Int J Public Health (2013) 58:417–425
DOI 10.1007/s00038-013-0463-4

ORIGINAL ARTICLE

Is the cardiovascular risk profile of people living in Roma settlements worse in comparison with the majority population in Slovakia?

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Received: 6 November 2012 / Revised: 26 February 2013 / Accepted: 20 March 2013 / Published online: 6 April 2013

Abstract
Objectives Roma constitute a large minority in several Central European countries, with a mostly disadvantaged societal and health position. The aim of this study was to assess biological and other cardiovascular diseases (CVD) risk factors in people living in Roma settlements and to compare them with non-Roma.
Methods We used data from the cross-sectional Hepa-Meta study conducted in Slovakia. The sample consisted of 452 Roma (mean age = 34.7, 35.2 % men) and 403 non-Roma (mean age = 33.5, 45.9 % men). The effect of ethnicity was analysed using logistic regression adjusted for age and stratified by gender.
Results Roma were more likely to have obesity, low HDL cholesterol, normal total cholesterol, and to smoke than non-Roma. Moreover, Roma women were more likely to have abdominal obesity and Roma men to have normal LDL cholesterol than non-Roma. No significant differences by ethnicity were found regarding hypertriglyceridaemia, hyperglycaemia and hypertension.
Conclusions Our study confirmed higher rates of some CVD risk factors in Roma compared with non-Roma. Our findings call for interventions aiming at decreasing CVD risks and improving health literacy among Roma, to reduce CVD morbidity and premature mortality.

Keywords Roma · Ethnicity · Cardiovascular diseases · Biological risk factors · Participatory approach

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Introduction

Roma constitute a large minority in several Central European countries and for the most part have a very disadvantaged societal and health position, for example, an estimated 430,000 Roma live in Slovakia, representing about 8 % of the Slovak population (Marcincin and Marcincinova 2009; Vasecka and Dzambazovic 2000). They are characterised by an extremely high degree of territorial segregation, poverty and perceived discrimination (Vasecka and Dzambazovic 2000; European Union Agency for Fundamental Rights 2009). Furthermore, the Roma population is characterised by a low educational level and high unemployment rate (Vasecka and Dzambazovic 2000; European Union Agency for Fundamental Rights 2009). The health of the majority of Roma is worse than that of the non-Roma population in Slovakia (Vasecka and Dzambazovic 2000; Ginter et al. 2001). In addition, all available data indicate that the health of the majority of Roma is currently deteriorating, which particularly holds true for those living in isolated Roma settlements (Vasecka and Dzambazovic 2000).

Cardiovascular diseases (CVD) cause 48 % of deaths worldwide (World Health Organization 2009), and the risk of CVD is even higher among low socio-economic groups (Elovainio et al. 2011; Mackenbach et al. 2008; Suresh et al. 2011; Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004; Skodova et al. 2010). Lower socio-economic position negatively affects several risk factors for CVD (waist circumference, body mass index, fasting glucose and fasting insulin) and increased the risk of new onset of metabolic syndrome in the Whitehall II cohort study (Elovainio et al. 2011). Accumulation of socio-economic disadvantages increases the risk of CVD even more (Singh-Manoux et al. 2004), and rates of and risks due to CVD risk factors vary somewhat by gender. Roma have a strong accumulation of socio-economic disadvantage and have a severe additional disadvantage due to discrimination. As a result, a rather wide gap in health and CVD risk factors may be expected, compared with the majority population, for example, Roma women in Spain are more likely to be obese but less likely to smoke (Carrasco-Garrido et al. 2011). Regarding Slovakia, several small studies confirm this higher prevalence of obesity and of low high-density lipoprotein (HDL) cholesterol levels but also show higher prevalence rates of smoking, hyperglycaemia and hypertriglyceridaemia among Roma in comparison with non-Roma (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004). Studies in which prevalence rates of biological CVD risk factors are compared for large samples of Roma and of the majority population are lacking.

Thus, the aim of this study was to assess rates of biological and other CVD risk factors in people living in Roma settlements as they represent the most vulnerable subgroup of Roma and to compare them with non-Roma.

Methods

We used data from the cross-sectional Hepa-Meta study conducted in 2011 in Slovakia. This project focused on assessing the prevalence of viral hepatitis B/C, metabolic syndrome (MS) and CVD risk factors in Roma living in separated and segregated Roma settlements and comparing these prevalences with those in the majority population. The Hepa-Meta study was set up following the principles of community-based participatory research. Roma as target group were involved in the process of questionnaire development (designing and piloting) and data collection through active involvement of Roma community workers in all steps of the study.

Sample and procedure

We sampled residents from the Kosice Region of East Slovakia, where the highest concentrations of the Roma population in Slovakia are found (Slusna 2010). The sample covered residents aged 18–55 from Roma settlements in that region and a control group from the majority population in the same region and of the same age range. The majority population was divided into two subgroups: majority population with (46 %) and without (54 %) a Roma settlement in the catchment area. The final sample comprised 452 Roma and 403 non-Roma respondents.

According to the sociographic mapping of Roma communities in the Slovak Republic, 430 settlements located in the Kosice Region and Roma living in settlements represent 11.2 % ($n = 86{,}341$ Roma) of the total population of Kosice Region. We randomly selected 37 separated or segregated Roma settlements with at least 300 inhabitants. The total number of Roma in the selected settlements was 32,494. We identified the general practitioners (GPs) who provided primary care for the inhabitants of these settlements, yielding 30 GPs. From these we randomly selected 19 who were contacted, and 12 agreed to participate (response rate 63 %). For the majority population in the catchment area, we randomly chose seven general practitioners from a list of general practitioners in the selected area without a nearby Roma settlement. Five agreed to participate in our study (response rate 71 %).

In the selected settlements, Roma were recruited via local Roma community workers. From all Roma who were present in the settlements and received information about our study, 452 chose to participate. Since the recruitment of

Roma respondents was carried out under the unpredictable conditions in Roma settlements, we were not able to compute the response rate. From the GP lists of patients, 710 people from the majority population were randomly chosen. They were contacted via phone and mail by trained research assistants, who provided information about our study and invited them to participate. A total of 403 agreed to participate in our study (response rate 56.8 %). Recruitment of the Roma and non-Roma population is visualised in Fig. 1.

Trained medical personnel collected the blood and urine samples and performed anthropometric measurements in the ambulance of the cooperating GPs. For the majority population, trained assistants were present in the ambulance to assist with questionnaires if needed. In Roma respondents, questionnaires were administered in community centres by community workers or trained assistants who provided help in case of limited literacy, which seem to have the smallest impact on validity of the data (Tourangeau and Smith 1996).

The study was approved by the Ethics Committee of the Medical Faculty at Safarik University in Kosice. Participation in the study was fully voluntary and anonymous. Detailed information about our study and its procedures was given to all the respondents, and informed consent was obtained prior to the medical examination.

Measures

Questionnaire

Questionnaire was developed by expert group consisted of Roma health mediators and community workers, public health experts and academics, and they gather information about socio-demographic background, living conditions, health, health-related behaviour and health care use. Questions concerning age, educational level and smoking were used in the analyses.

Based on the answers to the question "When were you born?" we calculated *age* of the respondents. *Highest education* as a socio-economic position indicator was measured by asking respondents the question "What is your highest educational degree attained?" Possible responses were *Unfinished elementary/Finished elementary/Apprenticeship/Secondary/University*. We merged first two categories into one category: *Elementary,* and last two categories into one category: *Higher* education. Respondents were asked whether they *currently smoke* cigarettes, cigars, pipes or tobacco and could answer by selecting from the following options: (1) I do not smoke, (2) I smoke sometimes but not daily, (3) I smoke daily and (4) I smoked in the past, but I quit completely.

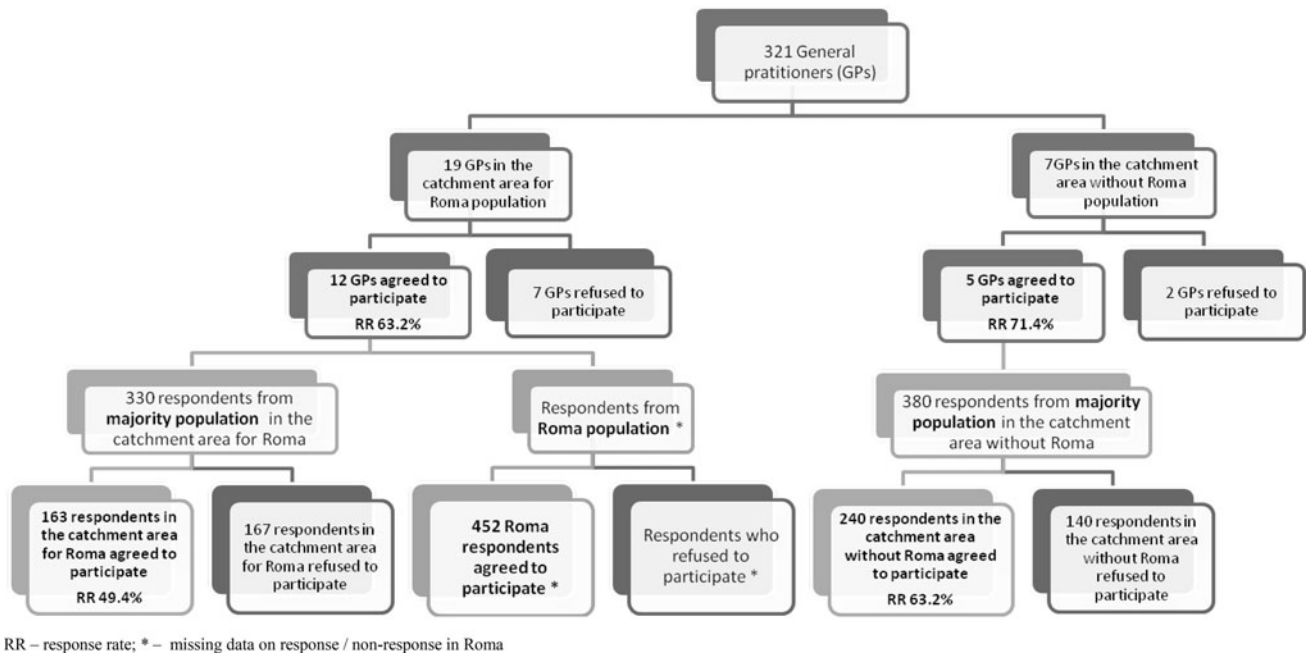

Fig. 1 Recruitment of the Roma and non-Roma population in the Hepa-Meta study, Slovakia, 2011; *RR* response rate, * missing data on response/non-response in Roma

Anthropometric measurements

Height and weight were measured using a scale with an altimeter. *Waist and hip circumferences* were measured using plastic tapes, with the waist midway between the lowest rib and the iliac crest and with the subject standing after a gentle exhalation, and hips at the greater trochanters. *Body mass index (BMI) and waist/hip ration* (WHR) were calculated.

Physical measurements

Blood pressure was taken using the Omron M3 digital automatic blood pressure monitor after 5 min of rest in a sitting position. The mean value of three blood pressure measurements was used in the analysis.

Biochemical measurements

Total cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides and glucose were determined by the enzymatic method, and *HDL cholesterol* was determined by the immuno-inhibition method. The *atherogenic index* was calculated as a ratio of total cholesterol and HDL cholesterol. Collection of venous blood was carried out under standard conditions, after fasting and in a seated position, from a peripheral vein in the antecubital fossa. Samples were collected and transported in accordance with standard operating procedures for sampling and transport of biological material to the LABMED laboratory, which holds a certificate of quality management as well as the necessary professional certification for the individual examinations, in line with international standards. All endpoints were determined by the selective biochemical analyser ADVIA 2400, Siemens–Bayer.

Diagnostic criteria for MS and CVD risk factor used in the study are shown in Table 1.

Statistical analysis

We first assessed the differences between Roma and non-Roma regarding various risk factors for CVD, anthropometric measures, blood pressure measures and biochemical measures. We stratified these analyses by gender and used *t* tests to assess differences in the mean values of the risk factors and χ^2 test to assess differences in proportions. Next, we examined the contribution of Roma ethnicity to risks due to unfavourable CVD risk factors using logistic regression models adjusted for age. The dependent variables were obesity, waist circumference, high total cholesterol, high LDL cholesterol, low HDL cholesterol, high triglycerides, high glucose, smoking and high blood pressure. The independent variables were Roma/non-Roma status and dichotomised age (≤40 years/>40 years). We again stratified this by gender. Because of their strong mutual association, findings regarding Roma/non-Roma status and level of education showed effects of collinearity. Therefore, in the subsequent analyses we used only Roma/non-Roma status and stratified these analyses by level of education to assess the effect of that variable on the ethnic differences. The analyses were performed with SPSS version 16 and Stata version 11.

Results

The analyses were performed on the sample of 452 Roma (mean age = 34.7, SD = 9.14, 35.2 % men) and 403 non-Roma (mean age = 33.5, SD = 7.4, 45.9 % men) respondents.

Characteristics of the sample by ethnicity

Roma women had a significantly higher BMI index, WHR index and waist circumference than non-Roma women. Roma men and women had significantly lower mean levels of total cholesterol, HDL cholesterol and significantly higher mean levels of atherogenic index. There were no significant differences between Roma and non-Roma participants regarding mean age, levels of triglycerides and glucose and blood pressure (Table 2).

Risk factors by ethnicity

Examination of the individual biological measures revealed that low HDL cholesterol was the most prevalent high-risk

Table 1 Diagnostic criteria used for cardiovascular diseases risk factor in the Hepa-Meta study, Slovakia, 2011

Risk factor	Cut-off points
Glucose	≥5.6 mmol/l*
Triglycerides	≥1.7 mmol/l*
Total cholesterol	≥5.0 mmol/l***
HDL cholesterol	<1.0 mmol/l (men)*, < 1.3 mmol/l (women)*
LDL cholesterol	≥3.0 mmol/l**
Blood pressure	≥130/85 mmHg*
Obesity	BMI index ≥30**
Waist circumference	≥94 cm (men)*, ≥80 cm (women)*
Smoking	Daily

* criteria defined by International Diabetes Federation (Zimmet et al. 2005)

** criterion defined by the Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and the European Atherosclerosis Society (Catapano et al. 2011)

*** criterion defined by European guidelines on cardiovascular disease prevention in clinical practice: executive summary (Graham et al. 2007)

Table 2 Basic characteristics of the Roma and non-Roma samples by gender (Hepa-Meta 2011, Slovakia) and *p* values for differences between Roma and non-Roma in the Hepa-Meta study, Slovakia, 2011

	Male		*p* value	Female		*p* value
	Roma ($n = 159$) Mean (STD)	Non-Roma ($n = 185$) Mean (STD)		Roma ($n = 293$) Mean (STD)	Non-Roma ($n = 218$) Mean (STD)	
Age	33.78 (9.25)	33.03 (7.41)	n.s.[a]	35.16 (9.06)	33.92 (7.40)	n.s.[a]
Height, cm	169.41 (6.87)	177.92 (7.25)	***[a]	155.89 (6.74)	165.51 (6.91)	***[a]
Weight, kg	76.65 (17.67)	81.80 (15.09)	**[a]	64.05 (14.99)	65.96 (13.17)	n.s.[a]
BMI index, kg/m^2	26.79 (5.94)	25.79 (4.26)	n.s.[a]	26.44 (6.01)	24.07 (4.36)	***[a]
WHR index	0.91 (0.10)	0.92 (0.63)	n.s.[a]	0.85 (0.06)	0.79 (0.07)	***[a]
Waist circumference, cm	93.35 (15.20)	91.99 (11.34)	n.s.[a]	87.16 (13.55)	80.78 (12.46)	***[a]
Total cholesterol (TC), mmol/l	4.67 (0.99)	5.16 (1.06)	***[a]	4.83 (0.99)	5.10 (0.87)	***[a]
LDL cholesterol, mmol/l	2.48 (0.67)	2.74 (0.74)	***[a]	2.53 (0.69)	2.55 (0.61)	n.s.[a]
HDL cholesterol, mmol/l	1.00 (0.29)	1.19 (0.28)	***[a]	1.13 (0.26)	1.42 (0.36)	***[a]
Triglycerides, mmol/l	1.53 (1.25)	1.36 (0.91)	n.s.[a]	1.24 (0.78)	1.14 (0.66)	n.s.[a]
Atherogenic index (TC/HDL)	5.01 (1.64)	4.58 (1.43)	**[a]	4.48 (1.29)	3.79 (1.11)	***[a]
Glucose, mmol/l	5.09 (1.29)	4.96 (0.61)	n.s.[a]	4.71 (0.87)	4.71 (0.57)	n.s.[a]
Systolic blood pressure, mm Hg	127.11 (15.84)	125.11 (14.08)	n.s.[a]	119.99 (18.99)	118.47 (14.69)	n.s.[a]
Diastolic blood pressure, mmHg	76.65 (12.03)	76.86 (9.89)	n.s.[a]	73.59 (11.44)	75.34 (9.52)	n.s.[a]
Education *n* (%)						
Elementary	117 (74.5)	4 (2.2)	***[b]	243 (85.0)	5 (2.4)	***[b]
Apprenticeship	36 (22.9)	47 (25.7)		37 (12.9)	37 (17.6)	
Higher	4 (2.5)	132 (72.1)		6 (2.1)	168 (80.0)	

[a] *t* test, [b] χ^2 test

** $p < 0.01$, *** $p < 0.001$, *n.s.* not significant

factor, with 55.7 % of Roma men and 75.4 % of Roma women having HDL cholesterol below the risk threshold. Rates were also high regarding waist circumference (43.3 % of men and 65.0 % of women), raised total cholesterol (34.2 % of men and 39.2 % of women), hypertension (39.5 % of men, 22 % of women) and obesity (28.9 % of men, 26.7 % of women) among Roma living in Roma settlements. Nearly half of Roma reported smoking (Table 3).

Differences by ethnicity were also found regarding obesity, waist circumference (only among women), total cholesterol, LDL cholesterol (only among men), low HDL cholesterol and smoking in the model adjusted for age.

Roma men had 2 times higher odds on obesity, 3.7 times on being a smoker and 4 times higher odds on low HDL cholesterol, but more than 2 times lower odds on raised total cholesterol and raised LDL cholesterol than non-Roma men.

Roma women had more than 2.5 times higher odds on obesity, 2 times on a waist circumference over 80 cm, nearly 4 times on being a smoker and 4.4 times on low HDL cholesterol, but more than 2 times lower odds on raised total cholesterol in comparison with non-Roma women.

Stratification by level of education yielded problems as there is a lack of Roma with higher education and lack of non-Roma with elementary education, causing a good comparison between Roma and non-Roma to be only possible for those with apprenticeship education (Table 2). The association between ethnicity and educational level was very high (gamma-coefficient = 0.980, Cramer's V = 0.851), showing that the two variables were almost exchangeable. Adjustment for educational level yielded similar findings for all risk factors in men except for HDL cholesterol, but this was due to exclusion of Roma indicator as a predictor in the first stratum, since it was a perfect (100 %) predictor. We found the same in women though such an exclusion happened for more risk factors in them.

Discussion

The aim of this study was to explore the prevalence of a series of biological CVD risk factors in population living in Roma settlements compared with non-Roma. We found that Roma had relatively unfavourable CVD risk factors compared to non-Roma. Roma women living in Roma settlements, in comparison with the majority population,

Table 3 Logistic regression (odds ratios, OR, and 95 % confidence intervals, CI) for cardiovascular diseases risk factors associated with ethnicity (adjusted for age), by gender in the Hepa-Meta study, Slovakia, 2011

	Male			Female		
	Roma ($n = 159$) *n* (%)	Non-Roma ($n = 185$) *n* (%)	OR (95 % CI)	Roma ($n = 293$) *n* (%)	Non-Roma ($n = 218$) *n* (%)	OR (95 % CI)
Obesity	45 (28.9)	30 (16.4)	1.89 (1.11–3.21)*	74 (26.7)	23 (11.0)	2.62 (1.54–4.44)***
Waist circumference	68 (43.3)	78 (42.6)	0.88 (0.56–1.38)	184 (65.0)	99 (46.7)	1.96 (1.35–3.63)***
High total cholesterol	54 (34.2)	96 (51.9)	0.41 (0.25–0.65)***	113 (39.2)	110 (50.9)	0.47 (0.32–0.70)***
High LDL cholesterol	36 (22.8)	63 (34.1)	0.51 (0.31–0.84)**	64 (22.2)	47 (21.8)	0.88 (0.56–1.38)
Low HDL cholesterol	88 (55.7)	43 (23.2)	3.96 (2.48–6.31)***	217 (75.4)	85 (39.4)	4.42 (2.99–6.54)***
High triglycerides	38 (24.1)	42 (22.7)	0.9 (0.53–1.52)	58 (20.1)	33 (15.3)	1.08 (0.66–1.77)
High glucose	21 (13.3)	21 (11.4)	1.15 (0.59–2.22)	20 (6.9)	9 (4.2)	1.36 (0.59–3.11)
Smoking	87 (54.7)	43 (23.6)	3.74 (2.35–5.96)***	127 (44.4)	33 (15.9)	4.02 (2.58–6.26)***
High blood pressure	62 (39.5)	74 (40.2)	0.91 (0.58–1.41)	61 (22.0)	49 (23.6)	0.66 (0.41–1.05)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

were more likely to have obesity and also abdominal obesity, to be a smoker, to have low HDL cholesterol, but also to have normal total cholesterol, and among Roma men also normal LDL cholesterol. We did not find differences by ethnicity regarding hypertriglyceridaemia, hyperglycaemia and hypertension.

In our study the prevalence of obesity among Roma was significantly higher than among non-Roma, particularly in women. This is in line with the previous studies indicating a higher risk of being overweight and obese among lower socio-economic groups (Roskam and Kunst 2008; Mackenbach et al. 2007) across various ethnicities (Suresh et al. 2011), including Roma (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004; Carrasco-Garrido et al. 2011), and of these being more distinct in women (Roskam and Kunst 2008; Mackenbach et al. 2007; Kavanagh et al. 2010). Some ethnic groups may have a genetic predisposition to obesity (Al-Attar et al. 2008), including Roma (Macekova et al. 2012), and this predisposition was mediated by education (Corella et al. 2012). As Roma were found to be strongly disadvantaged also in terms of education (Vasecka and Dzambazovic 2000; European Union Agency for Fundamental Rights 2009), the health gap between Roma and non-Roma is very likely to be expected. Inverse educational gradients in being overweight and obese are generally observed among European men and even more so among women (Roskam et al. 2010). Our finding of a very strong association of educational level with Roma ethnicity could be interpreted as support for the mediating role of educational level in the association between Roma ethnicity and obesity.

Our findings regarding ethnic differences in parameters of lipid metabolism partially differ from previous findings. Similar to the previous studies (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004), we found a higher prevalence of low HDL cholesterol among Roma. In contrast, we found that levels of total cholesterol and LDL cholesterol were more favourable in Roma; in other studies no differences were found (Ostrihonova and Beresova 2010; Carrasco-Garrido et al. 2011) or they were unfavourable for Roma in comparison with non-Roma (Vozarova de Courten et al. 2003). Finally, our finding of lower rates of increased triglycerides is in contrast with those of Vozarova de Courten et al. (2003) and of Ostrihonova and Beresova (2010), who found that Roma had a higher prevalence of this risk factor. These discrepancies might be caused by our sample being younger than in those other studies, ethnic differences becoming more visible at older ages (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010). In addition, differences in methodology may offer some explanation, for example, the way of collecting blood (capillary or venous) and the cut-offs that were used. This highlights the importance of keeping to (international) standards regarding this, which is a strength of the current study. Further research is needed to confirm this moderation of ethnic differences by age.

We did not find an (statistically significant) association between Roma ethnicity and hyperglycaemia. In contrast, Vozarova de Courten et al. (2003) and Ostrihonova and Beresova (2010) found a higher prevalence of hyperglycaemia among Roma in comparison with non-Roma. This discrepancy may be caused by the same factors as mentioned above regarding the lipid metabolism parameters. In particular, hyperglycaemia and type 2 diabetes mellitus are mostly observed in populations aged 40 years

and over, but in our study 74.1 % of the participants were younger. The relatively low prevalence of hyperglycaemia among the Roma in our sample because of their young age may also add to our finding that rates of hypertriglyceridaemia were not elevated among them either, as poorly regulated hyperglycaemia has been shown to make hypertriglyceridaemia more likely (Sundquist et al. 2011). Despite evidence for an association between socio-economic disadvantage and hypertension (Grotto et al. 2008), we did not find any differences in the prevalence of hypertension between Roma and non-Roma. However, our findings are in line with other studies carried out among Roma in Slovakia and Spain (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004; Carrasco-Garrido et al. 2011). Moreover, one study even found a lower risk of hypertension among Roma than in the majority population, in Croatia (Zeljko et al. 2008). This contracts the assumption that socio-economic disadvantage is associated with hypertension. The specific protective factors among Roma, for example, connected to their diet of genetic make-up, deserve additional study.

Similar to most previous studies, we found a higher prevalence of smoking among Roma than among non-Roma (Vozarova de Courten et al. 2003; Ostrihonova and Beresova 2010; Krajcovicova–Kudlackova et al. 2004; Peters et al. 2009; Voko et al. 2009). For example, Kosa et al. (2007) found heavy smoking to be 2–5 times more prevalent among Roma living in settlements in Hungary in comparison with the general population. However, the gender breakdown of smokers shows differences between countries. While the prevalence of daily smoking among men in most countries is more than 50 %, among women clear differences were revealed (Rodriguez and Derecho 2009). The highest prevalence of smoking among women was found in the Czech Republic (54 %) and in Greece (47 %); the lowest prevalence was reported in Portugal (4 %) and Spain (14 %) (Rodriguez and Derecho 2009). Carrasco-Garrido et al. (2011) also reported findings that show Roma women smoked significantly less than non-Roma women in Spain. Cultural background, myths and stereotypes, family traditions, attitudes, beliefs and values underpin health-related behaviour in this group and could explain a part of these different patterns of smoking across various studies (Nielsen and Krasnik 2010; Kosa and Adany 2007; Cleemput et al. 2007). Roma people consider smoking as a part of their ethnic and individual identity, and they do not regard smoking as a health risk (Petek et al. 2006; Belak 2005). Moreover, Roma are more resistant to efforts to limit tobacco use, especially policies that attempt to limit access to tobacco by minors and to eliminate smoking in public places (Paulik et al. 2011). At the same time, discrepancies in findings between studies in different countries on smoking among Roma and non-Roma population might be also explained by the effect of assimilation. In various countries this tendency of a minority population to cling to a typical behaviour of the majority of population might lead to different behaviour as countries differ in prevalent behaviour (e.g. smoking) as well as policies targeting this behaviour (e.g. smoking-related policies).

To obtain a more comprehensive picture of cardiovascular disease risk factors among Roma, it is essential to also consider a broader set of other health-related behaviours, such as eating habits, physical activity and alcohol consumption.

Strengths of our study are that we were able to collect data on biological risk factors for metabolic syndrome and CVD from a large sample of a hard-to-reach population of Roma living in settlements. This was achieved by following principles of community-based participatory research through engaging Roma community workers. Compared with other studies concerning Roma which collected self-reported data by asking respondents questions, we collected more reliable data by making use of blood samples and anthropometric measures.

However, our study also has some limitations. First, we were not able to compute response rates among Roma since recruitment of the Roma sample took place directly in settlements under difficult to control circumstances. However, we were able to collect some information on reasons for non-response among Roma. These were mostly unrelated to the outcomes as assessed, being were fear of blood-taking and a reluctance or fear to visit a general practitioner. Another limitation may be the relatively low response rate (56 %) of the majority population. Again, reasons for non-response seem to be unrelated to the outcomes, though. The main reasons for non-response were that respondents were not able to take a time off from work during the week of data collection, were busy at the moment, were not interested or in case of postal invitation that we did not reach recipient. Third, data on behaviour were collected differently among Roma and non-Roma by interview and by questionnaire, respectively. However, findings on biological and behavioural outcomes fully pointed in the same direction. Moreover, our results should be generalised with caution, as Roma are a heterogeneous group regarding living conditions and levels of integration. The results can be generalised in particular to Roma living in Roma settlements.

We found higher rates of smoking, low HDL cholesterol and obesity among Roma. This higher prevalence of CVD risk factors along with perceived barriers to health care (Jarcuska et al. 2013) may be the reason for the increased CVD morbidity and mortality among Roma in the elderly compared with non-Roma. Therefore, there is a need for early prevention in this minority population as well as for

changes in the provision of health care services. Health literacy should also be addressed due to its association with both health-related behaviour and the ability to benefit from health care services. As poverty and social exclusion considerably limit the opportunities of this ethnical minority, these should not be neglected in this process. Finally, our findings deserve confirmation in other groups of Roma, as those living in settlements are probably the most disadvantaged group among them.

Acknowledgements This project was partially supported by Roche Slovensko, s.r.o., and the Agency of the Slovak Ministry of Education for the Structural Funds of the EU, under project ITMS: 26220120058.

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