

Cardiovascular Diseases in Croatia and Other Transitional Countries: Comparative Study of Publications, Clinical Interventions, and Burden of Disease

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Aim	To determine the number of publications on cardiovascular diseases in the MEDLINE database, the rate of medical doctors and clinical interventions in cardiology, and health and socioeconomic indicators for Croatia, and to compare them with those for Slovenia, Hungary, the Czech Republic, and Austria.
Methods	PubMed was used in search for publications on cardiovascular diseases published in 1991-2004. Rates per million population and proportions of publications on cardiovascular diseases in the MEDLINE database were calculated. Gross domestic product (GDP) <i>per capita</i> was used as a socioeconomic indicator, whereas human resources in medicine were presented as the rate of medical doctors per million population. Standardized death rates from cardiovascular diseases and ischemic heart disease were used as indicators of cardiovascular health. Clinical interventions in cardiology, such as coronary angiograms, percutaneous transluminal coronary angioplasties (PTCA), and coronary bypass surgeries (CABG) were expressed per million population per year.
Results	Croatia had the lowest GDP <i>per capita</i> among the analyzed countries. The standardized death rate from cardiovascular diseases in Croatia was 91.7 per 100,000 population aged 0-64 in 2001, which was higher than that in Slovenia and Austria ($P < 0.001$), similar to that in the Czech Republic, and lower than that in Hungary ($P < 0.001$). Cardiovascular scientific output in Croatia was the lowest among investigated countries, ie, 1.1 per million population in 2003 ($P < 0.001$). Despite a significantly lower number of medical doctors in comparison with Hungary and the Czech Republic ($P < 0.001$), Croatia experienced a similar increment in the amount of clinical interventions in cardiology.
Conclusion	In contrast to high cardiovascular mortality rates, cardiovascular scientific production in Croatia was significantly lower than in other investigated countries. A positive trend in cardiovascular medicine was recorded in clinical practice, but has yet to be followed by scientific production.

Cardiovascular diseases represent a major cause of death and disability worldwide, an emerging global epidemic reflected in an ever increasing burden of disease (1,2). During the last years, these diseases have caused approximately 4.3 million deaths in Europe and 1.9 million deaths in the European Union (EU) per year, representing 49% of all deaths in Europe and 42% in the EU (3).

Eastern European transitional countries have the highest mortality rates from cardiovascular diseases in Europe. In 2001, the standardized death rates (per 100,000 inhabitants) from cardiovascular diseases for men and women aged 0-64 years were 212.1 in Ukraine, 176.0 in Bulgaria, and 149.8 in Romania. In contrast, these death rates were the lowest in economically stable

countries, such as France, Spain, and the Netherlands (31.2, 35.4, and 41.6 per 100,000 inhabitants, respectively; ref. 4). In Croatia, cardiovascular diseases also represent the leading cause of mortality and morbidity: the standardized death rate has been increasing for the last three decades and in 2001, it was 91.7 per 100,000 population (5).

Being aware of the differences among EU countries, candidate countries for EU, and the new independent states of the Former Soviet Union, the World Health Organization (WHO) divided the European Region into country groups according to their similarities in geopolitical position, population, development, socio-economic trends, and health indicators. According to this WHO division, referent countries for Croatia are Albania, Bosnia and Herzegovina, Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, and the FYR of Macedonia (6).

National biomedical research in each country is essential for the production of knowledge on the extent and burden of health-related problems, for identifying prioritized areas, and establishing databases on the epidemiological and clinical profiles of diseases leading to better health policy planning and management (7). Scientific publications have been used worldwide as a means of measuring productivity in scientific research (8). Gross domestic product could serve as a barometer of relative economic growth and development, strongly correlating with scientific output; together with human resources, it is one of the most important factors possibly influencing scientific productivity (9).

Cardiology is an ever-growing field of medicine, with a variety of new techniques introduced constantly. Percutaneous transluminal coronary angioplasty (PTCA) since its introduction in 1977 by Andreas Grüntzig, has become one of the most frequently performed major clinical interventions in medicine (10,11). According to the European Society of Cardiology, 1,806,238 coronary angiograms and 617,176 PTCA were performed in Europe in 2001, which is 10% and 17% more than in 2000, respectively. Coronary stenting increased by 25% in the same period (12).

Our aim was to estimate whether Croatian scientists have followed this increase in the major cause of mortality and morbidity with an adequate amount of biomedical publications on cardiovascular diseases in the MEDLINE database.

We also compared the amount of clinical interventions in cardiology with Slovenia, Hungary, and the Czech Republic as referent transitional countries, and Austria, as an economically stable country.

Materials and Methods

We identified biomedical publications on cardiovascular diseases in MEDLINE database for the 1991-2004 period. The search was performed via PubMed (www.ncbi.nlm.nih.gov/PubMed/medline.html) in August 2005. MEDLINE was chosen because it is the most extensive, easily accessible, and free-of-charge database covering the fields of medicine, nursing, dentistry, veterinary medicine, health care systems, and the pre-clinical sciences. We selected "Cardiovascular diseases" as a Medical Subject Headings (MeSH) descriptor, because it is highly positioned in the MeSH tree structure and covers the majority of publications in cardiovascular medicine. The dates 1991-2004 were entered in the "Publication date" field, and the country names (Croatia; Slovenia; Hungary; Czech Republic OR Czechoslovakia NOT Slovakia; and Austria) were entered in the "Affiliation field," to obtain publications with the first author's affiliation in one of these countries. This search allowed the identification of the first author's affiliation only, due to PubMed limitation.

The number of publications on cardiovascular diseases from each country was expressed as a publication rate (number of cardiovascular diseases publications per 1,000,000 population per year) and a proportion of publications on cardiovascular diseases in the total number of publications from that particular country in the MEDLINE database.

Data on GDP *per capita* and population size on January 1 in the selected years were obtained from the Eurostat database (www.epp.eurostat.ec.eu.int/portal). Human resources in medicine (number of medical doctors per 100,000 population per year) and the cardiovascular health indicators (standardized death rates from cardiovascular diseases and ischemic heart disease) were obtained for the 1991-2003 period for each country from the "European health for all database" (<http://www.euro.who.int/>). This database allows the analysis of trends and international comparisons for a wide range of health indicators to support the formulation and monitoring of health policy at national and international levels. Standard-

ized death rates are adjusted to the age structure of the standard European population and have allowed an unbiased comparison between countries, serving as health indicators and providing estimates of the cardiovascular health of the population.

The number of clinical interventions in cardiology, such as coronary angiograms, PTCA, and coronary artery bypass graft surgeries (CABGs), served as indicators of everyday clinical practice in cardiology, and allowed a comparison of cardiological health care among investigated countries. Rates of coronary angiograms and PTCA in selected countries were obtained for the 1992-2001 period from the European Society of Cardiology reports on interventional cardiology in Europe (11-21). Rates for the whole Europe were calculated from absolute numbers reported by Togni et al (12) in an overview of specific interventional cardiological activities from 29 of the 32 members of European Society of Cardiology (Bulgaria, Ireland, and Morocco did not provide sufficient data), representing more than 550 million people. The data on population in these 29 countries were obtained from Eurostat. Coronary artery bypass graft surgery rates for the years 1994 and 2002 were obtained from the European Cardiovascular Disease Statistics (3), the European Society of Cardiology (16), and a report by Ghosh and Unger (22).

The selected socioeconomic and health indicators for Croatia were compared with those in the Czech Republic, Hungary, and Slovenia, ie, countries that have joined the European Union in 2004. Slovakia and Poland were excluded from the analysis, because of much missing data in the European health for all database and Eurostat (for Poland: GDP in Euro in 1991-1994, death rates in 1997-1998, number of medical doctors in 2003; and for Slovakia: GDP in Euro in 1991-1992, death rates for 2003, number of doctors in 1996-1997, and angiograms in 1994). Austria was selected as a developed Central European country, and a member of EU-15.

Statistical Analysis

Due to a non-normal distribution of the data, we used the Mann-Whitney U-test to compare the rates between two countries or two groups of countries and the Kruskal-Wallis test for three or more countries or country groups. P values <0.05 were considered statistically signifi-

cant. All statistical analyses were performed with Epi-Info Software (Version 3.3, Centers for Disease Control, Atlanta, GA, US; <http://www.cdc.gov/epi/info/downloads.htm>).

Results

GDP *per capita* in the 1991-2004 period in Croatia was low, similar to that in Hungary and the Czech Republic ($P=0.114$). Slovenia was the leading referent country ($P<0.001$), with a 2.7 fold increase of GDP *per capita* in the investigated period. Since 1991, GDP *per capita* has continuously increased in all countries except in Croatia, where it showed a sharp decline in 1992 and reached the pre-war level as late as 1996 (Fig. 1).

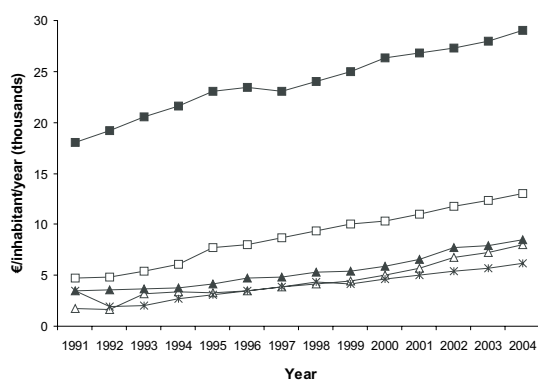


Figure 1. Gross domestic product (GDP) *per capita* in Euros (€) in the 1991-2004 period. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk: Croatia. Croatia vs Hungary and the Czech Republic, $P=0.114$. Slovenia vs Croatia, Hungary, and the Czech Republic, $P<0.001$.

In the investigated period, Croatia had the lowest rate of publications on cardiovascular diseases of all analyzed countries ($P<0.001$). Other transitional countries had similar and rather low rates of publications on cardiovascular diseases until 1995. Afterwards, all those countries, in contrast to Croatia, have increased their cardiovascular diseases publication output. The rate of publications on cardiovascular diseases in Croatia in 2003 was estimated at 1.1 per million population, ie, the lowest since 1991 (Fig. 2).

The overall proportion of publications on cardiovascular diseases in the MEDLINE database ranged from 8.8% in 1991 to 9.6% in 2003. With up to 12% of publications on cardiovascular diseases in the MEDLINE database, Austria ranked the highest among the investigated countries. Dur-

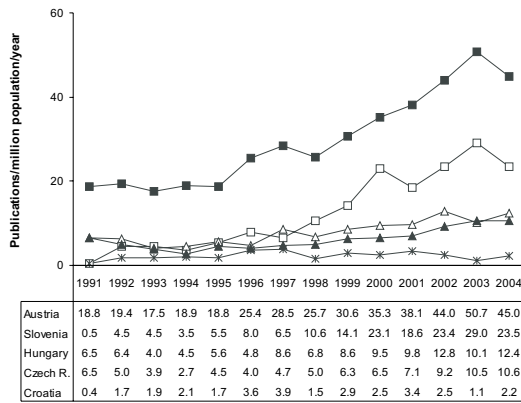


Figure 2. Number of publications on cardiovascular diseases in the MEDLINE database per 1,000,000 population per year in 1991-2004. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia. Croatia vs Austria, Slovenia, Hungary, and the Czech Republic, $P < 0.001$. Slovenia vs Hungary vs the Czech Republic, $P = 0.171$.

ing 1991-2004, Slovenia increased its proportion of publications on cardiovascular diseases in the MEDLINE database, whereas the Czech Republic and Hungary had an increase only after a slight decline in mid 1990s.

During the investigated period, the proportion of Croatian publications on cardiovascular diseases was significantly lower than that in Austria and transitional countries from this study ($P < 0.001$). After a slight increase in the second half of the 1990s, the proportion of Croatian publications on cardiovascular diseases continued to decline, reaching 1.2% in 2003, ie, the lowest value since 1991 (Fig. 3).

Standardized death rates from cardiovascular diseases were the lowest in Austria, closely followed by Slovenia. In both countries they were significantly lower than those in Croatia, the Czech Republic, Hungary, and the European average ($P < 0.001$).

In 1991, Croatia had lower standardized death rates from cardiovascular diseases than the Czech Republic, but the Czech Republic experienced a steeper decrease and in 2003, it had a lower rate than Croatia. Hungary was the only analyzed country with significantly higher standardized death rates in comparison to Croatia ($P < 0.001$; Fig. 4).

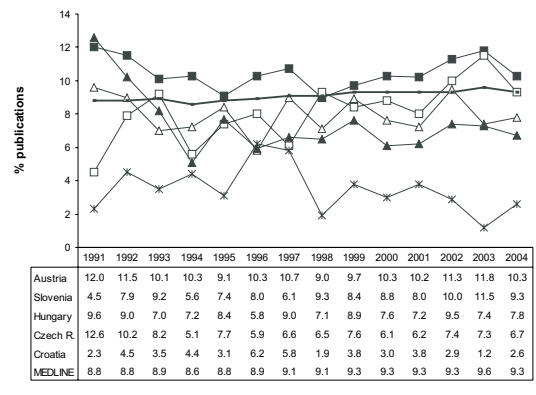


Figure 3. Proportions of cardiovascular publications in all MEDLINE publications in 1991-2004. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – overall proportion of publications on cardiovascular diseases in MEDLINE. Croatia vs Austria, Slovenia, Hungary, and the Czech Republic, $P < 0.001$.

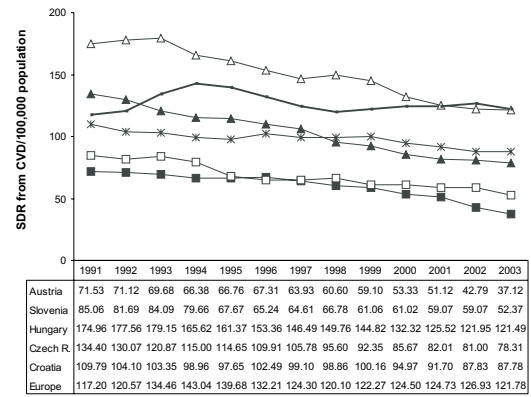


Figure 4. Standardized death rates (SDR) from cardiovascular diseases (CVD) per 100,000 population per year for both men and women aged 0-64 years in 1991-2003. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – European average. Austria and Slovenia vs Croatia, Hungary, the Czech Republic, and European average, $P < 0.001$. Croatia vs Hungary, $P < 0.001$.

In contrast to the previously mentioned figures, standardized death rates from ischemic heart diseases were the lowest in Slovenia, closely followed by Austria. Death rates in Austria and Slovenia were significantly lower than in Croatia, Hungary, the Czech Republic, and the European average ($P < 0.001$).

In 1991, Croatia had much lower standardized death rates from ischemic heart disease

than the Czech Republic, but the Czech Republic experienced a sharp decrease in the analyzed period and in 2003 the figures changed in favor of the Czech Republic. Hungary was again the only country with significantly higher mortality rates from ischemic heart disease than Croatia ($P < 0.001$). However, the comparison of standardized death rates from ischemic heart disease in 1991 and 2003 as the first and the last investigated years, respectively, indicated a decrease in the Czech Republic and Hungary by 53% and 43%, respectively, whereas Croatia experienced a decrease by only 10% (Fig. 5).

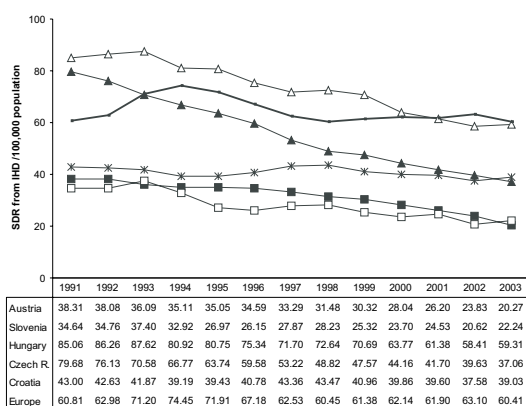


Figure 5. Standardized death rates (SDR) from ischemic heart disease (IHD) per 100,000 population per year for both men and women aged 0-64 years in 1991-2003. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – European average. Austria and Slovenia vs. Croatia, Hungary, the Czech Republic and European average $P < 0.001$. Croatia vs. Hungary $P < 0.001$.

All investigated countries had fewer medical doctors per 100,000 population per year than the European average ($P < 0.001$). In 1991, Croatia had the lowest rate of medical doctors among investigated countries. In the analyzed period, figures for Slovenia were very similar to those for Croatia ($P = 0.443$) and both countries had significantly lower rates of medical doctors than Austria, the Czech Republic, Hungary, and the European average ($P < 0.001$; Fig. 6).

The comparison of coronary angiogram rates per million population showed that Austria was the leading country in our study ($P < 0.001$) and had a rate close to the European average ($P = 0.09$). In the same period, Croatia, Hungary, and Slovenia had similar rates of coronary angio-

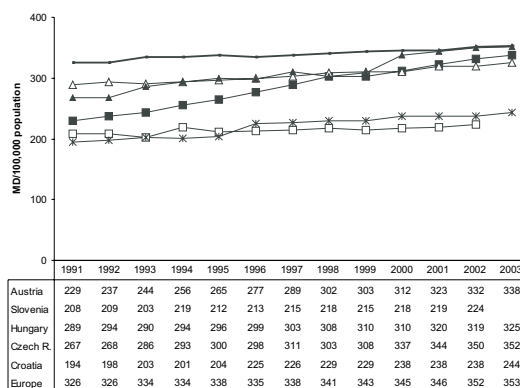


Figure 6. Number of medical doctors (MD) per 100,000 population per year in 1991-2003. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – European average. Data for Slovenia for 2003 are missing. Croatia and Slovenia vs. Austria, Hungary, the Czech Republic, and European average, $P < 0.001$. Austria, Hungary, and the Czech Republic vs. European average, $P < 0.001$.

grams ($P = 0.834$), which were significantly lower than the European average ($P < 0.001$). The Czech Republic experienced a quicker increase in the rates of coronary angiograms after 1994, but it was not significantly different than that in Croatia, Hungary, and Slovenia ($P = 0.143$; Fig. 7).

The number of PTCA's per million population per year revealed a similar pattern. As in the

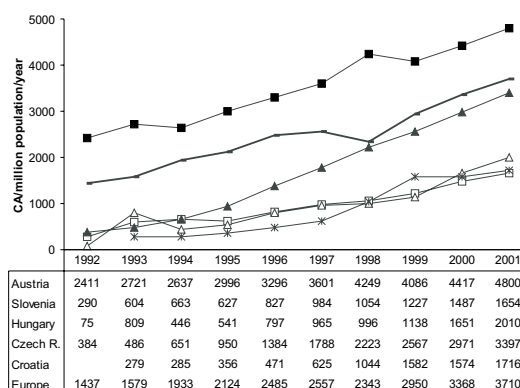


Figure 7. Coronary angiograms (CA) per million population per year in the 1992-2001 period. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – European average. Data for Croatia for 1992 are missing. Croatia vs. Slovenia and Hungary, $P = 0.143$. Croatia, Slovenia, and Hungary vs. the Czech Republic, $P = 0.143$. Croatia, Slovenia, and Hungary vs. Austria and European average, $P < 0.001$. The Czech Republic vs. Austria, $P < 0.001$. The Czech Republic vs. European average, $P = 0.143$.

case of angiograms, Austria was again the leading country ($P=0.001$), with a somewhat higher rate than the European average ($P=0.132$). Croatia, Hungary, and Slovenia again had similar rates in the analyzed period ($P=0.706$). The Czech Republic reached a similar rate as the European average ($P=0.251$), but it was still not significantly higher than in other three transitional countries ($P=0.088$; Fig. 8).

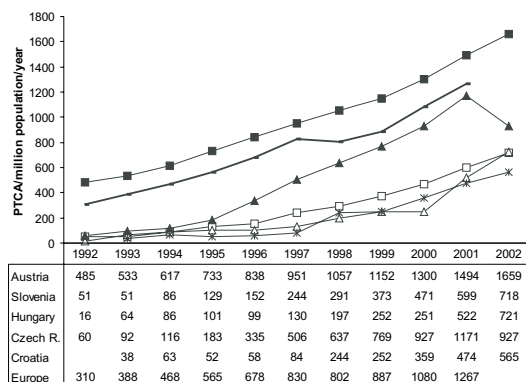


Figure 8. Percutaneous transluminal coronary angioplasties (PTCA) per million population per year in the 1992-2001 period. Closed squares – Austria; open squares – Slovenia; closed triangles – the Czech Republic; open triangles – Hungary; asterisk – Croatia; line – European average. Data for European average for 2002 are missing. Croatia vs Slovenia and Hungary, $P=0.706$. Croatia, Slovenia, and Hungary vs the Czech Republic, $P=0.088$. Croatia, Slovenia, and Hungary vs Austria and European average, $P<0.001$. The Czech Republic vs Austria, $P=0.023$. The Czech Republic vs European average, $P=0.251$.

Austria was also the leading country according to the rates of CABG surgeries per million population, with an increase of 22% from 1994 to 2002 (456 vs 557 per million population, respectively; data not shown). In the same period, the Czech Republic experienced a 2.6-fold increase in CABG rates (from 188 to 488 per million population), Hungary a 3.3-fold increase (from 143 to 476 per million population), whereas Croatia had a 6-fold increase (from 39 to 234 per million population). The rates in Croatia in 2002 were almost the same as those in Slovenia (230 per million population per year).

Discussion

Cardiovascular diseases are a major cause of death and disability in adults in developed countries. A substantial increase in cardiovascular diseases in the countries of Central and

Eastern Europe is concomitant with their recent economical and political changes (4). The majority of the post-communist countries in transition experienced a rapid deterioration of population health due to limited access to health care, growing inequity, increase in costs and the dominance of costly therapeutic medicine, and the disappearance of preventive care (23,24).

Poland, the Czech Republic, Hungary, Slovakia, and Slovenia have not experienced such a sharp deterioration of population health. We compared Croatia to some of these countries, which successfully recognized the need for monitoring and surveillance, prevention of risk factors, and modern treatment of cardiovascular diseases within the general framework of health problems, and also to Austria as a developed Central European country historically connected to Croatia.

Croatia, a former communist country, declared its independence and started a political transition and a health care system reform in 1991 (25). Despite the fact that some of the major national health problems were closely related to transition, Croatia was the only one among the investigated countries that was affected by the devastating war from 1991 to 1995 (26). The sharp decline in the GDP *per capita* in 1992 was probably the consequence of the war and caused the rapid deterioration of social and economic conditions. After 1996, when GDP finally reached the pre-war level, an increase in GDP was recorded, indicating a steady improvement of socioeconomic conditions in the country. Unfortunately, this increase in GDP was rather modest and slow in comparison with that in other transitional countries.

Cardiovascular diseases are also the leading cause of mortality and morbidity in Croatia, cardiovascular mortality having increased during the last three decades (5). Croatia had high cardiovascular death rates, but still lower than Hungary and the European average. As opposed to the Czech Republic and Hungary, which experienced a major decrease in standardized death rates from ischemic heart diseases since the 1990s, Croatia experienced a modest decline by only 10%.

Croatia's ranking on the list of selected countries can be partially explained by a high prevalence of cardiovascular risk factors in the population but also by a lack of good (or any) prevention strategies. Croatian adult health survey conducted in 2003 showed different but still high prevalence

of risk factors, such as smoking (10-33%), increased blood pressure (44-63%), physical inactivity (17-43%), obesity (12-26%), and inadequate nutrition (6-29%) in both men and women and in different regions of the country (27). Croatia is one among 18 Mediterranean countries with possibly protective heritage on cardiovascular diseases. In 2002, Croatian coastal counties recorded rates of cardiovascular diseases from 50 to 80/100,000 inhabitants aged 0-64 years, which were all below the Croatian average (87.83/100,000). Rates in these counties were similar to those in Greece (51.98/100,000), Slovenia (53.38/100,000), and Albania (70.65/100,000), but much higher than in other Mediterranean countries, such as Spain (34.08/100,000), Malta (47.05/100,000), France (31.16 in 2001), Italy (37.24 in 2001), and Israel (36.47/100,000 in 2000) (3). We can see that this protective heritage on cardiovascular diseases did not have a sufficient positive impact on the burden of cardiovascular diseases in Croatia.

Aside from the high prevalence of preventable cardiovascular risk factors in the Croatian population, Croatia is to face a further problem within the next few decades – a large proportion of the population older than 65 years. This proportion amounted to 15.7% in 2001 and it is predicted to increase to 22.7% and 29.6% in 2025 and 2050, respectively (28). High proportional mortality from cardiovascular diseases in people older than 65 (53.5% for men and 64.3% for women in 2002; ref. 29) will further increase the prevalence and mortality from cardiovascular diseases in Croatia. In response to such a high cardiovascular mortality, Croatian Ministry of Health initiated National Cardiovascular Disease Prevention Program in 2001 (30).

Although cardiovascular diseases account for more than a half of the overall mortality in Croatia, the support for research in this area has not been sufficient in the last decade. In 1991-2004, Croatia had the lowest cardiovascular diseases publication rates in the MEDLINE database among countries included into the analysis. Such inadequate scientific production on cardiovascular diseases raises concern about the capability of Croatian scientific and especially cardiovascular community to adequately respond to an emerging epidemic. Even though Croatia has experienced an increase in the overall MEDLINE publication rate in the post-war period (31), publications on

cardiovascular health issues did not follow that positive trend. In 2003, the estimated proportion of Croatian publications on cardiovascular diseases in MEDLINE was 1.2%, as opposed to 7.3-11.8% in other analyzed countries.

Publications on cardiovascular diseases can serve as an indicator of the cardiovascular research productivity, crucial for monitoring and surveillance, development and evaluation of prevention programs, and clinical practice in cardiology. Until recently, there were even no reliable epidemiological data on the prevalence of cardiovascular risk factors in the Croatian population. Previous studies consisted of small and unrepresentative samples, yielding conflicting results. A representative cross-sectional study was conducted as late as in 2003, providing the first overall prevalence of cardiovascular risk factors in the population. Results suggested some reasons for high cardiovascular diseases mortality in Croatia and indicated that Croatia has not faced the epidemic of cardiovascular diseases successfully (27).

To promote necessary health care policies and facilitate research, the first step national health authorities should make is a systematic collection of data through surveys and mandatory registries. These efforts should be facilitated by research promotion, guidelines development, critical review of everyday clinical practice in cardiology, and educational programs, but it presents a long-term process, which involves many different and costly components (32). Considering the complex etiology and the late onset of cardiovascular diseases, emphasis should be placed on cooperation of public health professionals and clinical practitioners in reducing the prevalence of major preventable cardiovascular risk factors in Croatia, primarily hypertension, obesity, smoking, and excessive alcohol consumption.

It is well known that primary prevention is of substantial importance in decreasing cardiovascular diseases mortality and morbidity, but the role of secondary prevention should not be underestimated. Interventions in cardiology represent the most frequent major interventions in medicine promoting cardiology as a rapidly growing field of medicine. The recent increase in the number of clinical interventions in Eastern European countries certainly contributed to the maintenance of such a position of cardiology among other fields in European medicine (11).

According to the rates of performed coronary angiograms and PTCAs, Croatia closely followed the rates in Slovenia and Hungary and even those in the Czech Republic, although to a smaller extent, indicating a rather high level of "everyday clinical practice" in Croatian cardiology. When the CABG rates were assessed, all the countries experienced a substantial increase, but Croatia was the highest ranked country with as much as 6.0 fold increase in the 1994-2002 period. This further supported the positive trend of clinical practice development in cardiovascular medicine.

Unfortunately, this rising trend in numbers of cardiovascular procedures in Croatia was not followed by an adequate data collection. For example, even data on the number of cardiologists is not yet available. In 2000, the European Society of Cardiology presented data obtained in 1997 by interviewing all European national scientific and professional organizations. The questionnaire consisted of items on the number of active cardiologists, number of trainees and retiring, physicians who perform coronary angiographies, PTCA, stenting, and other interventions. There were also items about mandatory data collection on procedures in interventional cardiology and peer reviews for interventional cardiology or pacemakers implantations. Croatia was among the countries, mainly from Eastern Europe (including Slovenia), that did not respond (33).

The rate of cardiologists in Austria has increased from 1997 to 2000 by 60% (from 20 to 32 per million population). In the same period in Hungary, the rate of cardiologists has increased from 69 to 76 per million population (10% increase) and in the Czech Republic from 35 to 37 (6% increase) (33). The only available data for Croatia were for the year 1995, published by the European Society of Cardiology (34), when there was a total of 230 cardiologists, ie, 51 cardiologists per million population. According to our information, these were only the members of the Croatian Society of Cardiology and not all cardiologists in Croatia. Slovenia had 70.2 cardiologists per million population in 1995 (34). This was the main reason for using the number of medical doctors in our analysis, instead of the number of cardiologists.

In all of the countries included into analysis, the number of medical doctors per 100,000 inhabitants per year was below the European aver-

age. Slovenia and Croatia had significantly lower rates than other analyzed countries. Croatia is one of the countries potentially facing a serious physician shortage (35), further affected by a decreased interest in entering medicine and a possible emigration of young physicians (36). These issues further aggravate the question of health care provision in Croatia. Given these data, we can say that a very small number of Croatian physicians performed a high number of cardiovascular procedures.

During the last decade, the Croatian government's policy has been focused primarily on health care expenditures, instead of national health targets. Such a policy, in addition to only a small proportion of GDP allocated to research and development, has not positively influenced the overall scientific research (37). On the other hand, Croatia is marked by long history of public health programs, which led to successful epidemiological actions in the past. Public health actions and prevention were implemented in the tradition of Andrija Štampar School of Public Health (38). Since it has already been proved as efficient, a comprehensive team approach that includes population and individual strategies might be crucial for the success in stopping and reversing the negative trends in rates of cardiovascular diseases risk factors and mortality.

We are aware of the limitations of our research. In the first place, the number of published articles is only a crude estimate of the scientific activity and hardly represents the quality of published articles. Such studies are also limited by the fact that PubMed includes only the institutional affiliation and address of the first author. This approach was used under the assumption that the first author was the person who contributed most to the study and initiated the research and fundraising, although this need not always be the case. The articles resulting from international cooperation may have authors from several countries, but only the country of the first author was detected with the applied search strategy. Second, the number of publications in Croatia in 1991, and even in 1992, as well as in the Czech Republic in 1992 and 1993 has to be regarded with caution because of the achievement of independency and changes of the countries' names in those years. Third, European averages of standardized death rates were calculated from whole European population (according to WHO), including the countries with

very high rates. Instead of death rates, rates of procedures in cardiology were calculated from data on only 29 European countries, excluding ones which were not members of European Society of Cardiology during the whole selected period (eg, Russian Federation, Ukraine, Byelorussia, Albania, FYR of Macedonia, Bosnia and Herzegovina, and Serbia and Montenegro). This could be a possible reason for very high rates of European averages on cardiovascular procedures. Finally, we chose to compare Croatia with referent countries that joined the EU in 2004. Unfortunately, we found later on that data on Poland and Slovakia in the used databases were largely insufficient. Despite the limitations, these crude estimates of cardiovascular diseases research productivity point that scientific production on cardiovascular diseases in Croatia was significantly smaller than in referent countries. Such results again showed the need for investment in research through upgrading, enhancing, and providing better funding and facilities for researches in the field of cardiovascular medicine.

To our knowledge, this study is the first one that provides some data about cardiovascular diseases publications as an indicator of the cardiovascular research productivity in Croatia. According to the burden of cardiovascular diseases, cardiology should be an increasingly productive field in biomedical research. Small cardiovascular scientific production in Croatia in relation to the burden of cardiovascular diseases represents a challenge that clinicians, public health practitioners, health care providers, and health policy workers are to face in the near future. Building a knowledge-based medicine and increase in research activity should be our future aim.

This article emphasizes the role of the Croatian cardiovascular scientific community in targeting health priorities and the need for changes in the current health care system. The authors' intention was not to criticize the current state of biomedical science and health care system in Croatia, but rather to express concerns about some negative trends and highlight directions for future positive changes.

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