BURDEN OF SUDDEN CARDIAC DEATH IN PERSONS AGED 1–40 YEARS IN THE CZECH REPUBLIC

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SUMMARY

Objectives: The aim of the study was to ascertain the incidence, circumstances and causes of sudden cardiac death in persons aged 1–40 years in the Czech Republic.

Methods: De-identified autopsy reports of all individuals who died suddenly between the ages of 1–40 years during the period 2014–2019 inclusive in a selected area of the Czech Republic were analysed retrospectively. Persons with substantial cardiovascular pathology defined by histopathological criteria and those with a negative autopsy were included in the study. The latter were designated as sudden arrhythmic death syndrome.

Results: In total, 245 sudden cardiac death cases were identified resulting in an incidence rate of 2.4/100,000 person-years. Among the deceased, we found an enormous gender gap with men representing 81% of cases. More than 80% of deaths occurred during everyday activities or sleep, whereas only 7% were sports-related. The most common cause of death was coronary artery disease detected in 38%, which was followed by cardiomyopathies in 15%, sudden arrhythmic death syndrome in 12%, left ventricular hypertrophy in 10%, and congenital heart defects in 7%.

Conclusions: Coronary artery disease is the predominant cause of sudden cardiac death in the young population of the Czech Republic. Hence, effective preventive measures targeted at the reduction of risk factors associated with early coronary artery disease should be reinforced. The second most prevalent cause in our population are potentially heritable heart conditions such as cardiomyopathies and sudden arrhythmic death syndrome. This fact has already prompted the introduction of molecular autopsy and cardiogenetic care for relatives in the Czech Republic.

Key words: sudden cardiac death, young, incidence, causes, consequences for public health

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INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of mortality accounting for almost 18 million deaths per year worldwide. Sudden cardiac death (SCD) generally refers to an unexpected death from a cardiovascular cause and represents approximately half of all cardiovascular deaths (1). In young individuals below 40 years of age the incidence of SCD is low with 2.6/100,000 person-years representing only approximately 200,482 deaths per year worldwide (2). Nevertheless, SCD in a young person strikes the family with an enormous psychological blow and means a great loss to both the family and to society.

Many countries have therefore used their national registries and autopsy reports to determine the burden of SCD in their young populations (3). In Australian (4) and Danish (5) cohorts up to 35 years of age sudden arrhythmic death syndrome (SADS) was revealed as the most common cause of SCD accounting for approximately 40% of cases. Coronary artery disease (CAD) represented only 24% and 13% of SCD cases in Australia and Denmark, respectively. Other causes of SCD in the young include cardiomyopathies (CM), myocarditis, thoracic aortic disease (TAD), and congenital heart defects (CHD) and comprise about 13–16%, 5–12%, 3–7%, and 6–7% of SCD cases in the young, respectively (4, 5). Hence, in young cohorts potentially heritable conditions such as SADS, CM and TAD constitute a dominant proportion of SCD cases. As their inheritance pattern is mostly autosomal dominant conferring a 50% risk of the disease in first degree relatives, some countries have already implemented strategies to improve post-mortem identification of these heritable cardiac diseases and their early detection in relatives using standardized autopsy protocols, molecular autopsy and cardiogenetic counselling in families (6, 7). Although this approach has been incorporated into international guidelines (8, 9), it has not been adopted in the Czech Republic on a nationwide basis as yet.

When the study population extends beyond 35 years of age, CAD becomes the predominant cause of death. For example, in a

Canadian study analysing SCD in 2–40 years old persons, CAD was identified as the major cause of SCD in 36% of cases (2).

The aim of this study was to ascertain the incidence, circumstances and causes of SCD in people aged 1–40 years in a defined area of the Czech Republic. For comparison with other populations some of the analyses were additionally performed for the cohort confined to 1–35 years of age. Similar data are unavailable for the Czech population and most neighbouring populations (Slovak, Polish, Hungarian and Austrian). These may differ from other regions due to a distinct socioeconomic status, lifestyle, mentality, and healthcare system. The results of this study could thus provide the context for the implementation of targeted preventive measures needed specifically in the Czech and similar populations.

MATERIALS AND METHODS

Study Design

In the Czech Republic, when a person is found dead and/or dies suddenly and unexpectedly, an external examination and a death scene investigation is performed by the emergency medical service or a coroner. In cases of suspected violent death, a medico-legal autopsy is performed. It complies with the Criminal Procedure Code and is usually more extensive than a medical autopsy, which is performed in most other cases of sudden death. According to Act 372/2011 § 88 both types of autopsy are performed at forensic medicine departments.

Forensic pathologists usually only obtain information provided by the physicians who perform an external examination, which is often insufficient. The contact details of a patient's general practitioner (GP) are rarely available. On the other hand, the autopsy rate for out of hospital deaths in the Czech Republic is very high at 93% for those between 1–40 years of age. The autopsy rate was calculated from data generated by the Czech Statistical Office and the Institute of Health Information and Statistics. Between 2014–2019, a total of 7,203 out of hospital deaths were recorded in the Czech Republic. Out of these, 6,729 underwent an autopsy.

The study was retrospective and limited to a selected area of the Czech Republic encompassing approximately one third of persons aged 1–40 years in the Czech population (1,675,552 out of 4,907,131 individuals of the same age in the Czech Republic). The number of residents was provided by the Czech Statistical Office*.

All autopsy protocols of persons aged 1–40 years autopsied from 2014 to 2019 inclusive at departments of forensic medicine in five large regions of the Czech Republic (Prague, Central Bohemia, Olomouc, Zlín, and Hradec Králové) were reviewed by the investigators at each site. Individuals who died from violent death or whose death was noncardiac were excluded. All the records of the remaining cases were carefully read by a cardiologist. Persons whose death was sudden and unexpected and who exhibited a substantial cardiovascular pathology were selected for the study. Additionally, individuals whose death remained unexplained after autopsy and toxicology analysis were included and designated as SADS cases. Most autopsy protocols contained height and weight of the decedent. Hence, subsequently BMI could be calculated and used to estimate the proportion of obese individuals. Thickness of subcutaneous fat was measured at autopsy with a caliper.

The records of most SCD cases included histological findings, toxicology results and records of the external examination at the death scene. Toxicological profiles were determined by gas chromatography or liquid chromatography with mass spectrometry. Routine post-mortem forensic toxicological testing covered the majority of prescribed drugs (e.g., antipsychotics, antidepressants, benzodiazepines, cardiovascular drugs, opiates, etc.); ethanol, methanol and acetone; and common illicit drugs (amphetamines, cocaine, cannabinoids, etc.).

In cases where a crime had initially been suspected, a medico-legal autopsy was indicated and additional information such as police reports, GP and/or hospital medical records were usually available. When the cause of death was not clear, the records of the deceased were re-evaluated by a forensic pathologist together with a cardiologist in order to reach consensus on the most accurate histopathological diagnosis. Cardiovascular causes of death were defined using macroscopic and microscopic criteria (10–12) shown in Table 1.

Statistical Analysis

Data are presented in absolute numbers as well as percentages. The incidence rates of SCD for several age subgroups were calculated based on the resident population in the studied area as provided by the Czech Statistical Office*.

Gender differences in multiple variables such as number of SCD cases, age, BMI, alcohol and drug exposure, etc., were assessed using the Fisher's exact test. Confidence intervals (95% CI) for incidence rates and incidence rate ratios were calculated using the Agresti-Coull method. The Mann-Whitney U test was used for comparison of median age and median amount of subcutaneous fat in CAD cases as opposed to other causes of cardiovascular death. The level of significance for all statistical analyses was set at 0.05.

RESULTS

SCD Population

During the six-year study period, 245 persons aged 1–40 years (median 36) died from SCD in the selected area of the Czech Republic. A histology was performed in 65% of cases, in the remaining cases macroscopic findings were considered sufficient to establish the cause of death. Among 84% of the deceased who had their alcohol level determined, 20% had more than the measurable threshold of 0.2 g/kg (range 0.2–3.4). Toxicology screens were performed in 51%. In 15% of these cases, illicit drugs in various combinations were detected, including amphetamines, cannabis, morphine, or cocaine. Prescription drugs were found in 30% of cases with methadone in 2. The most frequently detected prescription drugs included analgesics or antipsychotics. More than one prescription drug was detected in 53% of cases. Anabolic steroids (testosterone) were found in one bodybuilder. In total, alcohol and/or drugs were found in almost 40% of the deceased. None of their toxicological profiles or alcohol levels was such

*https://vdb.czso.cz (updated on 31st December 2018)

Table 1. *Pathological macroscopic and microscopic criteria defining main cardiovascular causes of sudden cardiac death*

	Macroscopic	Microscopic
Coronary artery disease	Acute coronary occlusion complete or occluding >75% of the arterial lumen (atherothrombosis, dissection or embolism) or coronary luminal stenosis >75%	Acute or chronic infarction or fibrosis in the left ventricle
Hypertrophic cardiomyopathy	Left ventricular wall thickness >15 mm and/or heart weight above 450 g in women and 500 g in men	Myocyte disarray extending beyond anteroseptal and posteroseptal junctions where it is considered physiologic
Left ventricular hypertrophy	Left ventricular wall thickness >15 mm and heart weight above 450 g in women and above 500 g in men	Myocyte hypertrophy +/- fibrosis in the absence of myocyte disarray
Idiopathic left ventricular fibrosis	Normal heart weight and wall thickness with/without scarring	Fibrosis in the anterior or lateral left ventricular wall or interventricular septum with no myocyte disarray
Arrhythmogenic cardiomyopathy	Fatty infiltration of the myocardium, replacement fibrosis, pronounced fat covering the posterior aspects of ventricles. Right or left ventricular thinning.	Fat and fibrosis of the right and/or left ventricle with fat extending from epicardium throughout the myocardial wall, degenerative changes of myocytes
Dilated cardiomyopathy	Increase in heart weight with dilated left ventricle (>4 cm) and thin wall (<1 cm)	Diffuse interstitial and replacement fibrosis in the left ventricle with degenerative changes in myocytes
Drugs/alcohol induced cardiac pathology (always supported by history of substance abuse and/or extracardiac autopsy findings and/or positive toxicology)	Non-specific changes not fulfilling cardiomyopathy criteria	Diffuse fibrosis of the myocardium especially in the interventricular septum and/or irregular muscle fibres and/or focal necroses
Myocarditis	Normal or dilated ventricles	Inflammation with myocyte necrosis
Sudden arrhythmic death syndrome	Normal	Normal or non-specific changes including small fibroses in the posterior walls of the ventricles insufficient to explain death; interstitial oedema and blood congestion

as to enable forensic pathologists to conclude that it could be the sole explanation of death. BMI was available in 76% of adult SCD cases and almost 40% of them were obese (BMI ≥ 30).

Circumstances of Death

The majority (73%) of SCD were unwitnessed and happened during everyday activity or sleep (83%). Everyday activities were defined as tasks not requiring physical exertion. Only 7% of deaths occurred during sport. More than half of the bodies were found at home and the least frequent time of death was during afternoon hours. Circumstances of death did not differ significantly with respect to age. We compared the proportion of younger persons (1–20 years old) who died in their sleep or during everyday activities, at home and unwitnessed with the rest (21–40 years old) and found no significant difference ($p=0.547$, 0.674 and 0.322, respectively).

Causes of SCD

The most common cause of death in the whole cohort was CAD detected in 38% (93/245) persons. Persons who died from CAD were significantly older than those who died from other causes (median 37 vs. 35 years, $p<0.001$). Interestingly, CAD cases did not differ significantly from other cardiovascular deaths with respect to thickness of subcutaneous abdominal fat (median 3.5 vs. 3 cm, $p=0.414$). The second most common cause of death were cardiomyopathies accounting for 15% of all SCD. Among CM, dilated and arrhythmogenic CM were the most frequently diagnosed subtypes. SADS accounted for 12% of deaths, followed by TAD found in 4% of the deceased. Hence, potentially heritable cardiac conditions with an autosomal dominant pattern of inheritance such as TAD, CM and SADS were diagnosed in 31% of all SCD cases. Further causes of death included left ventricular hypertrophy that did not meet the histological criteria for hypertrophic cardiomyopathy (12). It was found as a possible substrate for sudden death in 10%. Congenital heart defects including aortic stenosis, coarctation and other more complex heart defects were diagnosed in 7% of SCD. Causes of death in the cohort of 1–40 years old individuals in the Czech Republic are depicted in Figure 1.

Furthermore, we focused on the causes of death in several subgroups of the cohort. Among obese individuals, CAD was responsible for 38% (27/72) of SCD cases, followed by left ventricular hypertrophy found in 25% (18/72), CM in 11% (8/72), and SADS in 8% (6/72). Among children, we identified myocarditis, congenital heart defects, CM and SADS in 3, 2, 3 and 1 case, respectively. One child with Down syndrome died of acute right ventricular heart failure during a mild exacerbation of asthma. To allow for comparison with other studies, we also analysed causes of SCD for the age group of 1–35 years. CAD remained the most common cause responsible for 27% (32/118) and the proportion of potentially heritable cardiac conditions increased to 42% (50/118) of SCD cases.

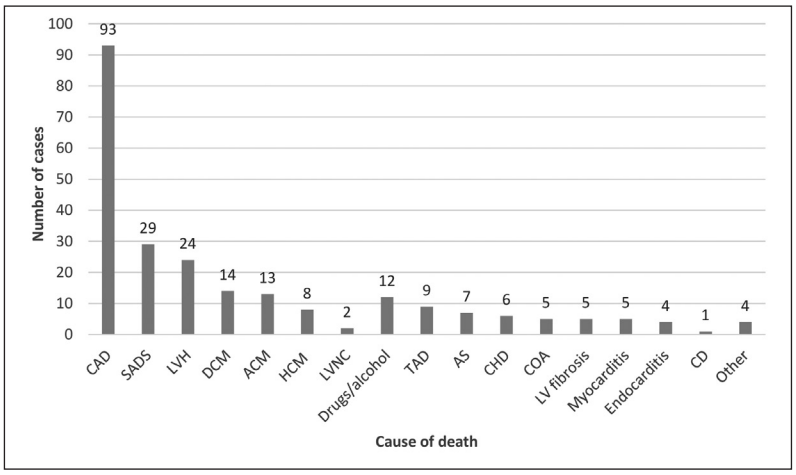

Fig. 1. *Histopathological causes of SCD in 245 people aged 1–40 years autopsied in 2014–2019 in a selected area of the Czech Republic.*

CAD – coronary artery disease; SADS – sudden arrhythmic death syndrome; LVH – left ventricular hypertrophy; DCM – dilated cardiomyopathy; ACM – arrhythmogenic cardiomyopathy; HCM – hypertrophic cardiomyopathy; LVNC – left ventricular non-compaction; Drugs/alcohol – drugs/alcohol-related cardiac pathology; TAD – thoracic aortic disease; AS – aortic stenosis; CHD – congenital heart defect; COA – coarctation; CD – conduction defect

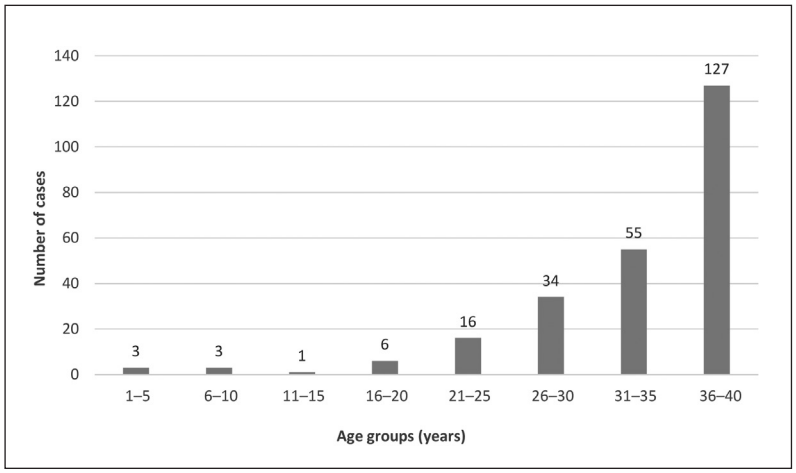

Fig. 2. *Age-related distribution of 245 SCD cases autopsied in 2014–2019 in a selected area of the Czech Republic.*

Incidence Rates

Incidence rates of SCD in people aged 1–40 years and 1–35 years were estimated at 2.4/100,000 and 1.2/100,000 person-years, respectively. Although men constituted 51% of the general population aged 1–40 years, their SCD incidence rate was four times higher than in women (3.2 vs. 0.8/100,000 person-years). However, the difference in incidence rates between the genders was not statistically significant ($p = 0.317$). Only 10 children (1–18 years) died from SCD during the six-year study period indicating an incidence of 0.2/100,000 children per year. The risk of SCD rose significantly with increasing age. The age-related distribution of SCD cases is shown in Figure 2. Incidence rates for various age groups and incidence rate ratios are provided in Table 2.

Gender Differences

There was a clear predominance of men – 198 (81%) vs. 47 (19%) women in our SCD cohort. Men were overrepresented in CAD as well as in potentially monogenic causes of death. Basic

Table 2. *Incidence rates with 95% confidence intervals calculated for age groups (N = 245)*

Age group (years)	n	Person-years	Incidence rate per 100,000 person-years (95% CI)	IRR (95% CI)
1–20	13	5,167,644	0.25 (0.14–0.44)	Ref. category
21–30	50	2,875,926	1.74 (1.31–2.30)	6.9 (3.75–12.7)
31–35	55	1,819,518	3.02 (2.32–3.94)	12.0 (6.6–22.0)
36–40	127	2,078,904	6.11 (5.13–7.27)	24.3 (13.7–43.0)

IRR – incidence rate ratio; CI – confidence interval
Incidence rate ratios with respect to the reference category of 1–20 years.

Table 3. *Characteristics and circumstance of death in persons aged 1–40 years who died of SCD in 2014–2019 in a selected area of the Czech Republic (N = 245)*

	SCD	Total n (%)	Men n (%)	Women n (%)	p-value*
SCD	All causes	245 (100.0)	198 (81.0)	47 (19.0)	< 0.001
	CAD	93 (38.0)	83 (42.0)	10 (21.0)	0.009
	Heritable cardiac conditions	75 (31.0)	67 (34.0)	8 (17.0)	0.025
	Age (median, years)	36	36	36	0.753
Presence of witnesses	Unwitnessed	179 (73.0)	139 (71.0)	40 (85.0)	0.043
	Witnessed	65 (27.0)	58 (29.0)	7 (15.0)	
	Total assessed	244 (100.0)	197 (100.0)	47 (100.0)	
BMI	< 18.5	9 (5.0)	3 (2.0)	6 (17.0)	< 0.001
	18.5–24.9	53 (28.5)	39 (26.0)	14 (40.0)	
	25–29.9	51 (27.5)	50 (33.5)	1 (3.0)	
	≥ 30	72 (39.0)	58 (38.5)	14 (40.0)	
	30–39.9	39 (21.0)	35 (23.5)	4 (11.0)	
	≥ 40	33 (18.0)	23 (15.0)	10 (29.0)	
	Total with available BMI	185 (100.0)	150 (100.0)	35 (100.0)	
Alcohol (g/kg)	> 0.2	40 (20.0)	35 (21.0)	5 (12.5)	0.207
	0.2–1.0	20 (10.0)	18 (11.0)	2 (5.0)	
	> 1.0	20 (10.0)	17 (10.0)	3 (7.5)	
	Total tested	204 (100.0)	164 (100.0)	40 (100.0)	
Toxicology screen	Illicit and/or prescription drugs	56 (45.0)	40 (42.0)	16 (53.0)	0.281
	Illicit drugs	19 (15.0)	17 (18.0)	2 (6.5)	0.135
	Prescription drugs	37 (30.0)	23 (24.0)	14 (46.5)	0.019
	Total tested	125 (100.0)	95 (100.0)	30 (100.0)	
Activity at death	Everyday activities	104 (45.0)	91 (49.0)	13 (29.0)	0.026
	Sleep	86 (38.0)	59 (32.0)	27 (60.0)	
	Moderate to high intensity sport	16 (7.0)	14 (7.5)	2 (4.5)	
	Toilet	16 (7.0)	14 (7.5)	2 (4.5)	
	Eating	4 (2.0)	3 (2.0)	1 (2.0)	
	Bath/shower	3 (1.0)	3 (2.0)	0 (0)	
	Total assessed	229 (100.0)	184 (100.0)	45 (100.0)	
Place of death	At home	146 (60.0)	115 (58.0)	31 (66.0)	0.361
	Public area	35 (14.0)	31 (15.5)	4 (9.0)	
	Health care provider	19 (8.0)	17 (8.5)	2 (4.0)	
	At work	10 (4.0)	9 (4.5)	1 (2.0)	
	Sport place	8 (3.0)	6 (3.0)	2 (4.0)	
	Social care institution	6 (2.5)	3 (1.5)	3 (6.0)	
	During transport to hospital	4 (1.5)	4 (2.0)	0 (0)	
	Other	17 (7.0)	13 (7.0)	4 (9.0)	
	Total assessed	245 (100.0)	198 (100.0)	47 (100.0)	
Time of death	12 a.m. – 6 a.m.	73 (30.5)	59 (30.5)	14 (30.0)	0.262
	6 a.m. – 12 p.m.	63 (26.0)	48 (25.0)	15 (33.0)	
	12 p.m. – 6 p.m.	43 (18.5)	39 (20.0)	4 (9.0)	
	6 p.m. – 12 a.m.	60 (25.0)	47 (24.5)	13 (28.0)	
	Total assessed	239 (100.0)	193 (100.0)	46 (100.0)	

SCD – sudden cardiac death; CAD – coronary artery disease;*Fisher's exact test

characteristics and circumstances of death in the whole cohort and in men vs. women are shown in Table 3.

DISCUSSION

One of the key findings of our study is the striking predominance of men within the Czech SCD cohort. The atheroprotective effect of estrogens has been well established (14). However, other protective mechanisms must be involved as men seem to be more vulnerable not only to CAD but also to potentially monogenic cardiac conditions. This fact has been confirmed by this as well as previous studies (15). In our study the incidence of SCD in men exceeded the incidence in women four times, whereas in Denmark (15) and Australia (4) male incidence was only double that of females with 3.6 vs. 1.8/100,000 person-years and 1.8 vs. 0.7/100,000 person-years, respectively. The reasons for this enormous vulnerability of Czech men could not be elucidated by this study. On the contrary, certain risk variables (such as underweight, absence of witnesses at death and ingestion of prescription drugs) were found in a significantly higher proportion of women than men (Table 3). Only overweight but not obesity was more prevalent in men within our SCD cohort. Hence, our study suggests that factors other than the effects of alcohol, drugs or obesity must play a gender-specific role in the increased risk for SCD in our population.

Apart from gender, obesity represents another well-established risk factor for cardiovascular diseases in general. Obesity was more prevalent in our cohort than in living Europeans below 40 years of age with 39% vs. 8.8%. The percentage of overweight persons (27.5%) in our cohort corresponded to the prevalence of overweight among living Europeans (28%) of the same age suggesting that obesity not merely being overweight increases the risk of SCD. Underweight persons were slightly more prevalent in our cohort than in the general population of the same age with 5% vs. 3.7% (16).

Furthermore, many psychotropic prescription drugs, illicit drugs and alcohol are known to increase the risk of SCD due to their effect on cardiac repolarization, heart rate and fibrinolysis (17, 18). In our cohort 20% probably consumed some alcohol before death, which is lower than in Finland, where 38% of CAD victims tested positive for alcohol (19). However, the Finnish study included older individuals. In Denmark 20% of SCD cases up to 49 years of age tested positive for alcohol (20). In Biscay only 12% of 15–35-year-olds were exposed to alcohol before SCD (17). Hence, our data show a rather high exposition to alcohol before death. The proportion of people with a positive illicit drug screen in our cohort was similar to Denmark (20) and Biscay (17).

Regarding circumstances of death, in accordance with previous studies, death occurred during rest, sleep or light activity in the vast majority of cases (4, 5). On the other hand, only 7% of people died during or after sport, which is slightly lower when compared to Denmark and Australia with 11% (5) and 15% (4), respectively. Regular sport in general decreases the risk of cardiovascular diseases. Even the annual incidence of SCD in young athletes estimated at 2/100,000 (21) does not differ significantly from the general population of the same age with 1.9/100,000 (5). Yet in many countries including the Czech Republic (according to Act 373/2011 § 51) only those participating in competitive sport undergo a meticulous pre-participation screening provided by sports medicine specialists, which includes a thorough personal and family history, physical examination and ECG.

As far as causes of death are concerned, CAD was the most common cause of death in our cohort. It accounted for a proportion of SCD comparable to that reported in Ontario, where CAD caused 36% of SCD among persons aged 2–40 years (2). CAD remained the most common cause of death even when our cohort was confined to the age group 1–35 years. In this age group, CAD in our population exceeded CAD cases reported in Denmark (5) and Australia (4), where CAD is responsible only for 13% and 24% of SCD, respectively. These findings may indicate insufficient willingness to adopt a healthy lifestyle in our population despite of the fact that multiple centres of preventive cardiology have been set up and most Czechs are aware of recommendations aimed at the reduction of atherosclerosis. The Czech Republic is actually recognized as one of the highest risk regions for CAD in Europe (22). In contrast to previous studies the proportion of SADS in our cohort was much lower. For instance, in Australia and Denmark (4, 5) SADS constituted approximately 40% of SCD cases. This discrepancy may be related to the fact that Czech forensic pathologists tend to ascribe more significance to findings that might not be sufficient to cause death. In addition, standardized histological criteria defining the substrate for SCD have only recently been adopted in routine practice. The underestimated number of SADS victims may also explain the lower proportion of potentially monogenic cardiac conditions (CM, TAD and SADS) in our study as compared to published data.

When we focus on the estimated annual incidence of SCD among the various subgroups of our study, the most remarkable finding is the relatively low annual incidence of SCD in children aged 1–18 years in our population compared to Ontario and Denmark, who reported incidence rates of 0.7 and 1.1/100,000 children per year, respectively (2, 13). We presume our results correspond with reality as only a negligible number of SCD cases occur in temporal association with medical procedures within hospitals. These cases are autopsied at departments of pathologic anatomy and could therefore have eluded our study. The relatively low incidence of SCD in children could possibly be explained by a very well-established system of preventive care in the Czech Republic. The extent of preventive care is even stipulated by the Health Services Act no. 372/2011 § 120 § 3. All children attend their physician many times during the first year of life and at least once every two years thereafter. From the age of three years all children have their blood pressure measured and urinalysis performed. From the age of five years, children from families with a history of early CAD are tested for dyslipidaemias. Furthermore, all these examinations are performed by paediatricians. In contrast, in many other countries such as Scandinavia, the UK, the Netherlands, etc., primary care for children is provided by GPs. Another factor could be the fact that in the Czech Republic primary as well as specialist care is readily available and free of charge. The annual incidence rate of SCD in the whole cohort of persons aged 1–40 years in the Czech Republic was estimated as slightly lower than in Ontario with 2.6/100,000 person-years (2).

Major limitations of the present study include inconsistent use of standardized autopsy protocols and histological criteria for SCD cases across forensic pathology institutes and a lack of clinical information available to forensic pathologists. There is

no database where a patient's medical history could be recorded and made accessible.

CONCLUSION

Key findings of this retrospective study include an extreme vulnerability of men to SCD and a dominant role of CAD in the young Czech population. Preventive measures should above all be targeted at the reduction of risk factors associated with CAD such as smoking, dyslipidaemias, elevated blood pressure, and obesity. Further studies exploring the reasons for the significant gender gap in the Czech SCD population should be performed to reveal new gender-oriented preventive measures.

Potentially monogenic heart conditions represented the second most prevalent cause of SCD in persons aged 1–40 years. Based on these results a multidisciplinary team has already been established to offer cardiogenetic counselling to first degree relatives of selected SCD cases in the Czech Republic. Furthermore, a pilot project assessing the yield of molecular autopsy with the aim to procure its funding by Czech insurance companies has started recently. And finally, standardized autopsy protocols with clear indication criteria for genetic analysis and cardiogenetic counselling in the families of the deceased were approved by the Czech Forensic Medicine Society in 2020.

Conflicts of Interests
None declared

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Adherence to Ethical Standards
Ethics Committee's approval was not required as all patients' data were strictly de-identified. The study did not involve living subjects nor did it involve any genetic analyses.

Authors' Contributions
KR was responsible for the design of the study and writing the manuscript. MD, MB, ŠPK, MK and PT as forensic pathologists re-evaluated autopsy protocols and histological findings when necessary in order to establish the most accurate diagnosis. TT provided valuable help with defining histological SCD criteria. IN performed statistical analysis. All co-authors contributed substantially to the study.

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