ORIGINAL ARTICLE

Estimating the Incidence of Metabolic Syndrome

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ABSTRACT

Background. Metabolic syndrome is a disease with a high prevalence and influence on cardiovascular morbidity and mortality. The aim of this study is to estimate, using analysis of large preventive check-up database, the frequency of metabolic syndrome in the district of Šumperk over the years 1979–1981.
Methods and Results. The database of preventive oncologic check-up from Šumperk district comprising 40,099 subjects with follow-up in the years 1979–1981 has been used to determine the prevalence of metabolic syndrome. The incidence of risk factors for metabolic syndrome was calculated and compared with the current situation in the Czech Republic. Depending on the selection criteria, the estimated incidence of metabolic syndrome ranged from 2.2% to 8.4%. Type 2 diabetes mellitus or glycemia higher than 6.1 mmol/l, systolic or diastolic hypertension, and a BMI higher than 30 kg/m^2 were considered risk factors. The incidence of metabolic syndrome was shown to rise with increasing age both in the male and female populations.
Conclusions. Based on the results of this study, one may assume that the incidence of metabolic syndrome has increased over the last decades. It is critical to focus our attention on simple and practical methods for early detection of metabolic syndrome. Also of importance is prevention, as metabolic syndrome plays an important role as a predictor of serious cardiovascular and metabolic diseases.
Key words: metabolic syndrome, prevalence, risk factors, increase.

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Metabolic syndrome is a disease with a very high prevalence, significantly increasing the risk of cardiovascular mortality and morbidity (1). Cardiovascular disease is the main cause of death in the Czech Republic and in most industrialized nations, contributing significantly to disability and morbidity of the population and, increasingly, also to rising health care costs, particularly in countries with generally aging population (2). The incidence of the most important risk factors for cardiovascular mortality and morbidity is causally associated with insulin resistance, i. e., decreased tissue sensitivity to insulin and decreased insulin metabolic action. The result is syndrome X, or the metabolic syndrome of insulin resistance, whose typical features include hyperinsulinemia, hyperlipidemia of a certain type (increase in TG and a decrease in HDL), obesity, arterial hypertension, hyperuricemia, and glucose intolerance, the latter gradually evolving into Type 2 diabetes mellitus. Given the common pathogenetic basis of these manifestations (insulin resistance), the above symptoms tend to cluster, thus raising cardiovascular risk considerably, as the adverse effect of the risk factors is not added but actually multiplies in many cases (3).

While no uniform diagnostic criteria for metabolic syndrome detection are currently available in the Czech Republic, it is possible to use either the 1998 criteria of the World Health Organisation (WHO) or the National Cholesterol Education Program (NCEP) (USA) criteria released in 2001 (4, 5). The 1998 WHO definition of the metabolic syndrome is shown in Tab. 1. Reporting and keeping track of the metabolic syndrome are likewise not practised; the 10th revision of the International Classification of Diseases does not include metabolic syndrome as a separate clinical entity (1) and only estimates from individual studies are available.

The aim of the present study is to estimate the incidence of the metabolic syndrome in Šumperk district over the years 1979–1981, according to available risk factors, by means of analysis of an extensive database of preventive check-ups performed in the above period.

GROUP OF PATIENTS AND METHODS

To determine the incidence of the metabolic syndrome, a database of preventive oncologic check-ups of Šumperk district was used, which includes a total of 40,099 individuals screened in the years 1979–1981. While the check-ups were originally designed to identify individuals with the initial stage of malignancies, they were soon extended to include laboratory investigations and physical examinations to detect hypertension, diabetes, obesity and other conditions. The aims and methods of the preventive check-ups are described in another publication (6). All individuals aged 30-64 years resident in Šumperk district were invited for screening. The above age group included a total of 24,286 males and 25,160 females. Of these numbers, 18,055 males and 22,044 females pre-

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sented for the screening and examination, resulting in respondent rates of 74.34% and 87.61% respectively.

The preventive screenings included, among other things:

- taking of personal, family and occupations histories,
- laboratory investigations of blood glucose, total cholesterol, uric acid, and blood group determination,
- determination of BMI, heart rate, and systolic and diastolic pressure and the presence of diabetes.

The database was used to determine the incidence of individual factors suggesting the presence of metabolic syndrome in the above period in Šumperk district and to compare the figures with the current status in the Czech population. As data on only some components of metabolic syndrome were available for retrospective analysis, the reported incidence of the syndrome is but an estimate.

Tab. 1. 1998 WHO metabolic syndrome definition

Risk factor	
Main	**Additional**
Diabetes mellitus or impaired glucose control	Increased blood pressure (≥160/≥90 mmHg) Increased triglycerides (≥1.7 mmol/l) or HDL-cholesterol (<0.9 mmol/l in males and <1.0 mmol/l in females)
Insulin resistance	Central obesity (waist/hip ratio >0.90 in males and >0.85 in females and/or BMI ≥30 Microalbuminuria (≥20 mg/min)

To establish the diagnosis of metabolic syndrome, one main risk factor and at least two additional risk factors should be present.

RESULTS

The Šumperk district database provides information of the incidence of individual metabolic syndrome risk factors available at that time (Tab. 2). The proportion of individuals with Type 2 diabetes mellitus (1.2%) was smaller than the nationwide average at that time, which was about 3.0-3.2% of all inhabitants. Likewise, when comparing the incidence of diabetes by age brackets in a series from Prague in 1993 (7), the incidence of Type 2 diabetes mellitus in Šumperk district was substantially lower (Tab. 3). Fasting blood glucose levels higher than 6.1 mmol/l were determined in 8.4% of individuals.

Systolic blood pressure over 160 mmHg was determined in 11.7%, diastolic blood pressure over 90 mmHg in 47.2%; both values simultaneously increased in 10.8%, and increases in systolic or diastolic pressure over the above values were present in 48.0% of individuals.

A BMI suggestive of obesity was determined in 22.3% of individuals - in 17.2% of males and 26.5% of females.

Total cholesterol was equal to or higher than 5.2 mmol/l in 66.9%.

However, only the following available risk factors were employed to establish the diagnosis of the metabolic syndrome for the purpose of the study:

- type 2 diabetes mellitus or blood glucose over 6.1 mmol/l (as the main factor),
- systolic or diastolic hypertension using WHO criteria (as an additional factor),
- a BMI over 30 kg/m^2 (as yet another additional factor).

Using the above risk factors, an attempt was made to determine the incidence of metabolic syndrome in individuals included in the Šumperk district database in the 1979–1981 period. If considering only the presence of Type 2 diabetes mellitus or increased fasting blood glucose levels as the main factor for establishing the diagnosis of metabolic syndrome, the percentage of metabolic syndrome patients was 8.4% (Tab. 4). Addition of systolic or diastolic hypertension as another factors decreased the percentage to 5.3% and all (database-)available risk factors of the metabolic syndrome (diabetes mellitus or increased blood glucose, hypertension and obesity) were only present in 2.2% of individuals (Tab. 5). When assessing the incidence of the metabolic syndrome by age, it is clear the incidence increases with age, both in males and females (Tab. 5).

DISCUSSION

The prevalence of metabolic syndrome is currently reported to be in the range of 25 to 30% in the Caucasian population; largely depending on the definition and the diagnostic criteria used. An epidemiological study was published in 2003 assessing the incidence of metabolic syndrome in 8,608 U.S. Caucasian adults aged over 20 years. The prevalence of the metabolic syndrome was 25.1% using WHO diagnostic criteria and 23.9% using those of the NCEP, with 86.2% of subjects meeting either criterion (8). No exact data on the incidence of the metabolic syndrome in the Czech Republic have been published to date. Only unpublished data on the prevalence of the metabolic syndrome in the Czech population are available, derived from the MONICA project, obtained from a selected sample of 3,000 individuals aged 25-64 years, with the prevalence reaching 32% and 24.4% of males and females respectively, in the 2000-2001 period. When all these facts are taken together, the incidence of the metabolic syndrome in the Czech Republic seems to be on the rise.

Given the frequent coincidence of Type 2 diabetes mellitus and obesity (9), this fact was also considered in the present study. Surprisingly, diabetes or increased blood glucose were associated with obesity in only 3.2% of individuals. If these available risk factors (diabetes or increased blood glucose or obesity) had been evaluated separated, there would have been as many as 27.5% of individuals (Tab. 4) significantly predisposed to developing metabolic syndrome in the ensuing period. As, presumably, individuals with hypercholesterolemia (66.9% in the present study) and those with a BMI over 30 (22.3%) were likely to have pathological levels of triglycerides and HDL-cholesterol based on the metabolic syndrome definition, the total estimate of the incidence of this disease in the study population of Šumperk district would have been much higher.

Given the very frequent coincidence of obesity, impaired glucose tolerance, dyslipidemia and hypertension, particularly in the elderly, some authors have speculated that metabolic syndrome may currently be diagnosed in over 50% of the Czech population (9).

Whereas Type 2 diabetes mellitus is present in about 6% of the general population of the Czech Republic, genealogical studies have suggested that the proportion of patients with diabetes in the elderly is as high as 25%. Type 2 diabetes mellitus is believed to be a culmination of sorts of the metabolic syndrome, although not every patient reaches that stage as they will die from another cause, thus decreasing the overall incidence of the syndrome. In our series, the incidence of Type 2 diabetes mellitus was shown to be only 1.2%, that is, two to three times lower than the overall incidence figure from the Czech Republic for the index period. This may partly explain the lower incidence of the metabolic syndrome in Šumperk district in the index period, as presence of Type 2 diabetes mellitus is considered one of the main components of the syndrome.

In the Czech Republic obesity is present in 31% and 21% of females and males, respectively; the figures are much more alarm-

Tab. 2. Incidence of individual risk factors

Factor	Criterion	Number of patients with positivity	Number of examined subjects	% of positive individuals in Šumperk district in 1979–1981	Incidence (in %) related to current Czech data (2004 ÚZIS)
Type 2 diabetes mellitus	–	492	40 099	1.2	6.0
Fasting blood glucose	≥6.1 mmol/l	3352	39 897	8.4	
Systolic blood pressure	≥ 160 mmHg	4634	39 613	11.7	
Diastolic blood pressure	≥ 90 mmHg	18 683	39 613	47.2	
Systolic or diastolic blood pressure		19 020	39 613	48.0	14.0
BMI	Males ≥30 kg/m^2	3070	17 831	17.2	21.0
	Females ≥30 kg/m^2	5638	21 273	26.5	31.0
Cholesterol	≥5.2 mmol/l	26 857	40 119	66.9	40.0*

*Data from MONICA project (>6.5 mmol/l)

Tab. 3. Prevalence Type 2 diabetes mellitus by age categories

Age	Type 2 DM (in %)	
	Šumperk 1979–1981	Prague registry 1993
18–29	0	0.11
30–39	0.18	0.32
40–49	0.84	1.43
50–59	1.51	4.81
60–69	2.17	11.09
70–79	7.69	15.23
80 and over	0	17.08

Tab. 4. Incidence of risk factors for the metabolic syndrome and combinations thereof

Risk factors	Frequency in %
Type 2 DM or increased blood glucose	8.4
Type 2 DM or increased blood glucose and hypertension	5.3
Type 2 DM or increased blood glucose and obesity	3.2
Type 2 DM or increased blood glucose and hypertension and obesity	2.2
Type 2 DM or increased blood glucose or obesity	27.5

ing if combining obesity with overweight, resulting in 68% and 72% of females and males, respectively. The incidence of obesity peaks at age 50-60 years. In the present study, the incidence of obesity is about consistent with nationwide figures reported for recent years.

Hypertension is known for its close associated with Type 2 diabetes mellitus and obesity, and it has been included as a component of metabolic syndrome since its very first definition. In the Czech Republic hypertension affects about 14% of the population, being present in over 60% of the elderly. The incidence of hypertension in the study population of Šumperk district was high (48 %) compared with the current status in the Czech population. The implication is that early detection and control of hypertension are now much better than in the past.

A typical patient with the metabolic syndrome is not hypercholesterolemic, but the metabolic syndrome picture includes hypertriglyceridemia and, usually, lower HDL-cholesterol levels. Given the frequent coincidence of familiar hypercholesterolemia and the metabolic syndrome, a random combination of both disorders or common diet-induced mixed hyperlipidemia, i. e., increase in total cholesterol and triglycerides, is rather frequent (9). Our group displayed a high prevalence of hypercholesterolemia, about 67%, thus significantly in excess of MONICA data, which is slightly below 40%. The difference is due, to a certain extent, to different methods for assessing increased cholesterol levels. In our analysis, normal levels of total cholesterol were defined as ones below 5.2 mmol/l, whereas normal cholesterolemia in the MONICA project was defined as values below 6.5 mmol/l. As total hypercholesterolemia is not a typical feature of the metabolic syndrome, it was not included among our selected criteria for the diagnosis.

In addition to the incidence of the metabolic syndrome, our study was intended to assess basic risk factors historically associated with the metabolic syndrome. This evaluation is an extension to a previous analysis of these factors (10). The lower-than-nationwide incidence of diabetes in the index period is one cause of the low incidence of metabolic syndrome in our group. Evaluation of fasting blood glucose only as the main risk factor can likewise be considered inadequate, since it is a well-known fact that a number of individuals with impaired glucose tolerance may have normal fasting blood glucose levels. It is therefore advisable to use postprandial blood glucose, a risk factor for cardiovascular mortality (11). Compared with MONICA data (12), the incidence of hypertension in the Šumperk district series was more than twice as high. Regarding evaluation of obesity by means of BMI as a risk factor for the metabolic syndrome, it is more appropriate to employ waist circumference, a better marker of abdominal obesity. However, the latter parameter was unavailable for the study population.

In addition to the above typical components of the metabolic syndrome, its definition has gradually evolved to include other biochemical and clinical parameters such as impaired blood coagulation, endothelial dysfunction and increased levels of inflammatory activity markers, non-alcohol steatohepatitis, ovarian hyperandrogenism and hirsutism, hyperhomocysteinemia, and so on. As a result, development of uniform criteria for establishing the diagnosis of metabolic syndrome seems most desirable because this would allow not only objective estimate of the syndrome prevalence but also subsequent intervention in individuals with metabolic syndrome.

From the practical point of view, the most challenging task is to determine the degree of insulin resistance which can be accomplished using different techniques. The most exact standard methods for determining insulin sensitivity are the euglycemic clamp or the minimal model; however, they are labor-intensive, invasive and also costly, which is why they are rarely used in clinical practice. For the purposes of epidemiology, the validity of so-called homeostatic models for insulin resistance assessment, HOMA IR and

Table 5. Metabolic syndrome incidence

Age	Metabolic syndrome Number			Number of patients screened			Metabolic syndrome (%)		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
30–39	47	41	88	5630	7791	13 421	0.8	0.5	0.7
40–49	91	120	211	6063	6153	12 216	1.5	2.0	1.7
50–59	138	287	425	4892	5926	10 818	2.8	4.8	3.9
60+	55	104	159	1649	1866	3 515	3.3	5.6	4.5
Total							1.8	2.5	2.2

QUICKI indexes, has been repeatedly documented (13). Insulin resistance is demonstrated at HOMA IR index values over 2.68. With QUICKI index, values below 0.357 are typical of individuals with insulin resistance.

Metabolic syndrome, or insulin resistance syndrome, is a cluster of many symptoms and determination of its incidence largely depends on the definition. It is self-evident that uniform criteria must be applied to assess changes in the incidence of the metabolic syndrome in individual populations and periods. Our data regarding the incidence of metabolic syndrome in Šumperk district population in the years 1979-1981 is but an estimate obtained in an effort to document that the prevalence of the metabolic syndrome in this country has been on the rise.

CONCLUSION

Our results suggest the incidence of metabolic syndrome has increased over the past decades. Given the value of this syndrome as a predictor of future serious cardiovascular and metabolic diseases, it is imperative to focus our attention on simple methods, which are easy to use in practice, for rapid detection, and on timely adoption of effective preventive measures.

Abbreviations

BMI - body mass index
DM - diabetes mellitus
HDL - high-density lipoprotein
MONICA - monitoring of cardiovascular risk factors (WHO project)
ÚZIS - Institute of Health Information and Statistics (CR)
WHO - World Health Organization

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COMMENTARY

Comments upon the Article by Horáková D. et al.: "Estimating the incidence of metabolic syndrome"

The authors from Olomouc, Zábřeh and Ostrava address a most interesting topic. The question why and whether the incidence of metabolic diseases is indeed on the rise today is a most puzzling one. One might also wonder whether there is an answer to it. Metabolic syndrome is a condition defined by Reaven in the late 1980s (for details, see, e.g., (1)), yet there is no doubt it is not a new disease. Typical features of metabolic syndrome can be seen in classical statues and medieval paintings. It was simply the need for epidemiological comparisons which led to the development of exact definitions of metabolic syndrome in the 1990s. The WHO definition was useless for clinical practice because of the lack of uniformity in determining insulin resistance in the population. By contrast, the NEC III definition, which is also used by the authors, has found widespread acceptance. Clearly it is most appropriate to employ a broad definition based on "at least one component of the metabolic syndrome", as the presence of one component makes it more likely that other components will also be present.

Epidemiological data, collected a quarter of a century ago (as presented by the authors), are rare. It goes without saying that the data are incomplete from the point of view of current metabolic syndrome definitions. Triglyceride and HDL-cholesterol levels were seldom determined, and waist circumference was not measured at all in the 1970s. Therefore it makes no sense to apply a metabolic syndrome definition to data collected in the 1970s. It is almost certain that another vast proportion of patients with pathologic values of the above three parameters, who presumably suffered from metabolic syndrome, was somewhere in the range of 15-20%. In this respect, the inclusion of Tab. 5 is confounding and unnecessary.

The study is thus unable to determine the increase in the incidence of the metabolic syndrome since the 1970s. It is a pity that the authors have focused in vain on this particular question. The study does provide answers to other exciting questions.

Have the increases in the individual components of metabolic syndrome been proportionate? Have there been proportionate increases in patients with diabetes, hypertension and obesity? The answers to these questions are clear-cut: no. The numbers of patients with diabetes may have doubled or tripled, the increase in the incidence of obesity has been in the range of 30% while the number of hypertensive patients had decreased. This latter finding seems to have been due to methodological bias, but still is seems likely that the increase in the number of hypertensive patients was not significant.

The study thus comes down in favour of the pathogenic heterogeneity of metabolic syndrome. Today's lifestyle, with an absence of exercise and emphasis on overfeeding, is doubtless primarily diabetogenic, with a slightly smaller effect on obesity, while affecting hypertension even less. As regards obesity, it should be noted that the absolute increase is not an important consideration, as an increase in body weight by several kilograms may be of critical relevance. Even a change in the spectrum of consumed fat by 2-5 % may be appreciably diabetogenic (e. g., see (2)). PIMA Indians form an extensively investigated population; they were not obese and did not have diabetes mellitus 100 years ago, while today obesity and diabetes are present in as many as 90% of them (2). Though it is not likely that the populations of districts would differ so much, some differences may exist. It would be most interesting to compare data from other districts, which should also be available.

The present study is attractive and, if the method was improved and the question formulated otherwise, it could be considered quite rare, even in international literature.

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