Przegląd Antropologiczny – Anthropological Review • Vol 62, pp. 41–47 (1999)

Urbanisation factor as a modifier of phenotypic development

Magdalena Kosińska, Maria D. Kaliszewska-Drozdowska

ABSTRACT The purpose of the research was to analyse the causes of the physical development differentiation of children (boys) coming from localities characterised by different degree of urbanisation. The material was collected over a span of ten years, from 1980 to 1990. It covered anthropometric measurements and data of an inquiry. The results confirmed the influence of the urbanisation variable. Urbanisation may be treated both as a socio-economic variable and as a life style variable. Cities create conditions for better development, which may be due to the fact that they are characterised by the stability of advantageous conditions.

Magdalena Kosińska, Maria D. Kaliszewska-Drozdowska, 1999; *Przegląd Antropologiczny – Anthropological Review*, vol. 62, Poznań 1999, pp. 41–47, figs 2, tables 5. ISBN 83-86969-44-X, ISSN 0033-2003

Getting to know the regularities of interactions between a population and its environment has become very important due to the great pace of the changes occurring in the human environment. Among all the environmental modifiers, which can affect phenotypic development, the degree of urbanisation of a child's place of residence is highly significant. The reasons for this variable influence are still undefined. They can be associated with socio-economic or perhaps even cultural (model of life) conditions. There is a noticeably strong gradation of developmental levels observed when looking at a range of environments from weakly urbanised areas to highly developed urban centres. This gradation reflects poor conditions for the development offered by Polish rural settlements.

The main aim of this work was to attempt to elucidate the reasons of the morphological differentiation of children (boys) coming from different urbanisation environments.

Materials and methods

The research was carried out in yearly intervals in successive cohorts of a homogenous, with regard to their calendar age, group of boys (N=4,098) over the span of ten years, from 1980 to 1990. The research material contained anthropometric measurements and data obtained as a result of an inquiry. These include the birth body length and mass and the body height and mass of nine-year-old children. The following variables were accepted as modifiers and determinants of the level of physical development: the

Institute of Anthropology
Adam Mickiewicz University
Fredry 10, 61-701 Poznań

degree of urbanisation of the place of living, the birth order, the number of children in the family, parental age at child's birth, parental education, parental body height and body mass and the year of examination. The above variables were classified in the following categories (Tab. 1):

Table 1. The percentage share of the distinguished categories of developmental variables

Developmental variable	Categories	Urbanisation categories City	Town	Village
Number of children in the family	1	16.24	9.17	4.62
	2	61.89	47.32	34.42
	3	15.19	27.22	30.52
	4	6.68	16.13	30.44
Birth order	1	54.94	42.74	37.69
	2	34.25	35.09	32.03
	3	6.81	13.69	15.22
	4	3.21	6.96	13.86
Father's age	1	1.04	2.37	4.06
	2	68.30	60.78	58.88
	3	30.65	36.85	37.05
Mother's age	1	4.85	5.20	7.97
	2	76.88	71.41	69.64
	3	18.27	23.39	22.39
Father's education	1	12.57	20.49	41.91
	2	39.03	44.11	41.51
	3	48.13	34.79	15.86
Mother's education	1	18.73	27.52	51.31
	2	25.67	27.29	26.45
	3	55.53	45.11	21.99

- Urbanisation: (1) city – including cities with population over 100,000 and capitals of the provinces (till 1998); (2) town, and (3) village;
- The birth order: (1) the first child, (2) the second child, (3) the third child, (4) the fourth child and succeeding;
- The number of children in the family: (1) one child, (2) two children, (3) three children, (4) four children and more;
- Parental education: (1) secondary and higher, (2) technical, (3) elementary;
- Parental age at the moment of child's birth: (1) up to 20, (2) from 21 to 30, (3) over 30;
- Categories of parental phenotypic traits were established on the basis of the normal distribution and standard deviations [(1) $x < 1SD$; (2) $-1SD \leq x \leq 1SD$; (3) $x > 1SD$]:

– Father's body height (1) less than 168 cm; (2) 168-180 cm; (3) more than 180 cm,
– Father's body mass (1) less than 68 kg; (2) 68-88 kg; (3) more than 88 kg,
– Mother's body height (1) less than 157 cm; (2) 157-167 cm; (3) more than 167 cm,
– Mother's body mass (1) less than 53 kg; (2) 53-73 kg; (3) more than 73 kg.

- With regard to the time factor (the year of the child's birth and the year of examination) 11 children's populations were distinguished: 80 – the population examined in 1980, composed of children born in 1971; ...; 90 – the population examined in 1990, composed of children born in 1981.

In order to analyse the causes of the physical development differentiation of children coming from the above described urbanisation categories the following methods were used: ANOVA, factor analysis, canonical correlation and the selection of the best normal population with respect to the mean value.

Results and discussion

The ANOVA confirmed the children's physical development differentiation with regard to the urbanisation variable (Tab. 2) [HULANICKA *et al.* 1990, BIELICKI *et al*. 1997, KOSIŃSKA 1998]. The differences were evident in body height and mass of 9-year-old children. The urbanisation category had no effect on the birth body length and birth body mass. These values are mainly subject to modifying operation of genetic (parental body height and body mass, $p<0.01$) and

Table 2. Differentiating influence of urbanisation category

Child's trait	F	p
birth body mass	0.543	0.581
birth body length	0.215	0.806
body height	6.201	0.002
body mass	20.542	0.000

paragenetic variables (birth order, parental age at the moment of the child's birth, $p<0.01$) [KALISZEWSKA-DROZDOWSKA 1980, 1996; KORNAFEL 1995]. This enables us to conclude that the examined children coming from different urbanisation categories commence their development at the same level. The influence of the modifier under study intensifies in the postnatal stage of ontogeny [BOGIN 1993, KOSIŃSKA 1998]. The results of the Lowest Significance Difference Test (LSD), being the extension of ANOVA, turned out to be particularly interesting. The test revealed differences in body height only between extreme urbanisation categories, i.e., city and village (Fig. 1). Taking into consideration these results as well as studies of other authors; it can be concluded that the great difference in socio-economic conditions between neighbouring urbanisation categories gradually decline [HULANICKA *et al.* 1990].

	City	Town	Village
City		–	♦
Town	●		–
Village	●	●	

Fig. 1. Results of the Lowest Significance Difference Test (LSD) for groups distinguished by the urbanisation category
♦ - significant differences in body height
● - significant differences in body mass
- non significant differences

There are many questions concerning the reasons of the occurrence of the differentiation among the urbanisation categories distinguished above. There is no precise definition of the notion of urbanisation modifier. What does this variable actually mean?

The results of factor analysis enable us to distinguish a group of variables including, besides urbanisation, variables such as parental education and number of children in the family (Tab. 3). Reducing the number of the common factors to two and making a projection of the studied variables on those factors' plane, we obtained a group of variables including parental age, the birth order and number of children in the family (Fig. 2). Factor analysis indicated also a specific character of the urbanisation variable's operation. The autonomous, specific character of this variable is understood as a lack of strong correlation with the set of other variables subjected to the analysis (multiple correlation coefficient is 0.245) or as a cross-correlation with non-defined developmental variables that were not included in the analysis.

The dependence of ontogeny on the modifiers under study was corroborated also by the values obtained as a result of the canonical correlation analysis (Tab. 4). The group of variables distinguished on the basis of this method comprised variables such as urbanisation, birth order and number of children in the family.

In the light of results obtained urbanisation factor may be treated as both a

Table 3. Matrix of loadings for 5 common factors

Feature	Common factors				
	1	2	3	4	5
year of examination	–0.015	0.134	0.022	**0.687**	0.046
urbanisation category	0.025	0.041	**–0.588**	0.416	0.093
birth order	**0.755**	–0.028	–0.315	0.203	0.079
number of children in the family	0.451	–0.047	**–0.499**	0.317	0.043
father's age	**0.900**	–0.036	–0.020	–0.086	0.016
mother's age	**0.910**	0.012	0.031	–0.077	0.000
father's education	–0.047	0.047	**0.818**	0.079	0.051
mother's education	–0.092	0.084	**0.812**	0.113	0.031
father's body height	–0.168	**0.669**	0.237	0.265	-0.042
mother's body height	–0.003	**0.580**	–0.029	0.010	0.100
father's body mass	0.038	**0.644**	0.065	0.238	-0.056
mother's body mass	0.283	**0.441**	–0.273	–0.117	0.237
birth body mass	0.113	0.024	0.024	–0.062	**0.841**
birth body length	–0.036	–0.009	–0.009	0.075	**0.873**
child's body height	–0.052	**0.658**	0.029	**–0.451**	0.173
child's body mass	–0.045	**0.596**	0.039	**–0.498**	0.172
% of explained variance	25.53	22.38	21.64	14.20	16.22

Table 4. Correlations among canonical variables (u_i) and independent variables

Developmental factor	u_1	u_2	u_3	u_4
year of examination	-0.157	-0.023	-0.120	-0.570
urbanisation category	-0.128	0.029	**-0.559**	-0.419
number of children in the family	-0.252	0.317	**-0.527**	0.018
birth order	-0.125	**0.593**	**-0.624**	0.263
father's age	0.130	0.443	-0.269	0.439
mother's age	0.098	0.396	-0.208	**0.620**
father's education	0.163	0.005	0.155	0.048
mother's education	0.191	-0.146	0.224	-0.064
father's body height	**0.615**	-0.459	-0.159	-0.132
mother's body height	**0.485**	0.155	0.306	-0.167
father's body mass	**0.661**	-0.214	-0.305	0.047
mother's body mass	**0.625**	**0.602**	-0.100	-0.237

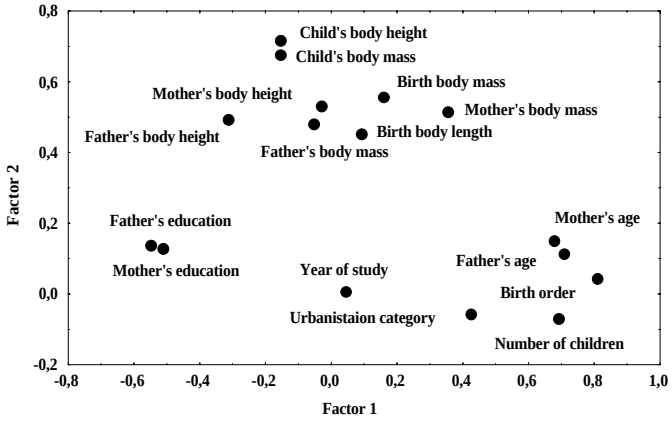

Fig. 2. Projection of features in the two common factors' plane

socio-economic variable correlated with the number of children in family and the level of parental education, and as a life style variable correlated with the adopted family model. Including the modifier and the variable defining the number of children in the family in the same complex may suggest that the developmental level differentiation as an effect of the urbanisation variable results primarily from the size of the family related to the prevailing family model, different in villages and in cities (Tab. 1).

The mode of operation of the factors modifying ontogenetic development is undoubtedly complex, and the variables under study do not constitute separate discriminants of development [KOSIŃSKA 1998, KACZMAREK 1995, BOGIN 1993, WOLAŃSKI 1991, ŻEKOŃSKI & WOLAŃSKI 1987]. When trying to find the reasons of interindividual variability one should take into account the interdependencies and cross-correlations among the variables under investigation. The developmental factors under study permeate one another and are complementary to one another. The multifactoral character of their influence makes it very difficult to evaluate the individual contribution of particular variables. One should also remember about the possible changes in time (in the successive years of the study) in the intensity of particular variables, and thus about the possibility of changes in their mutual interrelations.

The analyses performed indicate both socio-economic and cultural (related to the life style) character of the urbanisation factor. It is made up of a number of variables such as the number of children in the family, birth order, parental education and parental age. However, the total phenotypic variance, evaluated on the basis of the degree of urbanisation, is not fully elucidated by those variables. It is difficult to describe the phenomenon of this modifier's operation univocally. It appears that worse, from the point of view of developmental needs, conditions of life in rural areas can be only in part explained by the lower level of parental education and a high number of children in the family [BIELICKI *et al*. 1997]. The result of the selection of the best normal population with respect to the mean value [CIEŚLIK & SITEK 1993] proved that in cities most of the studied cohorts reached the highest values of morphological traits (Tab. 5), whereas in small towns and in villages the best conditions conducive to reaching the highest indicators of development were selected only in a small number of cases. The conclusion is that large cities create better conditions for development, which may be attributed due to the fact they offer the stability of advantageous conditions. Better access to jobs, sanitation, access to medical care and social and health awareness influence the developmental level of city populations. It is probably this fact that is re-

Table 5. Selection of the best normal populations with respect to the mean value from groups representing successive years of the study

Examined population	Birth body mass	Child's body height	Child's body mass
City	–	80; 81; 82; 83; 84; 88; 89	80; 81; 82; 84; 87; 89
Town	–	80; 83	80; 83; 87
Village	–	80	80; 81; 83; 87; 88; 89; 90

sponsible for the specific character of the urbanisation factor's operation. These modifiers are hidden partly in variables representing the family model or parental education level. However, their influence is still to be precisely defined, and it requires further thorough analysis.

References

BIELICKI T., A. SZKLARSKA, Z. WELON, C. BRAJCZEWSKI, 1997, *Nierówności społeczne w Polsce: antropologiczne badania poborowych w trzydziestoleciu 1965-1995*, Monografie Zakładu Antropologii PAN, **16**, Wrocław

BOGIN B., 1993, *Patterns of human growth*, Cambridge studies in biological anthropology, 3, Cambridge University Press

CIEŚLIK J., M. SITEK, 1993, *Selection of the best normal populations with respect to the mean value*, Variability and Evolution, **2/3**, 25-37

HULANICKA B., C. BRAJCZEWSKI, W. JEDLIŃSKA, T. SŁAWIŃSKA, A. WALISZKO, 1990, *City – Town – Village. Growth of Children in Poland in 1988*, Monographs of the Institute of Anthropology of the Polish Academy of Sciences, **7**, Wrocław

KACZMAREK M., 1995, *Wpływ warunków życia na wzrastanie i rozwój człowieka*, Seria Antropologia, **20**, Wyd. Naukowe UAM, Poznań

KALISZEWSKA-DROZDOWSKA M.D., 1980, *Stan biologiczny i akceleracja rozwoju noworodków*, Seria Antropologia, **9**, Wyd. UAM, Poznań

KALISZEWSKA-DROZDOWSKA M.D., 1996, *Influence of mother's age and child's birth order on birth body mass*, Variability and Evolution, **5**, 43-48

KORNAFEL D., 1995, *Czynniki determinujące urodzeniową masę ciała człowieka*, Acta Universitatis Vratislaviensis, 1712, Wyd. Uniwersytetu Wrocławskiego, Wrocław

KOSIŃSKA M., 1998, *Analiza synchroniczna i diachroniczna poziomu rozwoju cech ilościowych w ontogenezie*, Monografie Instytutu Antropologii UAM, **3**, Poznań

WOLAŃSKI N., 1991, *Ekologia człowieka – człowiek i jego kultura jako dynamiczna część ekosystemów*, Kosmos, **40**, 165-185

ŻEKOŃSKI Z., N. WOLAŃSKI, 1987, *Warunki społeczno – bytowe jako czynniki rozwoju człowieka*, [in:] *Czynniki rozwoju człowieka*, N. Wolański (ed.), PWN, Warszawa, 455-552

Streszczenie

Wśród czynników środowiskowych modyfikujących rozwój fenotypowy na szczególną uwagę zasługuje stopień zurbanizowania miejsca zamieszkania badanych dzieci. Różnice w rozwoju dzieci w miarę przechodzenia z ośrodków o niskim stopniu zurbanizowania do ośrodków wielkomiejskich świadczą o niekorzystnych warunkach jakie dla rozwoju stwarza polska wieś. Głównym celem pracy jest próba wyjaśnienia przyczyn tego zróżnicowania. Materiał badawczy zebrano w latach 1980-90 w kolejnych kohortach dzieci 9-letnich. Obejmuje on wyniki bezpośrednich pomiarów antropometrycznych: wysokości i masy ciała dziecka oraz dane ankietowe 4098 chłopców. Analizując przyczyny zróżnicowania poziomu rozwoju fizycznego dzieci z różnych środowisk urbanizacyjnych zastosowano metody jedno- i wielocechowe: analizę wariancji, analizę czynnikową, korelację kanoniczną oraz wybór najlepszych ze względu na średnią, populacji normalnych.

Przeprowadzona analiza potwierdziła zróżnicowanie poziomu wysokości i masy ciała 9-letnich chłopców ze względu na stopień zurbanizowania miejsca zamieszkania. Urbanizacja nie ma natomiast wpływu na długość i masę ciała w momencie urodzenia. Fakt ten pozwala wnioskować o wyrównanym poziomie startu dzieci z różnych środowisk urbanizacyjnych i nasilaniu się wpływu badanego modyfikatora w okresie życia postnatalnego. Na podstawie przeprowadzenia testu najmniejszych istotnych różnic można wnioskować o zanikaniu silnej gradacji warunków społeczno-ekonomicznych między sąsiadującymi ze sobą środowiskami urbanizacyjnymi. Analiza czynnikowa pozwoliła na utworzenie grupy zmiennych obejmującej urbanizację, wykształcenie rodziców oraz liczbę dzieci w rodzinie. Redukując liczbę czynników wspólnych do dwóch otrzymano grupę zmiennych obejmującą wiek rodziców, kolejność urodzenia oraz liczbę dzieci w rodzinie. Analiza czynnikowa wykazała również pewną specyfikę działania czynnika urbanizacyjnego, która rozumiana jest jako brak silnych korelacji ze zbiorem pozostałych zmiennych ujętych w analizie lub też jako współzależność ze zmiennymi niezdefiniowanymi, nie ujętymi w opracowaniu. Grupa zmiennych wydzielona na podstawie zastosowania analizy korelacji kanonicznej obejmowała urbanizację, kolejność urodzenia oraz liczbę dzieci w rodzinie. Umieszczenie w jednym kompleksie rozpatrywanego modyfikatora oraz zmiennej

określającej liczbę dzieci w rodzinie może sugerować, że zróżnicowanie urbanizacyjne poziomu rozwoju jest przede wszystkim wynikiem dzietności wynikającej z modelu rodziny, innego na wsi i w mieście.

Charakter działania modyfikatorów i determinatorów rozwoju ontogenetycznego jest kompleksowy. W skład czynnika urbanizacyjnego wchodzą takie zmienne jak liczba dzieci w rodzinie, kolejność urodzenia, wykształcenie rodziców, czy też wiek rodziców w momencie urodzenia badanego dziecka. Całkowita wariancja fenotypowa, obserwowana ze względu na wielkość ośrodka urbanizacyjnego, nie jest jednak w pełni wyjaśniana tymi zmiennymi. W wyniku wyboru najlepszej ze względu na średnią populacji normalnej stwierdzono, że w dużych miastach większość badanych kohort osiągała najwyższe wartości cech morfologicznych. Natomiast w małych miastach i na wsi najkorzystniejsze warunki rozwoju stwarzające możliwość osiągania najwyższych wskaźników rozwoju wybrano w pojedynczych przypadkach. Duże miasto stwarza więc możliwości lepszego rozwoju być może poprzez fakt stabilności warunków korzystnych.