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The effect of the economic transition on the body mass index of conscripts in Poland

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Abstract

The political and socio-economic transition initiated in Poland in the late 1980s is still continuing and has affected all social classes as well as all spheres of daily life of the people. The impact of this change on nutrition and health is examined here, by comparing the body mass index (BMI) of a 10% nationally representative sample of male conscripts aged 19 years (18.50–19.49), in 1986 ($n = 26{,}396$), 1995 ($n = 22{,}612$), and 2001 ($n = 26{,}178$). Mean BMI of young men did not change between 1986 and 1995, but then increased slightly from 22.0 to 22.3 between 1995 and 2001. There was also a significant and continuous increase in the variation of BMI in all social strata across the entire period 1986–2001. This effect is attributed to economic modernisation that has allowed increased diversity of life styles across occupational groups and between families. Sibship size was more important than socio-economic status in explaining variation in BMI after the political changes in 1990. The BMI-enhancing effect of small sibship size is attributed to nutritional intake, and to changes in food availability across the period under study.

JEL classification: I10; I31; P2

Keywords: Economic transition; BMI; Obesity; Poland

1. Introduction

The socio-economic transition initiated in Poland in the late 1980s is still continuing and has affected all social classes and all spheres of daily life of the people. This transition is a

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complex historical process, leading from the centrally planned economies of communism to a free market economy based on private property. It includes three simultaneous processes: liberalisation and stabilisation; institutional reform; and the microeconomic restructuring of existing productive capacity of the nation (Zienkowski, 1998; Keane and Prasad, 1999).

Until the end of the 1980s, the Polish economy stagnated, and was characterised by permanent shortages of consumption goods. The process of transformation began in 1989 with the introduction of a stabilisation program. The major effect of the first stage of transformation, until 1992, was the restructuring of industry. The second stage, the so-called "rebound from the bottom", between 1992 and 1997, witnessed a rapid increase in GDP (Keane and Prasad, 1999; Kaliński and Landau, 2003).

These changes have had an impact on human biology, including increased relative body mass, pushing the Polish population slightly towards increasing prevalence of obesity, similar to that observed in a number of Western societies (Rona, 1997; McLellan, 2002). The prevalence of obesity (proportion of persons with body mass index (BMI) exceeding 30.0) among Polish adults in Wroclaw has increased across the period 1986–1996 from 12.5 to 18.3% in males, but decreased slightly in females, from 21.4 to 19.3%. There was a dramatic increase in obesity among trade school educated groups, but only small or no obesity in college-educated groups of both sexes (Rogucka and Bielicki, 1999). Rogucka and Bielicki showed how social factors can play an important role as moderating agents in the onset of obesity in adults in the course of economic change. These rates of obesity are lower than for Spain, the USA, Finland, Germany and Russia, for females, and lower than rates of Finland, Germany and the USA for both males and females (Komlos et al., 2003).

The aim of this study is to examine the changes in distribution of BMI across the course of economic transition, and to estimate the relative effect of some social factors and their changes on BMI. Although the BMI is the most frequently used index of overall fatness in epidemiological studies, high values of this index can at least in part be attributed to muscle and bone mass (fat free mass), especially in young adults. For this reason, the right tail of the BMI distribution is considered in this study, since it is less affected by lean tissue.

2. Materials and methods

The present study explores three national surveys of Polish conscripts carried out during May and June of 1986, 1995 and 2001.[1] Each survey comprises a 10% representative national sample of all males aged 18.5–19.5 years at the time of examination. A total of 26,396 subjects in 1986, 22,612 subjects in 1995, and 26,178 subjects in 2001 were measured and interviewed during a medical examination at district recruiting boards throughout the country. All recruiting boards were asked to provide information on the 1st, and subsequently every 10th subject reporting for examination. The sampling method yielded a 10% random national sample representing all social strata and all regions of the country (Bielicki et al., 1992), because reporting for registration and examination at the exact specified date was compulsory for all 19-year-old males. In addition to taking height measurements at the

[1] The data are in possession of the Institute of Anthropology, Polish Academy of Science. Its collection was supported by State Committee for Scientific Research, Poland.

time of examination, each subject was asked about the socio-economic background of their families, including parental education, occupation, sibship size, and degree of urbanisation of their place of residence.

In the absence of reliable information on income, parental education and occupation are used as proxy measures of socio-economic status (SES). These variables were then included in principal component analysis (PCA) to obtain a common factor representing general SES. This was carried out separately for each survey, since there were differences in relationships between education and occupation across the surveys. This is referred to as the SES index. For each survey, the PCA produced one meaningful component (factor), which successfully extracted variance from 2.9 to 2.3 (eigenvalue), explaining 72.7–57.0% of the total variance of the four variables used. Loadings of four measures of socio-economic status, interpreted as the correlations between the component and the variables, varied from 0.89 to 0.66. Three categories of economic status were then defined (wealthy, middle-class, poor), on the basis of terciles of these factor scores, separately for each survey. This statistical procedure reduces the number of factors and allows all of them to be used in multiple analysis of variance.

Four-way, and tree-way analyses of variance was applied to estimate the net effect of all factors on BMI. BMI was the dependent variable and urbanisation (cities with more than 100,000 inhabitants, towns with between 100,000 and 10,000 habitants, and villages of less than 10,000 people), sibship size (one or two, three, four and more), general SES (wealthy, middle class, poor) and years of education were independent factors. Additionally, the analysis includes second order interactions between these factors and the cohort, which were used to examine changes in the effect intensity across cohorts for each analysed factor.

The prevalence of low and high BMI was calculated and defined for each cohort using the following classification: below 16 units, severe malnutrition; 16–18.5 units, mild and moderate malnutrition; between 18 and 25 units—normal; between 25 and 30 units, overweight; above 30 units, obesity (Ferro-Luzzi et al., 1992; Shetty and James, 1994).

3. Results

BMI increased between 1995 and 2001, however, its variance as well as its coefficient of variation started to increase earlier, i.e. between 1986 and 1995[2] (Table 1). This suggests that the process of increasing dispersion of the distribution of BMI took place during the process of economic transition. Table 2 shows the prevalence of severe malnutrition, malnutrition, normal range, overweight and obesity in the three successive surveys. The distribution of BMI became broader during the period considered, i.e. the fraction of the sample within the normal range decreased, and the extreme values of the BMI distribution increased, predominantly with the extension of the right tail of the distribution. That is to say, the share of both the malnourished and obese increased in the population.

The effect of each factor on BMI, and their interactions with year of study are presented in Table 3. All the factors analysed showed a significant impact on BMI, i.e. the independent effect exerted by each of the four factors had a highly significant F ratio (fifth column).

[2] Brown–Forsythe's test for homogeneity of variance: $F = 385.5$, $P < 0.001$.

Table 1
Means, standard deviations (S.D.), coefficients of variation (CV) and increment per decade[a] of BMI for three successive national samples of Polish conscripts

Cohort	N	Mean	S.D.	CV	Increment/decade
1986	26440	21.98	2.40	10.9	0.12
1995	26245	21.97	2.76	12.6	−0.01
2001	26528	22.26	3.09	13.9	0.48

Indeed the is a mistake in a last column in Table 1. The proper values are as follows: 0.12, −0.01, 0.45 (BMI units per decade). It was calculated as follows: (mean BMI in 2001 − mean BMI in 1995)/(2001 − 1995) × 0.01.

[a] An increment for 1986 year were calculated in relation to means for national sample of conscript surveyed in 1965, which is not included in this study.

Table 2
Distribution of BMI values among 19-year-old males across three national surveys in Poland

Ranges of BMI	Year of survey		
	1986	1995	2001
<16.0 (malnourished)	0.1	0.1	0.3
16.0–18.5 (moderately malnourished)	4.7	6.4	6.7
18.5–25.0 (normal)	85.6	81.6	78.8
25.0–30.0 (overweight)	8.8	10.2	11.9
> 30.0 (obese)	0.8	1.6	2.5

Table 3
Results of four-way analysis of variance: dependent variable is BMI

Factors	SS	d.f.	MS	F	P level
Urbanisation	802.76	2	401.38	52.91	0.00
Sibship size	1183.99	2	591.99	78.03	0.00
SES index	49.97	2	24.99	3.29	0.04
Year of study	887.86	2	443.93	58.52	0.00
Second order interaction with year of study					
Urbanisation	55.31	4	13.83	1.82	0.12
Sibship size	361.10	4	90.28	11.90	0.00
SES index	53.09	4	13.27	1.75	0.14

Note: SS, sum of squares presenting within-group variability; d.f., degree of freedom, MS, mean square representing between-group variability.

The mean square (MS), which presents between-group variability, can be seen as a measure of the degree of differences between groups (relative to the others factors considered), identified family size and year of study as the most powerful factors, while the SES index was of lesser importance.[3] Neither interactions of urbanisation nor the SES index with cohort were significant (Table 3). However, SES correlated negatively with the number of children in the household in all three years, so that is part of the reason why SES was

[3] The higher is MS, the greater is the difference between means—an indicator of the "power" of a particular factor.

Table 4
Results of three-way analysis of variance: dependent variable is BMI

Factors	SS	d.f.	MS	*F*	*P* level
Urbanisation	576.47	2	288.24	37.82	0.0000
SES index	268.88	2	134.44	17.64	0.0000
Year of study	1361.55	2	680.77	89.33	0.0000
Second order interaction with year of study					
Urbanisation	57.77	4	10.44	1.90	0.1082
SES index	98.60	4	24.65	3.23	0.0116

Note: SS, sum of squares presenting within-group variability; d.f., degree of freedom; MS, mean square representing between-group variability.

Table 5
Main effects of three-way analysis of variance applied separately for three cohorts: BMI is dependent variable

	SS	d.f.	MS	*F*	*P* level
1986					
Urbanisation	125.91	2	62.96	10.99	0.00
Sibship size	50.58	2	25.29	4.41	0.01
SES index	7.15	2	3.58	0.62	0.54
1995					
Urbanisation	484.33	2	242.17	31.92	0.00
Sibship size	887.19	2	443.60	58.47	0.00
SES index	14.28	2	7.14	0.94	0.39
2001					
Urbanisation	284.74	2	142.37	15.04	0.00
Sibship size	846.97	2	423.48	44.74	0.00
SES index	81.95	2	40.98	4.33	0.01

less important than expected.[4] The interaction between sibship size and cohort was highly significant, indicating that the influence of family size on BMI gained in importance across the period 1986–2001 (Table 3). The three-way analysis of variance with omitted family size was repeated similarly. In this model SES index was significant, although it had the smallest importance (the smallest value of MS), but significantly interacted with cohort (Table 4). These results indicate that due to interrelation between SES and family size, those two factors influenced the BMI of the young men similarly in all three cohorts. In the next step, the three-way analysis of variance carried out separately for the three cohorts supports this inference (Table 5). The net effect of sibship size raises its relative power, as determined by mean square, from being a less important factor than urbanisation (lower mean square value) in the 1986 survey, to becoming the most relevant variable (the highest mean square value) in both the 1995 and 2001 surveys. It appears that in the course of economic transition, family size becomes the most meaningful factor in explaining variation in BMI. The second order interaction effect between the year of study and sibship size on

[4] The correlation coefficients are: 2001: $r = -0.32$, 1995: $r = -0.35$, and 1986: $r = -0.38$.

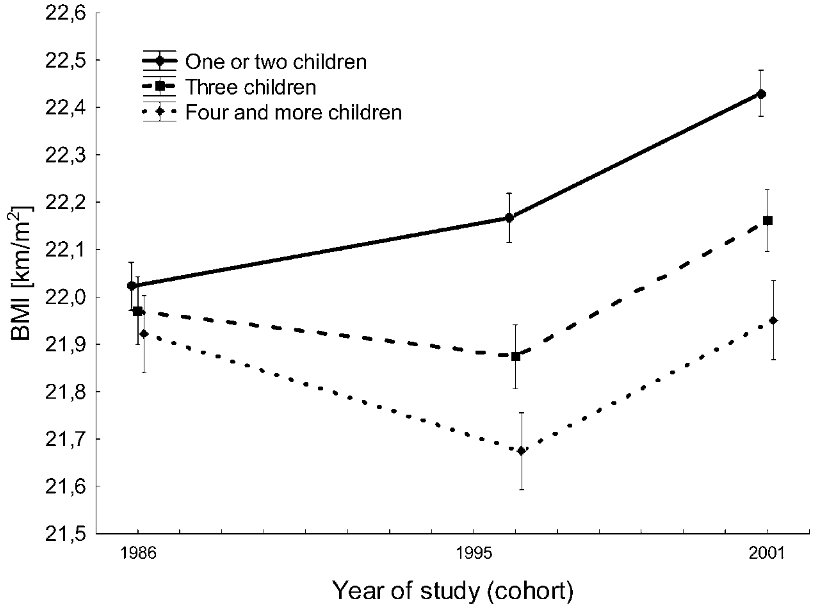

Fig. 1. Weighted means and standard errors presenting the second order interaction derived from analysis of variance between sibship size and cohort for BMI.

Fig. 2. Weighted means and standard errors presenting the second order interaction derived from analysis of variance between SES index and cohort for BMI.

Table 6
Weighted means and standard deviations of BMI for all categories of four factors: urbanisation, sibship size, SES index by the year of study

Factors	1986			1995			2001		
	N	Mean	S.D.	*N*	Mean	S.D.	*N*	Mean	S.D.
Urbanisation									
City	8061	21.98	2.53	6914	22.08	2.92	6854	22.35	3.14
Towns	7755	21.90	2.45	5971	21.82	2.78	9246	22.15	3.15
Villages	10580	22.04	2.24	9727	22.04	2.62	10078	22.28	2.99
Sibship size									
One or two	12496	22.01	2.50	12766	22.14	2.89	13293	22.43	3.22
Three	6439	21.98	2.36	6881	21.88	2.69	7267	22.17	2.99
Four or more	7461	21.94	2.23	5965	21.72	2.54	5618	21.96	2.83
SES index									
Wealthy	7136	21.97	2.50	9737	22.04	2.82	8900	22.34	3.11
Middle Class	6343	22.00	2.47	8777	21.94	2.78	8626	22.30	3.11
Poor	12917	21.98	2.30	7098	21.93	2.67	8652	22.12	3.02

the weight of conscripts derived from the four-way analysis of variance is given in Fig. 1. In the one or two child families, the relative weight increased slightly across the first two surveys, and more substantially thereafter, whereas in the other two family size groups the BMI decreased at first, especially in the group with four or more children, only to increase thereafter. The range of BMI values increased between 1986 and 1995 and then remained constant between the 1995 and 2001 surveys. A similar pattern appears in Fig. 2 presenting second-order interaction between SES index and cohort. This interaction reached a significant level only in three-way analysis of variance, if the sibship size was omitted. The weighted means for all SES groups showed the same pattern of changes between 1986 and 2001, but their magnitude is smaller.

Means and standard deviations for all factors enable us to gain some insight into the ways in which the factors affect BMI values (Table 6). The variance increases in all scores of each factor across the three survey years with a striking regularity. It indicates that the transformation process influences the whole population, independently of social status, urbanisation or family size. Moreover, BMI gradually decreases with shifting from category one or two children to four or more children across all cohorts, for sibship size only (Fig. 1). This supports the view that the strongest net effect on BMI is sibship size.

4. Discussion

Mean BMI of young adult males has increased during the period 1995 and 2001, but not between 1986 and 1995. The increase across the last 6 years period is about 0.45 units, representing a increment of 21.5% of the standard deviation in BMI. However, this is similar to the secular trend in weight gain among adults in practically all western industrialized nations including the UK, Denmark, the Netherlands, Portugal and the USA (Gulltford et al., 1994; Sorensen and Price, 1990; Seidel et al., 1995; Jacome de Castro et al., 1998;

Kuczmarski et al., 1994). The Polish trend may have started at about the same time as in these countries, with a significant prevalence of obesity being identified in the 1960s, increasing into the 1980s with higher levels of obesity among women than men, and among those with higher educational status than those with lower education levels (Rogucka and Bielicki, 1999). This latter trend is similar to that observed among populations in developing countries where obesity is emergent (World Health Organization, 2000; Osmani and Sen, 2003). The increase in mean BMI in the present analysis may be the effect of recent socio-economic changes in Poland, although the emergence of obesity took place under conditions of state socialism. The economic rebound from the lowest point of the economy after 1993 saw annual growth rates of Gross Domestic Product (GDP) of 6–7% in the 1995–1997 period. As a consequence, average real incomes increased across this period, although unevenly across occupational groups (Zienkowski, 2000). One reason for the increased BMI across this period may be that the quality and quantity of food consumed may have changed across social groups. Alternatively, there may have been social-group changes in levels of physical activity, or that fatter mothers may have predisposed their offspring to higher risk of obesity by way of physiological, behavioural and cultural factors.

Furthermore, the variance in the BMI values increased between 1986 and 2001 across all social strata. This was not caused by increases in the average values of BMI, and could reflect polarisation in Polish society, and more unequal income distribution after 1993 (Keane and Prasad, 1999). A similar change in BMI variance took place in the USA, across a period that saw increased income inequality (Flegal and Troiana, 2000; Piketty and Saez, 2003). It is possible that this trend in BMI variation in Poland is to some extent also an effect of modernisation initiated after World War II.

Another interesting pattern relates to the changes in prevalence of subjects in the five different categories of BMI used for assessing nutritional health. Between 1986 and the year 2001, there has been a decreasing proportion of subjects with BMI in the normal range of 18.5–25.0 and an increase in the proportion of subjects falling into the BMI categories of "malnourished" (from 4.8 to 6.9%), "overweight" (from 8.8 to 11.8%) and "obese" (from 0.8 to 2.4%). Thus, the variance of the BMI distribution increased, possibly in association with the recent socio-economic changes. Simultaneously with the rise of average real income, market forces increased income inequality (Zienkowski, 1998; Keane and Prasad, 1999). This process may have lead to increased between-family variation in the level of physical activity, the proportion of fat in the diet, the level of emotional stress, as well as smoking, all of which have an influence BMI (Bielicki et al., 2000).

This trend should be considered as unfavourable, inasmuch as obesity has obvious health consequences, as noted by McLellan (2002): "obesity is a first step, a gateway, to the rest of the chronic diseases". Obesity is accompanied by profound changes in physiological function and poses a risk for diabetes, hypertension, and cardiovascular disease (Kopelman, 2000), and is associated with increased death rates among cancer patients (Calle et al., 2003). "Sibship size" and "cohort" have the strongest, and SES index the weakest effect on BMI. Furthermore, throughout the period considered, the relative importance of sibship size for BMI was increasing, becoming the most important factor in the 1995 and 2001 surveys. This is best illustrated by the interaction of sibship size with cohort (Fig. 1). Differences in mean BMI between the three levels of sibship size increased between the three successive studies, especially between 1995 and 2001, where the population means increased, while the gradients remained the same. It seems likely that this BMI-enhancing effect of sibship size is mediated directly by nutrition, particularly by its changes across the period under study. It is plausible that the larger family was, the fewer nutrients were available *per capita*, in relation to both quantity and quality.

Along with the increasing importance of family size between the 1986 and 2001 cohorts, it is noteworthy that the SES index also increased its power and becomes a significant factor among the 2001 cohort. This could be at least in part due to decreasing correlation between family size and SES index from −0.38 in 1986 to −0.32 in 2001 (see endnote 4). In 1986 SES effect is partly mediated by sibship size, but in 2001 SES became a more independent and self-reliant factor. This notion is also justified by significant interaction between SES index and year of study, if family size is omitted (Table 4, Fig. 2).

The survey conducted in 1986 preceded a period of food rationing after economic collapse at the end of the 1970s, resulting in a more homogeneous diet, with limited access to protein-rich foods. In the 9 years between the first and second survey, Poland underwent an economic transition, which resulted in a dramatic improvement in food availability and diversity. At the same time the income of households became differentiated (Kaliński and Landau, 2003). Thus, large families could spend less money on food *per capita* in contrast to small families which, freer from economic constraints, could secure higher quantity and quality of food for their children, which would have had a direct impact on their BMI. The increase in mean BMI in one-or-two children families was balanced by a decrease in BMI in families with more than two children, keeping population mean BMI the same, but with greater between-family differences in BMI. This process may have continued in the period 1995–2001, accompanied by a rise in the population's mean BMI value, largely due to increased real salary levels.

Further scrutiny of Table 4 reveals that the factor "urbanisation" was systematically losing its importance for BMI in the period studied. It is difficult to determine whether this was due to diminishing socio-economic differences between cities, towns, and villages, or a statistical artefact caused by the greater influence of family size on BMI. It may be that children are becoming more expensive per capita, with reductions in state subsidies to children having taken place after 1990. Four-way ANOVA showed that the interaction between level of urbanisation and cohort was insignificant, suggesting that the impact of urbanisation on BMI did not change during the 15 years between 1986 and 2001. However, in 1986, 19-year-old males living in rural environments had the highest mean BMI, whereas the dwellers of small towns had the lowest mean value. This pattern changed in the subsequent two cohorts, when the gradient from highest to lowest mean BMI was ordered thus: cities, followed by village and town dwellers.

The BMI is a rough measure of obesity in that the relationship between BMI and body fat content varies according to body build and proportion (World Health Organization, 2000). It is commonly used because of its simplicity and its' high correlation with body fatness at the population level. From the biological point of view, BMI is highly sensitive to environmental fluctuations, and its response mirrors current nutritional status. This makes it an informative tool for the study of biological effects of social, economic and political change. Recent changes in Poland have resulted in shifts in BMI distributions similar to those already observed in western nations; it is plausible that future trends in BMI distribution will continue to mirror those patterns.

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