuringia, 11=Saxony, 12=North Rhine-Westphalia, 13=Rhineland-Palatinate, 14=Saarland, 15= Baden-Wuerttemberg, 16=Bavaria. States 5, 6, 7, 10 and 11 comprise East Germany, Berlin (3) was divided.

Source: Mikrozensus 1999, 2003

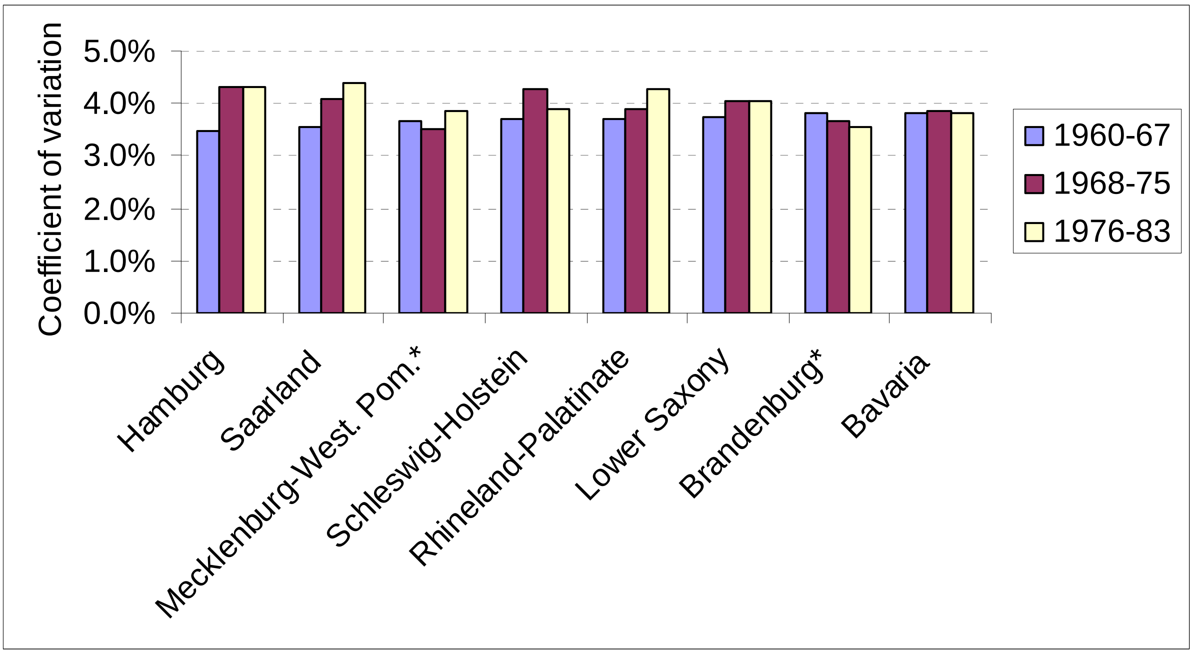
In most states, the CV is higher in 1976-83 than in 1960-67 (Figure 3.9)[11]. Exemptions are Brandenburg (both genders), Saxony (females), Hesse (females), Bremen (both genders), Berlin (males), Thuringia (males) and Schleswig-Holstein (males). For both genders, the CV was at any time between 3.3% and 4.5%. The mean male-to-female CV ratio was similar in

[11] For East-West averages see Figure A3.1.

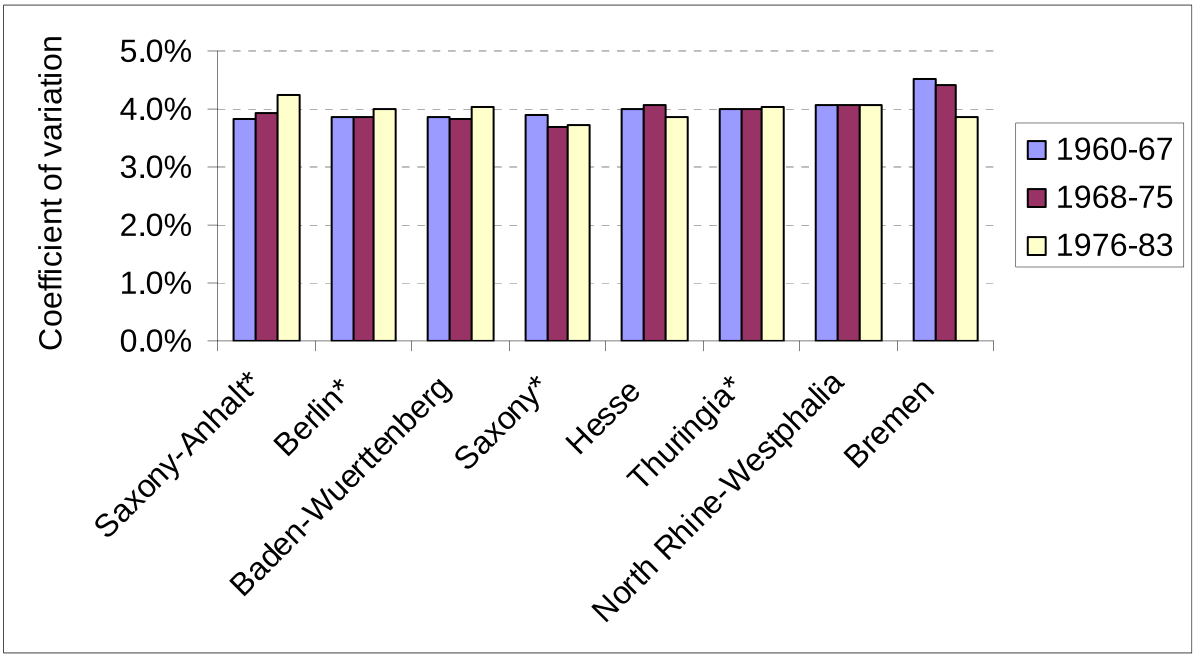
East and West and fairly constant over time (Figure 3.10). That the East's ratio was more volatile than the West's may be explained by the former's smaller sample size.

Figure 3.9: Average coefficient of variation by state, 1960-67, 1968-75, and 1976-83

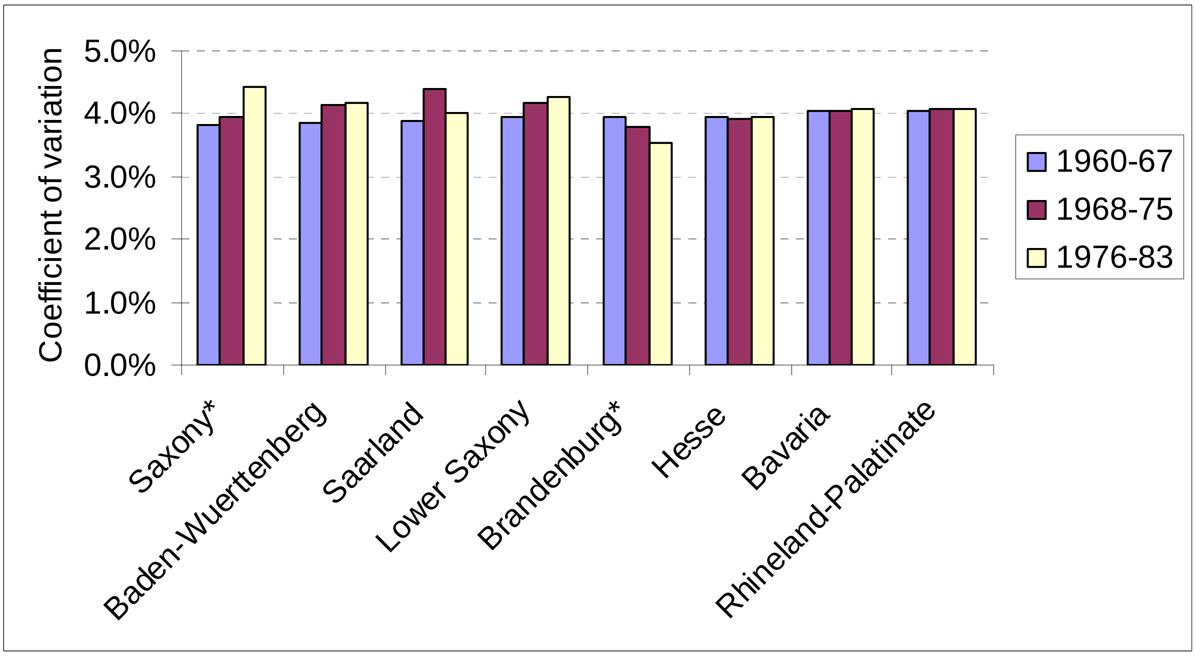
Females, Top 8 States



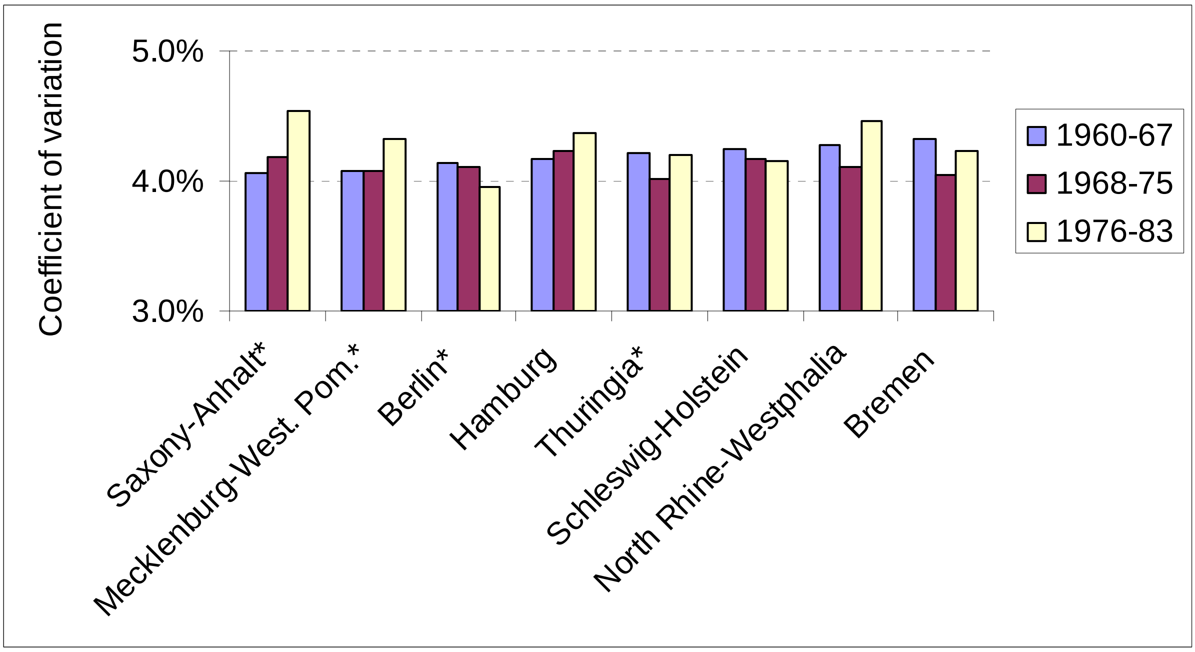
Females, Bottom 8 States



Males, Top 8 States

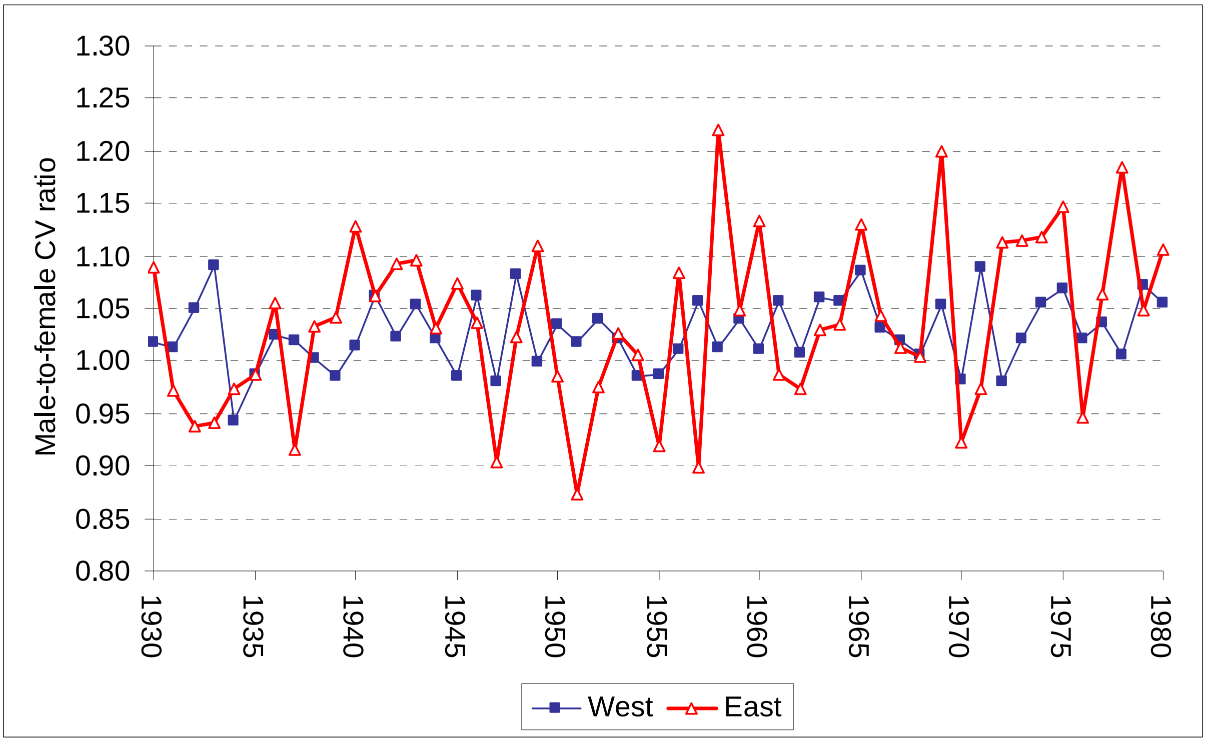


Males, Bottom 8 States



Note: States ordered by coefficient of variation in 1960-67. An asterisk denotes an East German state.
Source: Mikrozensus 1999 and 2003.

Figure 3.10: Male-to-female coefficient of variation ratio, by year of birth, East and West Germany



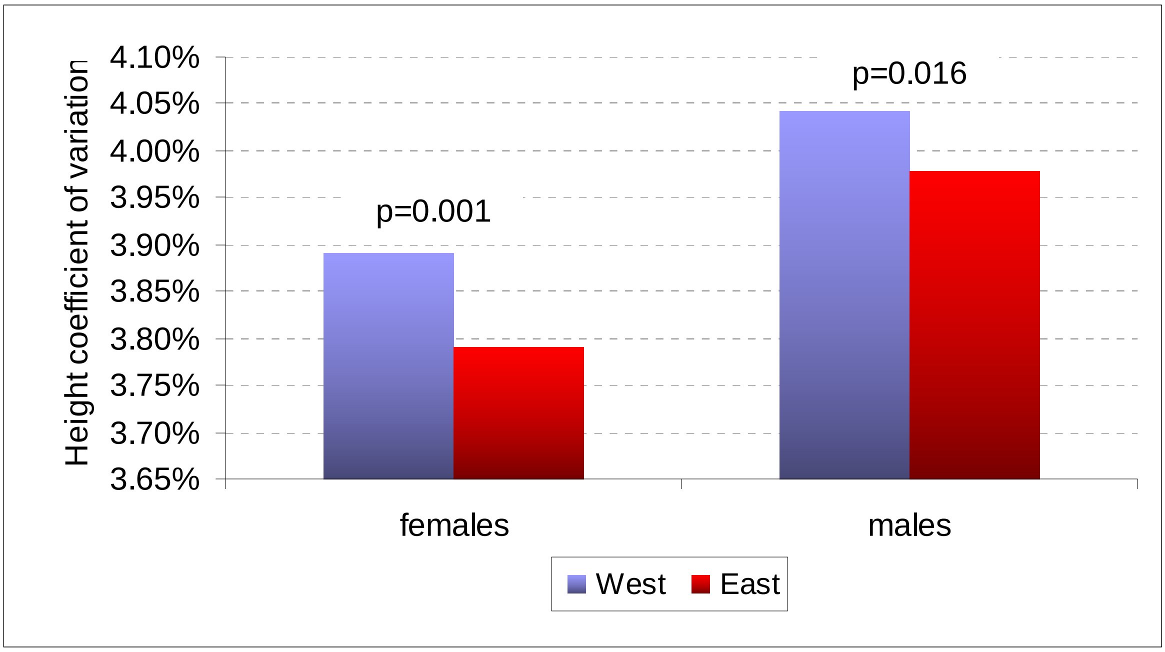
Source: Mikrozensus 1999 and 2003

We next explore the possible trade-off between equality and efficiency among those born in the years 1940-69 – the years for which the West's height advantage was established earlier. We test whether the West German pre-unification CV is significantly different from the East German one using the test for equality of coefficients of variation developed by Verrill and Johnson (2003, 2007)[12].

We find that before unification, the CV is significantly higher for West than for East Germans (females: +0.10%, p=0.001; males: +0.06%, p=0.016, Figure 3.11).

[12] A web-based program for performing this test is available at http://www1.fpl.fs.fed.us/covtestk.html. The Verrill-Johnson test is a likelihood ratio test of the equality of the coefficients of variation of two or more normally distributed populations. Comparisons can take place either on an annual or an aggregate basis. While it is not possible to include control variables, the test can be performed for sub-samples reflecting certain attributes.

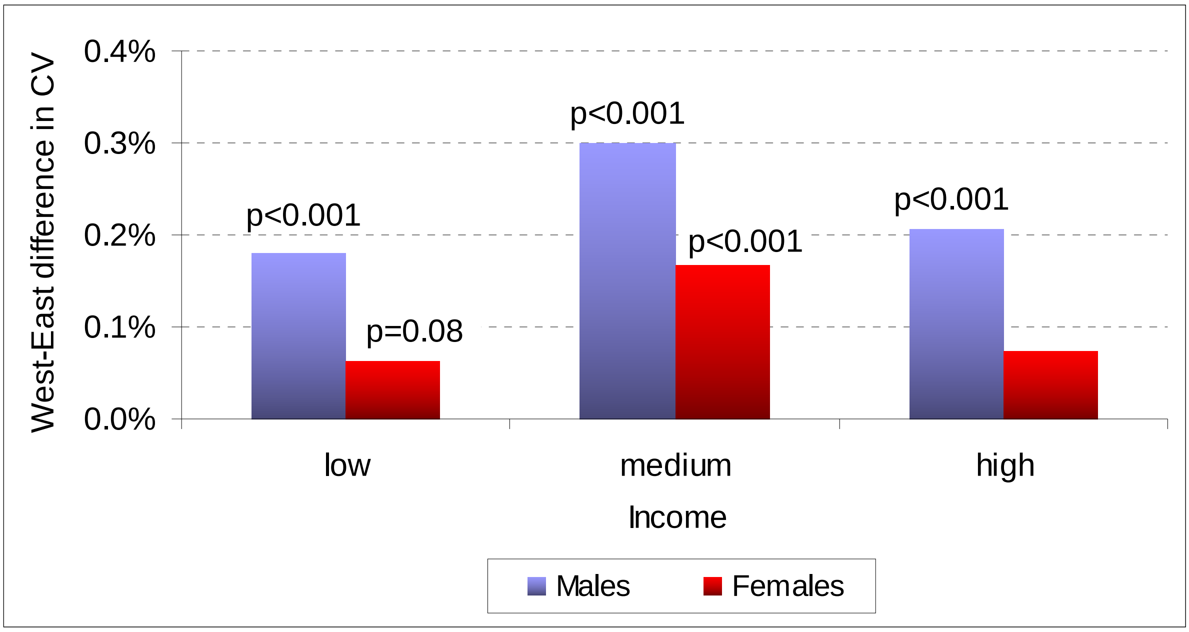
Figure 3.11: Pre-unification coefficient of variation for height in West and East Germany (1940-69 birth cohorts)



Note: Sample size is 54,090 for West German females, 14,168 for East German females, 54,416 for West German males, and 14,546 for East German males.
Source: Mikrozensus 1999, 2003

Furthermore, we stratify according to net monthly income in 1999 or 2003. Figure 3.12 shows that there is no significant difference in the CV for East and West German females of high income. However, the CV for West German females of low or medium income is significantly greater than the one for their East German peers ($p=0.08$ and $p<0.001$). For males, significant East-West difference exists for all categories ($p<0.001$ in all three cases).

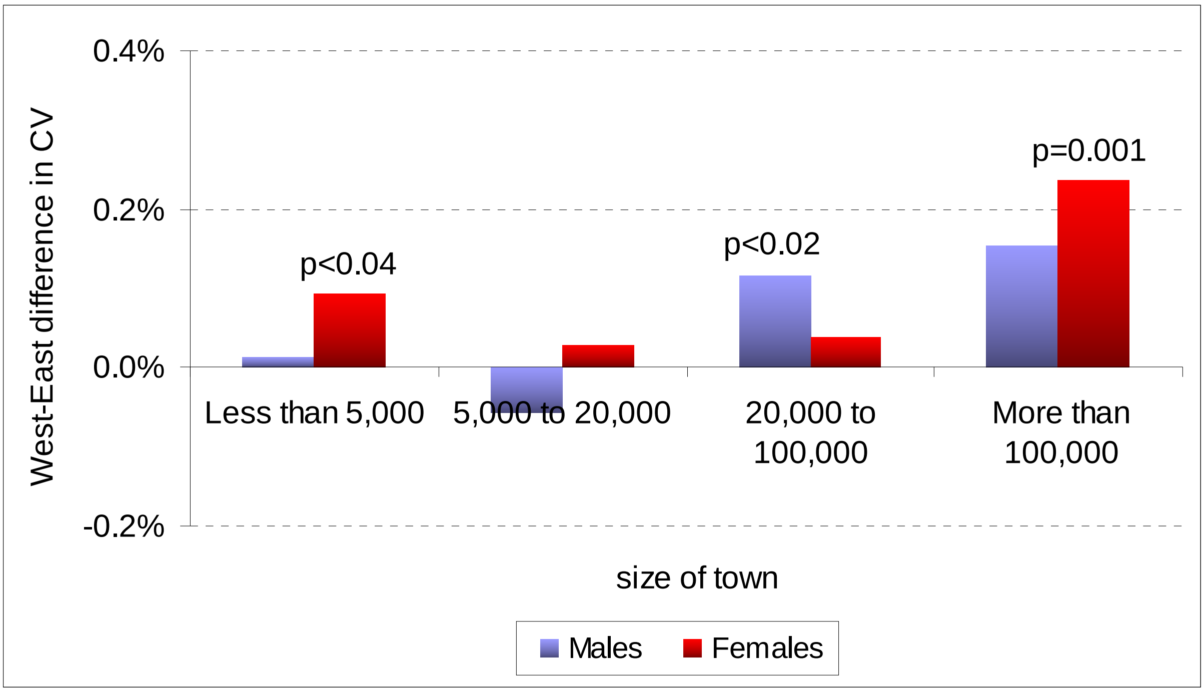
Figure 3.12: West-East difference in the pre-unification coefficient of variation for height as a function of income (1940-69 birth cohorts)



Note: Positive values indicate that West Germany was less equal than East Germany in the respective category. Social status is defined via the 1999 or 2003 income. Sample size is respectively 11,499, 9,550 and 23,041 for West German females and 2,716, 3,620 and 7,832 for East German females. For West German males, sample size is respectively 11,514, 9,544 and 23,071. For East German males, the numbers are 2,719, 3,626 and 7,830.
Source: Mikrozensus 1999, 2003.

For females in West German towns with less than 5,000 inhabitants and in West German cities with more than 100,000 inhabitants, the CV is significantly higher than in their East German counterparts ($p<0.04$ and $p=0.001$, Figure 3.13). For males, the same is true for cities with 20,000 to 100,000 inhabitants ($p<0.02$).

Figure 3.13: West-East difference in the pre-unification coefficient of variation for height as a function of town size (1940-69 birth cohorts)



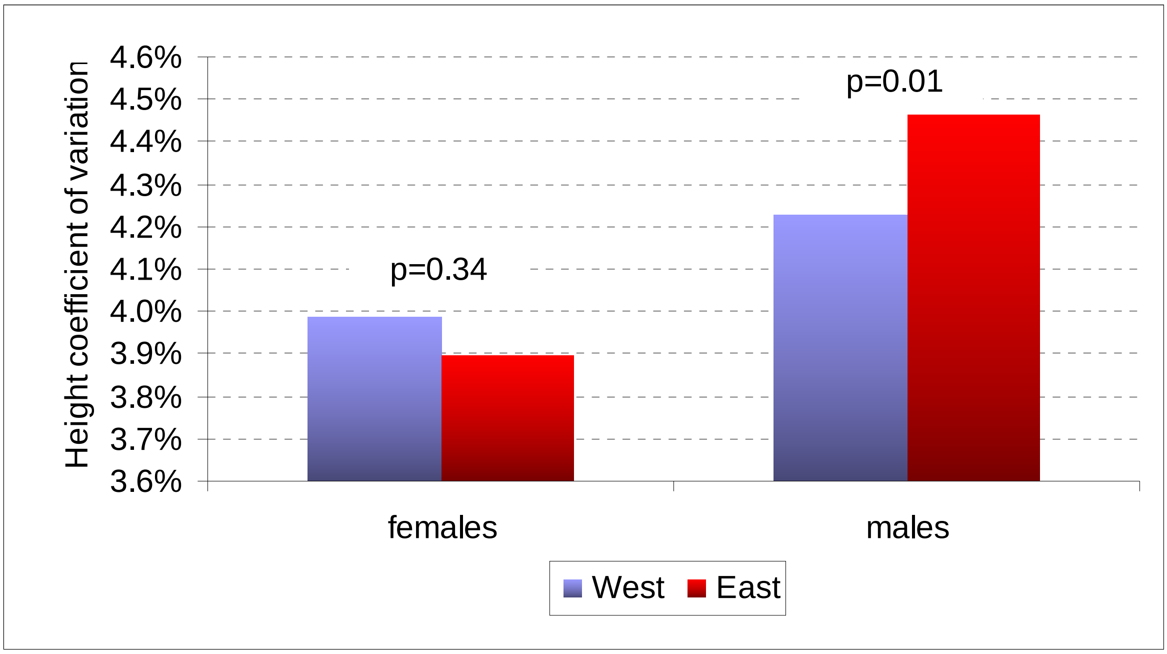
Note: Positive values indicate that West Germany was less equal than East Germany in the respective category. Sample size is respectively 12,064, 13,223, 12,143 and 10,543 for West German females and 2,146, 5,596, 3,913 and 3,862 for East German females. For West German males, sample size is respectively 14,171, 16,743, 14,919 and 20,203. For East German males, the respective numbers are 2,186, 5,902, 3,776 and 6,048.
Source: Mikrozensus 1999, 2003.

That East Germany had a significantly lower overall CV than West Germany before unification (Figure 3.11) does not necessarily prove that the state-socialist system in the East led to a more equal biological standard of living then the mixed economy system in the West. West Germany is a larger area with a potentially more diverse genetic heritage than East Germany, and it is possible that a higher CV reflects this fact, rather than some system-driven inequality. However, as already pointed out for height, unification provides us with a natural experiment: Over a very short period, the economic and political system changed completely, but area size remained unaffected.

We find that after unification the CV in the East is no longer statistically different from the one for the West (females: p=0.34) or is even higher (males: p=0.01, Figure 3.14). The same result holds for the birth cohorts of 1984-89 (p=0.21 for females, p=0.09 for males) and of 1990-96 (p=0.35 for females, p=0.06 for males). Relative to the birth cohorts of 1980-83, the 1990-96 birth cohorts have the advantage of having grown up entirely after unification, but have the disadvantage of being not of adult age when surveyed (this also explains the high values for the CV). Overall, these results suggest that a trade-off exists between a high and an equal biological standard of living[13].

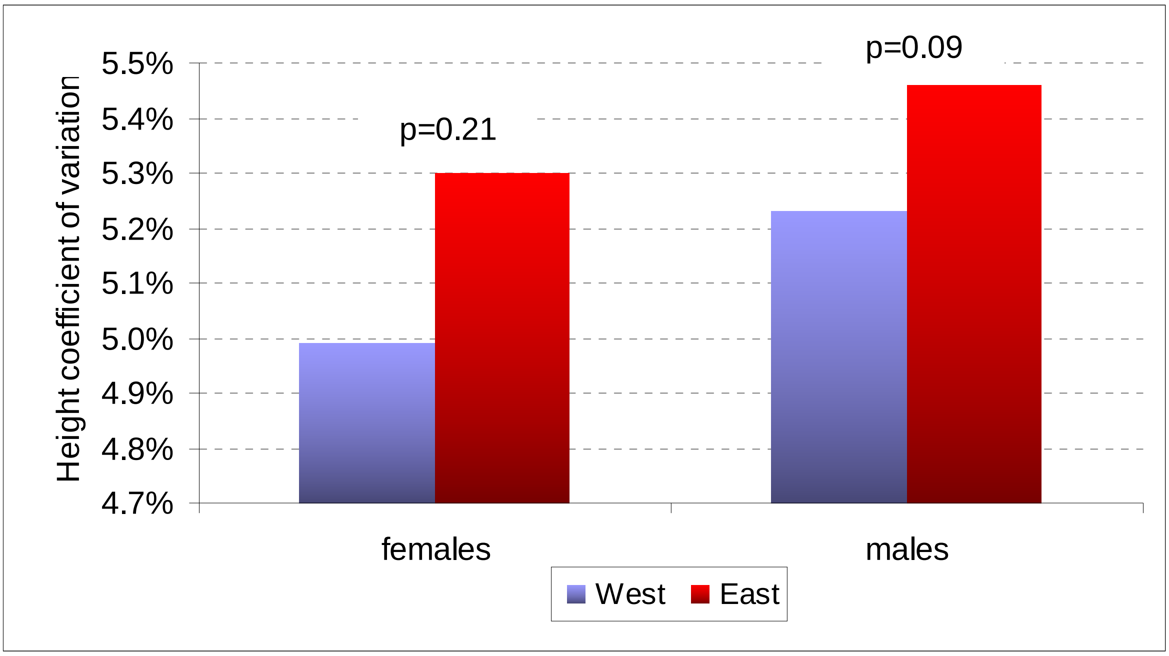
Figure 3.14: Post-unification coefficient of variation for height in West and East Germany

1980-83 birth cohorts

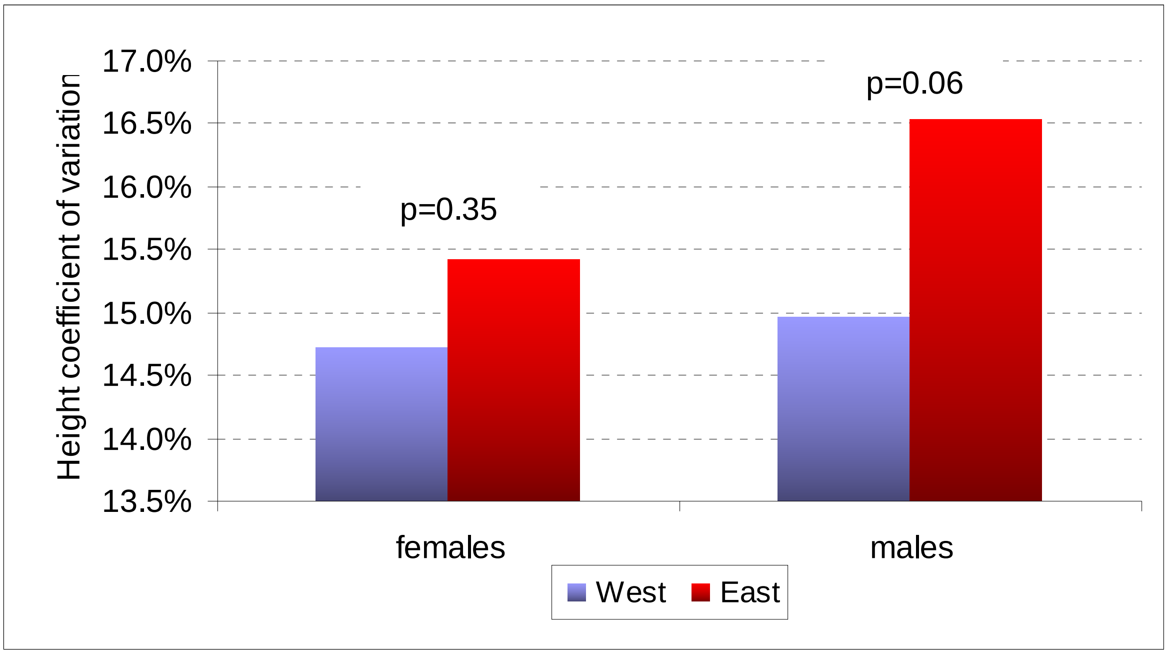


[13] All result are qualitatively unchanged when we run age-specific Verrill and Johnson tests (results omitted).

1984-89 birth cohorts



1990-96 birth cohorts



Note: With respect to the 1980-83 birth cohorts, sample size is 3,110 for West German females, 1,198 for East German females, 3,180 for West German males, and 1,370 for East German males. With respect to the 1984-89 birth cohorts, sample size is 1.853 for West German females, 765 for East German females, 1,622 for West German males, and 741 for East German males. With respect to the 1990-96 birth cohorts, sample size is 685 for West German females, 304 for East German females, 705 for West German males, and 254 for East German males.

Source: Mikrozensus 1999, 2003.

3.7 Regional equality convergence in East and West Germany

Adding a dynamic dimension to our analysis, we test whether pre-unification East or West Germany provided better conditions for an initially unequal sub-region to catch up with its more equal peers. To that end, we use the difference between the 1946-49 birth cohorts' and the 1976-79 birth cohorts' CV as dependent variable in a Baumol-type regression (Table 3.6). To test for East-West differences in equality in CV convergence between sub-regions, we include a term that interacts "West Germany" with the 1946-49 birth cohorts' CV. To capture convergence in the biological standard of living rather than convergence in the degree of urbanization, or income, we also include controls for birth cohorts, urbanization and net monthly income.

We find significant convergence both in East and West. The higher the CV for the birth cohorts of 1946-49, the greater the following decline in the CV. For males, unlike for females, convergence is significantly less in the West than in the East, mirroring the result obtained for height convergence.

Table 3.6: OLS estimates, dependent variable: difference in the coefficient of variation for height between the 1946-49 and the 1976-79 birth cohorts

	Females	Males
Coefficient of variation in height, 1946-49 birth cohorts	-0.76***	-1.27***
West*Coefficient of variation in height, 1946-49 birth cohorts	-0.18	0.31**
West	0.01	-0.01*
East	Reference	Reference
Share of population living in a town with…		
... less than 5,000 inhabitants	0.00	-0.01***
... 5,000-20,000 inhabitants	0.00	-0.01***

... 20,000-100,000 inhabitants	Reference	Reference
... more than 100,000 inhabitants	0.01**	-0.01***
Share of population with a net monthly income of…		
... less than € 900	Reference	Reference
... € 900 - € 1,300	0.01	0.03***
... more than € 1,300	0.00	0.00
Constant	0.02***	0.05***
Adjusted R-squared	0.66	0.84
F-statistic	169.5***	341.3***
Number of observations	88	88

Note: Heteroscedasticity-robust Huber-White (1967, 1980) standard errors are used. We use periods of four years (1946-49, 1976-79) to calculate robust coefficients of variation for the individual sub-regions (the number of observations is respectively 9,650 and 9,430 for females and 9,702 and 9,456 for males).
Source: Mikrozensus 1999, 2003.
* significant at 10%; ** significant at 5%; *** significant at 1%

3.8 Conclusion

As previous research (Komlos and Kriwy, 2003), we find that West Germany had a pre-unification height advantage. However, we do not find that it decreased with increasing urbanization. Rather, we find a U-shaped pattern for males. For females, the West's height advantage was largest in cities with 20,000-100,000 inhabitants. The difference between our finding and that of Komlos and Kriwy may be that they have a composite indicator to control for socioeconomic status, while we use nominal net monthly income. The periods under investigation are also different. While Komlos and Kriwy examined the years 1946-80, we focus on the years 1940-69.

Substantial height convergence occurred in both East and West Germany for both genders across regions. For East German males, convergence is significantly larger than for their West German peers. Equality was generally higher in pre-unification East Germany for all income groups but not for females of medium income. At the level of regions, substantial equality convergence (as measured by the coefficient of variation) existed both in East and West Germany for both genders. As with height convergence, equality convergence was significantly larger for East than for West German males but not for females.

For conventional welfare indicators such as income, a trade-off often exists between a high and equally distributed standard of living (Aghion et al. 1999, Baumol and Fischer 1979, Blyth 1997, Browning and Johnson 1984, Okun 1975, Persson and Tabellini 1994). Whether such a trade-off exists also for biological welfare indicators, such as height, has not been analyzed thus far. Following re-unification, East Germany moved from a state-socialist to a market-based economic system. Using West Germany as a control group, we examine how the change affected the level of, and the equality in the biological standard of living. Corroborating the work of Komlos and Kriwy (2003), we find that before unification West Germany had a higher biological standard of living than the East, but we also find that it was distributed less equally. With unification, both the difference in the level of the biological standard of living and the difference in equality disappeared, suggesting that a trade-off exists between efficiency and equality.

3.9 References

Aghion, P., Caroli, E. and Garcia Penalosa, C. (1999). “Inequality and Economic Growth: the Perspective of the New Growth Theories.” Journal of Economic Literature 37: 1615-60.

Barro, R.J. (1991). “Economic Growth in a Cross Section of Countries.” Quarterly Journal of Economics 106: 407-43.

Barro, R.J. and Sala-i-Martin, X. (1992). “Convergence.” Journal of Political Economy 100: 223-51.

Barro, R.J. and Sala-i-Martin, X. (1995). “Economic growth.” McCraw Hill, New York.

Baten, J. (2000). “Economic development and the distribution of nutritional resources in Bavaria, 1797–1839.” Journal of Income Distribution 9: 89-106.

Baten, J. and Fraunholz, U. (2004). “Did partial globalization increase inequality? The case of the latin American periphery, 1950–2000.” CESifo Economic Studies 50: 45-84.

Baten, J. and Murray, J. (2000). “Heights of men and women in nineteenth century Bavaria: economic, nutritional, and disease influences.” Explorations in Economic History 37: 351-69.

Baumol, W. (1986). “Productivity, convergence and welfare: what the long run data show.” The American Economic Review 76: 1072-85.

Baumol, W.J. and Fischer, D. (1979). “The Output Distribution Frontier: Alternatives to Income Taxes and Transfers for Strong Equality Goals.” American Economic Review 69: 514-25.

Benabou, R. (1994). "Human capital, inequality, and growth: A local perspective." European Economic Review 38: 817-26.

Benabou, R. (1996). “Inequality and Growth.” National Bureau of Economic Research. Working Paper 56/58.

Benabou, R. (2000). "Unequal Societies: Income Distribution and the Social Contract," American Economic Review 90: 96-129.

Benabou, R. (2005). "Inequality, Technology and the Social Contract," In: Aghion, P. and Durlauf, S., ed., “Handbook of Economic Growth.” Vol. 1.

Blyth, M. (1997). “Any More Bright Ideas? The Ideational Turn of Comparative Political Economy”. Comparative Politics, 29: 229-50.

Bogin, B. (1999). “Patterns of Human Growth.” 2nd edn, Cambridge University Press, Cambridge.

Brickman, P. and Campbell, D. (1971). “Hedonic Relativism and Planning the Good Society.” In: Apley, M.H., ed., “Adaptation Level Theory: A Symposium.” New York: Academic Press.

Browning, E. and Johnson, W. (1984). “The trade-off between equality and efficiency.” Journal of Political Economy 92: 175-203.

Buch, T. (2006). “Regionale Mobilität auf dem deutschen Arbeitsmarkt: Eine theoretische und empirische Analyse regionaler Mismatcharbeitslosigkeit in Zeiten der Hartz-Reformen.” SOCIALIA – Studienreihe soziologische Forschungsergebnisse, Bd. 77 Hamburg.

Clark A.E., Frijters, P. and Shields, M.A. (2006). "Income and happiness: Evidence, explanations and economic implications." PSE Working Papers 2006-24.

Dathe, D. (1998). “Kontinuität und Wandel ostdeutscher Ungleichheitsstrukturen.” In: Dathe, D., ed., “Umbruch - Beiträge zur sozialen Transformation in den alten und neuen Bundesländern”, Berlin.

Diener, E. (2005). “Guidelines for National Indicators of Subjective Well-Being and Ill-Being.” Mimeo, University of Illinois at Urbana Champaign.

Di Tella, R., MacCulloch, R.J. and Oswald, A.J. (2001). “Preferences over Inflation and Unemployment: Evidence from Surveys of Happiness.” American Economic Review 91: 335-41.

Di Tella, R., MacCulloch, R.J. and Oswald, A.J. (2004). “The Macroeconomics of Happiness.” Review of Economics and Statistics 85: 809-27.

Easterlin, R.A. (1974). “Does Economic Growth Improve the Human Lot?” In: David, P.A. and Reder, M.W., ed., “Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz.” New York: Academic Press, Inc.

Floud, R. (1994). “The heights of Europeans since 1750: a new source for European economic history”. In: Komlos, J., ed., “Stature, Living Standards, and Economic Development: Essays in Anthropometric History.” The University of Chicago Press, Chicago.

Fogel, R.W. (1994). “Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy.” American Economic Review 84: 369-95.

Frank, R.H. (1997). “The Frame of Reference as a Public Good.” Economic Journal 107: 1832-47.

Frey, B.S. and Stutzer, A. (2000). “Happiness, Economy and Institutions.” Economic Journal 110: 918-38.

Frey, B.S. and Stutzer, A. (2002). “What Can Economists Learn from Happiness Research?” Journal of Economic Literature 40: 402-35.

Godoy, R., Goodman, E., Levins, R. and Leonard, W.R. (2005). “Anthropometric variability in the USA: 1971–2002.” Annals of Human Biology 32: 469-86.

Hauser, R. (1992): “Die personelle Einkommensverteilung in den alten und neuen Bundesländern vor der Vereinigung.” In: Kleinhenz, G., ed., “Sozialpolitik im vereinten Deutschland.” Vol. 2, Berlin.

Heineck, G. (2006). “Height and weight in Germany, Evidence from the German Socio-Economic Panel, 2002.” Economics and Human Biology 4: 359-82.

Hepburn, L. and Eysenck, M. W. (1989). “Personality, average mood and mood variability.” Personality and Individual Differences 10: 975-83.

Huber, P. J. (1967). „The behavior of maximum likelihood estimates under nonstandard conditions.” Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability. Berkeley, CA: University of California Press, vol. 1: 221-23.

Kämper, N. (1992). “Gesetz über die Bildung eines Sachverständigenrates zur Begutachtung der gesamtwirtschaftlichen Entwicklung, Kommentierung.” In: “Das Deutsche Bundesrecht.” Vol. 3.

Komlos, J. (1985). “Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development.” American Historical Review 90: 1149-61.

Komlos, J. (1989). “Nutrition and economic development in the eighteenth century Habsburg monarchy.” Princeton: Princeton University Press.

Komlos, J. (2007). “Anthropometric evidence on economic growth, biological well-being and regional convergence in the Habsburg Monarchy, c. 1850–1910.” Cliometrica 1: 211-37.

Komlos, J. and Kriwy, P. (2003). “The Biological Standard of Living in the Two Germanies.” German Economic Review 4: 493-507.

Krupp, H. (1985). “Bisherige Ergebnisse alternativer geld- und finanzpolitischer Strategieansätze in der Bundesrepublik Deutschland.” In: Langkau, J. and Köhler, C., ed., “Wirtschaftspolitik und wirtschaftliche Entwicklung.” Bonn.

Layard, R. (2005). “Happiness: Lessons from a New Science.” New York: Penguin Publishing.

Lee, D.R. (1987). “The Trade-off Between Equality and Efficiency: Short-Run Politics and Long-Run Realities.” Public Choice 53: 149-65.

Lee, D.R. (1993). “Redistribution of Income.” In: Henderson, D.R., ed., “The Fortune Encyclopedia of Economics.” New York: Warner Books, Inc.

Loetsch, M. (1991). “Konturen einer Theorie der Sozialstruktur.” Berliner Journal für Soziologie 2: 195-202.

Loetsch, M. (1993). “Sozialstruktur und Systemtransformation.” In: Geißler, R., ed., “Sozialer Umbruch in Ostdeutschland.” Opladen.

Moeller, A. (1968). “Kommentar zum Gesetz zur Förderung der Stabilität und des Wachstums der Wirtschaft.” Hannover.

Morady, A. and Baten, J. (2005). “Inequality in sub-Saharan Africa: new data and new insights from anthropometric estimates.” World Development 33: 1233-65.

Niggle, C.J. (1997). "Changes in Income Distributions and Poverty Rates in Central European Transitional Economies," In: Davidson, P. and Kregel, J.A., ed., “Growth in Output and Employment in a Global Economy.” Elgar Publishing.

Niggle, C.J. (1998). “Equality, Democracy, Institutions, and Growth,” Journal of Economic Issues 32: 523-31.

Okun, A.M. (1975). “Equality and Efficiency: The Big Trade-Off.” Washington: Brookings Institute.

Persson, T. and Tabellini, G. (1994). “Is equality harmful for growth?” American Economic Review 84: 600-21.

Phelps, C.D. (2001). “A clue to the paradox of happiness.” Journal of Economic Behavior and Organization 45: 293-300.

Schiller, K. (1978). “Stabilitäts- und Wachstumsgesetz – ein Instrument der Krisenbewältigung?” In: Krise der ökonomischen Theorie – Krise der Wirtschaftspolitik. WSI-Studie zur Wirtschafts- und Sozialforschung. Düsseldorf.

Sen, A.K. (1970). “Collective Choice and Social Welfare.” San Francisco: Holden-Day Publishing.

Sen, A,K. (1985). “Commodities and Capabilities.” Amsterdam: North Holland Publishing.

Sen, A.K. (1992). “Inequality Reexamined.” New York: Russel Sage Publishing.

Sen, A.K. (1995). “Rationality and Social Choice.” American Economic Review 85: 1-24.

Sen, A.K. (1999). “Development as Freedom.” New York: Alfred Knopf Publishing.

Steckel, R.H. (1995). “Stature and the standard of living.” Journal of Economic Literature. 33: 1903-40.

Stolzenberg, H. (2000). “Bundes-Gesundheitssurvey 1998, Dokumentation des Datensatzes.” Robert-Koch-Institut, Berlin.

Sunder, M. (2003). “The Making of Giants in a Welfare State: The Norwegian Experience in the 20th Century.” Economics and Human Biology 1: 267-76.

Thomas, D. (1994). “Like Father, Like Son; Like Mother, Like Daughter: Parental Resources and Child Height.” Journal of Human Resources 29: 950-88.

Vallentyne, P. (2000). “Equality, efficiency, and the priority of the worse-off.” Economics and Philosophy 16: 1-19.

Verrill, S. and Johnson, R.A. (2003). “Confidence Bounds for Normal and Lognormal Distribution Coefficients of Variation.” Research Paper 609, USDA Forest Products Laboratory, Madison, Wisconsin.

Verrill, S. and Johnson, R.A. (2007). “Confidence Bounds and Hypothesis Tests for Normal Distribution Coefficients of Variation.” Communications in Statistics: Theory and Methods 36: Inference.

Waaler, H. (1984). “Height, weight, and mortality: the Norwegian experience.” Acta Medica Scandicana 679: 1-56.

White, H. (1980). “A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity.” Econometrica 48: 817-30.

3.10 Appendix

Table A3.1: Characteristics of the sample after excluding all observations without height information

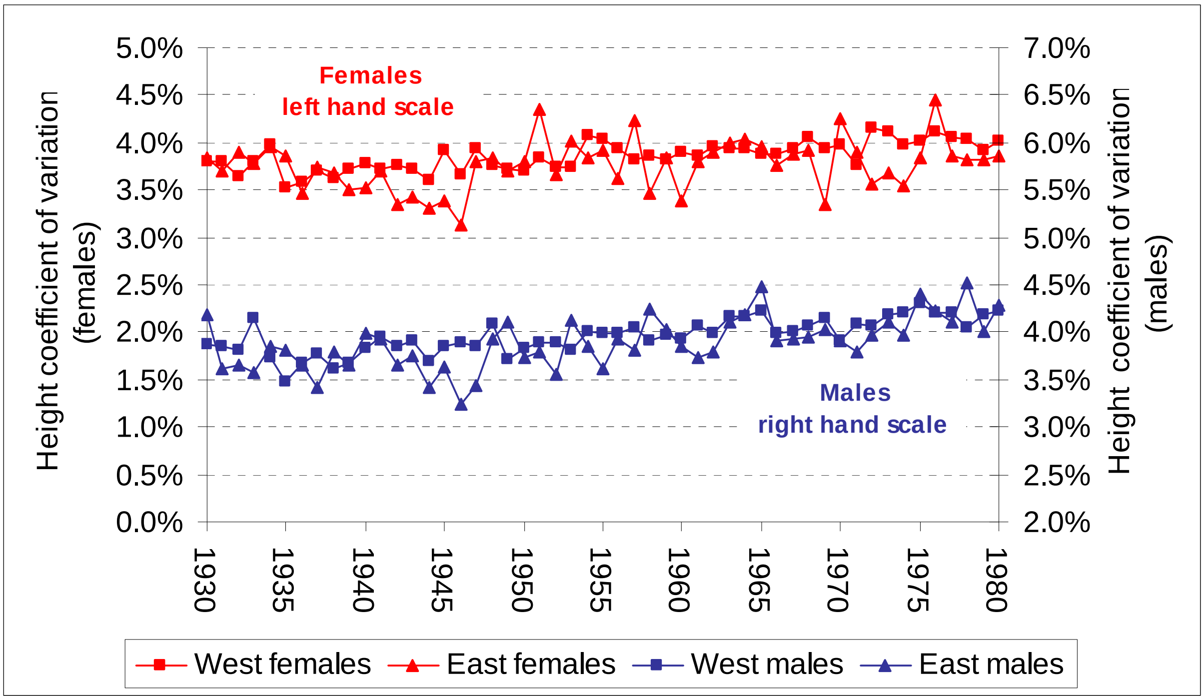
Gender of respondent			**Born in Germany?**	
Female	50.7%		Yes	95.0%
Male	49.3%		No	5.0%
Home state			**Year of birth**	
Baden-Wuerttenberg	11.0%		Before 1919	3.6%
Bavaria	16.4%		1920 to 1929	10.4%
Berlin	4.9%		1930 to 1939	15.4%
Brandenburg	3.5%		1940 to 1949	14.8%
Bremen	1.6%		1950 to 1959	17.0%
Hamburg	1.5%		1960 to 1969	19.0%
Hesse	8.2%		1970 to 1979	13.2%
Lower Saxony	8.2%		1980 to 1989	5.3%
Mecklenb.-West. Pom.	2.0%		1990 to 1999	1.0%
North Rhine-Westphalia	15.4%		2000 or later	0.1%
Rhineland-Palatinate	6.1%			
Saarland	1.8%		**Height at interview**	
Saxony	7.0%		Less than 150 cm	1.5%
Saxony-Anhalt	6.7%		150 to 155 cm	2.4%
Schleswig-Holstein	2.8%		155 to 160 cm	6.7%
Thuringia	2.8%		160 to 165 cm	14.7%
			165 to 170 cm	19.3%
West German?			170 to 175 cm	19.7%
Yes	73.0%		175 to 180 cm	15.7%
No	22.0%		180 to 185 cm	11.7%
Missing (Berlin)	5.0%		185 to 190 cm	5.6%
			190 cm or more	2.8%
Age at interview				

Less than 10 years old	1.1%		**Net monthly income**	
10 to 20 years old	4.9%		Less than 900 euro	38.5%
20 to 30 years old	13.4%		900 to 1,300 euro	26.5%
30 to 40 years old	18.6%		1,300 euro or more	35.0%
40 to 50 years old	17.2%			
50 to 60 years old	14.8%		**Size of home town**	
60 to 70 years old	15.7%		Less than 5,000 inha.	15.0%
70 to 80 years old	10.4%		5,000 to 20,000 inha.	30.3%
80 to 90 years old	3.5%		20,000 to 100,000 inha.	26.1%
90 to 100 years old	0.4%		100,000 inha. or more	28.6%

Note: Number of observations is 263,361.

Source: Mikrozensus 1999 and 2003.

Figure A3.1: Coefficient of variation for height in West and East Germany, by year of birth



Source: Mikrozensus 1999, 2003

Chapter 4: The Height and BMI values of West Point Cadets after the Civil War

4.1 Abstract

West Point cadets born in the 1880s were taller than those born in the 1860s (+1.46 cm) and had significantly higher BMI values (+0.85). However, the cadets were on average under-nourished by modern standards, with today's average reference values being about 5 BMI units higher than those of the cadets. Substantial regional differences existed for both height and weight. While West Point cadets born in the 1880s in the Upper South reached on average a height of 173.2 cm and a BMI of 21.0, their peers from New England were 171.5 cm tall with a BMI of 21.6.

4.2 Introduction

Mean height is a useful indicator of biological living standards of a society, particularly if conventional measures are unavailable or restricted (Komlos and Snowdon 2005). Height depends, in the main, on living conditions, the availability of food and the disease environment (Bogin 1999, Floud 1994, Fogel 1994; Komlos 1985, 1989, Steckel 1995, 2008, Sunder 2003, Waaler 1984). Genetic factors, while important for the determination of individual height, are irrelevant at the level of a population as long as its ethnic composition remains unchanged (Steckel 2008).

Heights declined in the US in the early stages of industrialization and recovered only in the 1870s[1] (Margo and Steckel 1983, Komlos 1987, 1996, A'Hearn 1998, Lang and Sunder 2003, Sunder 2004). Because the decline took place in a period in which output per capita grew at a rate of about 1.4% per annum (Weiss 1992), the phenomenon is known as the "antebellum puzzle" (Komlos 1996). Reasons for the diminution of stature include urbanization, rapid population growth, increases in inequality and in relative food prices, market integration

[1] Throughout the paper, dates generally refer to date of birth rather than the date of examination.

and an expansion of the non-farm sector (Komlos 1989). Declining height at a time when per-capita income was growing has been found in many other samples, both military and non-military (Baten 2000, Nicholas and Steckel 1991, Komlos 1993, Sandberg and Steckel 1987, Steckel 1995) and suggests that anthropometric measures are sensitive enough to document developments above and beyond the material well being of a population.

There has not been as much work on heights in the second half of the 19th century as on the first half. Recently, data has become available that enables us to extend the work of Komlos (1987) on West Point cadets, shedding additional light on the above mentioned recovery process after the Civil War.

4.3 Data

Individuals applying to the West Point Military Academy were required to take a medical examination. We have data on 721 candidates who were born between 1872 and 1884 and applied to the academy between March 1894 and March 1901[2]. We exclude individuals who were older than 21 at the time of the examination or who were not born in the US, leaving a working sample of 704 observations. We supplement these data with Komlos' (1987) data for the 1860s and 1870s[3]. Overall, this makes 2,468 observations pertaining to individuals born between 1860 and 1884. For all individuals, we have information on the date of examination, age, height, body mass index (BMI)[4], birthplace, residence, and whether the applicant was admitted. Descriptive statistics of the new and combined sample are given in Tables A4.1 of the Appendix.

---

[2] US National Archives, Washington, D.C. Signatures: 9W3/16/8/4 box 1 in record group 94 entry 234 and 9W3/16/8/4 in record group 94 entry 235.

[3] Komlos' data is from National Archives, Washington, D.C., Military Archives Division, Record Group 94, entries 103, 234.

[4] The BMI is calculated as weight in kilograms divided by height in meters squared.

4.4 Results

Controlling for age and region, we find that mean height decreased by 0.5 cm in the late 1860s in wake of the Civil War (Table 4.1, column 2, and Figure 4.1)[5]. This is the last offshoot of the general decline in heights during the antebellum period. Thereafter, heights increased by 1.26 cm in the first half of the 1870s and by 0.92 cm in the second (Table 4.1, column 2, and Figure 4.1), marking the post-reconstruction rebound as already described in Komlos (1987). In the first half of the 1880s, heights then decreased slightly (by 0.22 cm) and insignificantly (Table 4.1, columns 1 and 2, and Figure 4.1). Still, heights in the early 1880s were 0.80 cm above those of a decade earlier, and 1.96 cm above the through of 1865-69. The improving nutritional status was due to a number of factors including decreasing transportation costs (Chanda et al. 2008). Furthermore, with the invention of the refrigerated railroad car in the late 1850s (White 1986, 1993) and with canning becoming economical in the 1870s (Mokyr 1990, 1997), technology was for the first time sufficiently advanced to accommodate the shipment of perishables over long distances in sufficient quantities, benefiting town dwellers[6]. Sanitation also improved in cities (Schultz and McShane 1978).

There are indications that the plateau of the early 1880s was due to an economic downturn. From 1890 to 1894, when the cadets were children, GDP decreased by 3.34% (Officer and Williamson 2008). Herweijer at al. (2006) also estimate that a widespread and persistent drought took place from 1890-96, which may have affected the nutritional status of Americans born in the early 1880s. The recession of 1893 and the McKinley Tariff of 1890, which raised the prices of farm equipment imported by the US, may also have had the effect of putting pressure on the nutritional status of some groups in the US society. A similar decline in heights was found by Sunder (2007) for passport applicants and by Steckel and

[5] Histograms of error terms show no evidence of truncation due to a minimum height or weight requirement (Figure A4.1 of the Appendix).
[6] It has been shown frequently that food prices decrease with proximity to the source of food while the nutritional status improves (Baten 1996, Craig and Weiss 1998, 2000, Haines 1989, 1998 and Komlos 1987, 1989, 1996, 1998). Lower transport costs and improved technology can mediate this effect.

Haurin (1994)[7] for Ohio National Guardsmen (Figure 4.1). However, Roche (1979) and Coclanis and Komlos (1995) report increasing heights for this period for Harvard students and for students at the South Carolina military academy, The Citadel (Figure 4.1).

We find significant regional variation. Cadets from the Upper South, born 1875-79, were on average 1.77 cm taller than their peers from New England, reaching a height of 174.9 cm at age 20 (Table 4.1, column 2 and Figure 4.2). Candidates from the Lower South (173.8 cm) and the West (174.0 cm) were also relatively tall.

Table 4.1: OLS estimates, dependent variables: height and BMI of West Point cadets (age 16-21) born 1860 to 1884

	Height (cm)		BMI	
Decade of birth				
1860-1864	-1.62***	-1.68***	-0.56***	-0.64***
1865-1869	-2.12***	-2.18***	-0.07	-0.16
1870-1874	-0.87**	-0.92**	-0.37***	-0.48***
1875-1879	Reference	Reference	Reference	Reference
1880-1884	-0.21	-0.22	0.21	0.21
Age (years)				
16	-5.68***	-5.90***	-2.86***	-2.81***
17	-2.13***	-2.17***	-1.67***	-1.65***
18	-1.65***	-1.64***	-1.51***	-1.51***
19	-0.43	-0.42	-1.07***	-1.06***
20	Reference	Reference	Reference	Reference

[7] Because of a possible minimum height requirement, we use Sunder's (2007) re-estimation rather than Steckel and Haurin's original estimates.

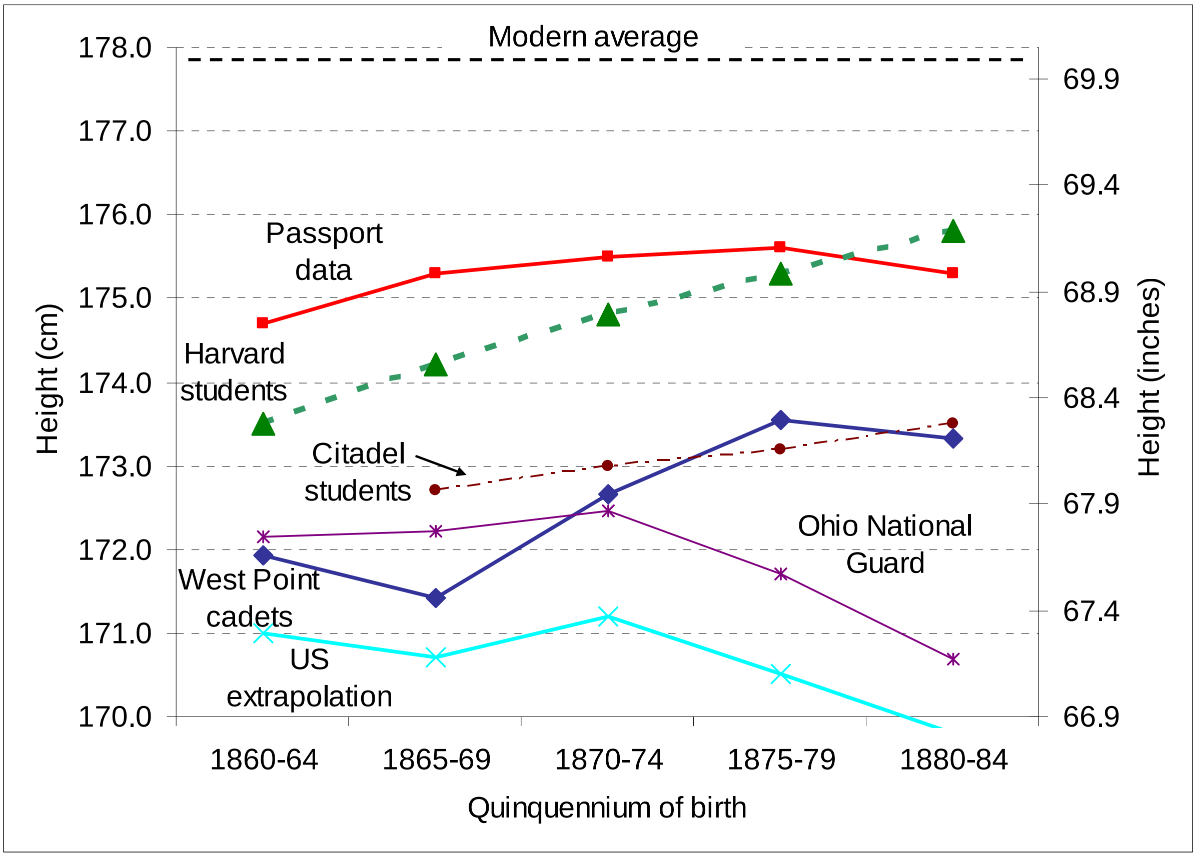
21	-0.21	0.20	0.41**	0.41**
Birthplace				
Mid-Atlantic		-1.66***		0.30**
Midwest		-1.48***		0.44***
Upper South		Reference		Reference
Lower South		-1.10**		0.05
New England		-1.77***		0.60***
West		-0.88		0.50**
Admitted				
Yes		Reference		Reference
No		-0.20		-0.20
Urban/rural				
Urban		-0.10		-0.12
Rural		Reference		Reference
Residence same as birthplace				
Yes		Reference		Reference
No		0.14		-0.18*
Constant	173.54***	174.90***	21.40***	21.21***
Adjusted R-squared	0.04	0.05	0.05	0.06
F-statistic	13.5***	8.9***	17.7***	12.7***
Number of observations	2,468	2,468	2,468	2,468

Note: Heteroscedasticity-robust Huber-White (1967, 1980) standard errors have been used.

Source: Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

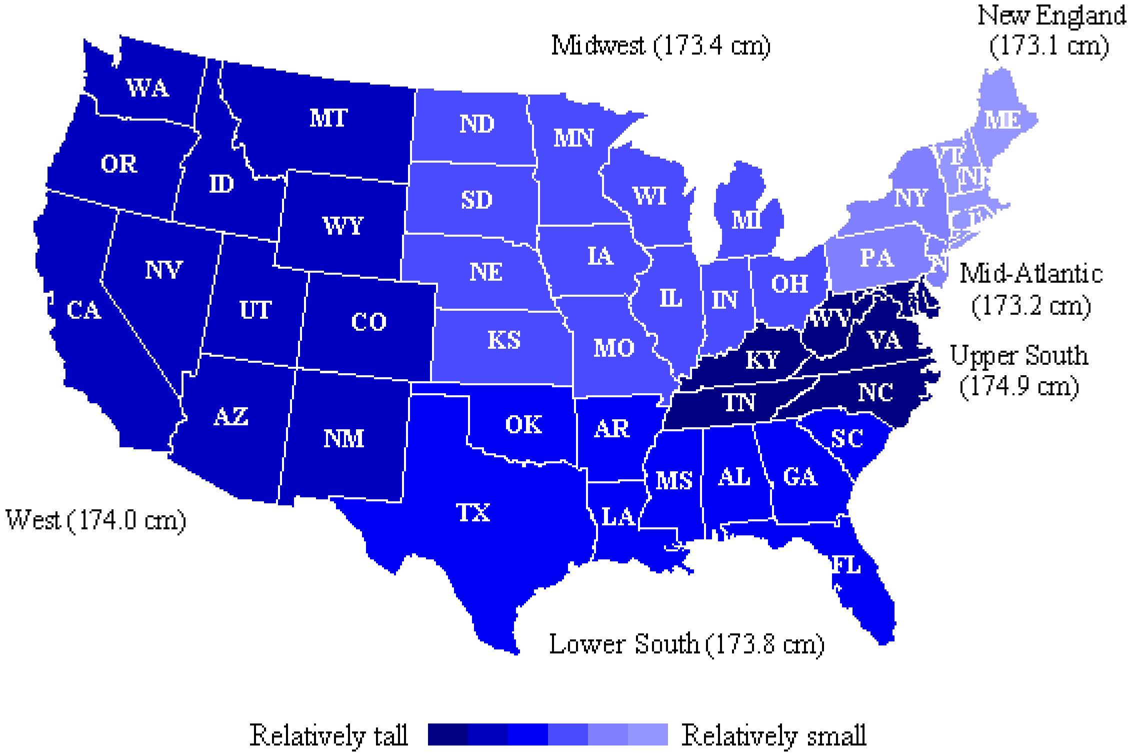
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 4.1: Average final heights of American male populations



Sources: Current NHANES 1996-2004 (modern average height, age 20); Sunder 2007 (passport data, age 22-50); Roche 1979 (Harvard students, age 21); Coclanis and Komlos 1995 (Citadel students, age 21); Steckel and Haurin 1994 (Ohio National Guard as re-estimated by Sunder 2007, age 25-30, US-born only); Steckel 2006 (US extrapolation, age 25-30); Table 4.1, column 1 (West Point Cadets, age 20, average for all regions under consideration).

Figure 4.2: Height of 20 year old West Point candidates (cm) born 1875-79, by region



Note: Based on Table 4.1, column 2.

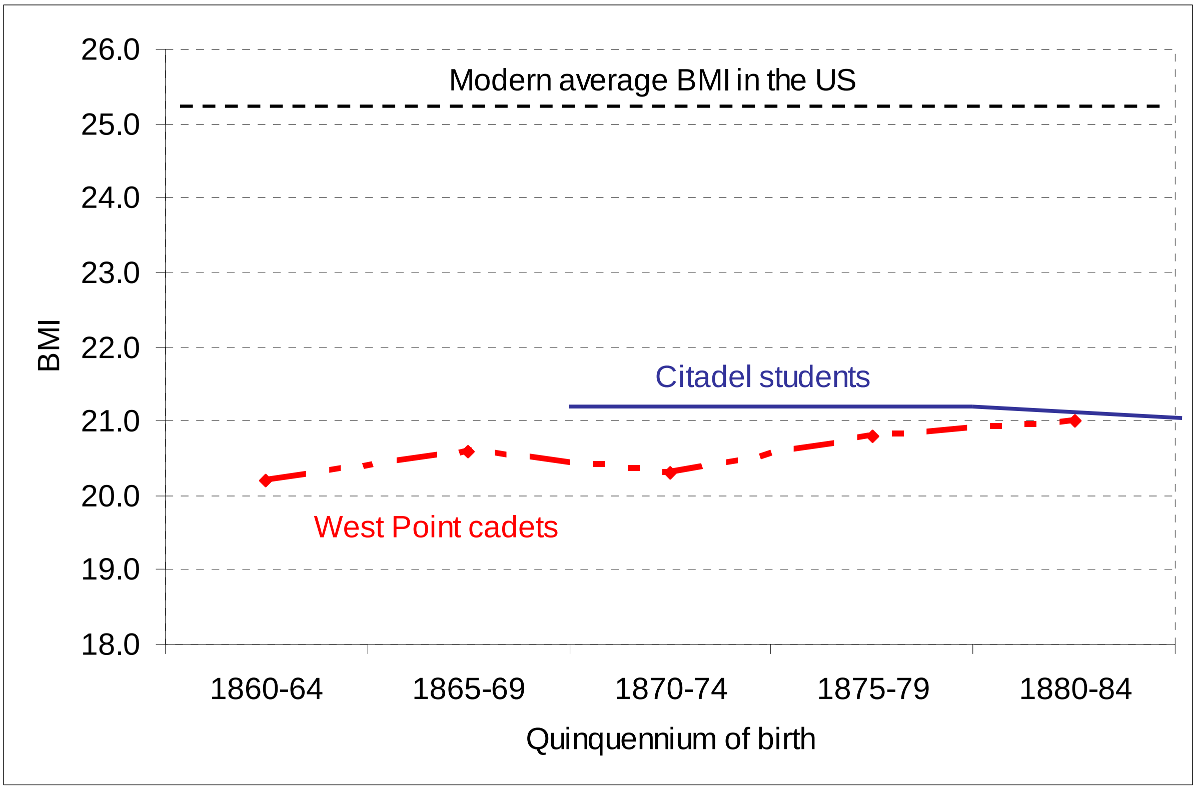
Source: Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

The BMI value of West Point cadets increased in the 1860s, fell in the first half of the 1870s and then increased again in the remaining ten years of the period under consideration (Table 4.1, columns 3 and 4 and Figure 4.3). Overall, BMI increased by about 0.85 units. About 36.6% of West Point cadets between the ages of 20 and 21 had a BMI of less than 19, indicating a degree of undernourishment that is usually associated with an increase in mortality risk (Cuff 1993)[8]. Today, only about 7% of the 20 to 21 age group have a BMI of less than 19, with the average BMI being in excess of 25 (Current NHANES 1996-2004, Komlos et al.

[8] For the whole sample, the share of individuals with a BMI of less than 19 is 31.7%.

2008, Figure 4.3). The BMI values of West Point cadets were slightly below those found among Citadel students during the same period (Coclanis and Komlos (1995), Figure 4.3).

Figure 4.3: Trend in BMI for 20-year old West Point cadets and Citadel students

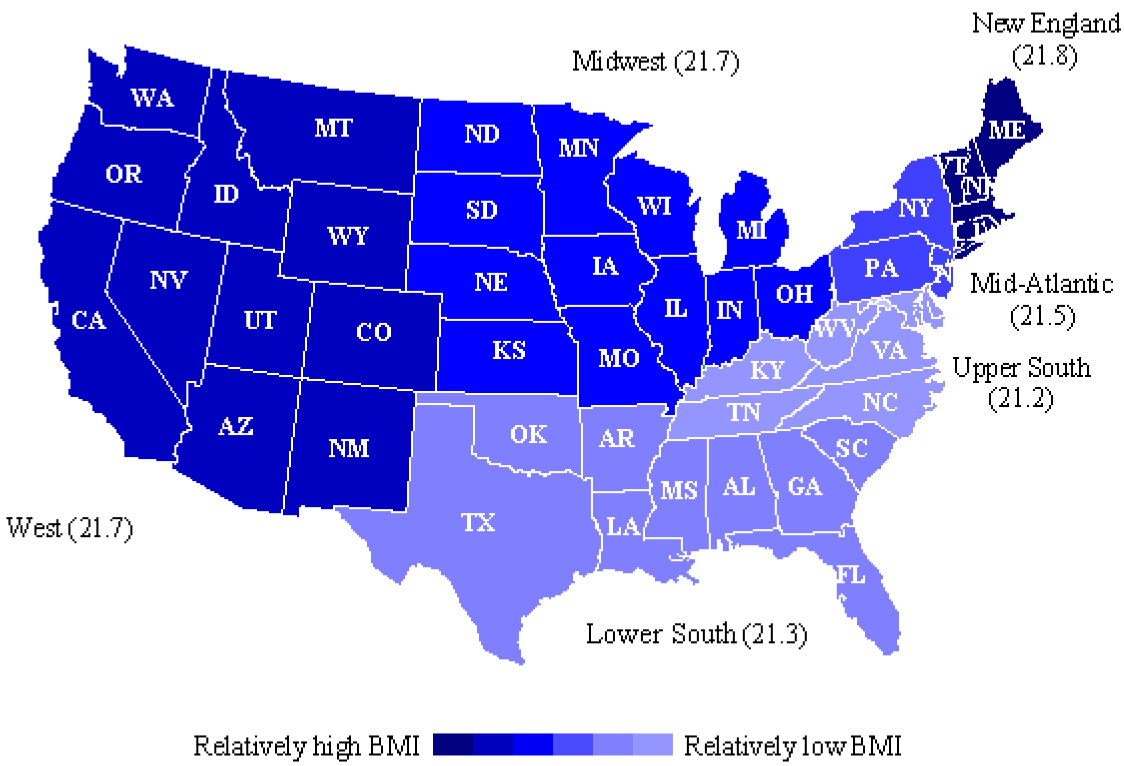


Note: The figure refers to an individual who was born in the Upper South. Citadel students are on a decade basis, while West point cadets are on a quinquennium basis.

Sources: Current NHANES 1996-2004 (modern average BMI); Coclanis and Komlos 1995 (Citadel students). Table 4.1, column 1 (West Point cadets). Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

Individuals, who were born in a state different from the one in which they lived at the time of the examination, had on average a 0.18 units lower BMI than their peers who did not move across state boundaries (Table 4.1, column 4). Cadets from New England, the Midwest and the West reached a higher BMI than their peers from the Upper South, the Lower South or the Mid-Atlantic region (Table 4.1, column 4 and Figure 4.4). This is in line with Coclanis and Komlos (1995) who report for the Citadel sample that “northerners were somewhat heavier for their height than southerners”. On average, a 20-year old West Point cadet born 1875-79 had a BMI value between 21.2 if born in the Upper South and 21.8 if born in New England (Figure 4.4). By region, the largest West Point/Citadel difference existed for cadets from the West (Figure 4.5), with average BMI value of 21.7 and 21.0, respectively. Small sample properties (only about 3.4% of West Point cadets and 1.9% of Citadel students were born in the West) may explain the deviation.

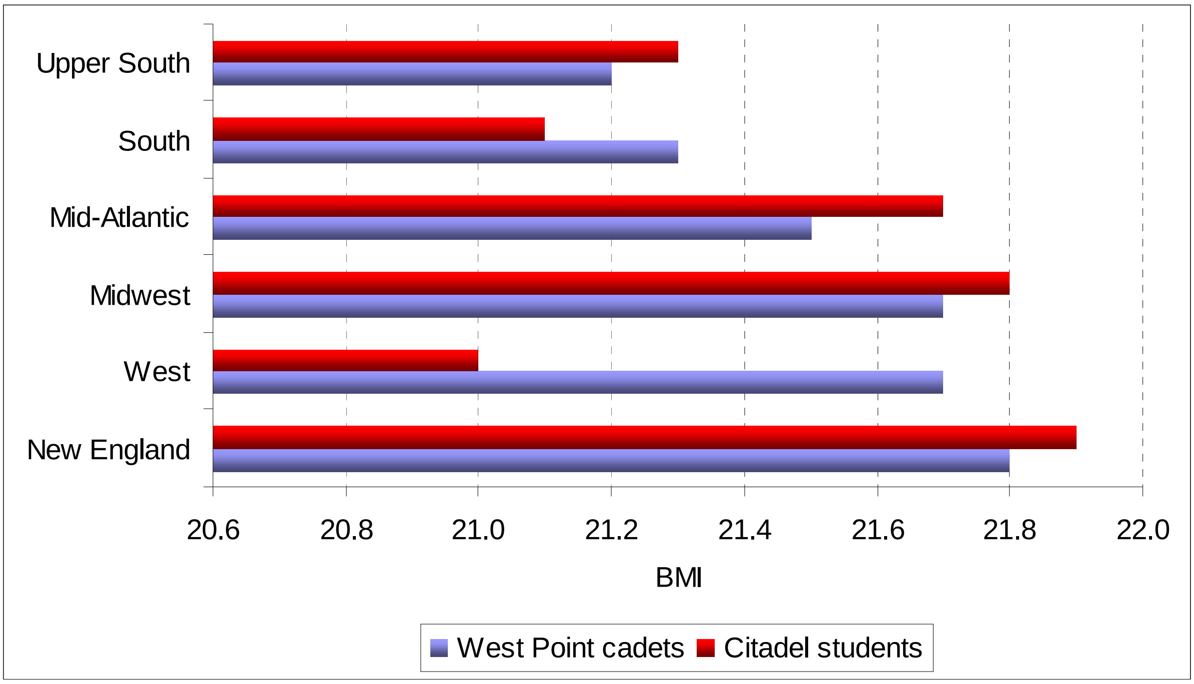
Figure 4.4: BMI of 20 year old West Point candidates (cm) born 1875-79, by region



Note: Based on Table 4.1.

Source: Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

Figure 4.5: BMI values of 20-year old West Point cadets and Citadel students born in the 1870s, by region

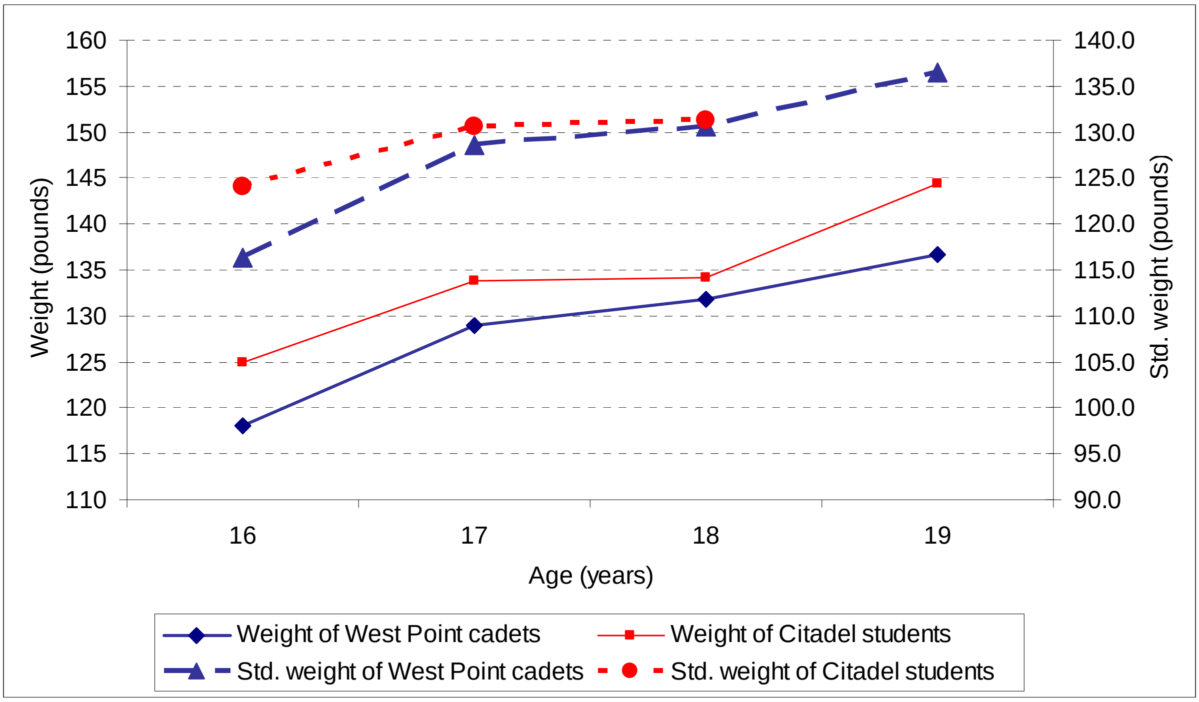


Note: Based on Table 4.1.

Source: Coclanis and Komlos (1995) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

In terms of weight, Citadel students born 1870-85 were on average heavier than their West Point peers for all age groups (Figure 4.6). The difference is largest at age 19 (7.8 pounds) and smallest at age 16 (2.4 pounds). For a more meaningful comparison, we standardize for height using BMI values and the heights of West Point cadets. In terms of this measure, Citadel students were heavier than their West Point peers (Figure 4.6), though the difference narrowed considerably with age. At age 18 (the oldest age available for which BMI information is available in the Citadel sample), the difference is 0.7 pounds, far less than what it was at age 16 (7.7 pounds).

Figure 4.6: Weight of West Point cadets and Citadel students born in 1870-85, by age



Source: Coclanis and Komlos (1995) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

4.5 Conclusion

Using data on the height and weight of 2,468 West Point cadets born between 1860 and 1884, we show that both height and BMI were greater in the 1880s than in the 1860s. For both measures of the biological standard of living, significant regional variation existed. While 20 year old cadets from the Upper South, who were born 1875-79, were on average 174.9 cm tall, their peers from New England reached a height of only 173.1 cm. On average, a 20-year old West Point cadet born 1875-79 had BMI values between 21.2 if born in the Upper South and 21.8 if born in New England. About 36.6% of West Point cadets between the ages of 20 and 21 had a BMI of less than 19, the approximate threshold which marks an increase in mortality risk (Cuff 1993). The increase in height and BMI was not constant, but was accompanied by short-term fluctuations. While decreasing transportation costs and inventions such as canning and the refrigerated railroad car allowed for advances in the biological standard of living, droughts and recessions meant some setbacks at least for parts of the population. The result calls for a larger-scale investigation into the relative importance of economic forces in the post-Civil War increase in height and BMI, similar to what has been done for the antebellum decline, where up to eight possible causes have been identified and discussed (Sunder 2004).

It is clear that the antebellum decline in height came to an end during reconstruction and even a rebound is evident. The nearly 2 cm increase in height of the decades under consideration is about the average increase in height of the developed European populations during the course of the 20th Century.

4.6 References

A'Hearn, B. (1998). "The Antebellum Puzzle Revisited: A New Look at the Physical Stature of Union Army Recruits during the Civil War." In: Komlos, J. and Baten, J., ed., "The Biological Standard of Living in Comparative Perspective." Stuttgart: Franz Steiner, pp. 250-67.

Baten, J. (1996). "Der Einfluss von regionalen Wirtschaftstrukturen auf den biologischen Lebensstandard." Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte 83: 180-213.

Baten J. (2000). "Economic development and the distribution of nutritional resources in Bavaria 1797–1839." Journal of Income Distribution 9: 89-106.

Bogin, B. (1999). "Patterns of Human Growth." 2nd edn., Cambridge University Press, Cambridge.

Bleakley, H. (2007). "Disease and Development: Evidence from Hookworm Eradication in the American South." Quarterly Journal of Economics 122: 73-117.

Chanda, A., Craig, L.A. and Treme, J. (2008). "Convergence (and Divergence) in the Biological Standard of Living in the United States, 1820-1900." Cliometrica 2: 19-48.

Coclanis, P. and Komlos, J. (1995). "Nutrition and Economic Development in Post-Reconstruction South Carolina: An Anthropometric Approach." Social Science History 79: 91-116.

Craig, L.A. and Weiss, T. (1998). "Nutritional Status and Agricultural Surpluses in the Antebellum United States." In: Komlos, J. and Baten, J., ed., "The Biological Standard of Living in Comparative Perspective." Stuttgart: Franz Steiner, pp. 190-207.

Craig, L. and Weiss, T. (2000). "Hours at Work and Total Factor Productivity Growth in the l9th Century U.S. Agriculture." Advances in Agricultural Economic History 1: 1-30.

Cuff, T. (1993). “The Body Mass Index Values of Mid-19th Century West Point Cadets.” Historical Methods 26: 171-183.

Floud, R. (1994). “The heights of Europeans since 1750: a new source for European economic history.” In: Komlos, J., ed., “Stature, Living Standards, and Economic Development: Essays in Anthropometric History.” The University of Chicago Press, Chicago, pp. 9-25.

Fogel, R.W. (1994). “Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy.” American Economic Review 84: 369-95.

Haines, M. (1989). “A State and Local Consumer Price Index for the United States in 1890.” Historical Methods 22: 97-105.

Haines, M. (1998). “Health, Height, Nutrition, and Mortality: Evidence on the 'Antebellum Puzzle' from Union Army Recruits for the New York State and the United States.” In: Komlos, J. and Baten, J., ed., “The Biological Standard of Living in Comparative Perspective.” Stuttgart: Franz Steiner, pp. 155-75.

Herweijer, C., Seager, R. and Cook, E. (2006). “North American droughts of the mid to late nineteenth century: a history, simulation and implication for Mediaeval drought.” The Holocene 16: 15-171.

Komlos, J. (1985). “Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development.” American Historical Review 90: 1149-61.

Komlos, J. (1987). “The Height and Weight of West Point Cadets: Dietary Change in Antebellum America.” The Journal of Economic History 47: 897-927.

Komlos, J. (1989). “Nutrition and economic development in the eighteenth century Habsburg monarchy.” Princeton: Princeton University Press

Komlos, J. (1993). “The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730-1860.” Economic History Review 46: 115-44.

Komlos, J. (1996). “Anomalies in Economic History: Reflections on the Antebellum Puzzle." Journal of Economic History 56: 202-14.

Komlos, J. (1998). “Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution.“ Journal of Economic History 58: 779-802.

Komlos, J. (2003). “Access to Food and the Biological Standard of Living: Perspectives on the Nutritional Status of Native Americans.” American Economic Review 93: 252-55.

Komlos, J., Breitfelder, A. and Sunder M. (2008). “The Transition to Post-industrial BMI values among US children” American Journal of Human Biology, forthcoming.

Komlos, J. and Snowdon, B. (2005). “Measures of Progress and Other Tall Stories.” World Economics 6: 87-135.

Lang, S. and Sunder, M. (2003). “Non-parametric regression with BayesX: a flexible estimation of trends in human physical stature in 19th century America.” Economics and Human Biology 1: 77-89.

Margo R. and Steckel, R. (1983). “Heights of Native Born Northern Whites during the Antebellum Period.” Journal of Economic History 43: 167-84.

Mokyr, J. (1990). “The Lever of Riches: Technological Creativity and Economic Progress.” Oxford: Oxford University Press.

Mokyr, J. (1997). “Technological Selection, Information, and Changing Household Behavior, 1850-1914.” Unpublished Manuscript, Department of Economics, Northwestern University.

Nicholas, S. and Steckel, R.H. (1991). “Heights and Living Standards of English Workers during the Early Years of Industrialization, 1770-1815.” Journal of Economic History 51: 937-57.

Officer, L.H. and Williamson, S.H. (2008), “Annualized Growth Rate and Graphs of Various Historical Economic Series” MeasuringWorth http://www.measuringworth.com/growth/

Roche, A.F. (1979). “Secular Trends in Stature, Weight, and Maturation.” Monographs of the Society for Research in Child Development 44: 3-27.

Sandberg, L. and Steckel, R.H. (1987). “Heights and Economic History: the Swedish Case.” Annals of Human Biology 14: 101-10.

Schultz, S.K. and McShane, C. (1978). “To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late-Nineteenth-Century America.” Journal of American History 65: 389-411.

Steckel, R.H. (1995). “Stature and the standard of living.” Journal of Economic Literature 33: 1903-40.

Steckel, R.H. (2006). “Health, Nutrition and Physical Well-Being.” Historical Statistics of the United States: Millenial Edition, 2-499 to 2-620. New York: Cambridge University Press.

Steckel, R.H. (2008). “Biological Measures of the Standard of Living.” Journal of Economic Perspectives 22: 129-152.

Steckel, R.H. and Haurin, D.R. (1994). “Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910.” In: Komlos, J., ed., “Stature, Living Standards, and Economic Development: Essays in Anthropometric History.” The University of Chicago Press, Chicago, pp. 117-28.

Steckel, R.H. and Prince, J.M. (2001). “Tallest in the World: Native Americans of the Great Plains in the Nineteenth Century.” American Economic Review 97: 287-94.

Sunder, M. (2003). “The Making of Giants in a Welfare State: The Norwegian Experience in the 20th Century.” Economics and Human Biology 1: 267-76.

Sunder, M. (2004). “The height of Tennessee convicts: another piece of the antebellum puzzle”, Economics and Human Biology 2: 75-86.

Sunder, M. (2007). “Passports and Economic Development: An Anthropometric History of the U.S. Elite in the Nineteenth Century.” Unpublished manuscript. University of Munich.

Waaler, H. (1984). “Height, weight, and mortality: the Norwegian experience.” Acta Medica Scandicana (Supplement) 679: 1-56.

Weiss, T. (1992). “U.S. Labor Force Estimates and Economic Growth, 1800-1860.” In: Gallman, R. and Wallis, J., ed., “American Economic Growth and Standards of Living before the Civil War”. Chicago 1992.

White, J.H. (1986). “The Great Yellow Fleet.” Golden West Books, San Marino, California.

White, J.H. (1993). “The American Railroad Freight Car.” The Johns Hopkins University Press, Baltimore, Maryland.

4.7 Appendix

Table A4.1: Characteristics of the combined and new sample

	Combined sample	**New sample**
Year of examination		
1878-79	3.5%	n/a
1880-84	27.5%	n/a
1885-89	27.8%	n/a
1890-94	14.6%	5.8%
1895-99	19.6%	68.4%
1900-01	7.3%	25.8%
Age at examination		
16	0.8%	1.7%
17	21.4%	16.1%
18	25.4%	23.1%
19	23.4%	25.4%
20	16.5%	19.3%
21	12.6%	14.0%
22	n/a	0.1%
23	n/a	0.1%
Admitted		
Yes	86.8%	53.3%
No	13.2%	46.7%
Year of birth		
1860-65	28.7%	n/a
1865-69	29.4%	n/a
1870-74	11.8%	4.6%
1875-79	23.7%	72.2%
1880-84	6.8%	23.2%

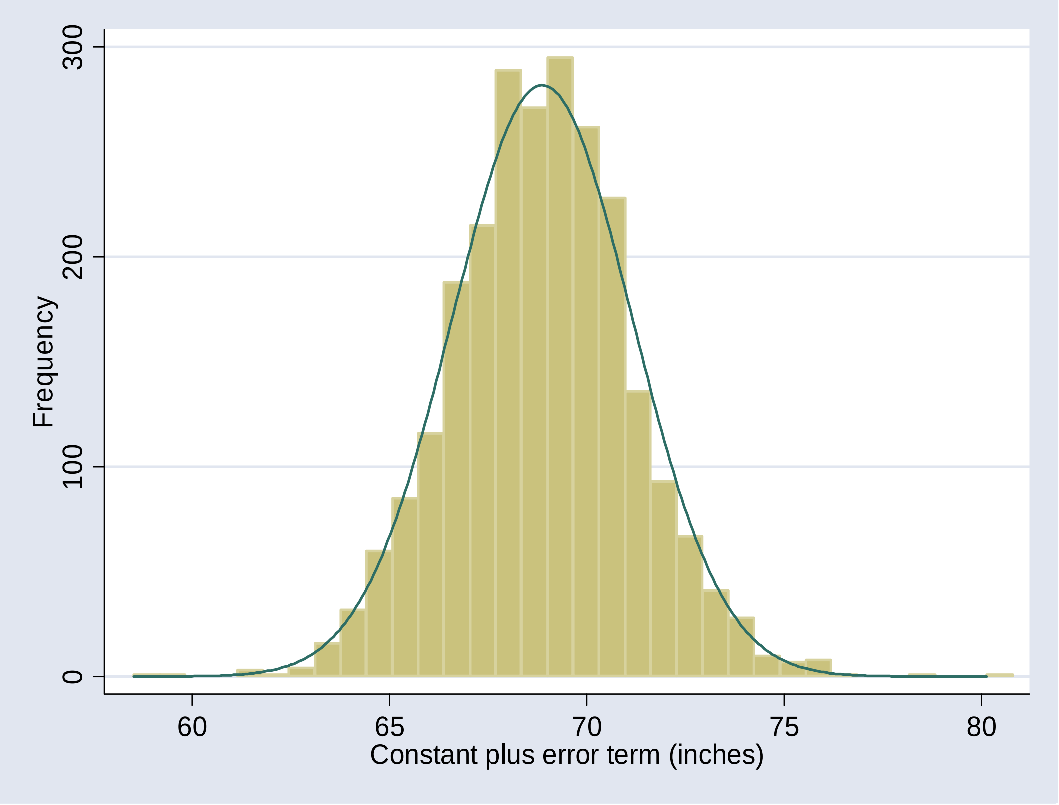
Urban/rural		
Urban	17.2%	15.2%
Rural	55.9%	40.3%
Missing	38.5%	44.5%
Birthplace		
Mid-Atlantic	26.7%	23.9%
Midwest	36.3%	35.0%
Upper South	11.1%	11.4%
Lower South	15.3%	17.2%
New England	7.3%	6.9%
West	3.4%	3.7%
Other	n/a	1.9%
Residence equal birthplace?		
Yes	21.6%	11.2%
No	78.4%	88.8%

Note: Number of observations is 2,468 for the combined sample and 704 for the new sample.

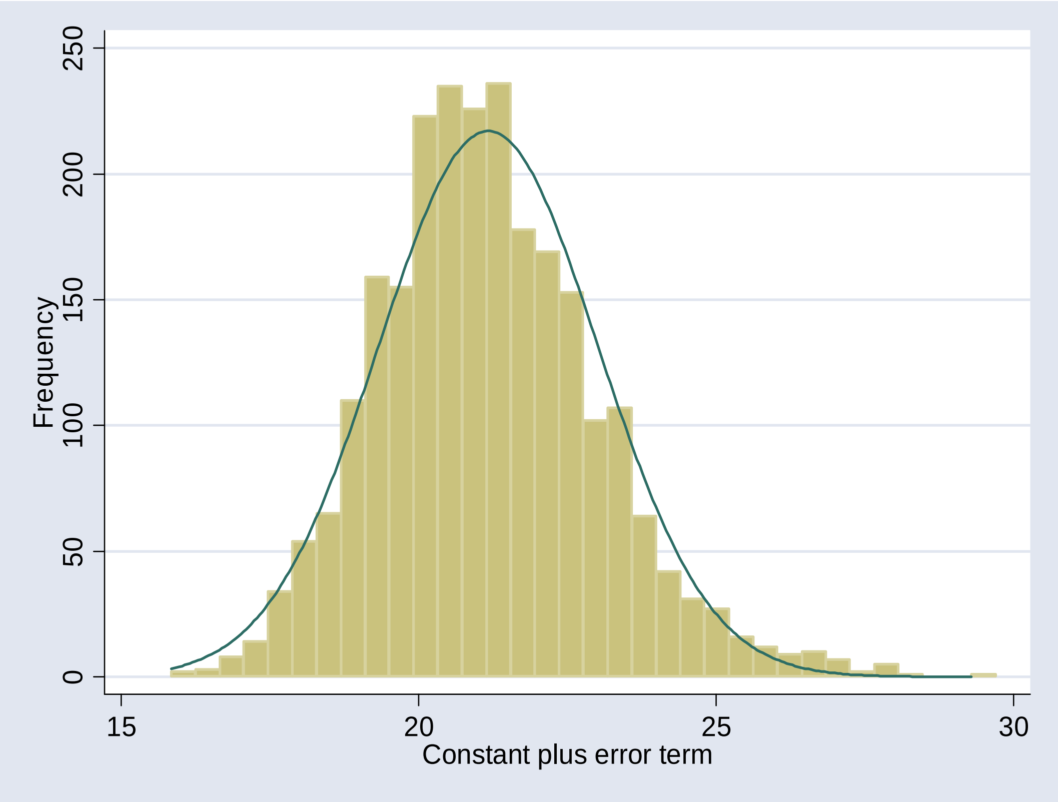
Source: Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

Figure A4.1: Histograms of regression error terms (plus constant)

Height regression



BMI regression



Note: Based on Table 4.1, column 2 (height regression) and column 4 (BMI regression).

Source: Komlos (1987) and US National Archives, Washington, D.C., Record Group 94, entries 103 and 234.

Chapter 5: Height and BMI values of German conscripts in 2000 and 2001

5.1 Abstract

We examine the height and weight of 320,000 German 18-22 year old conscripts born between 1979 and 1982. We show that height and BMI outcomes are associated with the socio-economic status of a person. For example, we find a positive correlation between education and height and a negative one between education and BMI. A West-East and a North-South gradient in both height and BMI is found. Today, West German recruits are about 5.5 cm taller than their peers 43 years ago and about 12.5 cm taller than those 100 years ago, reflecting a substantial improvement in the biological standard of living. To this day, however, individuals of high socio-economic status are able to reach an above-average height.

5.2 Introduction

Conventional standard-of-living indicators based on income do not accurately reflect the quality of life experience of the various members of a society, particularly of youth. This is the case because such aspects of welfare as health, life-expectancy, security, representation and equality are not fully integrated into GDP or income measures (Sen 1987, Osberg and Sharpe 2002). In an attempt to broaden the definition of living standards, the United Nations (1996) created the Human Development Index (HDI) which incorporates not only income but also education and life expectancy. Research on happiness is also helpful in overcoming the limitations associated with a single indicator (Frey and Stutzer 2002).

We approach the well being of the German population from the perspective of the biological standard of living proxied by the anthropometric indicators height and weight (Komlos and Baur 2004, Pradhan et al. 2001, Komlos and Baten 1998, Baten 2000, Mielck 2000, Steckel 2008). These measures are a mirror of how well the human organism thrives in its socio-economic and epidemiological environment (Tanner 1986, Komlos and Cuff 1998, Komlos and Baten 1998). Height is affected by the access to health care, nutrition, the state of medical technology, the quality of prenatal care, the attitude toward preventive medicine, the virulence of the disease environment, the state of the education system, and the degree of pollution[1] (Bogin 1999, Costa 1993, Komlos and Cuff 1998; Komlos and Baten 1998, Waaler 1984). Weight has recently raised particular concern in many Western industrialized countries as overweight and obesity have increased rapidly in the last 25 years (Philipson 2001, Popkin and Doak 1998, Komlos et al. 2008). By capturing the biologically relevant quality-of-life component of welfare – amongst other things, health and longevity independent of income –, height and weight as measures of living standards acknowledge explicitly that the human experience is inherently multidimensional (Komlos and Baur 2004).

5.3 Data

After finishing high school and/or vocational training, German males must attend a medical examination at the local draft office ("Kreiswehrersatzamt")[2]. If found fit, they are mustered either into military or civilian service ("Zivildienst")[3]. We have data on 320,000 males who were examined in the years 2000 and 2001 at the age between 18 and 22[4]. All individuals were measured and their educational status recorded. Furthermore, their health was determined by a physician. Grades of T1 (excellent health), T2 (very good health), T3 (good

[1] To be sure, at the individual level, anthropometric measures are also affected by genetics. However, this influence tends to be unimportant in the aggregate as long as the ethnic composition of the population examined is held constant (Fogel 1994, Tanner 1986, WHO 1995).

[2] Some exemptions exist. Delinquents sentenced to more than a year or charged with a felony against peace, democracy or the state will not be drafted. The same is true for priests and the families of those oppressed by the Nazi regime. Another provision exempts everyone from conscription who has two siblings who have already served. The same is true for men whose father, mother or sibling died while on service. Men who are married or have children are allowed to choose. Workers performing tasks in areas of public interest (such as policemen and firefighters) are exempted on request.

[3] In the civilian service, "conscientious objectors" fulfill their national service typically in hospitals, retirement homes or emergency medical services.

[4] The data was collected by the German Defense Medical Statistics Agency (Institut für Wehrmedizinalstatistik und Berichtswesen 2003), Aktienstraße 87, 56626 Andernach, phone +492612810, and is available upon request. The age at the time of the examination varies with the type of school/vocational education attended by the individual. Enrollment age and a possible repetition of a school year also play a role.

health) or T7 (minor health disturbance) mean that an individual is fit to serve. More specifically, T1 indicates that the individual has no health disturbance at all, perfect eye sight, is between 180 cm and 195cm tall and can be used in any military specialty. Individuals receiving a T2 grade are of similar health as those with a T1, but do not fulfill the eyesight and/or height requirement. We combine T1 and T2 to avoid selection based on the T1 height requirement. T3 means that, for some minor fitness concern, the individual is exempt from basic recruit training and can not be assigned to the physically most challenging military branches. T7 means that the individual has a minor health disturbance but is still able to perform some tasks in the military[5]. Individuals who temporarily have a major health disturbance are graded T4, meaning that they are exempted for now, but have to repeat the examination a year later. T5 means that a person has a major health disturbance and that improvement cannot be expected in the next couple of years. In consequence, the person is permanently exempted. T6 is reserved for (older) reservists who are not part of our sample.

Geographical information is available at the level of seven military districts[6]. We report descriptive statistics in Table A5.1 of the Appendix. In comparison to a normal distribution, a height of 178 cm is measured less frequently than expected, while a height of 179 cm is measured more frequently (Figure 5.1, panel a). Nonetheless, height is distributed normally in this sample according to the D'Agostino et al. (1990) and Royston (1991) skewness and kurtosis test. The distribution of the body mass index (BMI) values is positively skewed (Figure 5.1, panel b), a frequent finding in studies like this (Penman and Johnson 2006)[7].

---

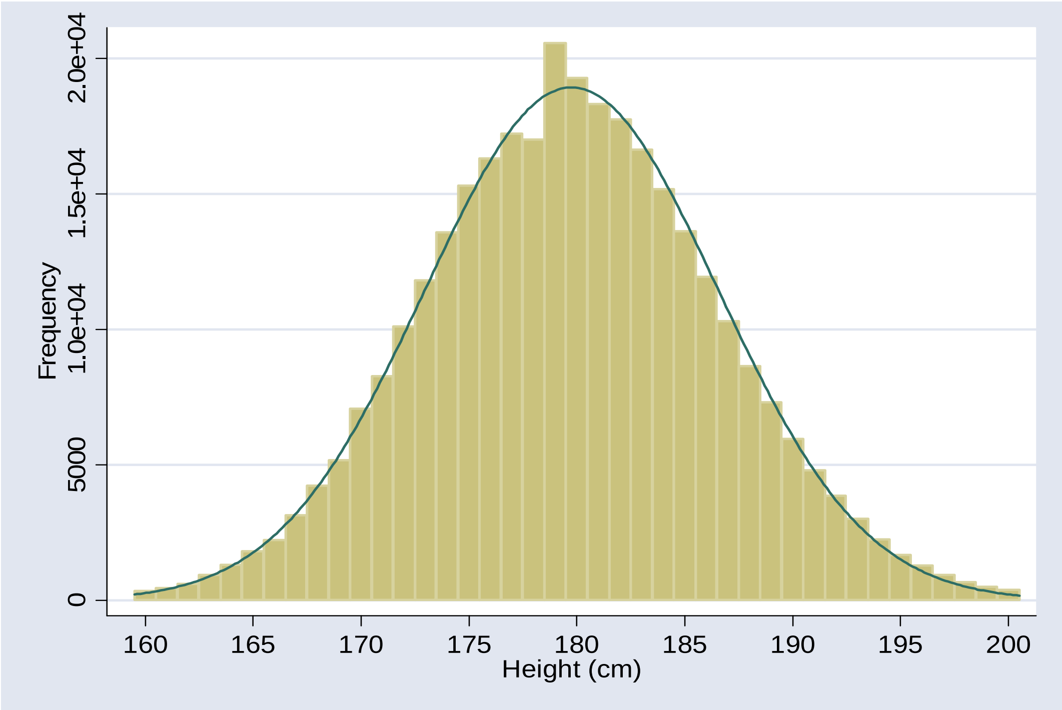
[5] In terms of draft equity (“Wehrgerechtigkeit” – the principle that the draft should apply equally and non-discriminatorily to all men) it was decided in 1995 that those individuals should also serve.

[6] The military districts are numbered from 1 to 7. In the following, we refer to Military District 1 as “North”, to Military District 2 as “Northwest”, to Military District 3 as “North Central”, to Military District 4 as “South Central”, to Military District 5 as “South West”, to Military District 6 as “South East” and to Military District 7 as “East” (for a map, see Figure 5.4).

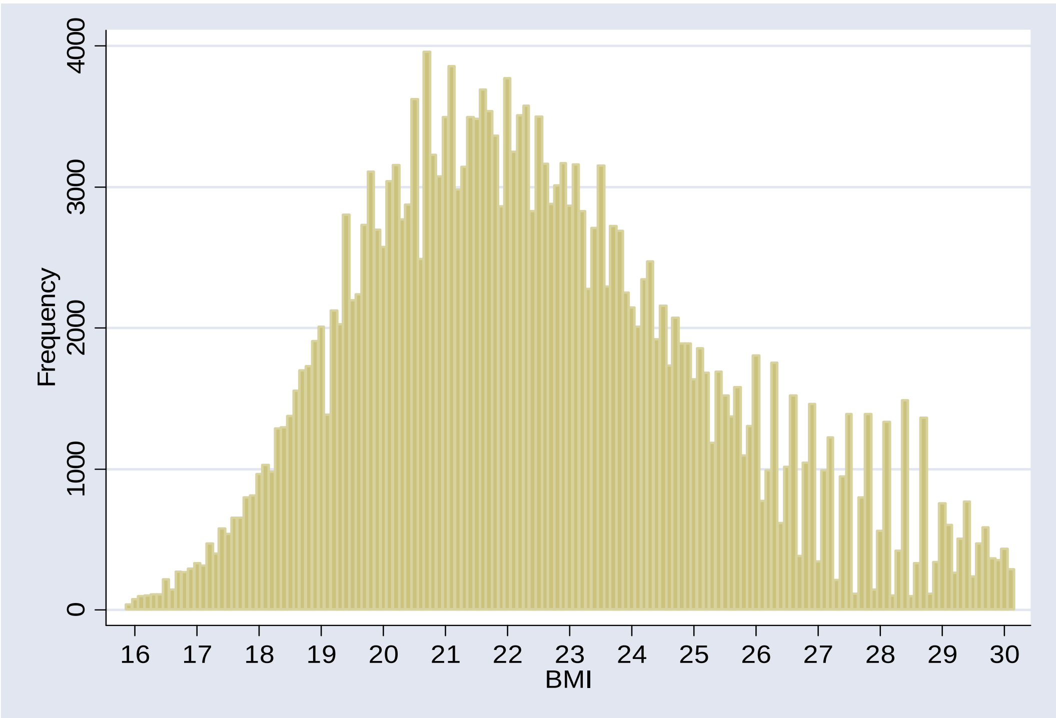
[7] The BMI can be calculated as weight in kg divided by height in meters.

Figure 5.1: Height and BMI distribution of German males (age 18-22) in 2000 and 2001

(a) Height



(b) BMI



Note: The range for is restricted to the interval 160 cm to 200 cm. BMI is rounded to one decimal place with range restricted to the interval 16 to 30.
Source: Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

5.4 Results

Controlling for the age and the socio-economic background of individuals, we find that mean male height increased by about 2 mm from 1979 to 1982[8] (Table 5.1, column 1), while average BMI remained virtually unchanged (Table 5.1, column 2). However, we do not know which individuals are repeating the examination because of a grade of T4 one year earlier. This may bias our coefficients for year of birth and age if repeaters are unusually tall or heavy, and distributed unequally over the years. We find a positive association between education and height and a negative one between education and BMI (Table 5.1 and Figure 5.2). We are unable to establish causation, however, insofar as height and BMI are not exclusively determined by one's education but also those of the parents for which we do not have data. Health tends to correlate positively with height and negatively with BMI (Table 5.1 and Figure 5.3).

Table 5.1: OLS estimates, dependent variables: adult height and BMI of German recruits, 2000 and 2001

	Dep. Variable: Height (cm)	Dep. Variable: BMI
Year of birth		
1979	-0.16*	0.01
1980	Reference	Reference

[8] Throughout the paper, dates generally refer to date of birth rather than the date of examination.

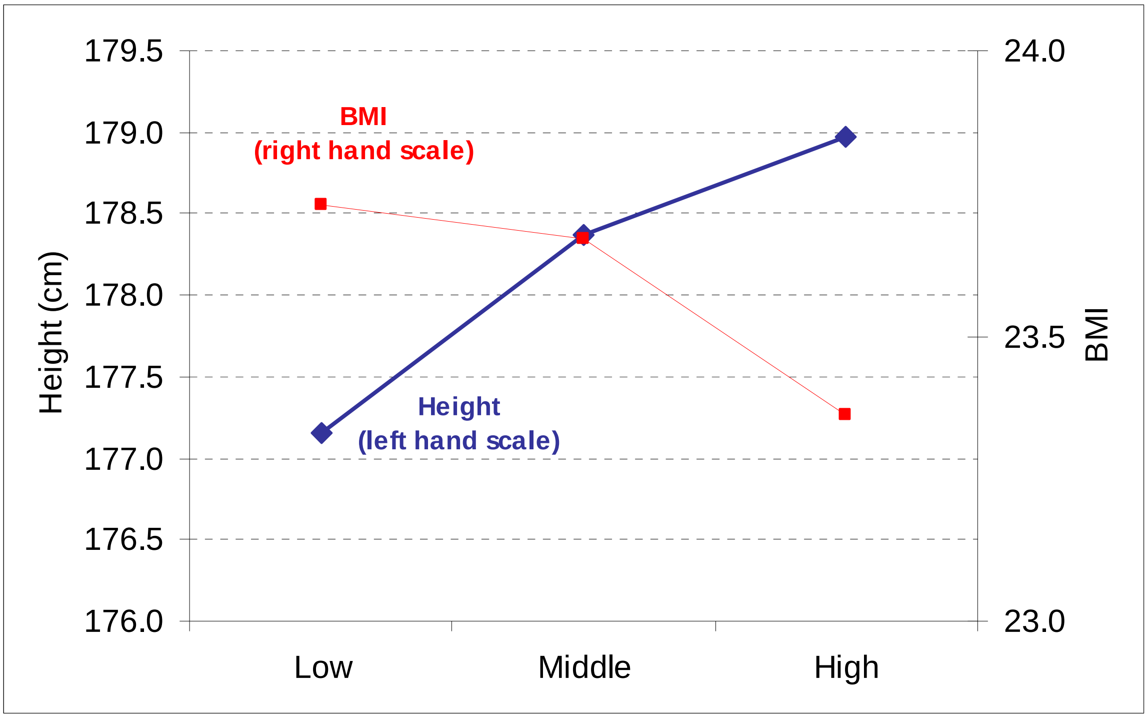
1981	0.15**	0.03
1982	0.07**	0.05
Age		
18	0.07*	0.23**
19	Reference	Reference
20	-0.23**	0.36***
21	-0.43***	0.56*
22	-0.96***	0.70***
Education		
Low (Hauptschule)	-1.21***	0.06***
Middle (Realschule)	Reference	Reference
High (Gymnasium)	0.60***	-0.31***
Health		
Perfect/Very good health	0.26***	0.02***
Good health	Reference	Reference
Minor health disturbance	0.02*	0.91***
Temporary major health disturbance	-0.75**	0.61**
Permanent major health disturbance	-0.87**	1.01***
Region		
North	0.48***	-0.10***
Northwest	1.27***	-0.08***
North Central	0.71***	0.04
South Central	Reference	Reference
South West	-0.96***	-0.17***
South East	-0.42***	-0.14***
East	-0.55***	-0.62***
Constant	178.37***	23.57***
Adjusted R-squared	0.04	0.02
F-statistic	1154.3***	294.3***
Number of observations	320,000	320,000

Note: Heteroscedasticity-robust Huber-White (1967, 1980) standard errors have been used.

Source: Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

* significant at 10%; ** significant at 5%; *** significant at 1%

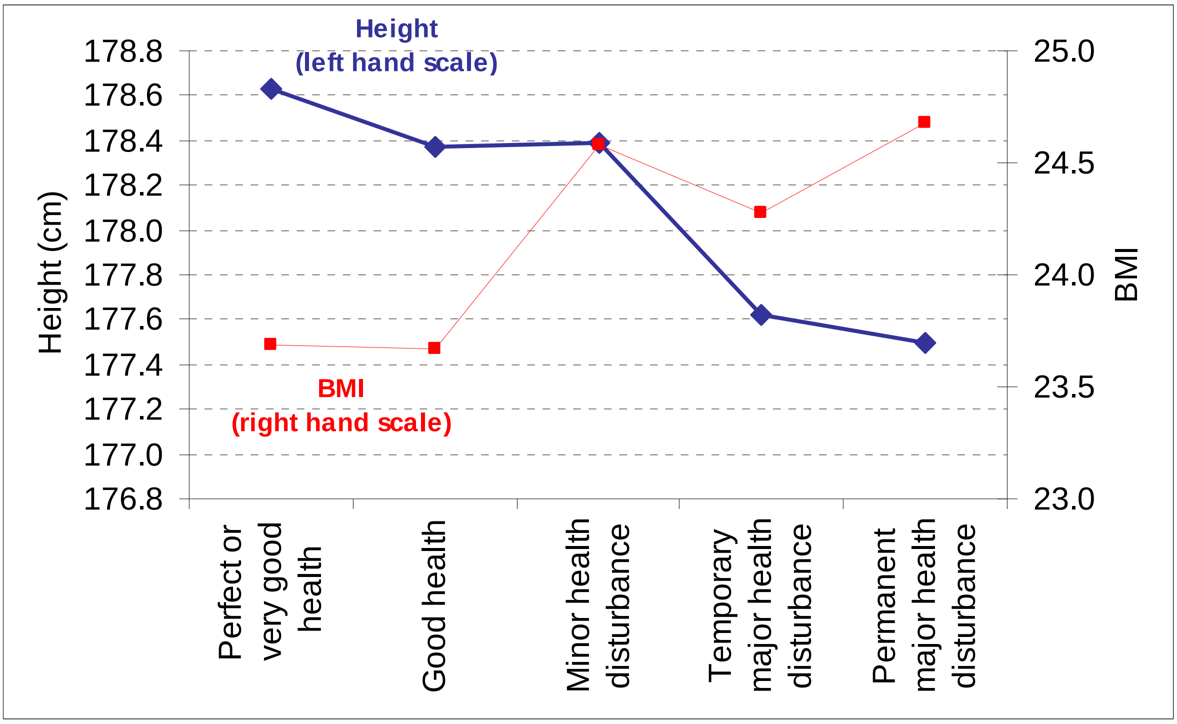
Figure 5.2: Height and BMI of German males as a function of education, 2000/01



Note: The figure is based on Table 5.1, columns 1 and 2, and refers to 22-year old males born 1979 in the South Central region and who are of very good health (T2).

Source: Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

Figure 5.3: Height and BMI of German males as a function of health, 2000/01



Note: The figure is based on Table 5.1, columns 1 and 2, and refers to 22-year old males born 1979 in the South Central region, who have a middle education.
Source: Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

People from the Northwest were tallest. A 22-year old individual of very good health with a middle education and born in 1979 reached a height of 179.6 cm there (Table 5.1, column 2, and Figure 5.4). This was 2.2 cm more than the average height of comparable conscripts from the South West. In contrast, regions with a short population tend to be in the South-West (Figure 5.4), reinforcing previous research that found a West-East and a North-South gradient in height in Germany (Heineck 2006). Lacking further information at the individual level, we report population density, monthly spending on dairy products and eggs, GDP per capita and income Gini coefficients at the level of regions (N=7, Figure 5.4)[9]. We find that the Northwest was not only the region with the tallest recruits, but also the one with

[9] We also have information on the unemployment rate and the disposable income per capita or per family. These measures are, however, closely related to GDP per capita.

the lowest population density (155 persons per square-kilometer) and the second lowest inequality of income (Gini coefficient of 0.273, Figure 5.4)[10]. However, the data presented here is meant to be merely descriptive. Any causal inference would have to be based on multiple regression analysis as a lack of control variables may mask existing associations, or generate artificial ones[11].

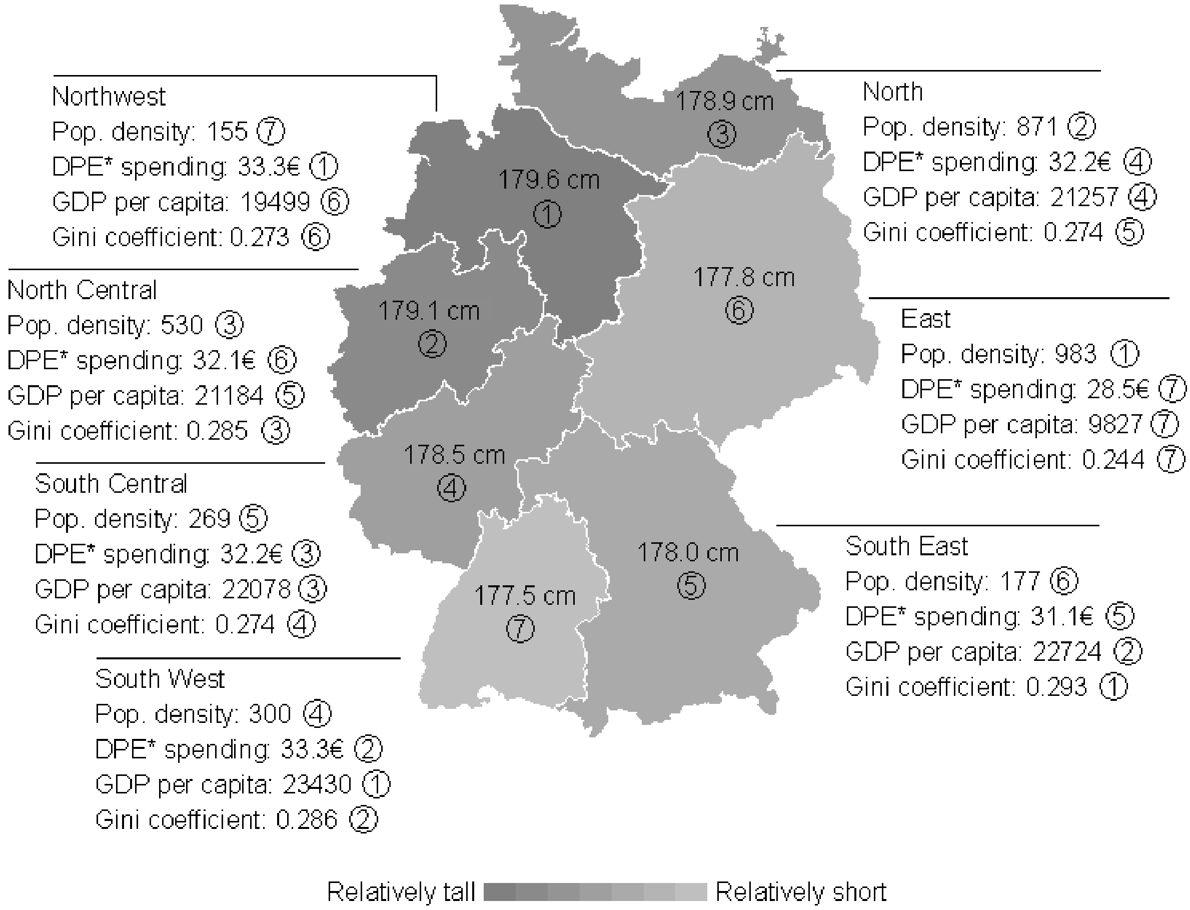
BMI was highest for men living in the North Central region (Table 5.1, column 2, and Figure 5.5). Those regions with the lowest mean heights – South West, South East and East – were also the ones with the lowest BMI (Figure 5.5). Therefore, a West-East and a North-South gradient in BMI exists similar to the one for height. The BMI gradients are in contrast to previous research which suggested that individuals living in the middle regions of Germany have a higher BMI than their Northern or Southern counterparts (Heineck 2006). A different choice of control variables and a different classification of regions (in particular with respect to Northern Germany), may explain these differences. Geographic correlates of height such as population density (coefficient of -0.11, p=0.81), spending on dairy products and eggs (coefficient of 0.18, p=0.70), per capita GDP (coefficient of 0.14, p=0.76) and inequality (coefficient of 0.11, p=0.78) are insignificant in terms of Spearman's rank correlation (N=7)[12].

[10] The Spearman rank correlation coefficient between height and population density is -0.3. However, we cannot reject the null hypothesis of mutual independence (p=0.48). The same is true for average monthly spending on dairy products and eggs (coefficient of 0.21, p=0.64) and per capita GDP (coefficient of -0.46, p=0.29). There is, however, a significant negative correlation between inequality and height (-0.77, p=0.07) if we exclude the East which, because of its socialist past, may be seen as a special case (Komlos and Kriwy (2003). Without excluding the East, the coefficient for inequality is -0.29 (p=0.53). Results for population density, spending on dairy products and eggs, GDP per capita are qualitatively the same irrespective of whether the East is included or not. The Bravais-Pearson correlation coefficient is -0.13 (population density), 0.42 (spending on dairy products and eggs), 0.15 (per capita GDP) and 0.07 (inequality), respectively.

[11] Since we have only seven observations (based on the seven regions), multiple regression analysis is difficult to implement here. At most, we can hope to use two or three control variables at a time. The small sample size, however, tends to render results insignificant. Hence, the evidence presented in Figure 5.4 can only suggest causal effects, which future research – based on a larger data set – could then corroborate.

[12] All results are qualitatively unchanged if we exclude the East because of its socialist past. The Bravais-Pearson correlation coefficient is -0.54 (population density), 0.81 (spending on dairy products and eggs), 0.83 (per capita GDP) and 0.70 (inequality), respectively.

Figure 5.4: Height and selected geographic environmental correlates of German males in 2000 and 2001 by region, rank

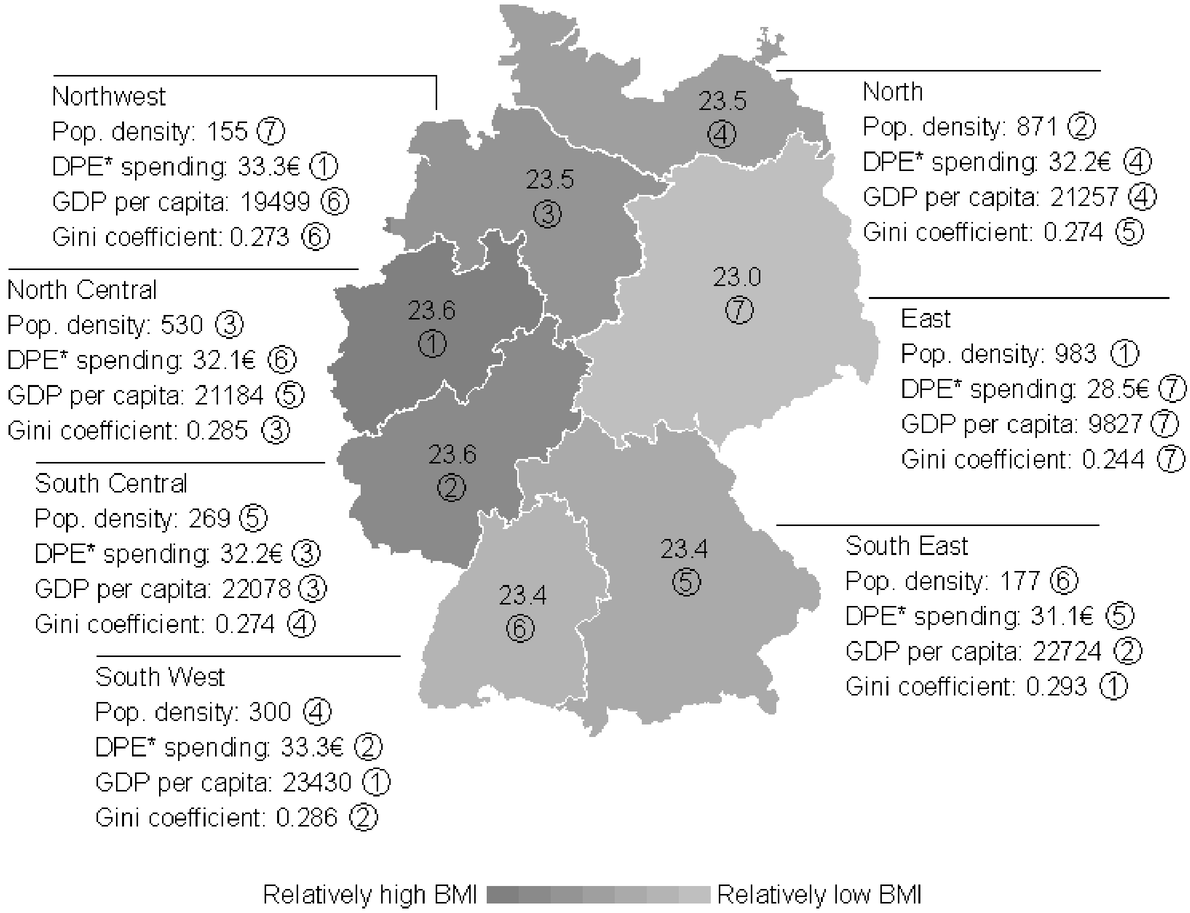


Note: The figure is based on Table 5.1, column 2, and refers to 22-year old males born 1979, who have a middle education and are of very good health (T2). Where possible, population density, monthly spending on dairy products and eggs, GDP per capita, and the Gini coefficient refer to the period in which respondents were growing up.

Source: Institut für Wehrmedizinalstatistik und Berichtswesen 2003 (height), Statistsches Bundesamt 2008 (population density, DPE spending, and GDP per capita), and Berlinpolis 2006 (Gini coefficient).

* DPE stands for dairy products and eggs; monthly per capita spending is reported.

Figure 5.5: BMI and selected geographic environmental correlates of German males in 2000 and 2001 by region, rank



Note: The figure is based on Table 5.1, column 2, and refers to 22-year old males born 1979, who have a middle education and are of very good health (T2). Where possible, population density, monthly spending on dairy products and eggs, GDP per capita, and the Gini coefficient refer to the period in which respondents were growing up.
Source: Institut für Wehrmedizinalstatistik und Berichtswesen 2003 (height), Statistsches Bundesamt 2008 (population density, DPE spending, and GDP per capita), and Berlinpolis 2006 (Gini coefficient).
* DPE stands for dairy products and eggs; monthly per capita spending is reported.

5.5 Historical comparison

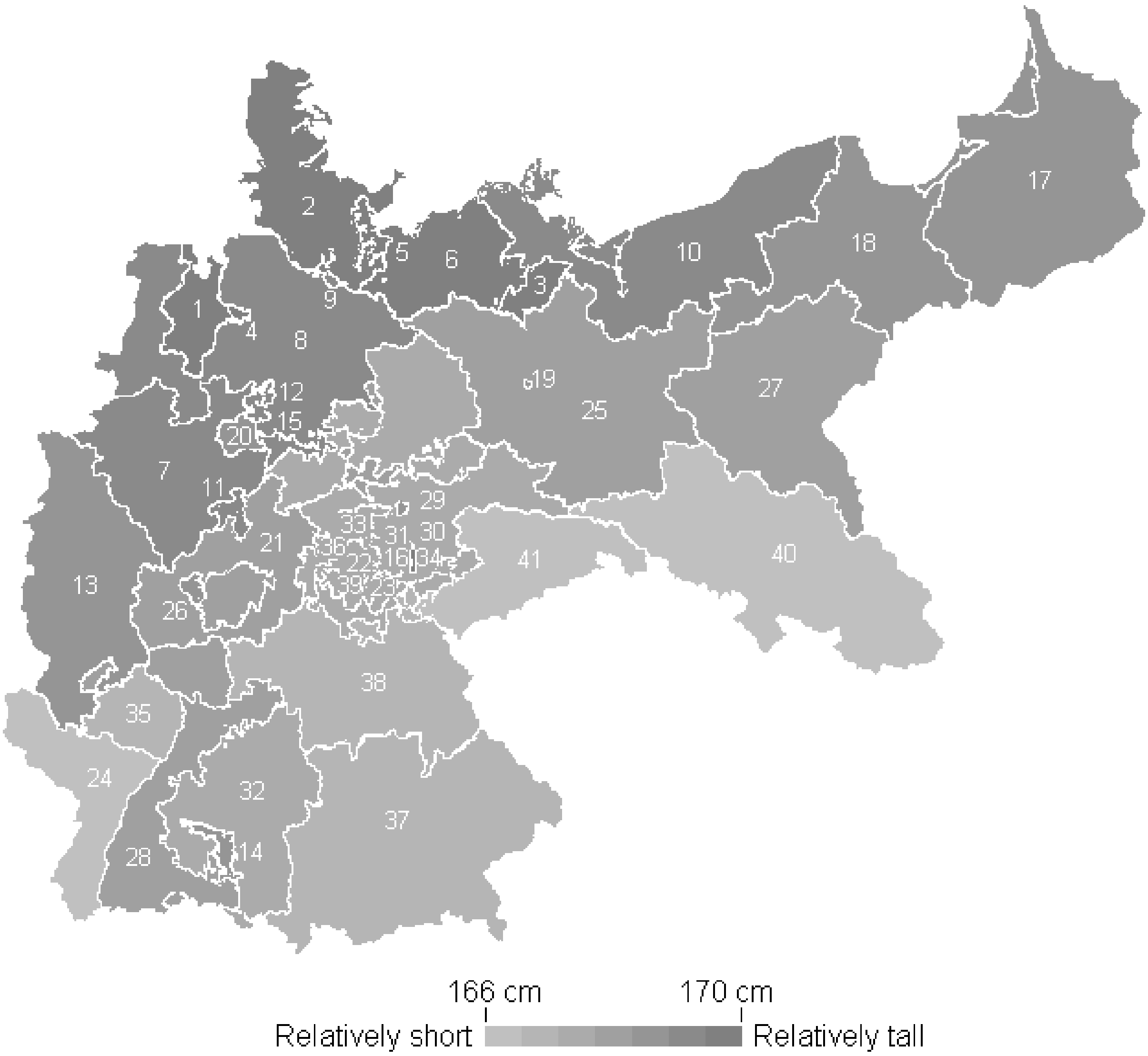
We compare the average height of today's generation to those of the 621,216 males who served in the Imperial German Army as of December 1, 1906[13]. Already then, individuals from the North and the West were tallest (Figure 5.6). Recruits from Oldenburg reached on average a height of 169.8 cm. This is 3.4 cm more than the average height of recruits from Saxony (166.4 cm), the shortest in our sample. About 2% (12,350) of the servicemen were reserve officer cadets ("Einjährig-Freiwillige"), while all others were enlisted soldiers. The prospective reserve officers were part of the society's elite in terms of educational achievement, as only those few who had passed the university entrance exam ("Sekundarreife" at a Gymnasium or a Mittelschule) could volunteer for this service. Furthermore, their parents generally had to be well-off as they were supposed to pay for their sons' accommodations and livelihood while the latter served in the active military. On average, reserve officer cadets were taller than enlisted men (Figure 5.7). The difference was largest for the East (+4.2 cm) and smallest for the North (+3.1 cm)[14]. However, even reserve officer cadets were much shorter than today's average. According to the Institut für Wehrmedizinalstatistik und Berichtswesen (2003) data from above, today's males are on average 8.8 cm taller than the reserve officer cadets of nearly 100 years earlier. For enlisted men, the difference is 12.5 cm. For reserve officer cadets, the difference is largest for the South East (+9.9 cm) and smallest for the South West (+8.1 cm); for enlisted men, the difference is also largest for the South East (13.5 cm) but smallest in the North (11.9 cm). The height gains are proof of the large increase in the biological standard of living that occurred in Germany over the course of the 20th century. However, even today, highly-educated individuals are still taller than their peers with less education (Figure 5.7).

---

[13] Height information is taken from the Royal Prussian Statistical Yearbook (1908).

[14] See Table A5.2 of the Appendix for how provinces of the German Empire relate to military districts/regions.

Figure 5.6: Height of German males in 1906, by region

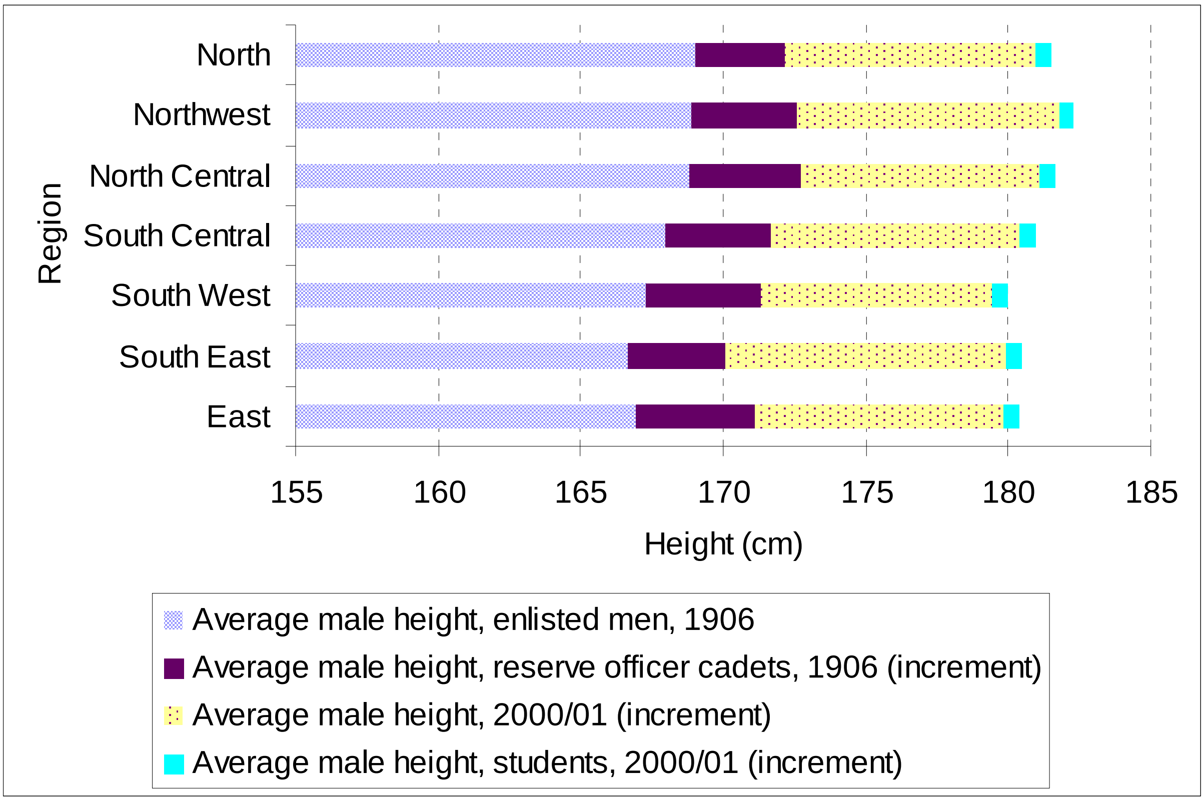


Note: A lower number indicates a greater average height. 1 = Großherzogtum Oldenburg, 2 = Provinz Schleswig-Holstein, 3 = Großherzogtum Mecklenburg-Strelitz, 4 = Freie und Hansestadt Bremen, 5 = Freie und Hansestadt Lübeck, 6 = Großherzogtum Mecklenburg-Schwerin, 7 = Provinz Westfalen, 8 = Provinz Hannover, 9 = Freie und Hansestadt Hamburg, 10 = Provinz Pommern, 11 = Fürstentum Waldeck, 12 = Herzogtum Braunschweig, 13 = Provinz Rheinland, 14 = Hohenzollern, 15 = Fürstentum Schaumburg-Lippe, 16 = Fürstentum Schwarzburg-Rudolstadt, 17 = Provinz Ostpreußen, 18 = Provinz Westpreußen, 19 = Stadtkreis Berlin, 20 = Fürstentum Lippe, 21 = Provinz Hessen-Nassau, 22 = Fürstentum Schwarzburg-Sondershausen, 23 = Großherzogtum Sachsen (Saxony)-Weimar, 24 = Reichsland Elsaß-Lothringen, 25 = Provinz Brandenburg, 26 = Großherzogtum Hessen, 27 = Provinz Posen, 28 = Großherzogtum Baden, 29 = Herzogtum Sachsen (Saxony)-Meiningen, 30 = Herzogtum Sachsen (Saxony) Coburg Gotha, 31 = Herzogtum Anhalt, 32 = Königreich Württemberg, 33 = Provinz Sachsen (Saxony), 34 = Fürstentum Reuß jüngere Linie, 35 = Pfalz, 36 = Fürstentum Reuß ältere Linie, 37 = Südbayern (Southern Bavaria), 38 = Nordbayern (Northern Bavaria), 39 = Herzogtum Sachsen-Altenburg, 40 = Provinz

Schlesien, 41 = Königreich Sachsen (Saxony).

Source: Royal Prussian Statistical Yearbook (1908).

Figure 5.7: Male height in Germany 1906 and 2000/2001, by social status and region

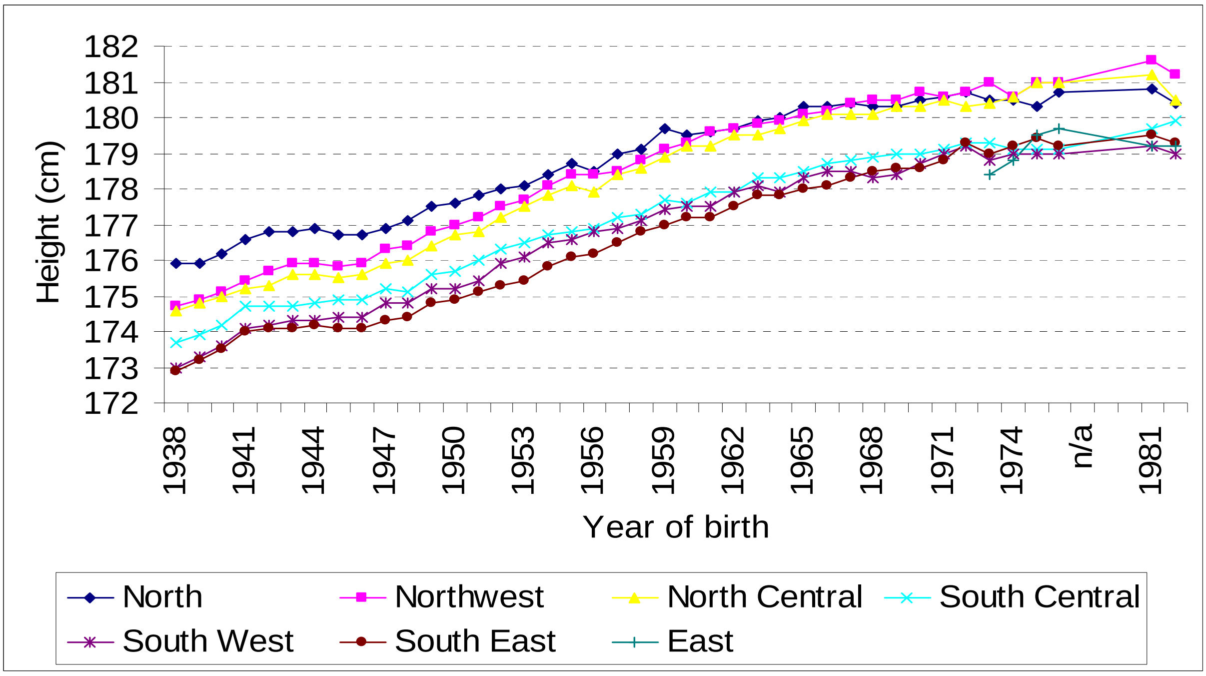


Source: Royal Prussian Statistical Yearbook (1908), Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

Official data from the German Ministry of Defense (Bundesministerium der Verteidigung 1997) also shows the general increase in heights with reference to German conscripts born between 1938 and 1976 and examined at age 19 (Figure 5.8). We supplement these data with information on the 1979-82 birth cohorts from above (Institut für Wehrmedizinalstatistik und Berichtswesen 2003). To foster comparison, we focus exclusively on recruits examined at age 19. This restricts our additional data to the birth cohorts of 1981 and 1982[15].

Of all recruits born 1938, those from the North were the tallest with a height of 176.0 cm. Until 1981, they gained an additional 4.5 cm to reach 180.5 cm. The gain was below the average of 5.9 cm and in particular below the height increase seen in the Northwest (+6.5 cm) and the South East (+6.4 cm). In 1938, the latter had the shortest male population. To test for convergence, the difference in height between the birth cohorts of 1982 and 1938 can be regressed on the height of the 1938 birth cohort (Komlos 2007, Baumol 1986, Barro 1991, Barro and Sala-i-Martin 1992, 1995). We find significant convergence (Figure 5.9, p=0.04, N=6), as great initial height is associated with a relative small subsequent increase in height, and vice versa. However, the result depends to a large extent on one region (the North).

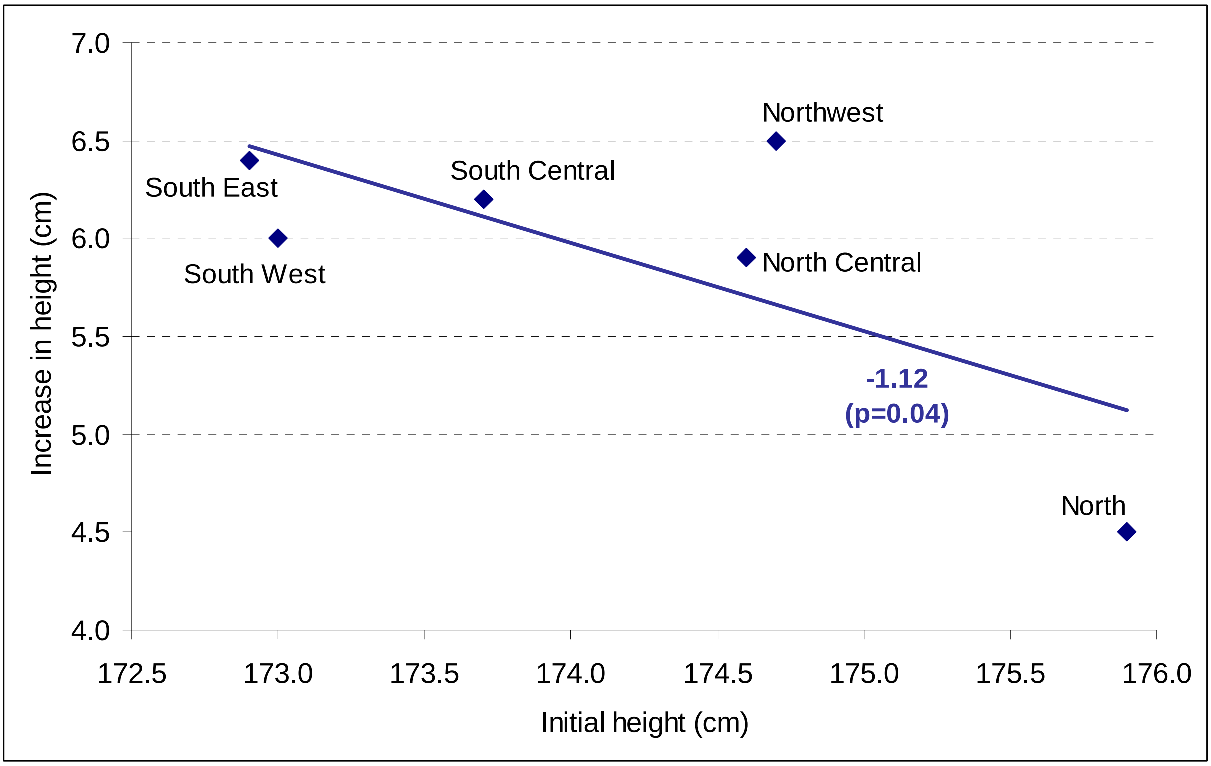
Figure 5.8: Male adult height in Germany, birth cohorts of 1938 to 1976 and of 1981/1982, by region



[15] Unlike the Bundesministerium der Verteidigung (1997) data, the additional data includes recruits who had to retake the examination. Potentially, this biases our estimates for the 1980/81 birth cohorts somewhat downwards.

Note: Information on the East has only become available after re-unification. At the same time, region North also expanded to include northern parts of the former GDR.
Source: Bundesministerium der Verteidigung (1997), Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

Figure 5.9: Average adult height (1938 birth cohort) and increase in average adult height (1938-1982 birth cohorts), by region

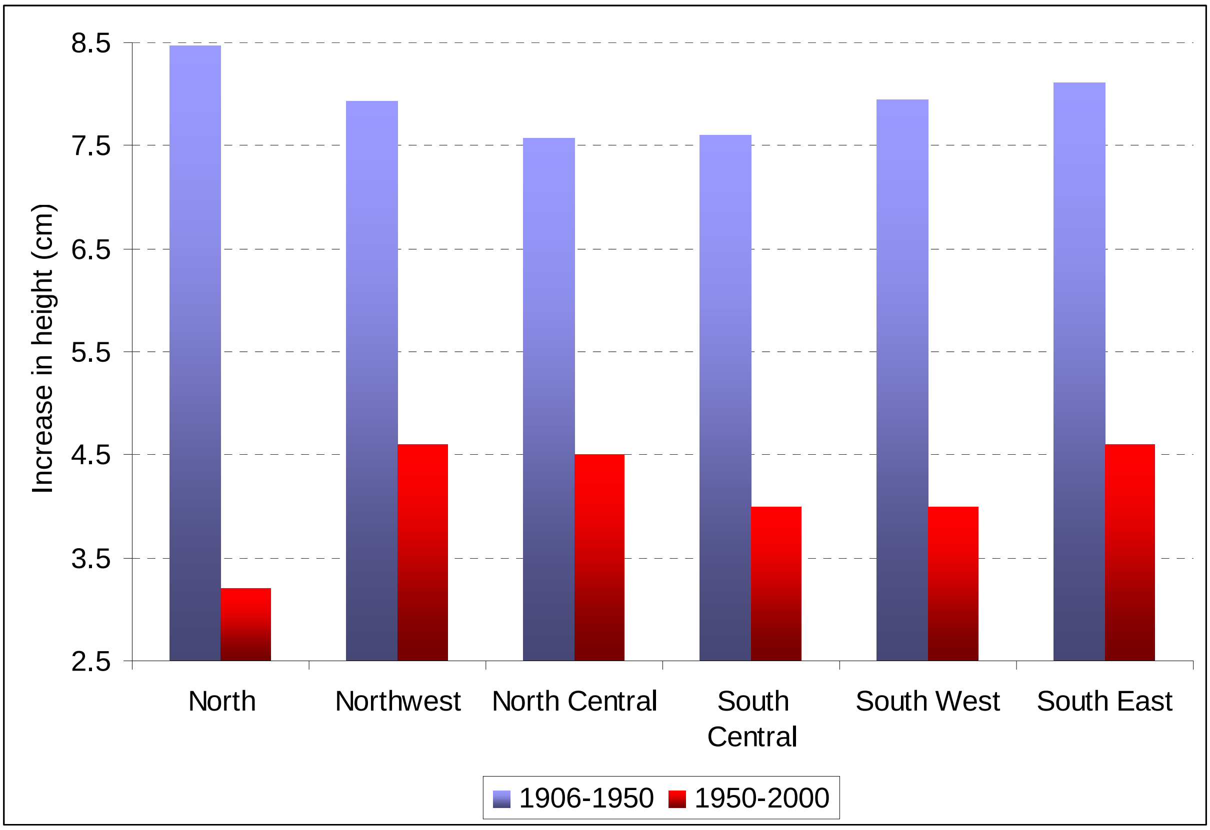


Note: Significance is evaluated using heteroscedasticity-robust Huber-White (1967, 1980) standard errors.
Source: Bundesministerium der Verteidigung (1997), Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

In 1950, average male adult height was 7.9 cm greater than in 1906 (Figure 5.10). The highest rates of increase occurred in the North (+8.5 cm); smaller increases took place in the South Central and North Central regions (about 7.6 cm in both cases). The high growth tempo of the first half of the century could not be sustained in the second half. In comparison to

1951, average male height was 4.2 cm greater in 2000. The largest increase was recorded in the South East (+4.6 cm), the smallest in the North (+3.2 cm).

Figure 5.10: Increase in height by region, 1906-1950 and 1951-2000

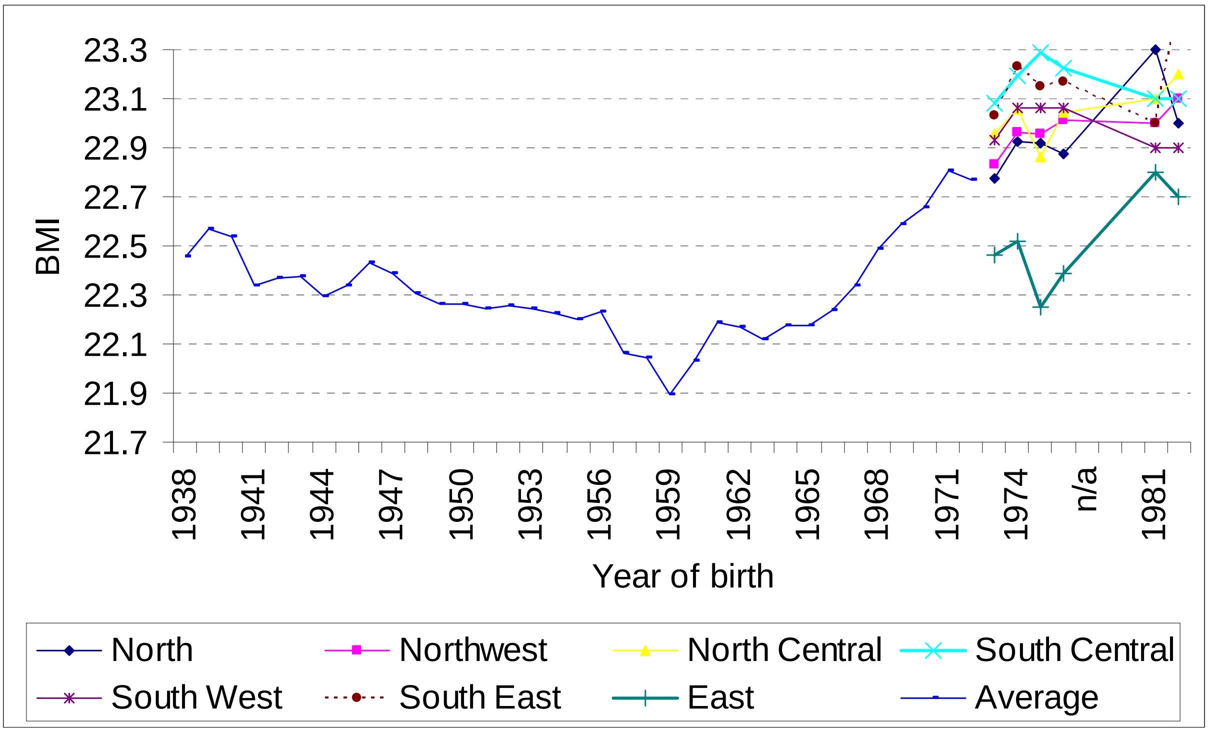


Note: Information on the East has only become available after re-unification. At the same time, region North also expanded to include northern parts of the former GDR.

Source: Royal Prussian Statistical Yearbook (1908), Bundesministerium der Verteidigung (1997), Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

At the level of regions, weight information in the Bundesministerium der Verteidigung (1997) data is available only beginning in 1973. Before that, we can only use a Germany-wide average, which shows that BMI tended to decline until the birth cohort of 1959 (Figure 5.11). BMI was 22.4 for males born 1938 and 21.9 for those born in 1959. A fast-food culture began to develop in Germany in the 1970s[16], possibly contributing to the general increase in BMI which began with the 1960 birth cohort. Recruits born 1973 in the East had a BMI of about 22.5, well below the 23.0 average for all other regions. For the 1981 East German birth cohorts, BMI then increased to 22.7. The change of 0.2 is relatively large when compared to the average for the other regions (+0.1). The South West even experienced a small decrease in the period under consideration (-0.02).

Figure 5.11: Male BMI in Germany, birth cohorts of 1938 to 1976 and of 1981/1982



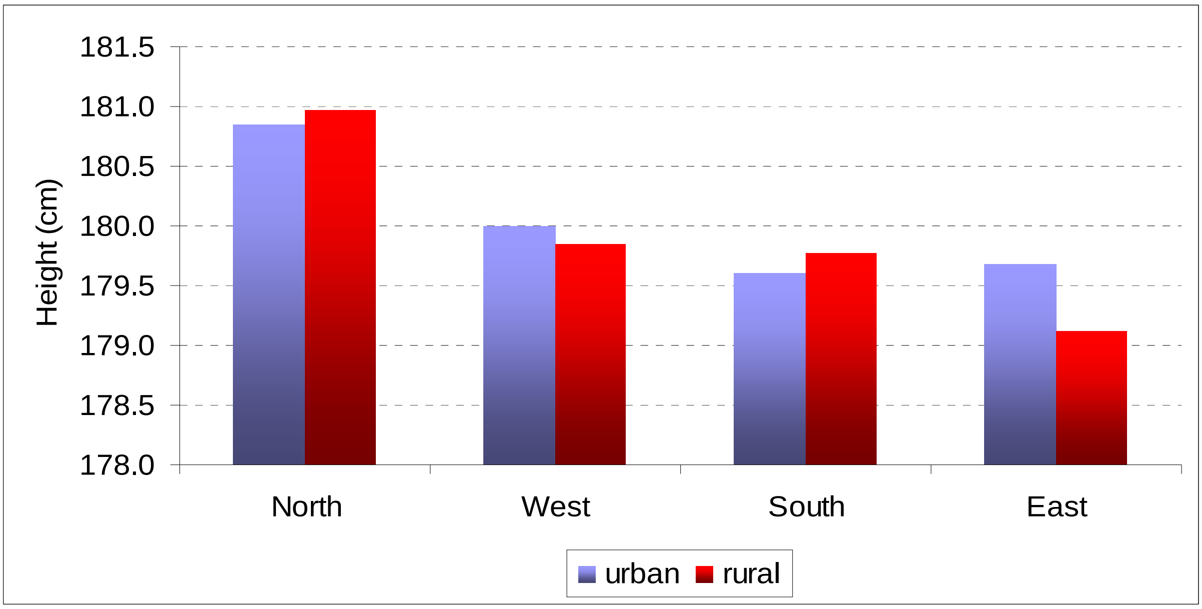
Source: Bundesministerium der Verteidigung (1997), Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

[16] The first McDonald's restaurant in Germany opened in Munich in December 1971.

Official (1997) data also enables us to compare, at the level of regions, average height and BMI by urbanization using selected areas[17]. While in the North and in the South, rural recruits are taller than town dwellers, it is reversed in the West and, in particular, in the East where recruits from Berlin are 0.5 cm taller than those from the surrounding countryside (Figure 5.12, panel a). Irrespective of region, town dwellers tend to have a lower BMI than recruits from rural areas (Figure 5.12, panel b). The difference is particularly pronounced for the North (0.7).

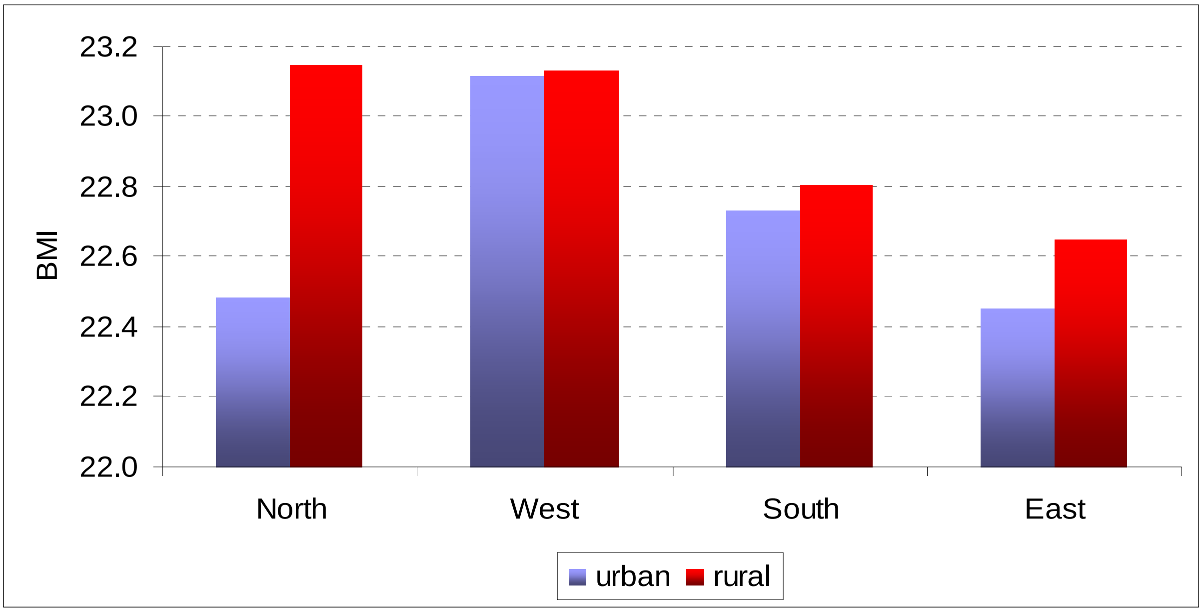
Figure 5.12: Height and BMI, 1973-76 birth cohorts, by urbanization (selected areas)

(a) Height



[17] Urban areas are the following cities: Hamburg (North), Düsseldorf (West), Munich (South), and Berlin (East). Rural areas are the following communities: Heide, Meppen, Nienburg (North), Jülich, Neuwied, St. Wendel (West), Lörrach, Traunstein, Weilheim (South), and Jena, Schwerin, Stendal (East).

(b) BMI



Note: See footnote 17 for definitions of "urban" and "rural".

Source: Bundesministerium der Verteidigung (1997).

5.6 Conclusion

We analyze the socio-economic variation in height and BMI using data on about 320,000 males who were examined in the years 2000 and 2001 for compulsory military or civilian service. Even after controlling for the influence of other variables, differences in height and weight by educational and health status remain inasmuch as better educated and healthier individuals tend to be taller and tend to have a lower BMI. For example, individuals with a high education were on average 0.60 cm taller and had a 0.31 points lower BMI than their peers with a middle education. Relative to individuals with a low education, the difference was 1.81 cm for height, and -0.37 units for BMI. Men found most healthy in the examination were on average taller than those classified as least healthy (+1.13 cm) and had a lower

BMI (-0.99 units). The regions with the greatest average height tend to be the ones with the highest equality, suggesting that anthropometric measures are sensitive to distributional effects. Regional differences imply that there is a North-South and a West-East gradient both in height and BMI in Germany. Individuals from the North are 1.6 cm taller than their peers from the South West and persons from North Central Germany reach a height 1.2 cm greater height than recruits from the East. The difference in BMI is 0.1 and 0.6 points, respectively. Data on the 1906 German Army shows that recruits then were about 12.5 cm shorter than their peers today. However, the North-South and West-East gradient in height existed already then, as did the height advantage for people of higher socioeconomic status.

5.7 References

Barro, R.J. (1991). “Economic Growth in a Cross Section of Countries.” Quarterly Journal of Economics 106: 407-43.

Barro, R.J. and Sala-i-Martin, X. (1992). “Convergence.” Journal of Political Economy 100: 223-51.

Barro, R.J. and Sala-i-Martin, X. (1995). “Economic growth.” McCraw Hill, New York.

Baten J. (2000). “Economic development and the distribution of nutritional resources in Bavaria 1797-1839.” Journal of Income Distribution 9: 89-106.

Baumol, W. (1986). “Productivity, convergence and welfare: what the long run data show.” The American Economic Review 76: 1072-85.

Berlinpolis (2006). “Wie sozial ist Deutschland? – Eine Studie an Hand von 27 Indikatoren.” Berlinpolis, Berlin.

Bogin, B. (1999). “Patterns of Human Growth.” 2nd edn, Cambridge University Press, Cambridge.

Bundesministerium der Verteidigung (1997). “Körpergröße bei Musterungsuntersuchung Wehrpflichtiger sowie bei Einstellungs- und Entlassungsuntersuchungen von Soldaten der Bundeswehr 1991 bis 1995 (Fünfjahresüberblick).” Beiträge zur Wehrmedizinalstatistik, Bundesministerium der Verteidigung In San I1.

D'Agostino, R. B., Balanger, A. and D'Agostino R. B., Jr. (1990). “A suggestion for using powerful and informative tests of normality.” American Statistician 44: 316-21.

Fogel, R.W. (1994). “Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy.” American Economic Review 84: 369-95.

Frey B. and Stutzer A. (2002). “What Can Economists Learn from Happiness Research?” Journal of Economic Literature, 40: 402-35.

Frie, E. (2004). “Das Deutsche Kaiserreich.” Wissenschaftliche Buchgesellschaft. Darmstadt.

Heineck, G. (2006). “Height and weight in Germany, Evidence from the German Socio-Economic Panel, 2002.” Economics and Human Biology 4: 359-82.

Huber, P. J. (1967). “The behavior of maximum likelihood estimates under nonstandard conditions.” Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability. Berkeley, CA: University of California Press, vol. 1: 221-23.

Komlos, J. (2007). “Anthropometric evidence on economic growth, biological well-being and regional convergence in the Habsburg Monarchy, c. 1850–1910.” Cliometrica 1: 211-37.

Komlos, J. and Baten, J. (1998). “The Biological Standard of Living in Comparative Perspective.” Stuttgart: Franz Steiner Verlag.

Komlos, J. and Baur, M. (2004). “From the Tallest to (One of) the Fattest: The Enigmatic Fate of the American Population in the 20th Century.” Economics and Human Biology 2: 57-74.

Komlos, J., Breitfelder, A. and Sunder M. (2008). “The Transition to Post-industrial BMI values among US children” American Journal of Human Biology, forthcoming.

Komlos, J. and Cuff, T. (1998). “Classics in Anthropometric History.” St. Katherinen: Scripta Mercaturae Verlag.

Komlos, J. and Kriwy, P. (2003). “The Biological Standard of Living in the Two Germanies.” German Economic Review 4: 493-507.

Komlos, J. and Lauderdale B.E. (2006). “Spatial Correlates of U.S. Heights and BMIs, 2002.” Journal of Biosocial Science 38: 209-19.

Mielck, A. (2000). “Soziale Ungleichheit und Gesundheit.“ Verlag Hans Huber, Bern Göttingen Toronto Seattle.

Osberg, L. and Sharpe A. (2002). “An Index of Economic Well-Being for Selected OECD Countries.” Review of Income and Wealth 48: 291-316.

Penman A.D. and Johnson, W.D. (2006). “The Changing Shape of the Body Mass Index Distribution Curve in the Population: Implications for Public Health Policy to Reduce the Prevalence of Adult Obesity.” Preventing Chronic Disease. Available from: URL: http://www.cdc.gov/pcd/issues/2006/jul/05_0232.htm.

Pradhan, M., Sahn, D.E. and Younger, S.D. (2001). “Decomposing world health inequality.” Unpublished Discussion Paper TI 2001-091/2. Tinbergen Institute, Amsterdam-Rotterdam.

Royal Prussian Statistical Yearbook (1908). “Ergänzungsheft XXVIII.” Edited by Dr. A. Blenck, Verlag des königlich preußischen statistischen Landesamtes: Berlin.

Royston, P. (1991). “sg3.5: Comment on sg3.4 and an improved D'Agostino test.” Stata Technical Bulletin 3:19. Reprinted in Stata Technical Bulletin Reprints 1: 110-12.

Sen, A. (1987). “The standard of living.” Cambridge; New York and Melbourne: Cambridge University Press.

Statistisches Bundesamt (2008). Lange Reihen Volkswirtschaftliche Gesamtrechnung http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Navigation/Statistiken/Zeitreihen/LangeReihen/

Steckel, R.H. (2008). “Biological Measures of the Standard of Living.” Journal of Economic Perspectives 22: 129-152.

Tanner, J. (1986). “Fetus into Man: Physical Growth from Conception to Maturity.” Cambridge, MA: Harvard University Press.

United Nations Development Programme (1996). “Human Development Report.” Oxford University Press, New York.

White, H. (1980). “A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity.” Econometrica 48: 817-30.

World Health Organization (1995). “Measuring Change in Nutritional Status: Guidelines for Assessing the Nutritional Impact of Supplementary Feeding Programmes for Vulnerable Groups.” WHO, Geneva.

5.8 Appendix

Table A5.1: Characteristics of the sample

Age			**Height**	
18	22.2%		Less than 170 cm	6.7%
19	41.1%		170 to 179.9 cm	42.6%
20	26.3%		180 to 189.9 cm	42.7%
21	8.9%		190 to 194.9 cm	5.9%
22	1.6%		195 cm and more	2.1%
Education			**BMI**	
Low ("Hauptschule")	32.6%		Less than 19	8.7%
Middle ("Realschule")	33.2%		19 to 24	59.0%
High ("Gymnasium")	34.2%		More than 24	32.3%
Year of birth			**Health/Fitness**	
1979	3.3%		T1	4.8%
1980	15.5%		T2	59.0%
1981	43.1%		T3 or T7	19.2%
1982	38.1%		T4 or T5	17.0%
Region			**Weight**	
North	7.5%		Less than 50 kg	0.5%
Northwest	12.0%		50 to 59 kg	8.1%
North Central	24.0%		60 to 69 kg	34.0%
South Central	10.7%		70 to 79 kg	28.3%
South West	14.5%		80 to 89 kg	14.2%
South East	12.8%		90 to 109 kg	9.4%
East	18.4%		110 kg and more	5.5%

Note: Number of observations is 320,000.

Source: Institut für Wehrmedizinalstatistik und Berichtswesen (2003).

Table A5.2: Provinces of the German Empire and today's states and regions

No.	Province	Today part of state/country	Region
1	Freie und Hansestadt Bremen	Bremen	Northwest
2	Freie und Hansestadt Hamburg	Hamburg	North
3	Freie und Hansestadt Lübeck	Schleswig-Holstein	North
4	Fürstentum Lippe	North Rhine-Westphalia	North Central
5	Fürstentum Reuß ältere Linie	Thuringia	East
6	Fürstentum Reuß jüngere Linie	Thuringia	East
7	Fürstentum Schaumburg-Lippe	Lower-Saxony	Northwest
8	Fürstentum Schwarzburg-Rudolstadt	Thuringia	East
9	Fürstentum Schwarzburg-Sondershausen	Thuringia	East
10	Fürstentum Waldeck	Hesse, Lower-Saxony	Northwest and South Central
11	Großherzogtum Mecklenburg-Strelitz	Mecklenburg-Western Pomerania	North
12	Großherzogtum Mecklenburg-Schwerin	Mecklenburg-Western Pomerania	North
13	Großherzogtum Oldenburg	Lower-Saxony, Saarland	Northwest and South Central
14	Großherzogtum Sachsen-Weimar	Thuringia	East
15	Großherzogtum Baden	Baden-Wuerttemberg	South West
16	Großherzogtum Hessen	Hesse	South Central
17	Herzogtum Anhalt	Saxony-Anhalt	East
18	Herzogtum Braunschweig	Lower-Saxony, Saxony-Anhalt	Northwest and East
19	Herzogtum Sachsen Coburg Gotha	Thuringia, Bavaria, Saarland	South Central, South East, and East
20	Herzogtum Sachsen-Altenburg	Thuringia	East

21	Herzogtum Sachsen-Meiningen	Thuringia	East
22	Hohenzollern	Baden-Wuerttemberg	South West
23	Königreich Sachsen	Saxony	East
24	Königreich Württemberg	Baden-Wuerttemberg	South West
25	Nordbayern	Bavaria	South East
26	Pfalz	Rhineland-Palatinate	South Central
27	Provinz Brandenburg	Brandenburg	East
28	Provinz Hannover	Lower-Saxony	Northwest
29	Provinz Hessen-Nassau	Hesse	South Central
30	Provinz Ostpreußen	Poland, Russia	n/a
31	Provinz Pommern	Mecklenburg-Western Pomera-nia, Poland	North
32	Provinz Posen	Poland	n/a
33	Provinz Rheinland	Rhineland-Palatinate	South Central
34	Provinz Sachsen	Saxony	East
35	Provinz Schlesien	Saxony, Poland, Czech Republic	East
36	Provinz Schleswig-Holstein	Schleswig-Holstein	North
37	Provinz Westfalen	North Rhine-Westphalia	North Central
38	Provinz Westpreußen	Poland	n/a
39	Reichsland Elsaß-Lothringen	France	n/a
40	Stadtkreis Berlin	Berlin	East
41	Südbayern	Bavaria	South East

Source: Based on Frie (2004). Former German colonies are excluded.

Eidesstattliche Versicherung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebenen Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

Datum:

Unterschrift:

Curriculum Vitae

October 2006 -	PhD student and research and teaching assistant, University of Munich, Germany
August 2007 - December 2007	Visiting PhD student, University of Cambridge, UK
October 2001 - June 2006	Diplom-Volkswirt, University of Munich, Germany
September 2003 - June 2004	Exchange student, University of Warwick, UK
September 1991 - May 2000	Abitur, Michaeligymnasium, Munich, Germany
10 March 1981	Born in Munich, Germany