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Sociogeographic variation of physical fitness of 12-19 year old Belgian boys

by

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1. Introduction

Ever since the Belgian astronomer and mathematician Lambert Adolphe Jacques Quetelet (1796-1874), who has been qualified as the father of 'kin-anthropometry' (Ross et al. 1980), pointed at the significant differences in physical growth between urban and rural populations, several contributions have been made on this topic. Rural-urban differences in motor fitness have received much less attention from researchers, and the reported observations are sometimes confusing. Different sports participation patterns between city and country dwellers are, on the other hand, a constant finding in sport and leisure surveys.

In this study, the somatic growth, motor fitness and sports participation of three groups of boys from different sociogeographic origins of Belgium are contrasted. The subjects are a representative sample of 12 through 19 year old boys who had been tested within the context of the Leuven Growth Study of Belgian Boys (Ostyn et al. 1980). The boys were subdivided by chronological age and classified according to their dwelling area as rural, semi-urban and urban. In view of the complex sociological and ecological differences between rural, semi-urban and urban settings, the effect of parental educational level, socioprofessional status and family size, on the physical fitness of boys from the three sociogeographic areas was also studied.

2. Review of literature

In his 1869 publication Quetelet (1869, p. 33) reported findings on the physique of the inhabitants of Brussels on the one hand and the surrounding province of Brabant on the other. These demonstrated that at the age of 19 the city-dwellers were 2 to 3 cm taller than the countrymen. Around the turn of the century, the

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French researcher De Lapouge (1909, p. 186-201) cited in his so called 'anthroposociological laws' that the dolichocephalous type was predominant in the cities, whereas the brachycephalous type was characteristic for the rural population. Data from Stettner (1921) pointed towards a retarded skeletal maturation process among rural children when compared with children from urban areas. Divergent findings were reported by Martin (1949), who among the 1939 British conscripts found a gradual decrease in body height and general fitness in function of the degree of urbanisation of the dwelling area. Boyne, Aitken and Leitch (1957) obtained similar results, showing that the body height and weight of primary school boys from rural areas were higher than those of city boys. All together, the above mentioned British observations occupy an isolated position. In contrast with the foregoing findings, Schwidetzky (1950, p. 161-181) has summarized the physique of the city-dweller as being distinctive from the countryman through a smaller head, a taller stature and a more slender body build.

Japanese observations by Katsuki (1966), Takahashi (1966) and Ishiko (1967), all showed higher means for height and weight – but not in chest circumference – among boys from the Tokyo metropolis when compared with boys from remote rural districts. In a very small sample (N = 31) of Japanese boys between 6 and 15 years from remote mountain areas, Ishiko (1967) found no significant differences in grip strength, back strength and 50 m run in comparison with the Tokyo norms. But, whereas the city boys performed better in the standing broad jump, the rural boys had a superior vital capacity.

In the German Democratic Republic, Buchmann (1966) observed better results for running, jumping, agility and general motor ability in favour of the city boys, who were compared with rural counterparts. Seliger (1970) in his physical fitness comparisons of 12 and 15 year old Czechoslovakian boys and girls from rural and urban areas, found no significant differences neither in motor tests (50 m run, chinning, broad jump, 2' sit ups, 1000 m run-boys, 800 m run-girls, 4×10 m shuttle run, 2 kg ball throw) nor in heart frequency and oxygen consumption during submaximal tests.

On the other hand, Parizkova and Berdychova have indicated in repeated publications (Parizkova & Berdychova 1977 ; Parizkova 1978, 1979) significant differences in somatic and motor development of Czechoslovakian pre-school boys and girls from different ecological situations. Both boys and girls from the capital displayed higher values of height, weight and chest circumference than their counterparts from small rural communities. Boys from the capital were characterized by a more linear constitution. In spite of better results in sensomotor tests (Limb and body control test according to Keogh 1968), children from the capital had a significantly poorer performance in 20 m dash and boys also in cricket ball throw, but no significant differences were observed for broad jump. Broekhoff (1978), who contrasted the physical fitness of a group of inner city elementary school children with those of suburban boys and girls from the Toledo

Growth Study, found no significant differences in standing height, body weight and grip strength, but the inner city children – especially the girls – had higher skinfolds at the iliac crest. These inner city children lagged behind their suburban counterparts in the Rogers P. F. Index, the standing broad jump, the dodge run and the softball throw. Broekhoff called upon some of the specific environmental differences between inner city and suburban populations in the U.S.A. to explain these differences.

In the Canadian Trois-Rivières Regional Study, Rajic and colleagues (1978) found that among 6 to 12 year old children, the urban children were taller at the age of 6 to 8 than those from a rural-industrial region, the weight differences were, however, small and only significant at the age of 6. With respect to oxygen consumption, the rural boys showed a higher VO^2/kg between the ages of 5 and 12 (JEQUIER et al. 1979). Several previously made partial observations about rural-urban differences within the context of the Leuven Growth Study of Belgian Boys (RENSON et al. 1973, 1975, 1978, 1979, 1980) will not be discussed here in detail because they will be extensively treated in this paper over the full 12 to 19 year age range.

3. PROCEDURES

Subjects and variables measured.

The Leuven Growth Study of Belgian Boys comprises a mixed longitudinal sample of approximately 21.000 subjects, representative of the Belgian secondary school population. They were tested at 1-year intervalls over a period of 6 years, starting with grade 7 in 1969 ending with grade 12 in 1974. The evaluation of the dependent variable, physical fitness, consisted of 1) 18 anthropometric dimensions, skeletal age (TWI, TANNER et al. 1962) and somatotype (SHELDON et al. 1970) ; 2) eight motor ability tests and a 1 min. step test on a 40 cm bench (OSTYN et al. 1980) and 3) a survey of the sports participation of the subjects (RENSON 1973). By means of a questionnaire and a controlled personal interview, the necessary information was obtained from the subjects for operationalizing the independent social variables, including the sociogeographic background of the boys. The sociogeographic origin was evaluated by means of a 9-point scale, ranking all Belgian communities according to their degree of urbanisation (DE BLOCK et al. 1967). For this study, the nine urbanisation categories were reduced to three : rural areas, semi-urban and urban (table 1 and table 2).

Statistical analysis.

After previously studying the interrelationships between the dependent somatic, motor and sports behavioral variables on the one hand, the sociogeographic constellation of the independent social variables were analysed (RENSON 1973).

Stepwise multiple correlations showed for instance that the degree of urbanisation (URB) was fairly independent of the other social variables (table 3). Only 14% of its variance could be explained by combining other social variables such as the educational level of the father (ELF), the family size (FAS), the sports participation of the mother (SPMO), etc. The educational level of the father (ELF), on the other hand, showed strong relationships with the other social variables (not less than 72% of its variance could be explained).

TABLE 1. – Degree of urbanisation of the dwelling area

URB	
1. Agrarian communities 2. Mixed rural communities 3. Small rural towns	I Rural area
4. Country towns 5. Small industrial centres 6. Small towns	II Semi-urban area
7. Towns 8. Regional centres 9. Urban agglomerations	III Urban area

TABLE 2. – Number of boys from rural, semi-urban and urban dwelling areas per age group

Sociogeographic area \ Age	12	13	14	15	16	17	18	19
– Rural	68	254	372	412	368	306	175	73
– Semi-urban	176	738	924	1006	1023	843	560	210
– Urban	237	884	1100	1158	1027	888	636	279
Total	481	1876	2396	2576	2418	2037	1371	562

For each age group, means and standard deviations were computed for the physical fitness variables to permit comparisons between the three sociogeographic groups. One way analyses of variance and Duncan Multiple Range tests were used to test the significance of the differences between the three groups. In order to test the possible interaction effect between the degree of urbanisation (URB) and educational level of the boys' father (ELF), two way analyses of variance were calculated. Furthermore, growth curves were plotted to compare the sociogeographic differentiation patterns of the physical fitness variables in a developmental perspective over an eight year period.

TABLE 3. – Interrelationship between the degree of urbanisation and the other sociocultural variables of 13 year old boys (N = 2.131)

Stepwise multiple correlations : variables selected	R^2 % explained	% additional
Degree of urbanisation		
URB . ELF (Educat. level father)	.063	
URB . ELF, FAS (Family size)	.107	+ 4.3
URB . ELF, FAS, SPMO (Sport mother)	.125	+ 1.8
URB . ELF, FAS, SPMO, SPFA (Sport father)	.130	+ 0.5
URB . ELF, FAS, SPMO, SPFA, ELM (Educat. level mother)	.135	+ 0.5
URB . ELF, FAS, SPMO, SPFA, ELM, SOF (Socio-prof. status father)	.140	+ 0.5
	14%	
Educat. level of the father		
ELF . SOF (Socioprof. status father)	.638	
ELF . SOF, ELM (Educat. level mother)	.710	+ 7.2
ELF . SOF, ELM, SPFA (Sport father)	.718	+ 0.8
ELF . SOF, ELM, SPFA, URB (Degree urbanisation)	.722	+ 0.4
	72%	

Finally, in order to ascertain which social and physical fitness variables contribute most to the differentiation of the three sociogeographic groups, discriminant analyses (Wilks' method) were used. For selecting the discriminating variables, the rejection level was set at 0.05.

4. RESULTS

Analyses of variance of the anthropometric data.

Results of the one and two way analyses of variance of the 18 anthropometric dimensions are shown in Table 4. It should be mentioned initially that significant differences in skeletal maturity between the three groups occur only in the 13 and 17 year old chronological age groups. These differences, though minimal, indicate a tendency for the boys from more urban areas to be slightly more mature skeletally than those from the more rural areas.

Differences in body weight among the three groups are significant only at 12, 13 and 15 years of age. Standing height, sitting height and reaching height, on the other hand, show significant differences between the three sociogeographic groups at all age levels. Growth curves of height and weight (figures 1 and 2) show that urban boys are taller than their semi-urban peers, who in their turn are taller than rural boys. This greater height of the urban boys is accompanied by greater body weight and biacromial width in only some of the younger age groups. A more linear body build thus seems to be a characteristic feature of the adolescent urban

youngsters compared to their rural counterparts. The significant differences in bicondylar diameter of the humerus at 14, 16 and 17 years of age suggest a somewhat greater bone width among the rural youngsters.

TABLE 4. – Results of analyses of variance of anthropometric data of 12 to 19 year old boys relative to the degree of urbanisation

Variables \ Age	12	13	14	15	16	17	18	19
Weight	*	*	–	*	–	–	–	–
Standing height	*	**	**	**	**	**	*	*
Sitting height	–	**	**	**	**	**	*	**
Reaching height	*	**	**	**	**	**	**	**
Biacrom. diameter	–	**	–	**	–	–	–	–
Chest width	–	–	–	–	–	–	–	–
Bicond. humer. diam.	–	–	**	–	*	**	–	–
Bicond. femur diam.	–	–	–	–	–	–	–	–
Chest circumf. insp.	–	–	–	–	–	–	–>	–
Chest circumf. exp.	–	–	–	–	–	–	–>	–
Thigh circumf.	–	*	–>	–	–	–	*	–
Calf circumf.	*	**	–	–	–	*	–	–
Upper arm circumf.	**	**	–	–	–	–	–>	–
Supra-iliac skinfold	**	**	**	**	–	–	–>	–>
Subscapul.skinfold	**	**	–	–	–	–	*	–
Triceps skinfold	**	**	–	–>	–	–	–>	–
Sum of 3 skinfolds	**	**	*	–	–	–	–>	–
Calf skinfold	**	**	*	–	–>	–>	–>	–

* F significant at .05 level.
** F significant at .01 level.
> significant two-way interaction with the educational level of the father at .05 level.
> at .01 level.

The preceding anthropometric comparisons are consistent with the somatotype ratings. Although somatotypes were available only for the 12 to 14 year old boys, the means show significantly higher ectomorphic and lower mesomorphic components in the urban boys compared to the rural boys. The endomorphic component does not differ significantly between the three sociogeographic groups.

Thicker skinfolds especially over the iliac crest, are characteristic of the younger urban boys, but the differences seem to disappear at 15 years and older. It is perhaps of interest that only few significant interactions appear when the sociogeographic variable is combined with the educational level of the father in a two way analysis of variance. However, at the age of 18 years, seven significant differences in circumference and skinfold measures appear. These were not apparent in the one way analysis. These findings seem to justify the interpretation

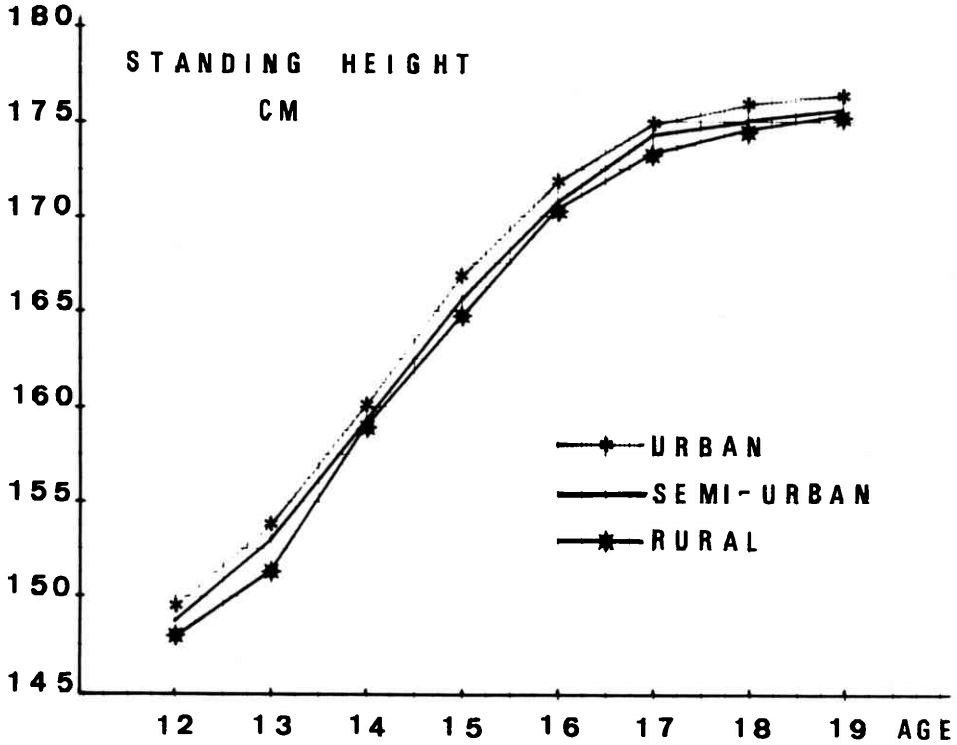

FIG. 1. – Standing height growth curves of three sociogeographic groups

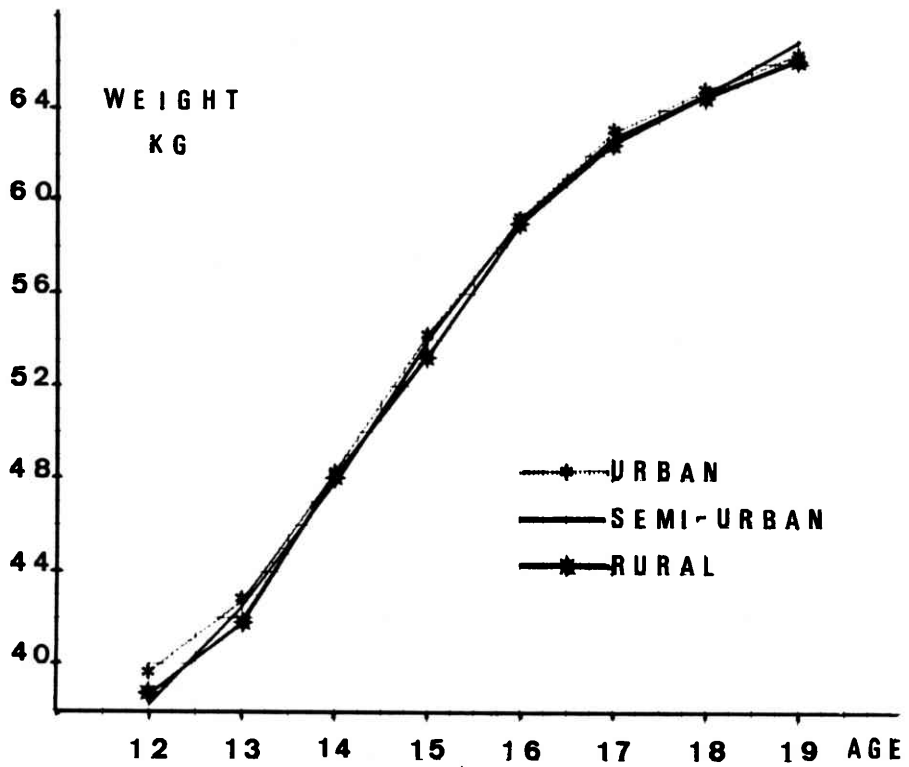

FIG. 2. – Body weight growth curves of three sociogeographic groups

that – at least in some of the older age groups – there is a tendency that the urban boys have higher circumference measures than rural boys, on the condition that these urban youngsters stem from higher paternal educational circles and that they have higher skinfold measures, when they stem from lower educational circles. This implies, of course, the opposite, namely that only adolescent rural boys whose fathers received more formal education are leaner than their age mates from the city.

TABLE 5. – Results of analyses of variance of motor fitness and sports participation of 12 to 19 year old boys relative to the degree of urbanisation

Variables \ Age	12	13	14	15	16	17	18	19
Stick balance	–	**	*	–	–	–	–	–
Plate tapping	**	** >	** >	** >	**	** >	*	–
Sit and reach	–	– >	–	**	**	– >	–	–
Vertical jump	–	**	** >	**	**	**	**	**
Arm pull	–	–	–	*	–	–	–	–
Leg lifts	–	** >	**	*	–	*	–	–
Bent arm hang	–	–	**	**	**	*	–	–
Shuttle run	–	–	**	–	–	– >	–	–
1' step test								
Resting pulse	–	–	**	–	–	–	–	–
Pulse following exercise	*	* >	**	** >	–	–	–	–
Pulse 1' after exercise	–	**	**	**	**	**	–	–
Pulse 2' after exercise	–	*	*	**	–	*	–	–
Sum of pulse rates after exerc.	–	**	**	**	*	*	–	–
Sport participation								
N sports practised	– >	–	–	–	–	–	–	–
N hours sport part./week/year	–	–	–	**	–	–	*	–

* F significant at .05 level.
** F significant at .01 level.
> significant two-way interaction with the educational level of the father at .05 level.
> at .01 level.

Analyses of variance of the motor fitness data.

Results of the analysis of variance of motor fitness are presented in table 5. The results indicate that plate tapping and vertical jump differ significantly in seven of the eight age groups. Urban boys perform significantly better in these speed of limb movement (figure 3) and explosive strength (figure 4) tests than their rural counterparts. The semi-urban boys occupy a mid-position between the urban and rural categories. It is apparent that the more urban boys perform better than the

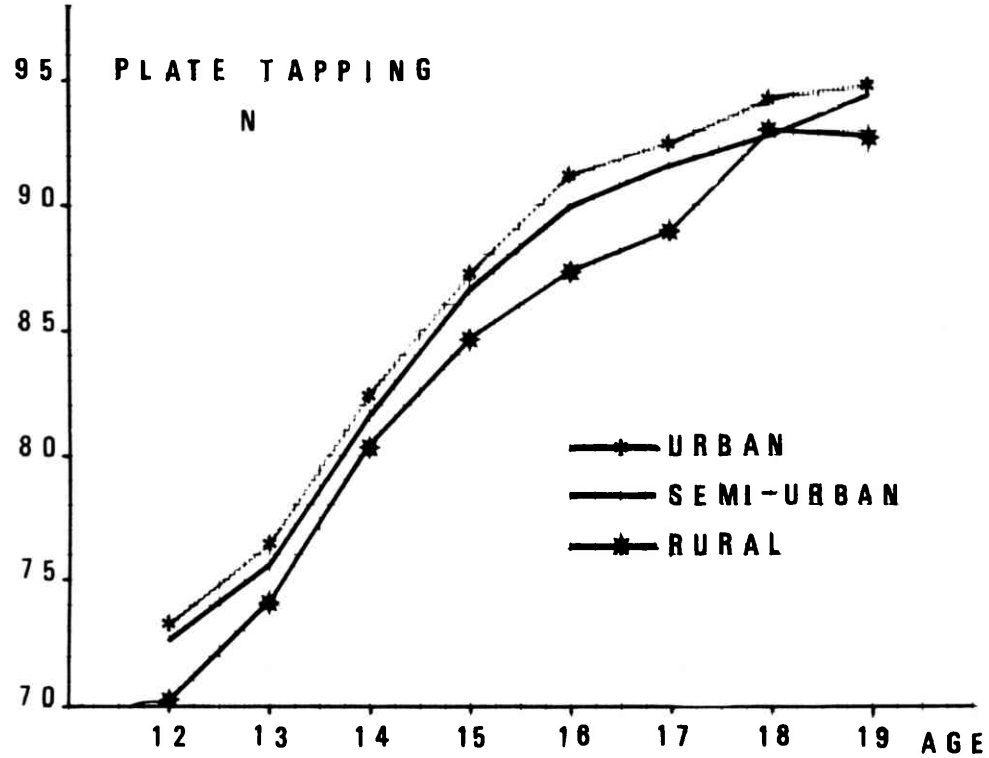

FIG. 3. – Plate tapping growth curves of three sociogeographic groups

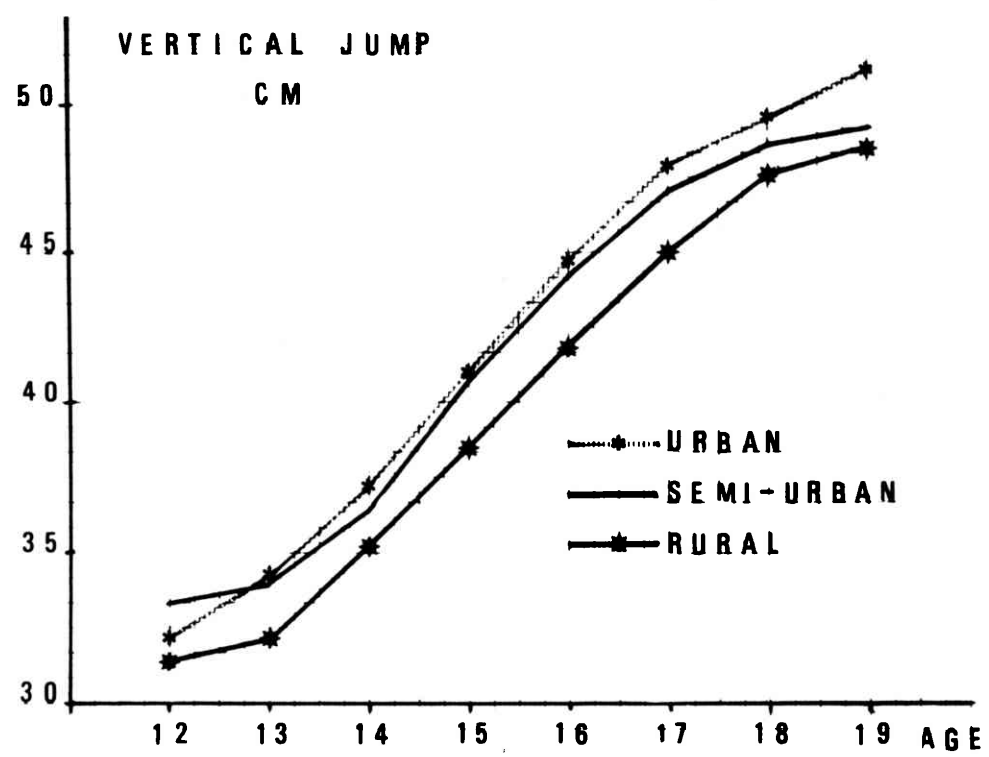

FIG. 4. – Vertical jump growth curves of three sociogeographic groups

more rural boys in leg lifts and the bent arm hang in four of the eight age groups. Age changes in leg lifts (figure 5) show that the rural boys have significantly lower trunk strength than the urban and semi-urban youngsters. Furthermore, poorer results are apparent in the rural boys for the stick balance, sit and reach, arm pull and shuttle run in some age groups, but these differences are not consistent over the age range considered.

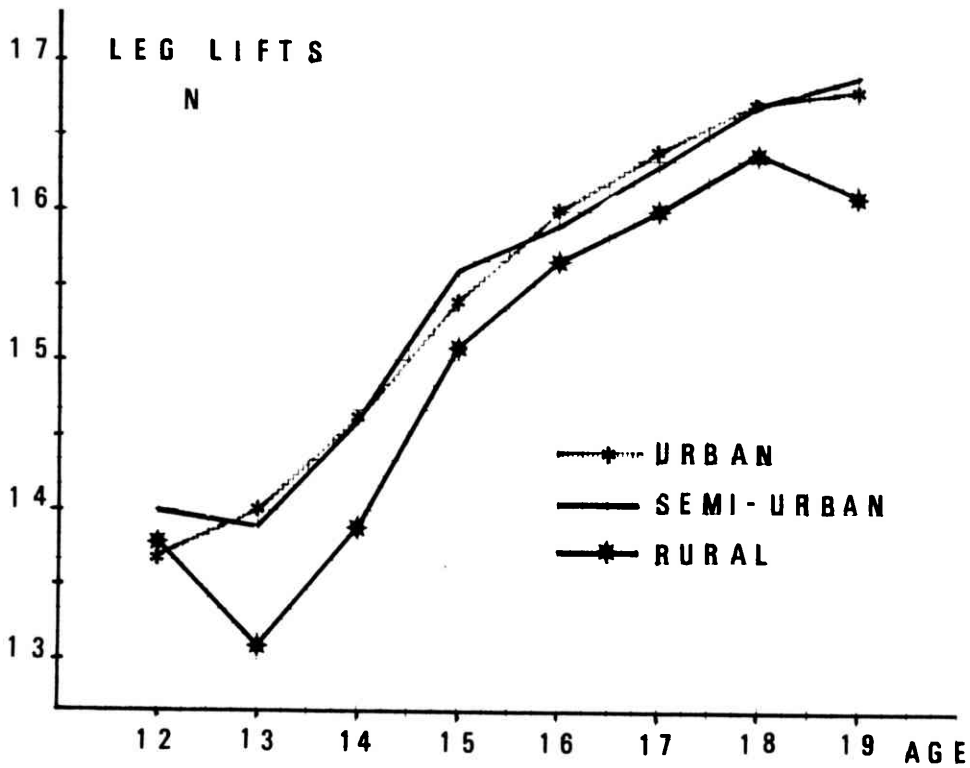

FIG. 5. – Leg lifts growth curves of three sociogeographic groups

In contrast to performance in the motor ability tests, rural boys show consistently better results in the 1 min. step test. In all age-groups the rural boys have lower pulse frequencies than their semi-urban and urban peers (figure 6).

Significant interactions between degree of urbanisation and educational level of the father are few for the motor tasks. However, for plate tapping, the combined effects of a higher degree of urbanisation and a higher educational level of the father appear to increase the differences apparent in four of the eight age-groups.

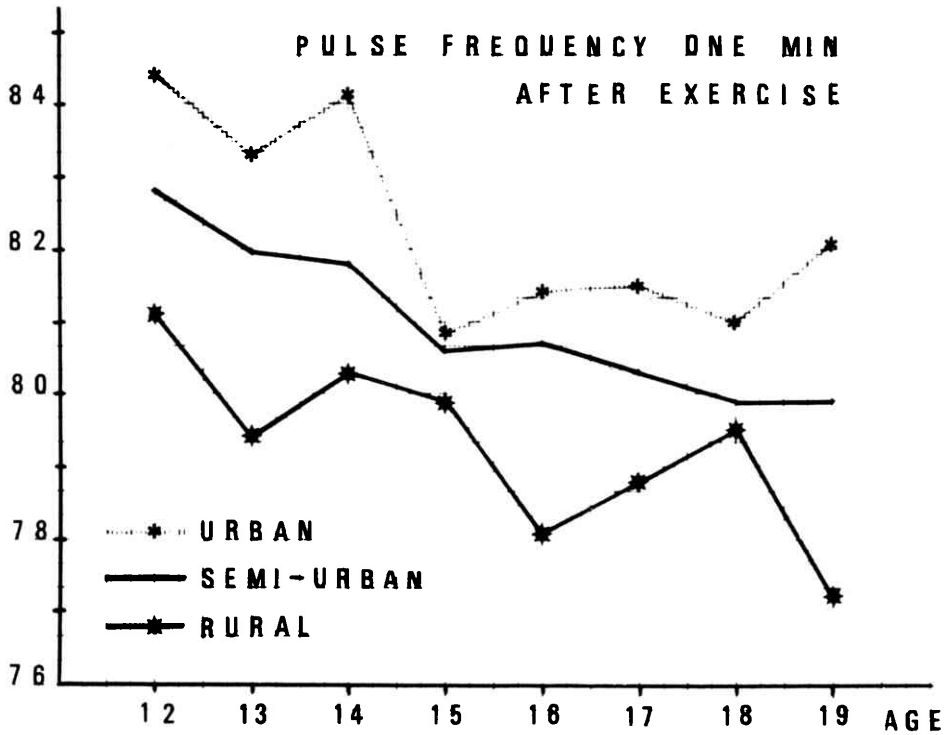

FIG. 6. – Step test growth curves of three sociogeographic groups

Analyses of variance of the sports participation data.

Although clear differences in preferences for specific sports are frequently observed in rural and urban populations (RENSON & VERMEULEN 1972), the analyses of variance do not indicate significant differences among the three sociogeographic categories of boys in the number of different sports practised. Only at ages 15 and 18 years, urban boys show a significantly greater sports involvement than the more rural boys as expressed in a greater number of hours of practice per week over a one year period.

Discriminant analyses.

The variables selected from discriminant analysis are listed in table 6.

The three different groups of rural, semi-rural and urban boys are clearly differentiated by social factors. The educational level of the father (ELF) is the most important discriminating factor, followed by the socioprofessional status of the father (SOF) and family size (FAS). Boys from more urbanised areas are generally from smaller families with fathers having higher educational and

socioprofessional backgrounds compared to rural boys. In addition, the vertical jump (VTJ) and bicondylar diameter of the humerus (BIH), contribute significantly to discriminate the three sociogeographic categories in seven and five of the age groups respectively. Greater explosive strength and lesser bone width thus seem to be relevant factors differentiating urban from rural youngsters.

TABLE 6. – Results of the discriminant analyses : variables selected

Discriminating rank order	Discriminating variables							
	age 12	age 13	age 14	age 15	age 16	age 17	age 18	age 19
1st	ELF	ELF	ELF	ELF	ELF	ELF	ELF	ELF
2nd	FAS	FAS	FAS	FAS	FAS	SOF	FAS	SKA
3rd	TSF	SOF	SOF	VTJ	SOF	FAS	SOF	SOF
4th	SOF	STB	VTJ	AGE	PLT	VTJ	VTJ	VTJ
5th	AGE	LEL	BIH	SAR	SKA	BIH	THIC	
6th	DIV	BAH	ITP	SOF	SIT	SIT	RCH	
7th		BIH	SIS	PLT	VTJ	BIF		
8th		CHEW	AGE	SHR	ARP	ARP		
9th		SUS	LEL	USP	BIH			
10th		VTJ	PF1	BAH	BIF			
11th		ECE		HEI	BOA			
12th		UAC		BIH	AGE			
13th		BIF		SIT				
14th				SIS				
15th				BIF				
16th				SKA				

Key : ELF – Educat. level father
FAS – Family size
SOF – Socioprof. status father
SKA – Skeletal age
TSF – Triceps skinfold
VTJ – Vertical jump
STB – Stick balance
AGE – Chronol. age
PLT – Plate tapping
LEL – Leg lifts
BIH – Bicond. diam. humerus
SAR – Sit and Reach
THIC – Thigh Circumference
DIV – N of sports practised
ITP – Ponderal index
SIT – Sitting height
RCH – Reaching height
SIS – Supra-iliac skinfold
BIF – Bicond. diam. femur
CHEW – Chest width
SHR – Shuttle run
ARP – Arm pull
SUS – Sum of skinfolds
USP – N of hours sport practice
PF1 – Pulse frequency after 1 min
BAH – Bent arm hang
ECE – Ectomorphic component
HEI – Standing height
BOA – Chest circumference
UAC – Upper arm circumference

5. DISCUSSION

Our observations from the nation-wide investigation of sociogeographic variation in the growth and physical fitness of Belgian secondary schoolboys show

several significant differences. Structurally, urban boys have a more pronounced linear development, which is not accompanied by greater width development, compared to rural youngsters. The more linear body type of the city-boys, is also apparent in their significantly higher ectomorphy ratings, while rural boys have higher mesomorphy. In the younger ages, thicker skinfolds are also a characteristic of urban boys. These results are of major importance, especially since no systematic differences in skeletal maturity are evident among the three groups compared. In the motor area, higher levels of performance in vertical jump, plate tapping and leg lifts are associated with an increase in urbanisation. In contrast, the boys from rural areas show significantly lower pulse frequencies after a 1 min. step test, suggesting greater cardiovascular efficiency. These lower pulse frequencies may, however, be related to psychological rather than physiological mechanisms. Because of the relatively light work load and lower cardiovascular demands of the short step test on one hand and because of a lack of rural-urban differences in the sports behavioral patterns on the other, it is suggested that the lower pulse rates of rural boys are due to a socio-psychological characteristic of less 'test achievement-arousal' than to ecologically induced physiological adaptations (RENSON 1973).

Since there are many uncontrolled environmental variables in our design, it is hazardous to speculate on the causes of the observed rural-urban differences in physical fitness. Broekhoff (1978) emphasized the combined effects of various environmental factors such as differences in quality of food consumption, physical education programs and access to large play areas, in order to explain performance differences between inner city and suburban children. Parizkova and Berdychova (1977, p. 237) suggest a "... lack of proper motor stimulation and restriction of spontaneous physical activity" as features of a big city. Our Belgian data do not, however, show a lag in physical fitness among the urban boys. On the contrary, the urban boys show a more linear body constitution and significantly better performances in at least four of the eight motor tests. These urban characteristics thus seem to point in the direction of a more advanced secular trend in the urban environment when compared with the country-side. This gives, however, rise to another – maybe much more important – question, which was indicated by Eiben (1979, p. 201), i.e. to what extent can the more linear body type of city dwellers be considered as an 'accomplishment' or 'regression' ? I am afraid that an attempt to answer this question will split up this audience in civilisation optimists and pessimists, in economists and ecologists or – to put it in more popular terms – in 'urban cowboys' and Indians. With respect to the Belgian situation, it can, however, be concluded that a so called 'physical fitness lag of urban boys' is a myth, probably induced through our nostalgia to the green, green grass of our grandfathers' country homes.

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