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Body structural and cellular aging of women with low socioeconomic status in Hungary: A pilot study

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Abstract

Objectives: The health status of an individual is determined not only by their genetic background but also by their physical environment, social environment and access and use of the health care system. The Roma are one of the largest ethnic minority groups in Hungary. The majority of the Roma population live in poor conditions in segregated settlements in Hungary, with most experiencing higher exposure to environmental health hazards. The main aim of this study was to examine the biological health and aging status of Roma women living in low socioeconomic conditions in Hungary.

Methods: Low SES Roma (n: 20) and high SES non-Roma women (n: 30) aged between 35 and 65 years were enrolled to the present analysis. Body mass components were estimated by body impedance analysis, bone structure was estimated by quantitative ultrasound technique. Cellular aging was assessed by X chromosome loss estimation. Data on health status, lifestyle and socioeconomic factors were collected by questionnaires.

Results: The results revealed that low SES women are prone to be more obese, have a higher amount of abdominal body fat, and have worse bone structure than the national reference values. A positive relationship was found between aging and the rate of X chromosome loss was detected only in women with low SES. Waist to hip ratio, existence of cardiovascular diseases and the number of gravidities were predictors of the rate of X chromosome loss in women.

Conclusions: The results suggested that age-adjusted rate of X chromosome loss could be related to the socioeconomic status.

1 | INTRODUCTION

Aging is a multistep biological process, which leads to a decreased ability to respond to stress, an increased

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homeostatic imbalance and disease susceptibility eventually causing death. Prolongation of life expectancy is associated with prolongation of the aging period (Beregi, 1984).

Aging has been studied exclusively not only in economically developed societies, but also in societies with low socioeconomic status (Wagg et al., 2021). Due to recent methodological advances, aging can be examined at the molecular level too as telomere shortening of the chromosomes is associated with the process of cellular aging. It has been shown that in populations with low socioeconomic status, the chromosome shortening begins earlier in life than among those with high socioeconomic status (Cherkas et al., 2006; Needham et al., 2013).

Shortening of the ends of chromosomes can lead to instability and the eventual loss of the whole chromosome (Pampalona et al., 2010). Another proven cytogenetic change associated with aging, is a decrease in the number of sex chromosomes. In the case of women, it affects one of the X chromosomes, whereas in the case of men it affects the Y chromosome (Guttenbach et al., 1995; Russell et al., 2007). Numerous studies have linked the numerical reduction of sex chromosomes to the development of Alzheimer's disease and malignant tumors (Dumanski et al., 2016; Noveski et al., 2016), but the relationship between socioeconomic background and cytogenetic aging has not been studied.

The Roma are one of the largest ethnic minority groups in Europe numbering about 11–15 million of which 800 000–1 000 000 live in Hungary (European Commission, 2011). In Europe and also in Hungary most of the Roma population lives in poor conditions in segregated settlements (Adany, 2014).

In Hungary despite the efforts (welfare services: social security, unemployment contribution, better terms of employment, maternity leave, Liptak, 2010; Kertesi & Kezdi, 2011) that have been invested to help and support the integration of the Roma population, there suffer from high rates of unemployment and low wages, and they live in poor hygienic conditions and lack running water and electricity. Their health status is mostly poor, and the prevalence of both infectious and non-communicable diseases (hypertension, diabetes, obesity) is higher than in the rest of the Hungarian population (Kosa et al., 2015; Mascie-Taylor et al., 2004; Masseria et al., 2010; Pronai, 2000). The life expectancy of Roma populations is up to 10–15 years less than non-Roma populations in Europe (Parekh & Rose, 2011).

The main aims of the project were to:

1. Study the suspected accelerated aging (body structure and reproductive aging) in the case of women living in segregated settlements in low socioeconomic status compared to the national references.
2. Study the rate of the suspected accelerated loss of sex chromosomes among Roma women compared to the pattern of cellular aging in women living in high socioeconomic status.
3. Understand the most common risk factors that contribute to the loss of sex chromosomes.

2 | SUBJECTS AND METHODS

2.1 | Subjects

Altogether 50 women (aged between 35 and 65 years) were examined of whom were 20 Roma women who lived in a segregated settlement in Hungary (Monor, Taban settlement), in low socioeconomic status (low SES) and a control group of 30 women with high socioeconomic status (high SES). The women in the control group were staff members at the Saint Janos Hospital and Unified Hospitals of North Buda. The study was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The project was approved by the Ethics Committee of Eotvos Lorand University, Budapest, Hungary. Informed consent was obtained from all individual participants. Body structural examinations were performed in the Roma settlement and the Department of Biological Anthropology, Eotvos Lorand University, Hungary.

2.2 | Cellular aging examination

The degree of X chromosome loss was estimated from lymphocyte venous blood cells using a fluorescent in situ hybridization (FISH) probe. X chromosome loss was defined by the decrease of XX normal karyotype cells in our analysis. The individual rate of XX karyotype cells was expressed as the percentage of the number of cells studied using the FISH probe. A total of 200 cells per donor were analyzed. The analyses were performed in collaboration with the Istenhegyi Gene Diagnostic Centre in Budapest, Hungary.

2.3 | Anthropometric examinations

Body structure was defined by body mass components and bone structural parameters. Fat mass (kg), skeletal muscle mass (kg), bone mineral content (BMC, kg) and visceral fat area (VFA, cm^2) were estimated by body impedance analysis (InBody 720 device). The bone structural parameters were measured by ultrasound osteometer (DTU-one Osteometer). The osteometer measured the broadband ultrasound attenuation (BUA, dB/MHz), and speed of sound (SOS, m/s), which quantify the ultrasound parameters estimates of the structural and mechanical characteristics of the calcaneus bone (SOS correlates with the

microarchitecture indices of the bone, BUA: associates with the biomechanical parameters of the bone). The measurements were performed on the non-dominant calcaneus. Bone mass (kg) was estimated by the Drinkwater and Ross (1980) anthropometric four-component model. The relative mass components (%) were determined by expressing the absolute mass components as the percentage of total body mass. Body structural aging was estimated by evaluating the body structural parameters in comparison with the Hungarian national references (altogether $n = 2500$ women aged between 30 and 70 years were used to construct the national references between 2010 and 2019; Zsakai et al., 2017; Feher et al., 2020).

2.4 | Data collections by questionnaires

Data on socioeconomic status, the level of habitual physical activity, the level of general and reproductive health status (existence of chronic illnesses, gynecological illnesses, general health status, number of pregnancies, menarcheal age, age at menopause) were collected by questionnaires (validated for the Hungarian population) through personal interviews.

Socioeconomic status was estimated by collecting data on the existence of kitchen, bathroom/toilet, heating, number of cars, number of cell phones, number of computers in the households, as well as on the number of family trips in the last 6 months. All Roma women live in the same very poor, segregated settlement, in very poor conditions (e.g., without having toilet, bathroom, running water, heating or electricity in their residences), they all were classified as having low SES.

Level of physical activity was estimated by collecting data on the regularity, intensity and duration of physical activity of women. Subjects were divided into active (physical activity reached 2.5 or more hours per week) and inactive (less than 2.5-hour activity a week; WHO, 2010) subgroups in the present analysis.

Self-rated general health status was estimated by a 4-point Likert scale (very good, good, fair, poor).

Data on chronic illnesses (type, age at diagnosis, length and duration of the illnesses) were also collected.

2.5 | Statistical analysis

The comparison of body structure parameters of Roma women living in low socioeconomic status to the national references as well as to non-Roma women belonging to the control group was conducted with Mann–Whitney test, Chi^2 test and Fisher exact test to compare the homogeneity of discrete variables by socioeconomic status. To determine the body structural aging the body structural indicators were compared to the national references in two age-groups (aged between 35 and 50 years; and aged between 50 and 65 years) by one-sample Wilcoxon signed rank test. Due to the small sample size, exact p-values were used to determine the significance level. Exact *p*-values were determined using R software. The relationship between the rate of X chromosome loss and the hypothesized predictors was assessed by linear regression analyses. The statistical analyses were carried out by using SPSS v. 25. Hypotheses were tested at the 5% level of random error.

3 | RESULTS AND DISCUSSION

3.1 | Living conditions and health status of Roma women

Roma women's families tended to live in poorer socioeconomic conditions than the control group families with the exception of assess to a kitchen (Table 1).

The prevalence of physical inactivity is very high in Roma women (95.0%) compared to the control group (50.0%). Smoking is a more frequent lifestyle habit in Roma women (85.0%) than in the control group (36.7%, Table 1). 80% of Roma women rated their health status as poor compared with 30.0% of the control group. The prevalence of chronic illnesses and gynecological illnesses was very similar in the two groups (Table 1) while 90% of Roma women had at least 3 pregnancies compared with only 23% of the control group (Table 1).

3.2 | Biological status of low SES women

The chronological ages of the two SES subgroups did not differ significantly, their body structural parameters were also comparable (Table 1). Roma women, on average, had smaller musculo-skeletal robusticity (relative muscle mass, relative bone mass and BMC), while having higher relative fat content (relative fat mass, VFA) than in high SES women. The menopausal age of the women with low SES did not differ significantly from the control group (Table 1).

3.3 | Body structural aging in low SES women

Roma and control group women's body structural indicators were compared to the national references in the two age-groups (the younger age-group: aged between 35 and 50 years; and the older age-group aged between 50 and 65 years) after centile transformation. The height, the

TABLE 1 Differences in socioeconomic, lifestyle factors, body structural parameters between control and Roma groups

	High SES women (n: 30)	Low SES women (n: 20)	*p*
Socioeconomic factors (%)			
Bathroom/toilet (possessed in the residence)	100.0	55.0	**$p < 0.001$**
Heating (possessed in the residence)	100.0	45.0	**$p < 0.001$**
Kitchen (possessed in the residence)	100.0	85.0	0.058
Number of cars (1 or more cars in the family)	10.0	90.0	**$p < 0.001$**
Number of cell phones (more than 1)	96.7	65.0	**0.05**
Number of computers (at least 1)	100.0	60.0	**$p < 0.001$**
Number of trips in the last 6 months (1 or more trips) change 1 or more	16.7	70.0	**$p < 0.001$**
Lifestyle factors (%)			
Level of physical activity (inactivity)	50.0	95.0	**0.001**
Smoking (smokers)	36.7	85.0	**0.001**
Health status (poor)	30.0	80.0	**0.001**
Chronic illnesses (experienced)	60.0	70.0	0.556
Gynecological diseases (experienced)	40.0	35.0	0.774
Number of pregnancies (>3 pregnancies)	23.3	90.0	**$p < 0.001$**
Chronological age, median (year)	46.76	39.30	0.281
Menopausal age, median (year)	(n: 7) 50.00	(n: 10) 50.00	0.887
Body structural parameters			
Height (cm)	162.70	155.60	**0.001**
Weight (kg)	70.75	76.30	0.169
Muscle mass (kg)	25.15	24.60	0.303
Relative muscle mass (%)	36.64	30.61	**0.001**
Bone mass (kg)	10.27	10.18	0.607
Relative bone mass (%)	15.32	13.20	**0.006**
Fat mass (kg)	21.95	33.75	**0.007**
Relative fat mass (%)	33.89	44.37	**0.001**
BMC (kg)	2.70	2.50	0.059
Rel. BMC (%)	4.01	3.10	**0.001**
VFA (cm^2)	81.35	161.50	**$p < 0.001$**
SOS (m/s)	1544.00	1553.05	**0.015**
BUA (dB/MHz)	39.65	45.15	0.635

Note: p values in bold refer significant differences between low SES and high SES women

relative bone and muscle mass as well as relative BMC of Roma women were significantly lower, while the weight (in age-group 2) and fatness indicators exceeded the corresponding references (one-sample Wilcoxon signed rank test, Figure 1) in both age-groups.

In comparison to the national references, the increased level of fatness and decreased relative mass of muscle and bone indicated accelerated body structural aging of Roma women which was worse in younger aged Roma women (Figure 1).

In the control group the BUA and the WHR were significantly lower in the younger age-group than the national references while other examined body and bone structure parameters did not differ significantly from the international references in either younger or older age groups (one-sample Wilcoxon signed rank test, Figure 2).

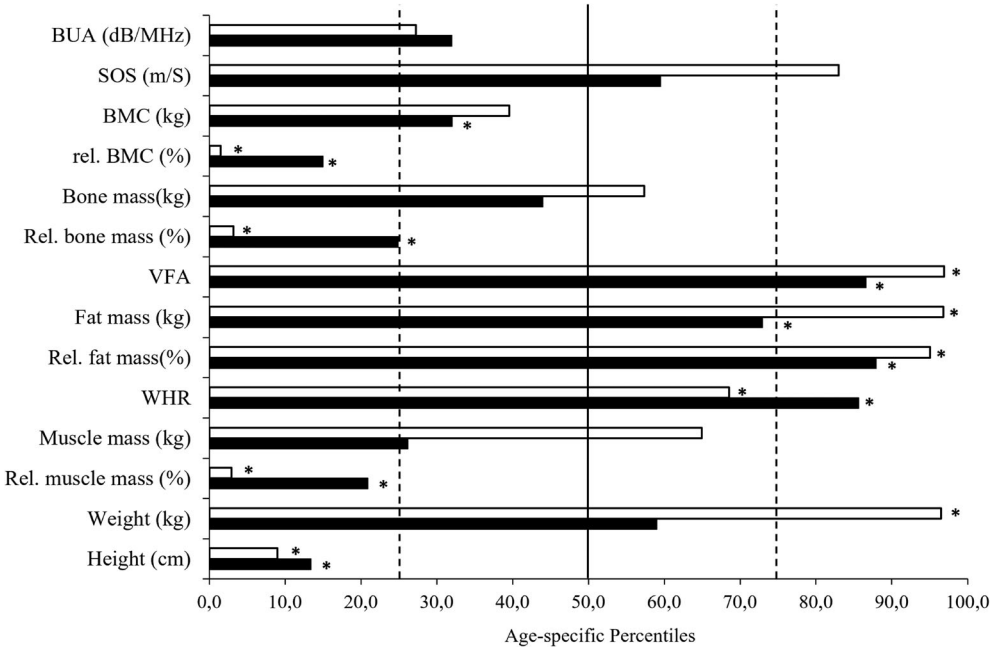

FIGURE 1 Body and bone structural parameters (age-group medians of individual centile values) of women with low socioeconomic status (□: 'Age-group 1' – 35–50 years in low SES women (n: 11), ■: 'Age-group 2' – 50–65 years in low SES women (n: 9)) compared to the national references (one-sample Wilcoxon signed rank test, *: Exact p-value < .05)

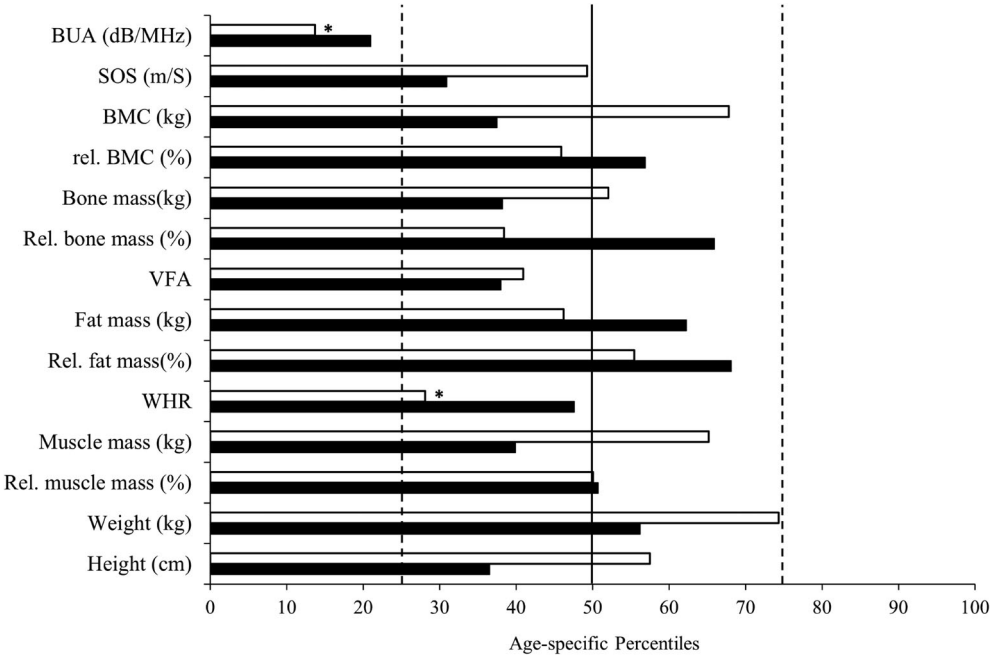

FIGURE 2 Body and bone structural parameters (age-group medians of individual centile values) of women with high socioeconomic status (□: 'Age-group 1' – 35-50 years in high SES women (n: 18), ■: 'Age-group 2' – 50-65 years in high SES women (n: 12)) compared to the national references (one-sample Wilcoxon signed rank test, *: Exact p-value < .05)

3.4 | Cellular aging in women

3.4.1 | The pattern of X chromosome loss by age

The relationship between the rate of X chromosome loss and chronological age was studied separately in Roma and control women (Figure 2). The rate of X chromosome loss showed a just significant linear relationship with age in Roma women ($F = 4.689$, $p = .044$), but in the control group there was no evidence of a linear ($F = 0.484$, $p = .492$) or curvilinear ($F = 0.637$, $p = .537$) relationship between the two variables (Figure 3).

3.4.2 | Identification of X chromosome loss predictors

Multiple linear regression analyses were used to predict the rate of X chromosome loss based on components of body composition and lifestyle factors in women (in the joint group of Roma and control groups together. A

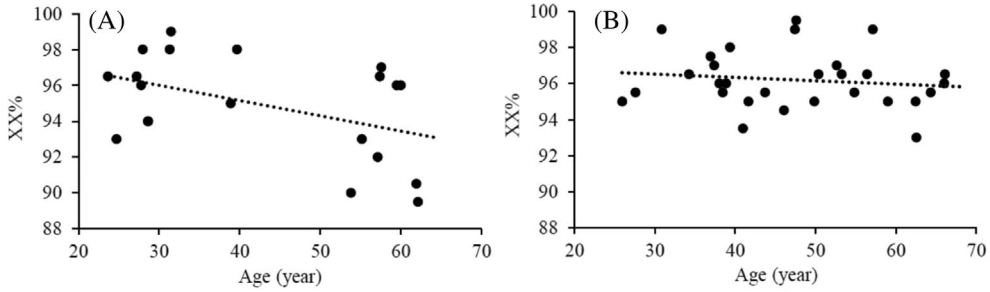

FIGURE 3 Relative X chromosome loss (the number of XX cells in the percentage of the studied cells number) by age in the women with low socioeconomic status (A), and women with high socioeconomic status (B)

	B	Std. error (B)	β	*p*
Constant	106.431	4.773	–	$p < 0.001$
Waist to hip ratio (WHR)	−13.448	5.647	−0.328	$p = 0.022$
Existence of cardiovascular diseases	−3.595	0.761	−0.649	$p < 0.001$
Number of gravidities	0.369	0.126	0.448	$p = 0.006$
Physical activity level	0.627	0.636	0.129	$p = 0.330$
Smoking	0.268	0.574	0.058	$p = 0.643$

TABLE 2 Variables associated with X chromosome loss in a multiple linear regression model (model was significant, $p < .001$)

significant regression equation was found ($F[5.40] = 6.577$, $p < .001$, with an R^2 of 0.451). The predicted percentages of normal cells (XX%) was equal to 106.431–13.448 × WHR - 3.595 × code of cardiovascular diseases +0.369 × number of gravidities (where cardiovascular disease was coded as 0 = no cardiovascular disease, 1 = at least one diagnosed cardiovascular disease). The percentage of normal cells decreased by 1.345% for 0.1 increase in WHR, decreased 3.595% with the presence of cardiovascular diseases and increased by 0.369% with the increasing number of pregnancies. WHR, presence of diagnosed cardiovascular diseases and gravidity were significant predictors of the percentage of normal cells with XX karyotype. The level of physical activity (hour/week) and smoking were not significant predictors of the percentage of normal, XX karyotype cells (Table 2).

4 | CONCLUSIONS

Although the sample size was not large to draw definitive conclusions, the results highlighted potential factors that could be related to the body structure aging and the rate of X chromosome loss in women. The main results of these analyses were:

1. Body structural aging was accelerated in Roma women compared to the national references, with aging-related loss of bone and muscle mass, as well as the aging-related accumulation of fat in women compared with the national references
2. The results confirm a positive relation between aging and the rate of X chromosome loss only in Roma women.
3. Socioeconomic status can have an influential impact on X chromosome loss. Abdominal fat accumulation, the presence of cardiovascular diseases and the number of gravidities are significant predictors of the rate of X chromosome loss in women.

4.1 | The limitations of the study

A larger sample of women should be studied in order to confirm the present preliminary results. The Roma population is an ethnic group in the Hungarian population, so the body structural and cellular aging differences between Roma and non-Roma women groups can be caused not only by the significant differences in their socioeconomic status but also by genetic differences. Future work will extend the study to Roma women, who live in average socioeconomic conditions, that is, outside the segregated settlements.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

Dorina Annar: Conceptualization; formal analysis; funding acquisition; investigation; methodology; project

administration; resources; visualization; writing - original draft; writing-review & editing. **Piroska Feher:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration; resources; visualization; writing - original draft. **Anna Madarasi:** Investigation; methodology. **C.G. Mascie-Taylor:** Formal analysis; methodology; visualization. **Anna Kekesi:** Methodology. **Irina Kalabiska:** Methodology. **Agota Muzsnai:** Methodology; writing-review & editing. **Annamaria Zsakai:** Conceptualization; formal analysis; investigation; methodology; project administration; resources; supervision; visualization; writing - original draft.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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