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ORIGINAL ARTICLE

"CEM" risk factors and severity of obstructive sleep apnoea in central European Roma and non-Roma patients referred for a diagnostic polysomnography

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Abstract
Objective Obesity and metabolic syndrome are common among Roma subjects in Slovakia. We hypothesised that Roma subjects are at high risk to suffer from severe obstructive sleep apnoea (OSA).
Methods 137 non-Roma and 23 Roma subjects referred for a diagnostic polysomnography were consecutively recruited. Overnight polysomnography, anthropometric variables and standard biochemical analyses were analysed.
Results Obstructive sleep apnoea was diagnosed in 91% Roma and 65% non-Roma subjects ($p < 0.001$). Roma subjects had higher apnoea–hypopnoea index (AHI) (61.2 ± 7.9 vs. 22.8 ± 2.3 events/h, $p < 0.001$), lower dip oxygen saturation (56.7 ± 4.9 vs. $79.3 \pm 1.3\%$, $p < 0.001$), and higher waist circumference as compared to non-Roma subjects (121.3 ± 3.1 vs. 105.2 ± 2.4 cm, $p < 0.001$). In multiple regression analysis, Roma background ($p < 0.001$) and waist circumference ($p < 0.001$) were independent predictors of AHI ($R^2 = 0.330$). Roma background was associated with significantly higher risk of severe OSA (odds ratio 3.73; 95% confidence interval 1.20–11.65, $p = 0.023$), independently of age, gender and waist circumference.
Conclusions Among subjects referred for polysomnography, Roma background is associated with significantly higher risk of severe OSA. Knowledge of common OSA pattern in Roma patients may help in identifying high risk individuals and guide early therapy of this disease.

Keywords Roma subjects · Romany health · Obstructive sleep apnoea · Metabolic syndrome · Cardiovascular risk

Introduction

Obstructive sleep apnoea (OSA) is a prevalent medical condition in developed countries. In the community, among predominantly white men and women with mean body mass index of 25–28 kg m^{-2}, approximately 1 in every 5 adults has at least mild OSA and 1 in every 15 has at least moderate OSA (Young et al. 2002). OSA is characterised by repeated episodes of upper airway occlusion during sleep, which is associated with hypoxia and arousals from sleep. Acutely, repetitive apnoeas and hypopnoeas during sleep trigger surges in sympathetic nervous system activity, blood pressure and heart rate (Tkacova et al. 1998; Leung and Bradley 2001). As a consequence of repetitive obstructive apnoeas associated with intermittent hypoxia, repetitive arousals from sleep and changes in intrathoracic pressure, hemodynamic variables and cardiovascular autonomic activity oscillate between apnoeic and ventilatory phases. Chronically, OSA is associated with increased sympathetic nervous system activity, reduced baroreflex sensitivity and heart rate variability, activation of inflammatory pathways, oxidative stress, endothelial dysfunction and metabolic dysregulation. Patients with OSA are at an increased risk for development of arterial hypertension (Nieto et al. 2000; Peppard et al. 2000), stroke (Arzt et al. 2005), and myocardial ischaemia (Peker et al. 2002) and

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have an increased cardiovascular morbidity and mortality (Marin et al. 2005; Kato et al. 2009).

In a random Central European cohort of patients, we have recently demonstrated that severe OSA is related to higher global cardiovascular risk, independently of the presence of metabolic syndrome and insulin resistance (Tkacova et al. 2008). However, several reports suggest that cardiovascular risk factors may vary between ethnic minorities such as Roma (Gypsy) subjects and the majority population. The Roma population is genetically related to Asian Indians, and their original home was Central Northern India (Ginter et al. 2001). About 1,000 years ago, Romanies moved westward from India. Roma people constitute one of the few ethnic groups that has not adequately adapted to European or western societies in general, including countries such as Sweden (Lehti and Mattson 2001), England (Parry et al. 2007; Van Cleemput et al. 2007) or USA (Thomas 1985, 1987; Sutherland 1992). Their first language is "Romany" that is similar to Sanskrit. Indeed, significant health inequalities exist between the Roma and non-Roma subjects in England (Parry et al. 2007): being a Roma was associated with poorer health outcomes than the non-Roma residents (Peters et al. 2009). In Roma subjects residing in the USA, high prevalence of hypertension, diabetes, and dyslipidemia (Thomas 1985), in association with short-life expectancy have been observed (Thomas 1987). Similar health inequalities have been described in Slovakian Roma residents who have a higher prevalence of type 2 diabetes, metabolic syndrome and cardiovascular mortality when compared with the majority population (Vozarova de Courten et al. 2003). These differences were paralleled by higher prevalence of cardiovascular risk factors, such as hyperlipidemia, insulin resistance and obesity among Roma subjects. Similarly, higher prevalence of obesity in the Roma as compared to the non-Roma population was reported in USA (Thomas 1985). Because obesity, and central obesity in particular, represents one of the major risk factors for the development of OSA, and OSA severity is tightly linked to the severity of obesity (Patil et al. 2007), we hypothesised that a higher proportion of Roma subjects referred for a diagnostic sleep study will suffer from severe OSA as compared to non-Roma individuals.

Methods

Subjects

Subjects ($n = 160$) were consecutively recruited from the sleep laboratory at the tertiary referral centre in a teaching hospital, and were studied when they were in a stable clinical condition as evidenced by an absence of any medication change for at least 1 month prior to the sleep study. Roma participants were identified through their own self-identification in association with the information provided by the patient's relatives, in combination with the knowledge of local general practitioner. Similar approach was used before in studies aimed to address health inequalities between the Roma and non-Roma populations in other European countries (Parry et al. 2007). Importantly, the referral pattern in Roma subjects for the diagnostic polysomnography by health-care specialists was similar to the general experience of our laboratory. In the Roma cohort, seven subjects were referred by a respirologist, five by a general practitioner, four by a cardiologist, four by a neurologist, three by an ear-nose-throat specialist, and one by general internal medicine practitioner. The information on the presence of comorbid conditions was retrieved from medical reports of physicians referring the subjects for the diagnostic polysomnography. The study had local ethics committee approval, and all subjects gave written consent to the study.

Sleep studies

Subjects underwent an attended overnight polysomnography using standard techniques and scoring criteria (Alice 4 System; Respironics, Murrysville, PA, USA). They were advised not to drink alcohol during the day preceding polysomnography. The polysomnography consisted of continuous polygraphic recording of electroencephalography, electrooculography, electromyography, electrocardiography, thoracic and abdominal impedance belts for respiratory effort, thermistors for nasal and oral airflow, pulse oximetry, and tracheal microphone for snoring. Polysomnographic records were scored manually. The apnoea–hypopnoea index (AHI) was defined as the number of apnoeas and hypopnoeas per hour of sleep. The diagnosis of OSA was based on the presence of obstructive apnoeas and hypopnoeas occurring at a rate of >5 per hour of sleep. According to the American Academy of Sleep Medicine guidelines (American Academy of Sleep Medicine 1999), severe sleep apnoea was diagnosed in patients with AHI >30 episodes/hour.

Biochemical analyses

In all patients, peripheral venous blood samples were collected between 7 and 8 a.m. following an overnight 12 h fast and overnight polysomnography. After supine rest for at least 20 min, blood sample was taken from the antecubital vein and after immediate centrifugation, aliquots of plasma and serum were stored at −70°C until analysis. Serum insulin was determined with electrochemiluminescence immunoassay kits (Elecsys) on Roche Elecsys 1010/

2010 and modular analytics E170 immunoassay analyzers (Roche Diagnostics, Basel, Switzerland); glucose was measured by the glucose oxidase method on a Beckman autoanalyzer. Fasting cholesterol, triglycerides, and high density lipoprotein (HDL) cholesterol were measured by routine enzymatic methods (Pliva-Lachema, Czech Republic). Low density lipoprotein (LDL) cholesterol was derived using the Friedewald equation. Fibrinogen was assessed by thrombin coagulation method; apolipoprotein A–I (apoA1), and apolipoprotein B (apoB) by turbidimetric methods (Pliva-Lachema, Czech Republic).

Metabolic syndrome

The metabolic syndrome was diagnosed according to the recent International Diabetes Federation definition (International Diabetes Federation 2005). Patients had metabolic syndrome if they had central obesity defined as waist circumference ≥94 cm for men and ≥80 cm for women, plus any two or more of the following factors: triglycerides ≥1.7 mmol/L or specific treatment for this abnormality, reduced HDL cholesterol (<1.03 mmol/L in males and <1.29 mmol/L in females) or specific treatment for this lipid abnormality, raised blood pressure (systolic ≥130 or diastolic ≥85 mmHg) or treatment of previously diagnosed hypertension, and raised fasting plasma glucose (≥5.6 mmol/L) or previously diagnosed type 2 diabetes.

Statistical analysis

Student's two-tailed unpaired *t* tests were used to compare means and χ^2 tests to compare the proportion of categoric variables between the two groups of patients. To assess the relationships between selected variables, linear regression analysis was used. In the multivariate analyses, multiple linear regression model was used with AHI as the dependent variable, and Roma background, age, gender, and waist circumference as independent variables. In multiple logistic regression model, the presence of severe OSA (i.e. >30 events/hour) was used as the dependent variable, and Roma background, age, gender, and waist circumference as independent variables. Statistical analyses were performed using SPSS software version 14.0 (SPSS Inc., USA). Continuous variables are shown as mean ± SEM; a $p < 0.05$ was considered statistically significant.

Results

One hundred and sixty subjects [mean age 50.0 ± 1.1 years; 114 (71.2%) men] were recruited to the study at the tertiary referral centre for sleep-disordered breathing in the teaching hospital (Kosice, Slovakia). Patients were divided into two groups: non-Roma subjects [$n = 137$; mean age 50.3 ± 1.2 years; 92 (67%) men], and Roma subjects [$n = 23$; mean age 48.3 ± 2.5 years; 18 (78%) men]. Higher proportion of patients treated for type 2 diabetes was observed in the Roma versus the non-Roma group (35 vs. 9%; $p = 0.002$). The prevalence of other comorbidities that were recognised before the diagnostic polysomnography did not differ between the two studied groups (Table 1). In both non-Roma and Roma subjects, high prevalence of arterial hypertension (61 and 65%, $p = 0.849$) and metabolic syndrome (58 and 74%, $p = 0.214$) was observed.

The analysis of cardiovascular risk factors revealed no differences between the non-Roma and Roma subjects in BMI, and serum total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, apoA1, apoB or fibrinogen levels (Table 2). Nevertheless, Roma subjects had higher waist circumference and higher plasma fasting glucose concentrations as compared to non-Roma subjects (121.3 ± 3.1 vs. 105.2 ± 2.4 cm, $p < 0.001$; 6.37 ± 0.26 vs. 5.57 ± 1.16 mmol/L, $p = 0.005$, respectively).

The proportion of patients who met diagnostic criteria for OSA was significantly higher in Roma as compared to non-Roma group [21 of 23 (91%) Roma subjects vs. 89 of 137 (65%) non-Roma subjects, $p < 0.001$]. In addition, Roma patients with OSA were more likely to suffer from the severe form of the disease [17 (74%) Roma vs. 38 (28%) non-Roma patients, $p < 0.001$]. Mean AHI and movement arousals index were also significantly higher in Roma versus non-Roma patients ($p < 0.001$, $p < 0.001$, respectively) (Table 3). Consequently, the lowest (dip) oxygen saturation during sleep was significantly lower in Roma as compared to non-Roma patients ($p < 0.001$).

Table 1 The list of comorbidities recognised before the diagnostic polysomnography in the non-Roma and Roma cohort of patients referred to the tertiary referral centre for a diagnostic polysomnography (*n*%)

Variable	Non-Roma group	Roma group	*p* value
Arterial hypertension	83 (61)	15 (65)	0.849
Metabolic syndrome	79 (58)	17 (74)	0.214
Type 2 diabetes	12 (9)	8 (35)	0.002
Ischaemic heart disease	28 (20)	7 (30)	0.423
Myocardial infarction	6 (4)	1 (4)	0.586
Stroke	6 (4)	0 (0)	0.667
Heart rhythm disturbances	24 (18)	1 (4)	0.194
COPD	19 (14)	4 (17)	0.901
Bronchial asthma	13 (9)	3 (13)	0.881
Pickwickian syndrome	3 (2)	3 (13)	0.797
Smoking	52 (38)	8 (35)	0.954

COPD chronic obstructive pulmonary disease

Table 2 Components of metabolic syndrome and parameters of lipid metabolism in the non-Roma and Roma cohort

Variable	Non-Roma group	Roma group	*p* value
BMI (kg/m^2)	32.3 ± 1.9	37.5 ± 1.4	0.269
Waist circumference, cm	105.2 ± 2.4	121.3 ± 3.1	<0.001
Cholesterol (mmol/L)	5.16 ± 0.09	5.03 ± 0.24	0.578
Triglycerides (mmol/L)	2.12 ± 0.26	1.96 ± 0.11	0.556
HDL cholesterol (mmol/L)	1.23 ± 0.04	1.08 ± 0.07	0.137
LDL cholesterol (mmol/L)	2.97 ± 0.07	2.85 ± 0.21	0.921
apoA1 (g/L)	1.30 ± 0.02	1.19 ± 0.05	0.097
apoB (g/L)	0.97 ± 0.02	0.90 ± 0.06	0.242
Fibrinogen (g/L)	2.95 ± 0.08	3.27 ± 0.18	0.137
Fasting glucose (mmol/L)	5.57 ± 1.16	6.37 ± 0.25	0.044
Systolic BP (mmHg)	139.2 ± 1.5	137.0 ± 3.5	0.571
Diastolic BP (mmHg)	85.1 ± 0.8	86.7 ± 2.1	0.435

BMI body mass index, *HDL* high density lipoprotein, *LDL* low density lipoprotein, *apoA1* apolipoprotein A1, *apoB* apolipoprotein B, *BP* blood pressure

Table 3 Polysomnographic findings in the non-Roma and Roma cohort

Variable	Non-Roma group	Roma group	*p* value
Total time asleep (min)	394.4 ± 6.5	414.4 ± 14.4	0.241
Sleep stage			
Stage 2 (min)	242.2 ± 6.3	267.8 ± 23.8	0.164
Slow wave (min)	47.8 ± 3.7	42.3 ± 8.7	0.566
REM (min)	71.9 ± 3.5	47.7 ± 7.5	0.008
AHI (no/h)	22.8 ± 2.3	61.2 ± 7.9	<0.001
Movement arousals (no/h)	22.2 ± 1.7	42.9 ± 4.8	<0.001
Minimum SaO_2 (%)	79.3 ± 1.3	56.7 ± 4.9	<0.001

REM rapid eye movement, *AHI* apnoea–hypopnea index, *SaO_2* oxyhemoglobin saturation

Higher severity of OSA in Roma subjects was associated with significant differences in the sleep structure between the two groups. The time spent in rapid eye movement (REM) sleep was significantly reduced in Roma compared to non-Roma subjects ($p = 0.008$) (Table 3). Linear regression analysis revealed a significant inverse relationship between AHI and time spent in REM sleep ($r = -0.300, p < 0.001$). In multiple linear regression analysis with AHI as the dependent variable, and Roma background, age, gender, and waist circumference as independent variables, two variables were independent predictors of AHI ($R^2 = 0.330$): Roma background ($p < 0.001$) and waist circumference ($p < 0.001$). Roma background was associated with significantly higher risk of having severe OSA (odds ratio 3.73; 95% confidence interval 1.20–11.65, $p = 0.023$), independently of age, gender and waist circumference.

Discussion

Findings of the present study suggest that Roma patients referred for a diagnostic polysomnography are more likely to suffer from OSA, and to have more severe form of the disease independently of age, gender and central obesity reflected by waist circumference. These results are clinically relevant especially in the view of increased cardiovascular morbidity and mortality in patients with OSA (Marin et al. 2005; Kato et al. 2009). In our previous study, we have estimated the global cardiovascular risk by calculating the NCEP ATP III primary event risk scores in patients with newly diagnosed OSA, and found that the predicted cardiovascular risk was significantly increased in patients with severe OSA (Tkacova et al. 2008). Therefore, the finding of a 91% occurrence of severe OSA in Roma patients who were referred to our sleep laboratory is alarming.

Previously, health inequalities between Roma and non-Roma populations have been observed in various countries. In England, Gypsies and Travellers reported poorer health status with higher likelihood to have a long-term illness, health problem or disability that limits daily activities or work, had more problems with mobility, pain, anxiety or depression, and a higher overall prevalence of reported chest pain, respiratory problems, arthritis, miscarriage and premature death of offspring (Parry et al. 2007). In the region of Sheffield, nearly five times as many Roma subjects reported symptoms of chronic bronchitis, and over twice as many reported asthma-like symptoms or symptoms of angina than a general population (Sheffield Primary Care Trusts Informatics Service 2000). Shorter life expectancy in Roma individuals as compared to the majority population has also been observed (Thomas 1987). In central Europe, the average life expectancy among Roma subjects is 15 years lower than that of the non-Roma population (Koupilova et al. 2001).

Our finding of health inequality in sleep-disordered breathing between Roma and non-Roma subjects leaves open the question regarding factors responsible for the observed differences. Potentially, lower socioeconomical status and lower education in Roma patients might have led to delays in seeking health-care providers. Indeed, in previous studies Roma subjects were shown to be less educated, less physically active, more likely to smoke, had more children and were more likely to be caring for a dependent relative as compared to non-Roma individuals (Vozarova de Courten et al. 2003; Parry et al. 2007). In addition, several studies suggest that Romanies tend to delay seeking health services due to strong ethnic identity, and coherent cultural beliefs that markedly differ from the non-Roma majority population (Thomas 1987; Sutherland 1992). In the USA, most Roma individuals will go to a

hospital stay only if they are in serious danger of dying or if they view the situation as a crisis (Sutherland 1992). To study cultural beliefs and attitudes of Roma population was beyond the scope of the present study. Nevertheless, it has to be emphasised that combination of low expectation of health, acceptance/normalisation of ill health, stoicism, fatalism, ignorance and fear have been described in Roma population previously (Lehti and Mattson 2001; Van Cleemput et al. 2007). All these features are frequently encountered by medical practitioners treating Roma individuals in central Europe, and might have contributed to the late recognition of OSA and its severity in Roma subjects in the present study.

Nevertheless, socioeconomic factors related to minority status, specific cultural beliefs and behaviour likely do not constitute the only factors that are potentially related to our observation of increased severity of OSA in Roma patients evaluated in the sleep laboratory compared to the majority population. Importantly, more pronounced central obesity in Roma patients may represent one of the crucial health-related factors responsible for higher severity of OSA in this group in the present study. Of interest, our findings of increased abdominal obesity and higher proportion of patients with type 2 diabetes among Romanies support previous reports on cardiovascular risk profile in central European Roma population (Krajcovicova-Kudlackova et al. 2002; Vozarova de Courten et al. 2003). Interestingly, similarly to Slovakian Roma subjects, Romanies residing in the USA have also higher prevalence of obesity, type 2 diabetes, and dyslipidemia compared to the majority population (Thomas 1985). In addition, Asian Indians have high incidence of obesity, insulin resistance, and are at high risk for developing diabetes and coronary heart disease (Raji et al. 2001). Further studies need to address the question whether increased prevalence of various cardiovascular risk factors among Romanies in different countries stems from maladaptation to the western lifestyle including unhealthy diet and/or is rather linked to some unknown genetic predisposition.

Several limitations of the present study need to be addressed. First, it was not feasible to assess reliably the socioeconomic status, accommodation type, employment and/or travelling pattern of Roma subjects. Second, although in our study group, all Roma patients spoke Slovakian fluently as their second language, and were literate, detailed information on the educational level of the studied subjects was not available. Therefore, the present study does not answer an important question whether the observed differences are due to the ethnicity or to education background and the socioeconomic status. One might assume that lower education, lower socioeconomic status (Vokó et al. 2009), higher unemployment rate in association with lower daytime professional activities previously described in central European Roma individuals (Vozarova de Courten et al. 2003) might have potentially contributed to higher abdominal obesity and higher severity of OSA in Roma subjects in the present study. Therefore, relationships between socioeconomic status, education level, accommodation and employment pattern in relationship to the presence and severity of OSA need to be addressed by future investigations. Second limitation concerns the size of the Roma cohort sample. OSA, similarly to cancer and hypertension tend to be "silent" diseases until their later stages. Therefore, OSA may be under-reported in the Roma population, despite high prevalence of central obesity through ignorance of the diagnosis on the patient's side similarly to other disorders (Van Cleemput et al. 2007). Under such circumstances, it is difficult to achieve large size of Roma cohort in specialised tertiary referral centre. Practical solution might be to continue studies similar to ours over longer period of time, in tight cooperation with general practitioners. Nevertheless, it is essential to underline that the pattern of referral to our sleep laboratory did not differ between the Roma and non-Roma cohorts which strengthens interpretations of our findings.

In conclusion, Roma subjects referred for a diagnostic polysomnography suffered from higher severity of OSA, lower oxygen saturation and more profound disturbances in sleep architecture compared to non-Roma individuals. Knowledge of common OSA pattern in Roma patients may help in identifying high risk individuals and guide early therapy to prevent complications of this disease.

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