Introduction

Roma are the largest ethnic minority in Europe with an estimated number between 12 and 15 million. Their representation in the population is greatest in Bulgaria, Romania, Slovakia, Hungary, the Czech Republic and Slovenia, but the EU enlargements of 2004 and 2007 have enabled increasing numbers to migrate into and to settle in other countries of the EU. The Roma are concentrated in economically deprived regions, often living in segregated parts (colonies) characterized by severely unfavourable environmental conditions of human habitats. Independent of the country where they live, the common problems that this population group experiences are poverty, restricted access to education, high level of unemployment and social exclusion.

On the base of the predominantly low socio-economic status of the Roma population and socio-economic status as determinant of health, it is a reasonable assumption that their health status is much worse and their average life expectancy is much shorter than that of the majority population, as is frequently mentioned both in research and public communications. Considering the fact that recording Roma ethnicity is not permitted in any kind of official documentation including medical records, birth and death certificates as well as some major obstacles that hinder or prevent the collection of reliable data on Roma and other minorities, these cannot be considered as evidence proved.

In a longitudinal study conducted in 2011 covering the entire population of Bulgaria between 1992–98, Kohler and Preston presented ‘the first reliable life table measures and cause-specific mortality indicators according to ethnicity and religion’ by linking data in the 1992 census to subsequent death records. Although identification of Roma was found to be the least reliable among the groups considered and they were most likely to be misclassified, resulting in undercounting, their mortality was found to be high.
compared with all other ethnic/religious groups according to nearly all major causes of death.

Although many studies have documented high prevalence of communicable diseases, fewer have documented non-communicable diseases among the Roma people (see reviewed11). Even fewer studies have compared Roma health status with that of the majority population, and even if comparisons were made they were restricted to one or only a few (hypertension, diabetes) health indicators.14,15 In addition, the comparative studies were mainly questionnaire-based health interview surveys when self-assessed health status and functional limitations were considered as outcome indicators, and no medical examinations were carried out. The ethnic identification of individuals can also be contested.16

The objective of our study was to compare the health status of the Roma people with that of the general population in Hungary. We conducted a study measuring the prevalence of metabolic syndrome and its components that overcomes the limitations with the existing evidence base on Roma health noted above.

- First, it is a definitive health examination survey from the epidemiological point of view.
- Second, it targets health status of Roma people in complexity by investigating the prevalence of metabolic syndrome and the prevalence of its components as defined by the International Diabetes Federation Consensus Group.17 Although the definition and clinical interpretation of metabolic syndrome is a subject of intense scientific discussion,18 there is a general agreement that it is the most robust predictor of the increased susceptibility to different non-communicable diseases (cardiovascular diseases, type 2 diabetes, polycystic ovary syndrome, fatty liver, cholesterol gallstones, asthma, sleep disturbances and some forms of cancer),19 most of them with high morbidity and mortality burden.
- Third, data are compared with reference data of the majority population in Hungary.
- Fourth, by involving representatives of the Roma population at all stages of the study, high-level validity has been reached through avoiding the misclassification of the study subjects and low response rate of selected Roma adults.

Methods

Sampling

A nationwide project surveyed the segregated colonies (SCs) in Hungary. Roma field workers nominated by Roma non-governmental organizations identified the SCs. In all, 94% of SCs’ inhabitants declared themselves to be Roma.20

The present investigation used this colony registry in stratified multistep sampling. The study embraced two Hungarian counties (Hajdu-Bihar and Szabolcs-Szatmar-Bereg) where Roma colonies are accumulated. To focus the investigation to the highly segregated, closed Roma population, SCs with >100 inhabitants were considered as the study base. Of the 64 eligible SCs, 40 and 25 households from each SC were randomly selected using the general practitioners’ (GPs’) validated (and corrected, if needed) household lists. The 20–64-year-old inhabitants of the resulting 1000 households comprised the final sampling frame, and one person from each household has been chosen by a member of the primary health-care team using a random table.

Roma health examination survey

The participants were invited to the GPs’ office where a questionnaire on socio-demographic factors, lifestyle and self-assessed health status was completed by GPs or practice nurses on the basis of interviewees’ answers, and physical examination was carried out. The health status description used the former medical records of participants as well. Blood samples for laboratory investigations were taken. Informed consent from the participants was obtained. The data collection started in September 2011 and took 4 months, and it applied the methods of a former study on metabolic syndrome (Hungarian Metabolic Syndrome Survey, HMSS).20

Socio-demographic characteristics (age, gender and level of education), results of physical examination (body weight, height, waist circumference and blood pressure), serum concentrations of triglyceride, HDL cholesterol and glucose assessed in fasting blood samples and the medical history of lipid disorders, hypertension and type 2 diabetes mellitus have been processed in the present investigation.

The consensus definition of the International Diabetes Federation was used to determine the presence of metabolic syndrome.22 Applied thresholds: central obesity ≥94 cm for men and ≥80 cm for women; serum triglyceride concentration ≥1.7 mmol/l or specific treatment for it; serum HDL cholesterol concentration <1.03 mmol/l for men and <1.29 mmol/l for women or specific treatment for it; systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg or specific treatment for it; fasting plasma glucose level ≥5.6 mmol/l or previously diagnosed type 2 diabetes mellitus.

Reference dataset

The SCs’ data have been compared with reference values determined by the above mentioned HMSS on a representative sample of the Hungarian population (n = 1819).20 The present investigation used the 1542 complete records of 20–64-year-old adults from HMSS as the reference dataset.

Data analysis

The SC-specific and the HMSS-derived datasets were joined. The final SC-HMSS database contained anonymized records. The prevalence of metabolic syndrome and that of its components were calculated for different strata (age groups in both genders of the samples investigated). The prevalence of the metabolic syndrome and that of its components were estimated for different strata (age groups in both genders of the samples investigated), and their 95% confidence intervals were computed using the normal distribution. The chi-square test was used for the comparison of prevalences between both ethnicities and males and females. Stata 10.1 was used for the statistical analyses.

Results

Because of some non-collaborative GPs, the data collection was impossible in three SCs. Therefore, the sample contained 925 persons. The informed consent was signed, the questionnaire was completed and the physical examination was undertaken by 725 adults. The records with any missing metabolic syndrome-related data were excluded from the analysis. Finally, 646 SC records were analysed.

There were remarkable demographic differences between SC and Hungarian reference samples (table 1). The male proportion was much lower in studied SCs (39.16%) than in the representative Hungarian sample (47.47%). The age distribution of the SC sample was shifted towards the younger age groups and strongly deviated from the Hungarian reference distribution. The level of education was considerably lower among SC inhabitants than the national reference. Both in the general Hungarian and the Roma populations the prevalence of the raised fasting plasma glucose concentration or formerly diagnosed diabetes mellitus, as well as that of the raised triglyceride level or treated lipid disorder, was significantly more frequent among males, whereas the frequency of central obesity was higher among females. In the general population, the prevalence of hypertension was higher among males, but the same difference cannot be detected in the Roma group (table 2A and B).
Central obesity ($P < 0.001$) and hypertension ($P < 0.001$) were less frequently found among SC inhabitants of both genders. Contrary, the reduced HDL cholesterol level ($P = 0.029$) and the higher fasting blood glucose concentration ($P < 0.001$) were significantly more frequently seen in the SC sample. The raised triglyceride level was similar in the studied samples ($P = 0.084$). Altogether, the observed prevalence data of metabolic syndrome in SC (56.38%) and control Hungarian (34.96%) samples did not deviate from each other ($P = 0.525$) (table 2C–E).

The age-specific prevalence estimates show that central obesity and hypertension were less frequent only among older CS inhabitants. On the other hand, the reduced HDL cholesterol levels and higher fasting blood glucose concentrations were manifested in almost every age group (figure 1).

In a multivariate model, age proved to be a significant risk factor for metabolic syndrome (OR $= 1.06$, 95%CI 1.05–1.07) and for every of its components (table 3). Apart from the decreased HDL cholesterol level, all the studied outcomes were significantly influenced by gender: central obesity was more frequent among women; other components and metabolic syndrome (OR $= 0.75$, 95%CI 0.62–0.91) were associated with the male gender. The studied outcomes were independent of education. Raised fasting plasma glucose or known type 2 diabetes mellitus (OR $= 2.65$, 95%CI 1.90–3.69), reduced HDL cholesterol level or treated lipid disorder (OR $= 2.15$, 95%CI 1.65–2.79) and, consequently, metabolic syndrome (OR $= 1.37$, 95%CI 1.03–1.83) were more frequently found among SCs’ inhabitants.

### Discussion

Roma, the largest minority population of Europe, shows an accumulation in the central, eastern and southern (CES) European countries, so the problems related to this low-educated, typically unemployed and marginalized population living in deep poverty were considered as regional challenges of CES European countries. The opening of borders in the process of previous and ongoing EU expansion has enabled increasing numbers of Roma to settle in other parts of the EU and has focused attention on the need to address Roma exclusion not only at national but also international levels and has highlighted Roma problems as common European challenges. Recent changes to Canada’s immigration legislation (Bill C-31) clearly show that the Roma problems do not respect even the continental borders.

### Table 1 Socio-demographical characteristics of study samples representative for segregated Roma colonies and for Hungarian adult population

<table>
<thead>
<tr>
<th>Socio-demographical factors</th>
<th>Segregated Roma sample, N = 646 (%)</th>
<th>Representative Hungarian sample, N = 1542 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–24</td>
<td>68 (10.53)</td>
<td>93 (6.03)</td>
</tr>
<tr>
<td>25–29</td>
<td>59 (9.13)</td>
<td>157 (10.18)</td>
</tr>
<tr>
<td>30–34</td>
<td>79 (12.23)</td>
<td>161 (10.44)</td>
</tr>
<tr>
<td>35–39</td>
<td>101 (15.63)</td>
<td>155 (10.05)</td>
</tr>
<tr>
<td>40–44</td>
<td>117 (18.11)</td>
<td>171 (11.09)</td>
</tr>
<tr>
<td>45–49</td>
<td>72 (11.15)</td>
<td>185 (12.0)</td>
</tr>
<tr>
<td>50–54</td>
<td>66 (10.22)</td>
<td>237 (15.37)</td>
</tr>
<tr>
<td>55–59</td>
<td>47 (7.28)</td>
<td>210 (13.62)</td>
</tr>
<tr>
<td>60–64</td>
<td>37 (5.73)</td>
<td>173 (11.22)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>253 (39.16)</td>
<td>732 (47.47)</td>
</tr>
<tr>
<td>Female</td>
<td>393 (60.84)</td>
<td>810 (52.55)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than primary</td>
<td>250 (38.7)</td>
<td>31 (2.01)</td>
</tr>
<tr>
<td>Primary</td>
<td>304 (47.06)</td>
<td>266 (17.25)</td>
</tr>
<tr>
<td>Vocational</td>
<td>75 (11.61)</td>
<td>504 (32.68)</td>
</tr>
<tr>
<td>High school</td>
<td>15 (2.32)</td>
<td>521 (33.79)</td>
</tr>
<tr>
<td>University</td>
<td>1 (0.15)</td>
<td>204 (13.23)</td>
</tr>
<tr>
<td>Missing</td>
<td>1 (0.15)</td>
<td>16 (1.04)</td>
</tr>
</tbody>
</table>

### Table 2 Ethnicity- and gender-specific prevalence of metabolic syndrome and its components among 20–64-year-old Hungarians (A) and inhabitants of segregated Roma colonies (B), compared with each other (C, D, E)

<table>
<thead>
<tr>
<th>Metabolic syndrome components</th>
<th>A. Representative Hungarian sample by gender</th>
<th>B. Segregated Roma sample by gender</th>
<th>C. Studied sample by ethnicity</th>
<th>D. Segregated Roma vs. Representative Hungarian males</th>
<th>E. Segregated Roma vs. Representative Hungarian females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central obesity</td>
<td>76.17% (73.25–79.09)</td>
<td>62.43% (58.94–65.92)</td>
<td>0.013</td>
<td>0.004</td>
<td>-0.001</td>
</tr>
<tr>
<td>Raised blood pressure or treated hypertension</td>
<td>44.32% (40.92–47.72)</td>
<td>38.88% (35.43–42.34)</td>
<td>0.030</td>
<td>0.007</td>
<td>-0.001</td>
</tr>
<tr>
<td>Raised triglyceride level or treated lipid disorder</td>
<td>31.36% (28.18–34.54)</td>
<td>33.90% (30.57–37.46)</td>
<td>0.084</td>
<td>0.533</td>
<td>0.004</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>32.72% (29.53–35.93)</td>
<td>37.43% (33.94–40.93)</td>
<td>0.179</td>
<td>0.496</td>
<td>0.525</td>
</tr>
</tbody>
</table>

### Central obesity

- $P = 0.525$ for each sample but similar in the studied samples ($P = 0.084$).

### Hypertension

- $P = 0.013$ for each sample but similar in the studied samples ($P = 0.004$).

### Reduced HDL cholesterol level or treated lipid disorder

- $P = 0.273$ for each sample but similar in the studied samples ($P = 0.554$).
Figure 1  Age-specific prevalence (with 95% confidence interval) of central obesity (a), raised blood pressure or treated hypertension (b), raised fasting serum glucose concentrations or formerly diagnosed type 2 diabetes mellitus (c), raised serum triglyceride levels or treated lipid disorders (d), reduced serum HDL cholesterol concentration or treated lipid disorders (e) and metabolic syndrome (f) in 20–64-year-old females' samples representative for Hungary and for segregated Roma colonies in Hajdu-Bihar and Szabolcs-Szatmar-Bereg counties.

Table 3  Socio-demographical risk factors of metabolic syndrome and its components by multivariate logistic regression model for 20–64-year-old adults in Hungary (odds ratios and 95% confidence intervals)

<table>
<thead>
<tr>
<th>Metabolic syndrome components</th>
<th>Age</th>
<th>Sex (Female/Male)</th>
<th>Education*</th>
<th>Ethnicity (Roma/Hungarian)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central obesity</td>
<td>1.06</td>
<td>1.05–1.07</td>
<td>1.93</td>
<td>1.59–2.36</td>
</tr>
<tr>
<td>Raised blood pressure or</td>
<td>1.09</td>
<td>1.08–1.10</td>
<td>0.62</td>
<td>0.51–0.76</td>
</tr>
<tr>
<td>treated hypertension</td>
<td></td>
<td></td>
<td>1.09</td>
<td>0.78–1.53</td>
</tr>
<tr>
<td>Raised fasting plasma glucose</td>
<td>1.07</td>
<td>1.06–1.08</td>
<td>0.40</td>
<td>0.31–0.51</td>
</tr>
<tr>
<td>concentration or known type</td>
<td></td>
<td></td>
<td>1.31</td>
<td>0.91–1.90</td>
</tr>
<tr>
<td>2 diabetes mellitus</td>
<td></td>
<td></td>
<td>1.03</td>
<td>0.66–1.62</td>
</tr>
<tr>
<td>Raised triglyceride level or</td>
<td>1.05</td>
<td>1.04–1.06</td>
<td>0.52</td>
<td>0.43–0.62</td>
</tr>
<tr>
<td>treated lipid disorder</td>
<td></td>
<td></td>
<td>1.21</td>
<td>0.87–1.68</td>
</tr>
<tr>
<td>Reduced HDL cholesterol level</td>
<td>1.02</td>
<td>1.02–1.03</td>
<td>0.93</td>
<td>0.78–1.11</td>
</tr>
<tr>
<td>or treated lipid disorder</td>
<td></td>
<td></td>
<td>0.96</td>
<td>0.70–1.30</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>1.07</td>
<td>1.06–1.08</td>
<td>0.75</td>
<td>0.62–0.91</td>
</tr>
</tbody>
</table>

a: Less than primary education serves as reference category.
Over the past decades, a series of national and international policy initiatives have been designed to improve the situation of the Roma people, and EU-wide policy networks focusing on education, employment, housing and health have also been established to support Roma inclusion. Unfortunately, there has been limited assessment of actual outputs and results of the projects benefiting Roma inclusion and improving Roma health. Additionally, new concern has been raised that the current economic crisis may disproportionately affect vulnerable communities, including the Roma population.

Epidemiological studies on the health of the Roma people were focused almost exclusively on communicable diseases and reproductive health before the turn of millennium, and research has only recently extended to the field of non-communicable diseases and their risk factors. These studies are limited in number and have severe uncertainties on the identification of Roma ethnicity and are restricted to one or a few indicators. Most of these studies cannot be really conclusive because no comparison was made with the overall population. Some others who have made comparisons report contradictory findings: some studies show no difference between Roma and non-Roma populations in cardiovascular disease (CVD) occurrence, whereas others report increased prevalence of various CVD risks among Roma people.

A comparative study of the CVD risk profile for a sample of 430 Roma adults living in rural Croatia compared with those for the general Croatian population was recently published. The findings indicated that the Roma population bears a high CVD risk load related to smoking and high glucose level, and a higher prevalence of CVD risks in women and higher body mass index in the younger age group (18–34 years) characteristic for the Roma population were in contrast to the findings in the general population of Croatia. However, although the components were targeted in the study, the prevalence of metabolic syndrome was not defined.

Until now only a single report tried to estimate the prevalence of metabolic syndrome among Roma people and concluded that it is high. The small sample size (N = 77), as well as the method used for sampling (Roma people who visited GPs with different complaints were included), excludes the possibility of obtaining scientifically acceptable estimates. The reported 50.6% prevalence can be interpreted as an overestimation.

In this study, the sample frame and size were almost identical with those we previously used in a comparative health interview survey, and data obtained in the Roma sample have been compared with reference values determined in the Hungarian reference population. The prevalence of every component of metabolic syndrome showed continuous elevation by age in the Hungarian reference population. A similar pattern was observed for the Roma population only among 20–54-year-old adults, but further elevation was not observable in the 55–59- and 60–64-year age groups; values were unchanged (HDL cholesterol) or slightly decreased (blood pressure, fasting serum glucose, triglyceride), whereas the prevalence of central obesity became even significantly lower for the 55–59-year-old group of Roma people. The analysis of data with age-group stratification clearly shows that the significantly lower prevalence of elevated blood pressure or treated hypertension, as well as that of central obesity, is the effect of their decreased prevalence in the older age groups and not a characteristic of the whole Roma population; it is reasonable to suppose that the decrease is a consequence of the death of people with combined risk factors before reaching age of 55 years. Considering the sex composition of the Roma sample, it can be suggested that mainly the men are affected.

The fact that the prevalence of elevated fasting glucose level and that of decreased HDL cholesterol concentration is higher in all age groups of Roma people strongly suggest that genetic background exists behind these phenomena. A current review summarizing recently published reports on the genetic architecture of lipid metabolism reports 52 genes responsible for HDL cholesterol level. In a large-scale epidemiological study (Tehran Lipid and Glucose Study), the estimates of age- and gender-adjusted heritability for abdominal obesity, low HDL cholesterol, high triglyceride, high fasting blood glucose and high blood pressure were 22, 40, 34, 38 and 23%, respectively (P < 0.05), i.e. the contribution of genetic factors was highest to the development of low HDL cholesterol (40%) and high fasting blood glucose (38%) levels. Concerning genetic determinants of carbohydrate metabolism, recent genome-wide association studies have identified and replicated 75 susceptibility loci associated with type 2 diabetes and related metabolic traits (see reviewed in ). Studies convincingly support the hypothesis on the strongly increased prevalence of the gene–environment interactions in the development of type 2 diabetes and also demonstrate interactions of gene variants with measures of dietary intake and exercise. Although it is generally accepted that in the case of metabolic syndrome lifestyle changes are the most adequate therapeutic interventions and presently there is insufficient support for clinical application of gene-based prediction models in metabolic syndrome, there is direction and encouraging progress in a rapidly moving field that is beginning to show clinical relevance. It has to be accepted that careful clinical trial programs are needed to determine which HDL-raising therapeutic interventions may indeed exert protective effect.

The most obvious limitation of the current health examination survey of Roma people was that it was not representative of the overall Hungarian Roma population. Some Roma who have assimilated with the majority population were excluded, and consequently the survey captured the characteristics of the most disadvantaged part of the Roma population. However, identification of the needs of this group is most important from a policy perspective. It is also important to note that the random sample representative for the general Hungarian population of the HMSS has included some people who are Roma, so it is possible that their inclusion slightly diluted the true difference between the populations.

Our results show that metabolic syndrome strongly contribute to the development of the poor health status of the Roma population. Among the components of metabolic syndrome, decreased HDL cholesterol and elevated fasting blood glucose levels with genetic predisposition are the most prominent findings, findings which give specific importance to the screening for these blood components on a regular basis.

Human participant protection

The study has been approved by the Ethical Committee of the Hungarian National Scientific Council on Health (8907-O/2011-EKU, 285/PI/11).

Supplementary data

Supplementary data are available at EURPUB online.

Acknowledgements

The contribution of fieldworkers, the Roma advocates and other study personnel is gratefully acknowledged. Literature review was carried out as Activity 3 of the WHO Vulnerability and Health Collaborating Centre’s Program. R. A. had the original idea for the comparative Roma Health Examination Survey, participated in the questionnaire and sampling design, interpreted the results and wrote the article. Z. K. and A. M-K. participated in the questionnaire and sampling design, performed the sampling and interpreted the results. Z. S. specified the diagnostic criteria and methods used to detect the metabolic syndrome’s components. J. S. planned the sampling, performed the statistical analysis and interpreted the results. J. D. and B. R. contributed to the writing of the manuscript.
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Conflicts of interest: None declared.

Key points
- This study shows that the prevalence of metabolic syndrome is significantly higher among Roma people than in the general population in Hungary because of the much higher frequency of raised fasting plasma glucose (or known type 2 diabetes mellitus) and that of reduced HDL cholesterol level (or treated lipid disorder).
- Reduced HDL cholesterol and the higher fasting blood glucose concentrations were significantly more frequent in all age groups of the Roma sample in both genders, which may indicate a genetic background.
- These findings suggest that besides tackling the socio-economic determinants of the poor health of Roma people, specific public health interventions considering increased susceptibility to disturbances both in carbohydrate and lipid metabolisms are needed to improve their health status.

References