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Diabetes Research and Clinical Practice 62 (2003) 95–103
DIABETES RESEARCH AND CLINICAL PRACTICE
www.elsevier.com/locate/diabres

Higher prevalence of type 2 diabetes, metabolic syndrome and cardiovascular diseases in gypsies than in non-gypsies in Slovakia

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Received 28 March 2003; received in revised form 13 May 2003; accepted 24 June 2003

Abstract

Objective: Gypsies (or Roma) recently experienced a transition from a traditional to a Westernized lifestyle. Although mortality in this population is 4-fold higher compared with non-Gypsies, very limited information is available on their morbidity especially with regard to non-communicable diseases. Our aim was to determine the prevalence of type 2 diabetes mellitus (T2DM), metabolic syndrome and cardiovascular diseases in Gypsies and non-Gypsies living in the same region of southern Slovakia. *Materials and methods:* We examined 156 Gypsies and 501 non-Gypsies who participated in a population survey. Age- and sex-standardized prevalence rates were computed for each of the following: T2DM, obesity, hyperlipidemia, hypertension, hyperinsulinemia, elevated albumin/creatinine ratio (ACR), metabolic syndrome and cardiovascular disease. *Results:* Age–sex standardized prevalence of T2DM was 30% (95% CI = 22–39) in Gypsies and 10% (8–13, $P = 0.0001$ for comparison of ethnic groups) in non-Gypsies. Corresponding prevalence of the other variables are: 65% (56–74) and 30% (26–34, $P = 0.0001$) for obesity, 69% (61–76) and 59% (54–63, $P = 0.04$) for hypercholesterolemia, 66% (59–74) and 39% (35–43, $P = 0.009$) for hypertriglyceridemia, 49% (42–56) and 43% (39–47, $P = 0.1$) for hypertension, 33% (26–50) and 8% (2–14, $P = 0.002$) for hyperinsulinemia, 16% (9–22) and 5% (3–7, $P = 0.0001$) for elevated ACR, 20% (12–27) and 4% (3–6, $P = 0.0001$) for metabolic syndrome and 35% (28–43) and 26% (22–29, $P = 0.004$) for cardiovascular disease. *Conclusions:* Compared with non-Gypsies,

Abbreviations: ACR, albumin/creatinine ratio; BMI, body mass index; NGT, normal glucose tolerance; T2DM, type 2 diabetes; WHR, waist to hip ratio.

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doi:10.1016/S0168-8227(03)00162-1

Gypsies had a much higher prevalence of T2DM, metabolic syndrome and cardiovascular disease, which may contribute to their higher mortality.

Keywords: Ethnicity; Roma; Obesity; Cardiovascular disease; Type 2 diabetes

1. Introduction

Linguistic and genetic analyses suggest that Gypsies (a.k.a Roma, Romany) originated in Northern India. They arrived in the Balkans in the 14th century and then dispersed throughout Europe. Although originally welcomed, their way of life soon was considered antisocial. Punitive policies were established throughout Europe that prohibited travel, trade, assembling, the use of their language and wearing traditional dress. After World War II, Gypsies were forced by compulsory assimilation policies in many post-war communist countries to settle in communities and education in schools was encouraged [1]. Because of their present and historical isolation, Gypsies only rarely marry non-Gypsies and consanguineous marriages are quite common [2]. Today there are an estimated 8–12 million Gypsies scattered throughout Europe, with over 5 million living in countries of central and Eastern Europe [1]. Slovakia has one of the largest Gypsy populations [3].

The age distribution of the Gypsy population in Slovakia is similar to that of populations in developing countries [3,4]. In comparison to the world standard population [5], Gypsies have a greater proportion of children and adolescents but fewer older people [3]. Mortality among Gypsies is estimated to be 4-fold that of non-Gypsies [6] and the average life expectancy is 15 years lower [3]. In spite of a high mortality rate, very limited information is available on morbidity among Gypsies especially with regard to non-communicable diseases [3]. Gypsies are one of the populations that have recently experienced a rapid transition from a traditional lifestyle [3] characterized by high levels of physical activity and a diet with relatively low energy (but high nutrient) density to a more sedentary lifestyle with high caloric intake. Such populations often exhibit extreme rates of obesity, type 2 diabetes mellitus (T2DM), and cardiovascular diseases in contrast with societies maintaining a more traditional lifestyle [7–9]. Empirical observations from the regional out-patient clinic in Samorin (southern Slovakia) suggest that when compared with non-Gypsies, Gypsies have a higher prevalence of T2DM. We are aware of only one small study, which reported a high prevalence of obesity, diabetes, dyslipidemia and hypertension in 58 Gypsies living in Boston, MA [2].

Therefore, our aim was to examine the prevalence of T2DM, metabolic syndrome and cardiovascular diseases in Gypsies and non-Gypsies living in the same region of rural southern Slovakia.

2. Research design and methods

2.1. Subjects

Participants in this study were residents of Zlate Klasy, a small village located in southern Slovakia approximately 10 km from the next larger city Samorin, and 35 km from the capital of Slovakia, Bratislava. High unemployment rates (47%) for the entire village of whom 80% are Gypsies, low family income and a lack of accessible leisure options characterize daily life in this village. Concerning the standard of living, unemployment rates and family income for non-Gypsies, the village is comparable to the rest of rural Slovakia. At the time of the start of the survey (September 1998), the population of Zlate Klasy was approximately 1800, with 40% being Gypsies. All inhabitants ≥ 30 years of age received a written invitation to participate in the study. The individual names and addresses based on the 1998 voting census were provided by the mayor's office. According to the voting census from 1998, the total population of Zlate Klasy (≥ 30 years of age and later referred to as the total population) was 951 non-Gypsies (457 M/494 F) and 550 Gypsies (280 M/270 F). If the invitee did not appear for the exam, the same written invitation was sent to him/her two more times. Subsequent attempts did not significantly improve the response rate. Written invitations were reinforced by public radio announcements from the mayor's office. The response rate was 53% for non-Gypsies (230 M/271 F) and 28% for Gypsies (70 M/86 F). The protocol was approved by the Institutional Review and Ethics Board of the regional hospital and outpatient clinic in Samorin. All subjects provided written informed consent prior to participation.

2.2. Methods

During the 18-month study period, all subjects were given a basic physical and laboratory examination and were asked to complete a questionnaire written in Slovak (the common language used by both ethnic groups) within the same day. Questionnaires were answered in the presence of a physician who provided assistance in interpretation of the questions and ensured confidentiality. The questions addressed family and personal medical histories, with an emphasis on risk factors for diabetes and cardiovascular disease. Data concerning socio-economic background, and consumption of alcohol, tobacco and medications were also collected. Heavy use of tobacco was defined as smoking ten or more cigarettes per day. Increased alcohol consumption was defined as drinking more than two beers, two glasses of wine, or 50 ml of distilled spirits per day (ca. 1.5–2 standard drinks). Low leisure time physical activity was defined as performing sports $\leq$ twice a day. A physical examination was performed by one of three physicians (BV, AZ, HPE). Measurements of weight and height were used to calculate body mass index (BMI). Waist circumference was measured at the midpoint between the lower rib margin and the iliac crest and the hip circumference was measured at the level of the trochanter. Waist to hip ratio (WHR) was used as a measure of central obesity. Blood pressure was measured once, in the sitting position, after 5 min of rest, using a manual mercury sphygmomanometer. Blood samples for laboratory examination were obtained after an overnight fast. Plasma samples for glucose, insulin, total cholesterol and triglycerides were collected for measurement in all subjects. HDL and LDL-cholesterol were measured in the first 371 participants (78 Gypsies and 293 non-Gypsies). Plasma glucose was measured by the glucose oxidase method (DIALAB GES.MBH); insulin was assessed by radioimmunoassay IRMA (Immunotech); and total cholesterol and triglycerides were measured by enzymatic methods (Cholesterol PAP, MA-kit 100, Roche, Triglycerides PAP, Uni-kit III, Roche). HDL-cholesterol was assessed using a precipitation procedure with dextran sulfate and magnesium chloride and LDL-cholesterol was calculated according to the Friedewald formula [10]. First morning urine samples were collected to measure urine albumin using an Immunotech Albumin RIA kit (Immunotech) and urine creatinine by the kinetic Jaffé fys-1 method (Roche). Urine creatinine and albumin were used for calculation of albumin/creatinine ratio (ACR). Insulin resistance was estimated using fasting plasma glucose and insulin concentrations by the HOMA-IR equation [11].

Diabetes was defined according to WHO criteria [12] for fasting plasma glucose levels ≥ 7.0 mmol/l. The total prevalence of T2DM was calculated from newly diagnosed diabetes and previously diagnosed diabetes (medical documentation). Obesity was defined at BMI ≥ 30 kg/m^2 [13]; central obesity at WHR in males > 0.90 and in females WHR > 0.85; hypercholesterolemia at fasting plasma cholesterol concentration ≥ 5.2 mmol/l; hypertriglyceridemia at triglyceride concentration ≥ 1.7 mmol/l; hyperinsulinemia at fasting plasma insulin > 20 μU/ml; and elevated ACR as > 2.5 mg/mmol in males and > 3.5 mg/mmol in females [14]. Hypertension was defined as either systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg if previously non-diagnosed or having a history of hypertension or use of antihypertensive medication [15]. Insulin resistance (HOMA-IR) was defined at the upper quartile of the distribution of HOMA-IR values for the total study population. Metabolic syndrome was defined as having insulin resistance

(HOMA-IR) or T2DM plus two of the following: hypertension, hypertriglyceridemia, obesity (or central obesity), and microalbuminuria (ACR > 3.4 mg/mmol (30 mg/g)) [12,14]. Cardiovascular disease was defined as either a self-reported history of any form of ischemic heart disease and/or stroke and/or peripheral vascular disease or from medical documentation.

2.3. Statistical analyses

Statistical analyses were performed using the software of the SAS Institute (Cary, NC). Prior to analysis, values for plasma glucose, insulin, cholesterol, triglycerides, ACR and HOMA-IR were logarithmically transformed to reduce skewness. Age- and sex-standardized prevalence of T2DM, obesity, central obesity, hyperlipidemia, hypertension, hyperinsulinemia, insulin resistance and elevated ACR were computed by the direct method using the total population as a reference. Differences between ethnic groups to the answers of the questionnaire and development of diabetes and cardiovascular disease were assessed by analysis of contingency tables and logistic regression to allow adjustments for age and sex. Logistic regression was used to investigate the relationships between diabetes/cardiovascular disease and risk factors of diabetes/cardiovascular disease after adjustment for covariates. Multiple linear regression models were used to examine the relationships between metabolic and anthropometric variables after adjusting for covariates.

3. Results

In general, participating Gypsies were younger (47 vs. 52 years, respectively), heavier (87 vs. 78 kg) and had a higher BMI (32 vs. 28 kg/m^2) and WHR (0.91 vs. 0.87) when compared with non-Gypsies (all $P < 0.0001$). Gypsies also reported higher smoking rates (42 vs. 21%, respectively, $P = 0.001$), less physical activity (3 vs. 14%, $P = 0.001$) and lower levels of education (24 and 58%, $P = 0.0001$ for high school and university education) than non-Gypsies. Thirty-eight percent of Gypsies were unemployed and 30% had monthly income less than 2000 Slovak crowns (equivalent of US$ 40) compared with 5 and 4% of non-Gypsies (both $P = 0.001$), respectively.

3.1. Prevalence of T2DM, metabolic syndrome and cardiovascular disease

The age- and sex-standardized prevalence of obesity was more than two-times higher in Gypsies than in non-Gypsies, while the prevalence of T2DM was three-times higher. Gypsies had also higher prevalence rates of hypercholesterolemia, hypertriglyceridemia, hyperinsulinemia, insulin resistance, elevated ACR, metabolic syndrome and cardiovascular disease but similar rates of hypertension (Table 1).

3.2. Risk factors for obesity, type 2 diabetes and cardiovascular diseases

3.2.1. Obesity

Lower education, income levels and higher levels of physical inactivity (all $P < 0.05$) were associated with a higher BMI, after adjustment for age, sex, alcohol consumption, income and ethnicity. After adjustment for age, sex, income, education, alcohol consumption, and level of physical activity, BMI was higher in Gypsies compared with non-Gypsies (31 and 28 kg/m^2, respectively, $P = 0.0001$).

3.2.2. Type 2 diabetes and cardiovascular diseases

Potential risk factors for T2DM and cardiovascular diseases are summarized in Tables 2 and 3. Ethnicity (being Gypsy) was an independent risk factor of T2DM but not for cardiovascular diseases.

3.3. Analyses of non-diabetic subjects

The anthropometric and metabolic characteristics of non-diabetic Gypsies and non-Gypsies adjusted for age and sex are summarized in Table 4. Plasma insulin, triglycerides, and ACR were additionally adjusted for BMI, WHR and plasma glucose. After this adjustment, plasma insulin and insulin resistance remained higher in Gypsies than in non-Gypsies (both $P < 0.0005$). Plasma trigly-

Table 1
Age–sex standardized prevalence of risk factors for T2DM, metabolic syndrome and cardiovascular disease in Gypsy and non-Gypsy populations in southern Slovakia

	Gypsies $N = 156$	Non-Gypsies $N = 501$	P-value
T2DM	30% (22–39)	10% (8–13)	0.0001
Undiagnosed type 2 diabetes	11% (4–18)	6% (3–8)	0.04
Obesity	65% (56–74)	30% (26–34)	0.0001
Central obesity	38% (31–44)	20% (16–23)	0.04
Hypercholesterolemia	69% (61–76)	59% (54–63)	0.04
Undiagnosed hypercholesterolemia	61% (52–70)	54% (49–59)	0.2
Hypertriglyceridemia	66% (59–74)	39% (35–43)	0.009
Undiagnosed hypertriglyceridemia	57% (49–66)	31% (30–36)	0.0001
Hypertension	49% (42–56)	43% (39–47)	0.1
Undiagnosed hypertension	16% (9–23)	23% (18–27)	0.8
Hyperinsulinemia	33% (26–50)	8% (2.2–14)	0.002
Insulin resistance (HOMA)	54% (46–62)	22% (18–26)	0.005
Increased ACR	16% (9–22)	5% (3–7)	0.0001
Metabolic syndrome	20% (12–27)	4% (3–6)	0.0001
Cardiovascular disease	35% (28–43)	26% (22–29)	0.004

Unless indicated otherwise, prevalence represents total combined prevalence rates of the disease, i.e. diagnosis made prior to survey examination (medical documentation) and newly diagnosed disease. Results are presented as age–sex adjusted prevalence rates and 95% confidence intervals.

cerides were also higher in Gypsies after additional adjustment for cholesterol, and alcohol consumption ($P = 0.002$). ACR was higher in Gypsies ($P = 0.0001$) after additional adjustment for blood pressure level and presence of white blood cells in the urine. When analyses were performed in a subgroup of non-diabetic subjects free of cardiovascular disease, BMI, WHR, plasma triglycer-

Table 2
Factors potentially associated with T2DM in the whole population

	Univarate model		Multivariate model	
	Odds ratio	P	Odds ratio	P
Low education	1.2 (0.7–2.0)	0.6	–	–
Unemployment	0.6 (0.3–1.3)	0.2	–	–
Monthly income higher than $40 per person	0.8 (0.4–1.8)	0.6	–	–
Active in sports	1.8 (0.6–5.4)	0.3	–	–
Age (per 10 years)	2.1 (1.8–2.7)	0.0001	2.1 (1.6–2.8)	0.0008
Sex (female vs. male)	0.8 (0.5–3.7)	0.4	–	–
BMI (per 5 kg/m^2)	2.0 (1.5–2.6)	0.0001	1.4 (1.1–2.0)	0.05
WHR (per 0.1)	1.6 (1.1–2.3)	0.02	1.1 (0.8–1.4)	0.6
Insulin resistance (μU/ml mmol per l)	1.4 (1.2–1.5)	0.0001	1.3 (1.2–1.5)	0.0001
Plasma cholesterol (mmol/l)	0.7 (0.05–6.1)	0.8	–	–
Plasma triglycerides (mmol/l)	5.9 (1.6–6.9)	0.0003	1.7 (0.3–8.1)	0.5
ACR (mg/mmol)	2.4 (1.4–3.9)	0.0007	1.9 (0.9–3.9)	0.09
Systolic blood pressure (per 10 mmHg)	1.0 (0.9–1.1)	0.8	–	–
Diastolic blood pressure (per 10 mmHg)	0.8 (0.7–1.0)	0.04	0.8 (0.6–1.1)	0.2
Ethnicity (non-Gypsy vs. Gypsy)	0.3 (0.2–0.5)	0.0001	0.3 (0.1–0.9)	0.03

Univariate risk factors are adjusted for age, sex and ethnicity (except for age and sex, which are adjusted only for ethnicity). Questionnaire answers compare no vs. yes answers. Only significant univariate risk factors were entered into the multivariate model. If the factor was not significant in the multivariate analysis, it was not independent of other variables.

Table 3
Factors potentially associated with cardiovascular diseases in the whole population

	Univariate model		Multivariate model	
	Odds ratio	P	Odds ratio	P
Low education	1.2 (0.8–2.0)	0.07	–	–
Smoking	2.6 (1.5–4.5)	0.0009	1.5 (0.7–3.0)	0.3
Increased consumption of alcohol	1.9 (1.0–3.6)	0.04	1.8 (0.9–3.4)	0.08
Unemployment	2.0 (1.0–4.0)	0.04	2.5 (1.1–10.0)	0.02
Monthly income higher than $40 person	0.4 (0.2–0.9)	0.03	0.6 (0.2–1.9)	0.4
Active in sports	0.8 (0.4–1.7)	0.6	–	–
Age (per 10 years)	3.5 (2.8–4.2)	0.004	3.4 (2.5–4.6)	0.0001
Sex (female vs. male)	1.3 (0.9–1.9)	0.9	–	–
BMI (per 5 kg/m^2)	1.7 (1.4–2.2)	0.0001	1.2 (0.8–1.5)	0.2
WHR (per 0.1)	1.0 (0.9–1.0)	0.8	–	–
Insulin resistance (μU/ml mmol per l)	4.7 (2.1–10.0)	0.0001	1.2 (1.1–1.3)	0.01
Plasma cholesterol (mmol/l)	3.2 (0.3–39.2)	0.4	–	–
Plasma triglycerides (mmol/l)	8.3 (3.2–21.3)	0.0001	4.3 (1.9–13.1)	0.01
ACR (mg/mmol)	2.4 (1.4–4.2)	0.003	2.1 (1.2–3.9)	0.01
Systolic blood pressure (per 10 mmHg)	1.4 (1.2–1.5)	0.0001	1.1 (0.9–1.3)	0.5
Diastolic blood pressure (per 10 mmHg)	1.8 (1.5–2.3)	0.0002	1.7 (1.2–2.5)	0.007
Ethnicity (non-Gypsy vs. Gypsy)	0.5 (0.3–0.8)	0.004	0.6 (0.3–1.3)	0.2

Univariate risk factors are adjusted for age, sex and ethnicity (except for age and sex, which are adjusted only for ethnicity). Questionnaire answers compare no vs. yes answers. Only significant univariate risk factors were entered into the multivariate model. If the factor was not significant in the multivariate analysis, it was not independent of other variables.

ides, insulin, ACR and insulin resistance, were all higher in Gypsies compared with non-Gypsies (all $P < 0.001$).

4. Discussion

In the present study, we found that Gypsies had a much higher prevalence of T2DM, metabolic syndrome, and cardiovascular disease when compared with non-Gypsies from the same village in southern Slovakia. The higher prevalence of T2DM and cardiovascular diseases in Gypsies compared with non-Gypsies are paralleled by higher prevalence of risk factors including obesity, insulin resistance, hyperlipidemia, and elevated ACR. Moreover, non-diabetic Gypsies were more obese and insulin resistant and had higher plasma triglyceride concentrations and urinary ACR compared with non-Gypsies.

Presence of more risk factors for obesity, T2DM and cardiovascular disease in Gypsies compared with non-Gypsies could be explained, in part, by lifestyle factors such as physical inactivity, higher smoking rates, lower levels of education and socioeconomic status. Children in traditional Gypsy families are raised in a different social and cultural environment than their counterparts in the majority population of Slovakia [3]. It is estimated that 75–85% of Gypsy children do not complete primary education. This compromises their ability to compete in the job market, which translates into social problems marked by low income and high unemployment [3]. As in our study, low socioeconomic status was found to be a risk factor for cardiovascular disease in other populations such as aboriginal people of Canada [16] and urban Swedes [17].

In contrast to other risk factors for the metabolic syndrome and cardiovascular diseases, the prevalence of total as well as undiagnosed hypertension was similar in Gypsies and non-Gypsies. A small study of 58 Gypsies living in Massachusetts showed a similarly high prevalence of T2DM, hyperlipidemia and chronic renal insufficiency, but also a high prevalence of hypertension and occlusive vascular disease [2]. That study, however, did not provide data in a non-Gypsy population for

Table 4
Physical and metabolic characteristics of non-diabetic Gypsies and non-Gypsies in Slovakia

	Gypsies ($n=134$) (64 M/70 F)	Non-Gypsies ($n=436$) (180 M/256 F)
Age (years)	46±9	51±13*
Height (cm)	165±8	167±9
Weight (kg)	84±16	77±15****
BMI (kg/m^2)	32±5	28±5****
WHR	0.91±0.06	0.87±0.08****
Fasting plasma glucose (mmol/l)	5.4±0.8	5.5±0.6
Fasting plasma insulin (μU/ml)	10.6±5.2	7.0±4.3****
Insulin resistance (HOMA; μU/ml mmol per l)	2.8±1.5	1.8±1.2****
Systolic blood pressure (mmHg)	132±21	133±19
Diastolic blood pressure (mmHg)	81±13	82±11
Total plasma cholesterol (mmol/l)	5.6±1.0	5.7±1.2
HDL cholesterol (mmol/l)[a]	1.5±0.3	1.7±0.4****
LDL cholesterol (mmol/l)[a]	3.3±1.0	3.5±1.1
Plasma triglycerides (mmol/l)	2.4±2.2	1.6±1.2****
ACR (mg/mmol)	2.6±6.8	0.9±2.7****

Asterisks indicate significant differences (adjusted for age and sex, except for age) between Gypsies and non-Gypsies (ANOVA). *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; ****, $P < 0.0001$.
[a] HDL and LDL cholesterol are available in a subgroup of 78 Gypsies and 293 non-Gypsies.

comparison. The similar prevalence of hypertension in Gypsies and non-Gypsies in our study was unexpected since Gypsies had a higher prevalence of risk factors for hypertension such as obesity and a higher prevalence of cardiovascular diseases. Low eduction and socio-economic status are most likely linked with higher prevalence rates of undiagnosed T2DM and hypertriglyceridemia. Initiating long-term diabetes and cardiovascular detection programs tailored to the characteristics of the Gypsy population could, therefore, be of great benefit for the improvement of morbidity and mortality in Gypsies.

Low levels of education and income and higher levels of physical inactivity were associated with obesity in our study population. After adjustments for these covariates, BMI was still higher in Gypsies than in non-Gypsies suggesting that other factors (which were not measured and/or are genetic) may play a larger role in the development of obesity in this population. Gypsies belong to one of the populations that experienced rapid transition from a traditional lifestyle, characterized by high levels of physical activity and a diet with a relatively low energy (but high nutrient) density to a more sedentary lifestyle with an excess of caloric intake [18]. Such populations often exhibit extreme rates of obesity, T2DM and cardiovascular diseases [7] as is observed in Australian Aboriginal people [7], Pima Indians [8] and Pacific Islanders [9]. It has been hypothesized that the high prevalence of a “thrifty genotype” in these populations is due to a selective advantage in the “feast and famine” conditions that historically characterized the traditional environment [19].

The fact that ethnicity was associated with T2DM after adjustment for key risk factors for diabetes such as obesity [20] and insulin resistance [8] suggests that the observed ethnic differences were due to other factors which may be genetic. We showed that higher diastolic blood pressure, ACR, triglyceride levels, insulin resistance, age and unemployment but not ethnicity were risk factors for cardiovascular disease in our study. Nozdrovicky [21], who for 11 years followed a community of Gypsies in Slovakia, reported that cardiovascular diseases were the most common cause of death. He showed that high consumption of animal fat, low consumption of fruit and vegetables, obesity, smoking, lack of physical activity and increased consumption of alcohol were the most important determinants of cardiovascular morbidity and mortality in Gypsies [21].

An obvious limitation of this survey is the low response rate. There are two possible explanations for this: (1) the voting census which we used for calculations of the response rate might have overestimated the actual number of people living in the village, and (2) the only incentive to participate in the study was a free medical check-up. Since health care in Slovakia is free, this would not represent a big incentive. Failure to recruit more volunteers is a common issue particular to studies in the Gypsy community. In addition, a described poor health consciousness [1] could be a reason why there is so little information available on health issues of Gypsies. The investigators, however, refrained from paying volunteers for their participation to avoid recruitment bias. As only 28% of Gypsies but 53% of non-Gypsies participated in our study, our data could in addition suffer from preferential selection bias, i.e. more Gypsies affected by T2DM, cardiovascular disease or related conditions participated in the study. However, we show that non-diabetic Gypsies without cardiovascular disease were also more obese and insulin resistant and had higher triglyceride concentrations and ACR than non-diabetic non-Gypsies without cardiovascular disease. This suggests that healthy Gypsies already may be at higher risk for the development of T2DM and cardiovascular disease than non-Gypsies.

In conclusion, the high prevalence of T2DM, cardiovascular disease and their common risk factors in the Gypsy population may be a reason for their higher mortality in comparison with non-Gypsies. Although this hypothesis still needs to be tested in longitudinal studies, cardiovascular disease and diabetes prevention programs should take into account the particular burdens and characteristics of Gypsy communities.

Acknowledgements

The authors wish to thank the Berlin Chemie-Menarini Group for financial contributions to this research. We also gratefully acknowledge the nurses of the regional hospital in Samorin, the staff of the local laboratory and all the participants of this study. The first author also wants to acknowledge specifically the support received from Darina Krizanovicova Vozarova and regrets that she could not see this work published.

References

[1] S. Hajioff, M. McKee, The health of the Roma people: a review of the published literature, J. Epidemiol. Community Health 54 (11) (2000) 864–869.

[2] J.D. Thomas, M.M. Doucette, D.C. Thomas, J.D. Stoeckle, Disease, lifestyle, and consanguinity in 58 American gypsies, Lancet 2 (8555) (1987) 377–379.

[3] I. Koupilova, H. Epstein, J. Holcik, S. Hajioff, M. McKee, Health needs of the Roma population in the Czech and Slovak Republics, Soc. Sci. Med. 53 (9) (2001) 1191–1204.

[4] E. Ginter, M. Krajcovicova-Kudlackova, O. Kacala, V. Kovacic, M. Valachovicova, Health status of Romanies (Gypsies) in the Slovak Republic and in the neighbouring countries, Bratisl. Lek. Listy 102 (10) (2001) 479–484.

[5] Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects, The 2000 Revision 2002; http://www.un.org/esa/population/demobase.

[6] M. Braham, The Untouchables: A Survey of the Roma People of Central and Eastern Europe, UNHCR, Geneva, 1993.

[7] R. McDermott, K.G. Rowley, A.J. Lee, S. Knight, K. O'Dea, Increase in prevalence of obesity and diabetes and decrease in plasma cholesterol in a central Australian aboriginal community, Med. J. Aust. 172 (10) (2000) 480–484.

[8] W.C. Knowler, D.J. Pettitt, M.F. Saad, P.H. Bennett, Diabetes mellitus in the Pima Indians: incidence, risk factors and pathogenesis, Diabetes Metab. Rev. 6 (1) (1990) 1–27.

[9] P.Z. Zimmet, D.J. McCarty, M. de Courten, The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome, J. Diabetes Complications 11 (2) (1997) 60–68.

[10] W.T. Friedewald, R.I. Levy, D.S. Fredrickson, Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge, Clin. Chem. 18 (6) (1972) 499–502.

[11] D.R. Matthews, J.P. Hosker, A.S. Rudenski, et al., Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man, Diabetologia 28 (7) (1985) 412–419.

[12] World Health Organization, Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications, WHO, Geneva, 1999.

[13] M.R. Brown, L.A. Fisher, Glucocorticoid suppression of the sympathetic nervous system and adrenal medulla, Life Sci. 39 (11) (1986) 1003–1012.

[14] J. Vozar, A. Kreze, I. Klimes, Diabetes Mellitus, Slovak Academic Press, Bratislava, 1998.
[15] G. Cizza, A. Lotsikas, J. Licinio, P.W. Gold, G. Chrousos, Plasma leptin levels do not change in patients with Cushing's shortly after correction of hypercortisolism, J. Clin. Endocrinol. Metab. 82 (1997) 2747–2751.
[16] S.S. Anand, S. Yusuf, R. Jacobs, et al., Risk factors, atherosclerosis, and cardiovascular disease among aboriginal people in Canada: the Study of Health Assessment and Risk Evaluation in Aboriginal Peoples (SHARE-AP), Lancet 358 (9288) (2001) 1147–1153.
[17] G. Engstrom, I. Jerntorp, H. Pessah-Rasmussen, et al., Geographic distribution of stroke incidence within an urban population: relations to socioeconomic circumstances and prevalence of cardiovascular risk factors, Stroke 32 (5) (2001) 1098–1103.
[18] M. McKee, The health of gypsies, Br. Med. J. 315 (7117) (1997) 1172–1173.
[19] J.V. Neel, A.B. Weder, S. Julius, Type II diabetes, essential hypertension, and obesity as "syndromes of impaired genetic homeostasis": the "thrifty genotype" hypothesis enters the 21st century, Perspect. Biol. Med. 42 (1) (1998) 44–74.
[20] R.A. Sicree, P.Z. Zimmet, H.O. King, J.S. Coventry, Plasma insulin response among Nauruans. Prediction of deterioration in glucose tolerance over 6 yr, Diabetes 36 (2) (1987) 179–186.
[21] P. Nozdrovicky, Mortality from cardiovascular diseases in Gypsy, Slovensky Lekar 2 (1991) 13–14.