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Paper 251

Socioeconomic Factors in Circulatory System Mortality in Europe:
A Multilevel Analysis of Twenty Countries

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Introduction

This paper is the result of a teamwork that emerged from an advanced course of Health Statistics at University of Bologna.

This experience had two main aims:

1. Put students in front of concrete research problems, usually ignored by traditional university courses.
2. Prove that it's possible to carry out interesting studies, with scientifically coherent conclusions, starting from free institutional on-line databases.

Five students, according with their professor, discussed several possible application topics for Multilevel Models and finally focused on Mortality for Circulatory System Diseases in Europe.

Circulatory System Diseases Mortality

Several recent studies confirm that CSD mortality, although it's declining in the majority of European countries, still presents a high incidence in Europe and requires special attentions from health policy makers.

Previous researches analysed this topic in terms of:

- trends of cause-specific mortality
- avoidable mortality

The majority of well-know studies about CSD mortality are restricted to trends until the year 2000 while more recent data are now available.

Circulatory System Diseases Mortality

It's also interesting to study the association between CSD mortality and several socioeconomic and lifestyles indicators as possible explanatory factors in order to plan efficient policies.

Although this kind of data are easily available from free institutional databases, powered by prestigious international organizations such as the WHO, recent papers hardly concentrated on these aspects.

Data and Countries

• **Main data source** – "Health for All" database (August 2009 version) published by the Regional Office for Europe of the World Health Organisation.

• **Time span** – from the year 1992 to the year 2003; this choice depended mainly on the data availability for our outcome variable (Standardised Death Rate for Circulatory System Diseases) in the HFA database.

• **Selected countries** – 20 European countries divided into 5 different geographical areas, chosen according to the availability of the outcome variable for the selected time span.

1. *Northern Europe*: Denmark, Finland, Iceland, Sweden
2. *Central Europe*: Austria, France, Netherlands, Switzerland
3. *Southern Europe*: Italy, Portugal, Macedonia
4. *Eastern Europe*: Czech Republic, Hungary, Slovakia, Slovenia
5. *Former Soviet Republic*: Azerbaijan, Belarus, Kazakhstan, Ukraine, Uzbekistan

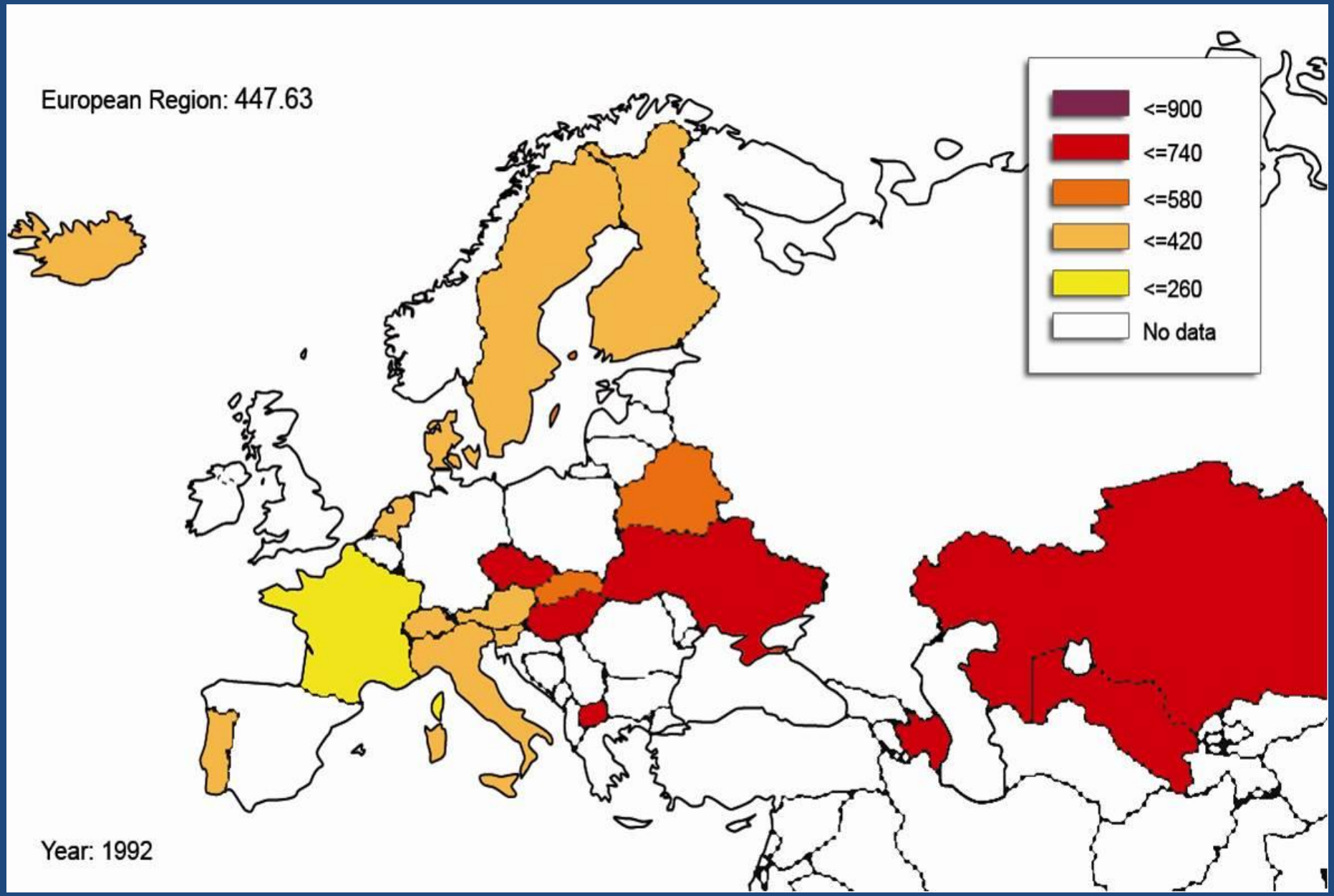


Figure 1. SDR for diseases of circulatory system per 100,000 in the selected countries for the year **1992** (figure from the European HFA Database)

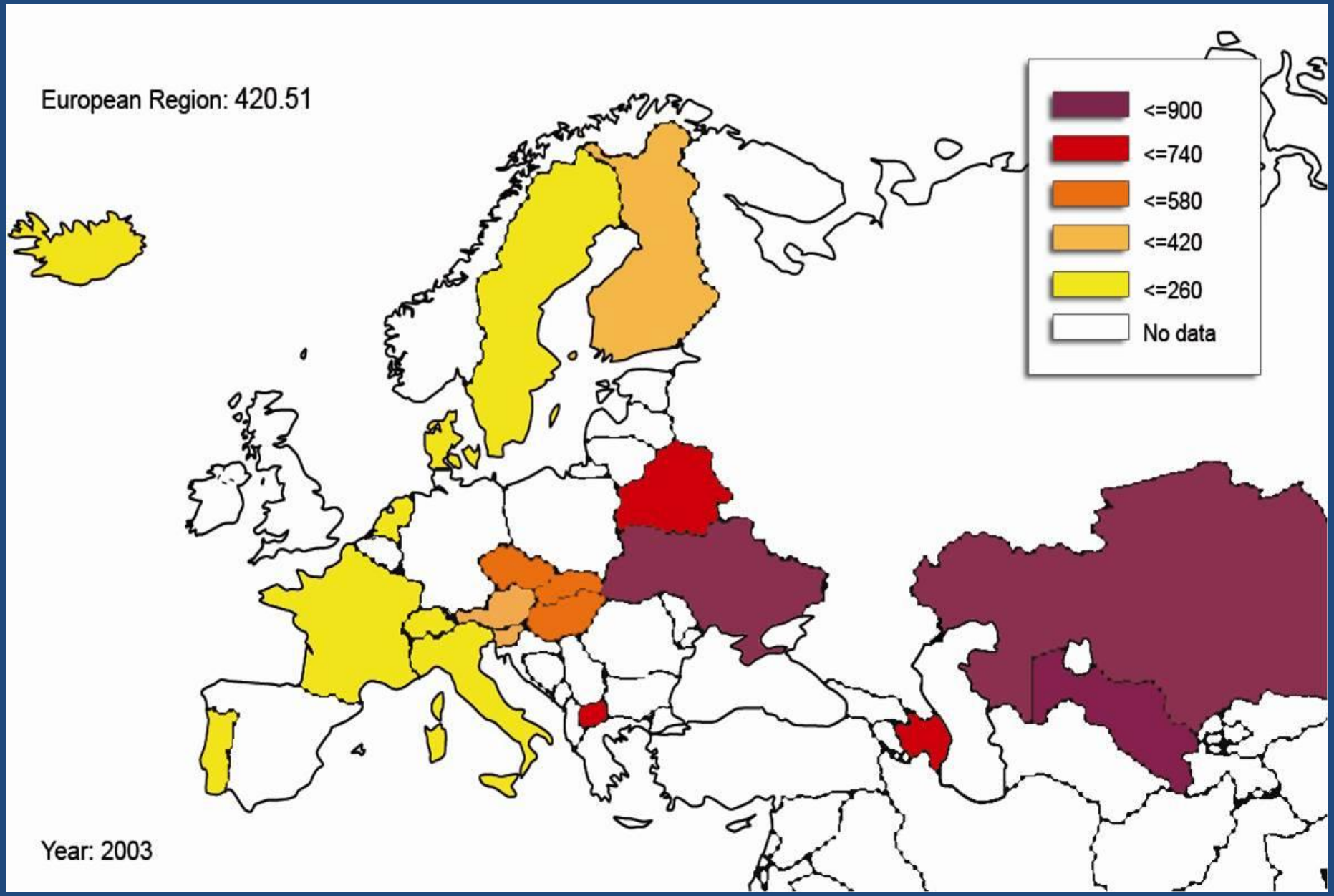


Figure 2. SDR for diseases of circulatory system per 100,000 in the selected countries for the year **2003** (figure from the European HFA Database)

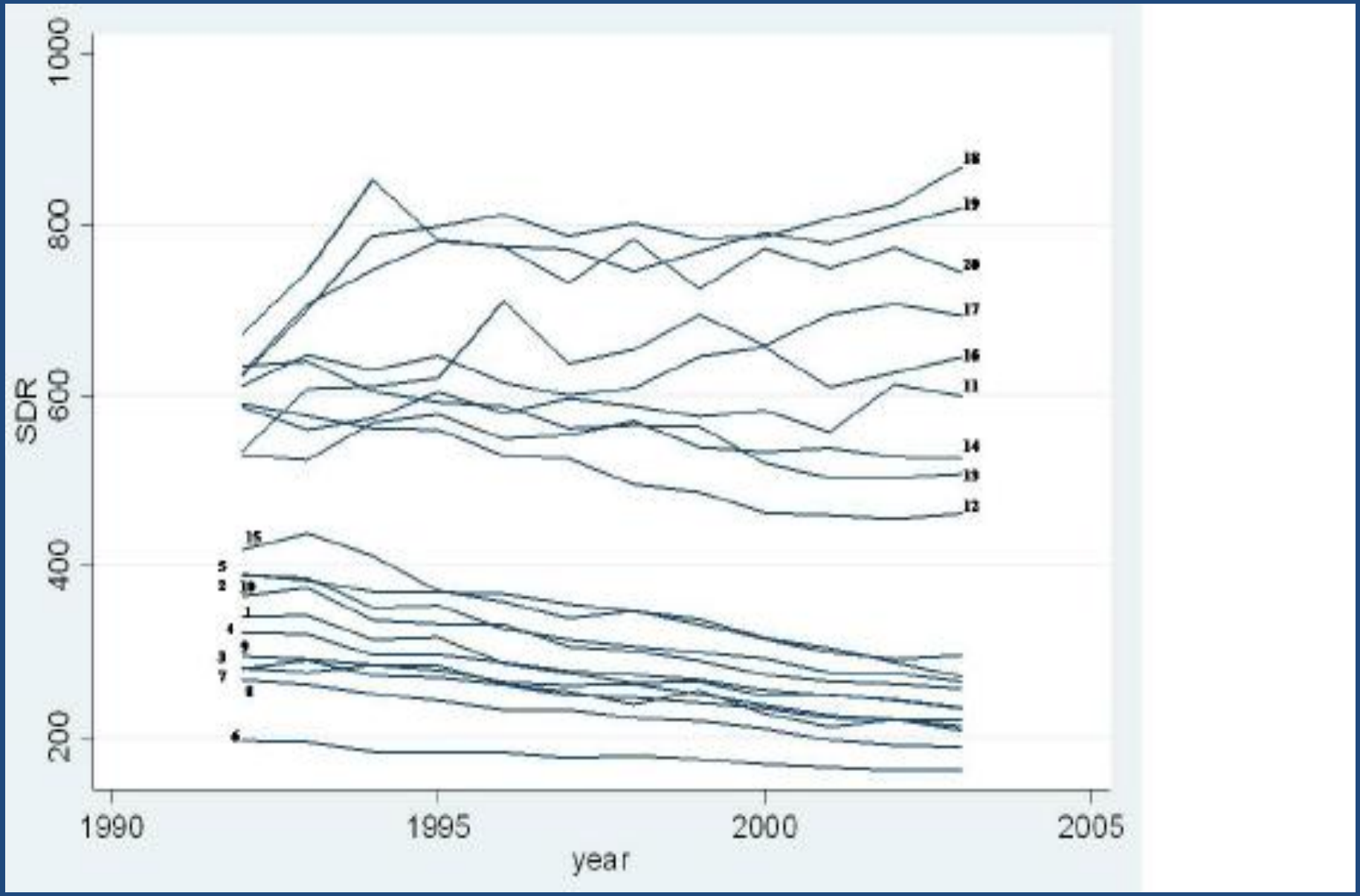
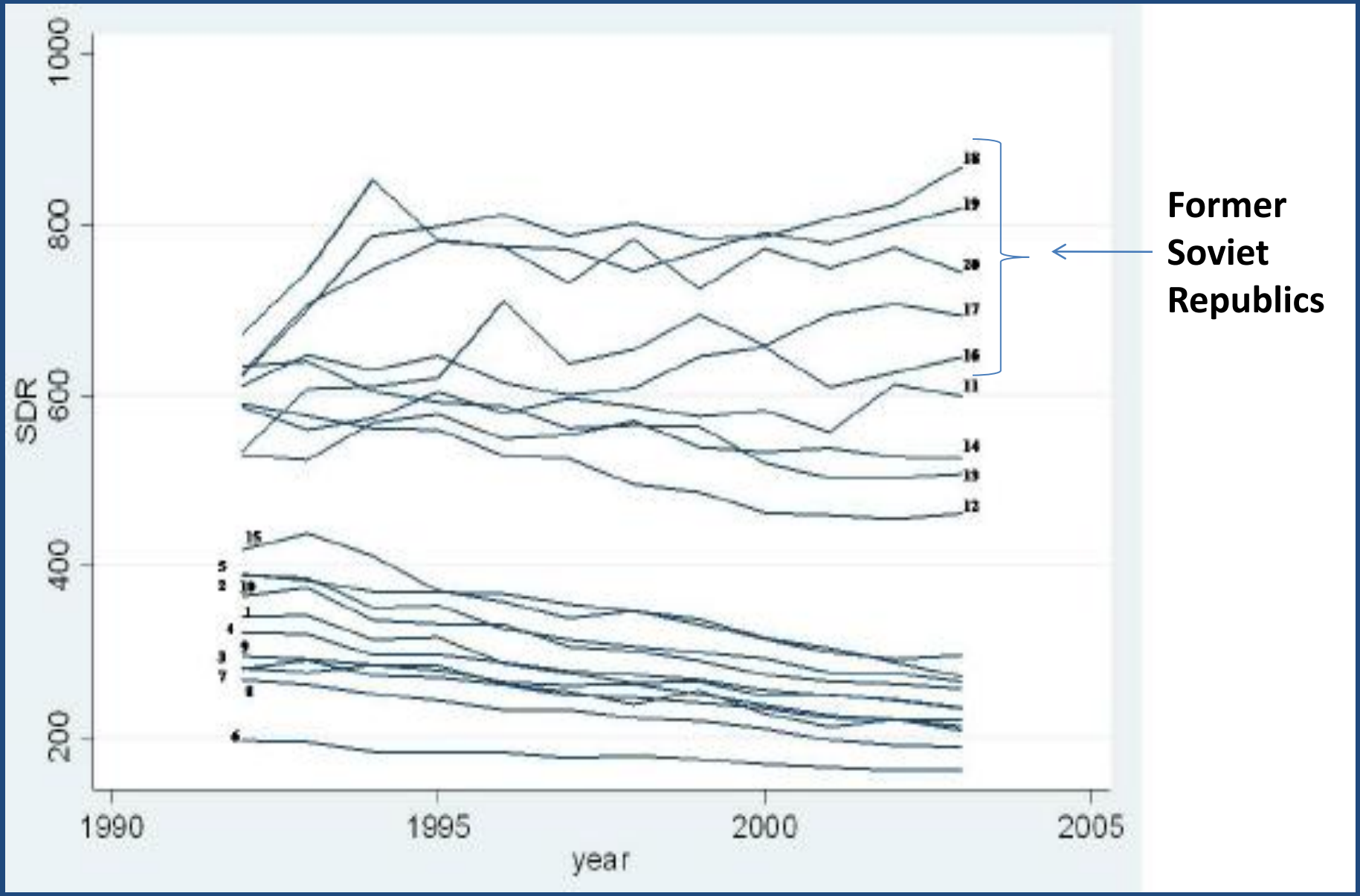


Figure 3. SDR for diseases of circulatory system per 100,000 between 1992 and 2003 in the twenty selected European countries



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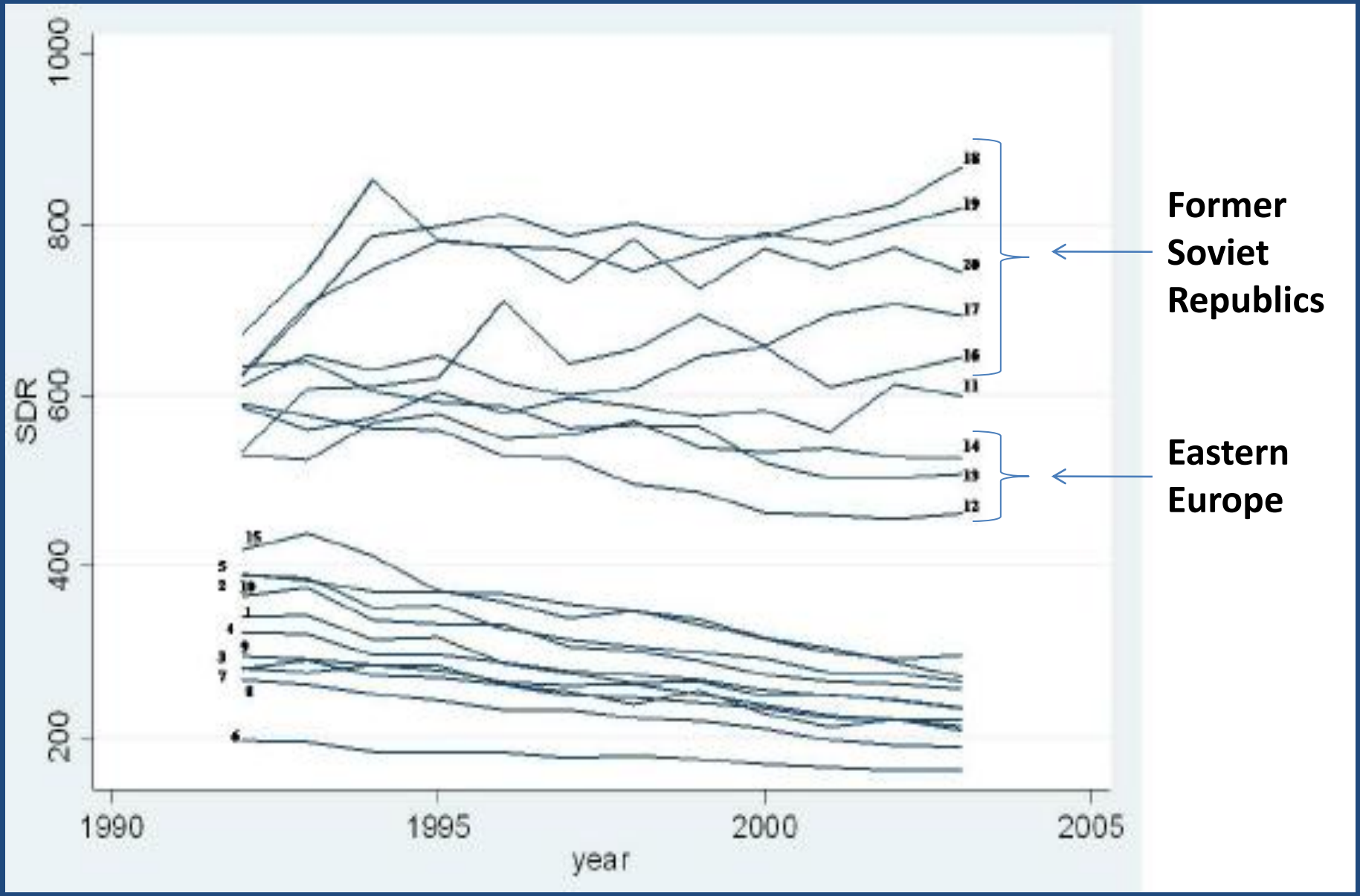

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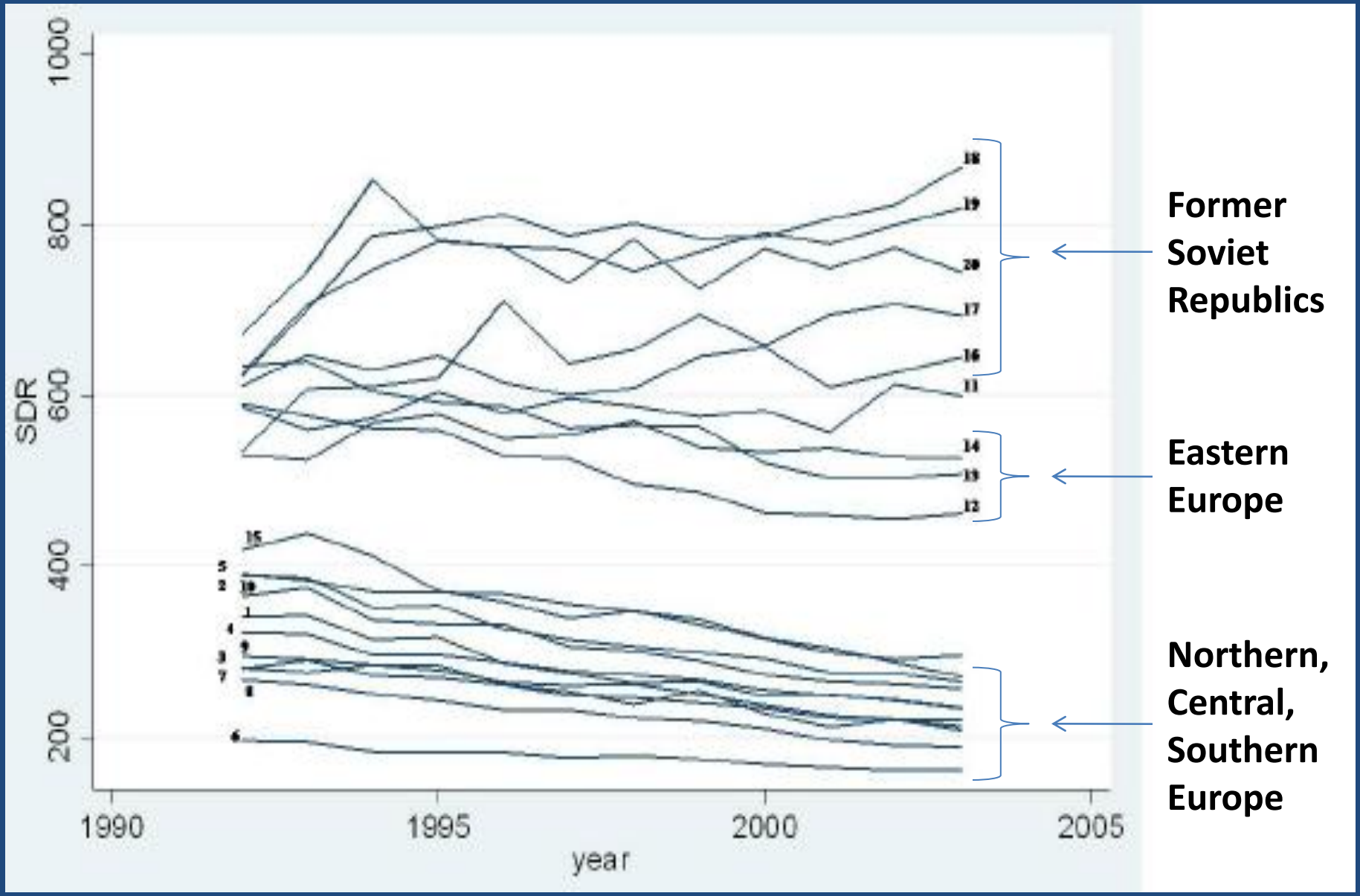

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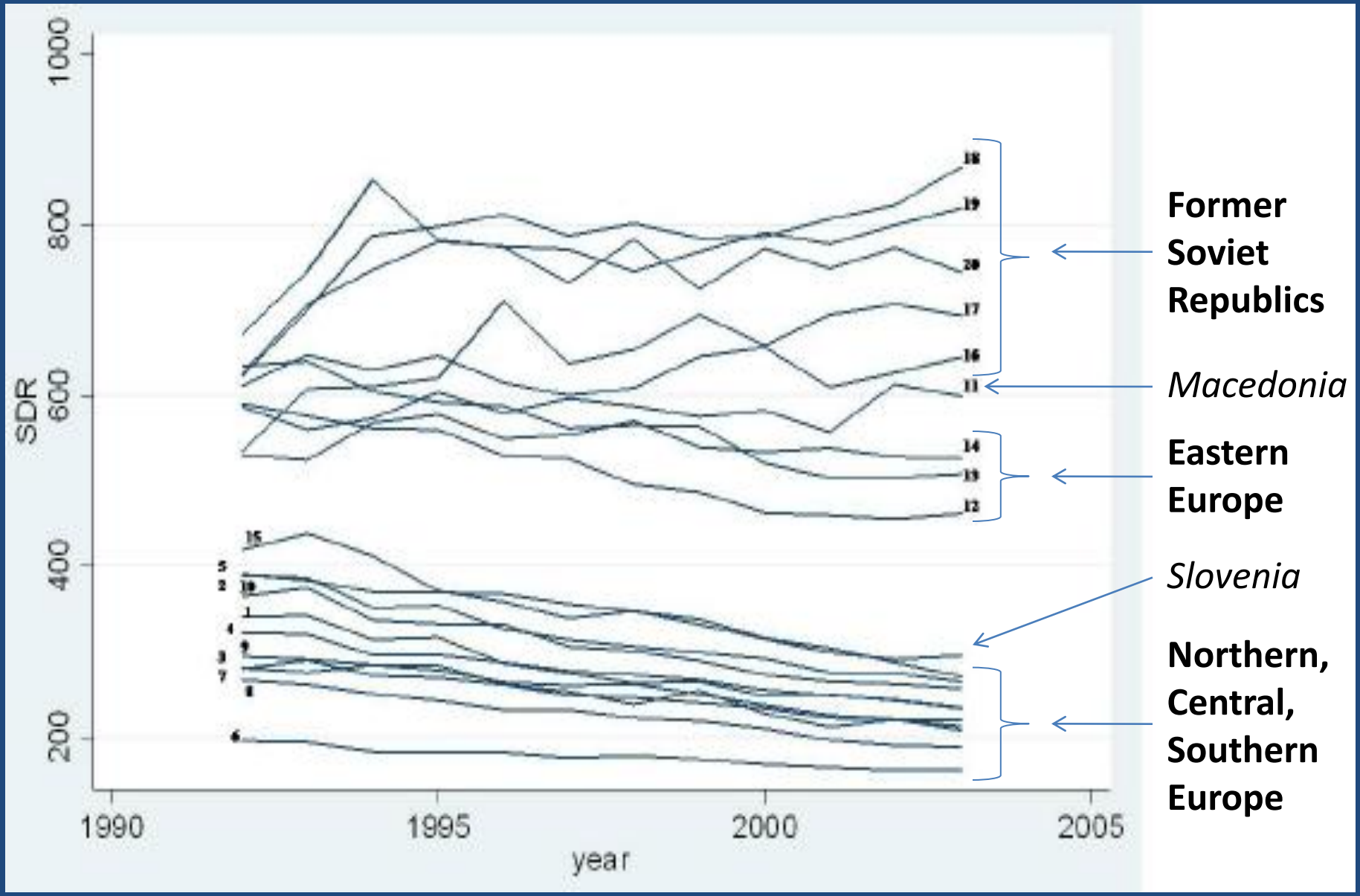

Figure 3. SDR for diseases of circulatory system per 100,000 between 1992 and 2003 in the twenty selected European countries

The Multi-Level Linear Model

$$Y_{ijk} = \gamma_{000} + \gamma_{p0} X_{ijp} + \gamma_{0q} Z_{jq} + \gamma_{pq} X_{ijp} Z_{jq} + u_{0j} + e_{ij}$$

Overall mean of the outcome variable

First level variables coefficients

Second level variables coefficients

Cross-level interactions coefficients

Second level residuals

First level residuals

An important indicator, related to multi-level models, is the Variance Partition Coefficient (VPC) that tells us the amount of total variance explained by the two-level structure of the model:

$$VPC = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}$$

The software used for the analysis was ***STATA, version 10.0***

The Multi-Level Linear Model

Main characteristics of our model:

- ***First Level*** **>** **Years**
- ***Second Level*** **>** **Countries**

- VPC for the Null Model = **0.97** (two-level structure very important)
- VPC for the Full Model = **0.19** (significant reduction in the variance produced by the explanatory factors)

Considering the nature of the database, we used the following criterion to determine whether an indicator had to be considered as a level 1 or a level 2 factor:

- *Level 1 factors* > High variance over time and high variance among countries
- *Level 2 factors* > Low variance over time and high variance among countries

Factors were put into the model following a forward procedure, from level 1 to level 2 factors, and AIC and BIC were used to check the model that best fitted our dataset.

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
% population aged 65+, male	1	7.08	2.41	0.003
% total energy available form fat	1	2.35	1.28	0.068
% total energy available form protein	1	-22.20	4.05	< 0.001
Hospitals	1	-2.19	9.12	0.810
Hospital beds	1	0.20	0.04	< 0.001
General practitioners	1	-1.01	0.15	< 0.001
Gross Domestic Product per capita (US $)	2	-0.01	0.002	< 0.001
Diabetes prevalence (%)	2	10.70	4.91	0.029
% regular daily smokers, age 15+	2	4.13	0.77	< 0.001
Total health expenditure per capita	2	-0.31	0.05	< 0.001
Public sector health expenditure as % of total health expenditure	2	3.09	0.67	< 0.001
Total pharmaceutical expenditure as % of total health expenditure	2	-13.89	0.97	< 0.001
Public sector expenditure on health as % of total government expenditure	2	-34.66	5.41	< 0.001
INTERACTIONS		**COEF.**	**SE**	**P-VALUE**
Public sector exp. on health as % of total gov. exp. * Tot. health exp. per capita		0.01	0.003	< 0.001
Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

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General decrease of CSD Mortality along the considered time span.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

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Positive association between CSD Mortality and percentage of male population, aged 65+.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
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Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Positive association between CSD Mortality and percentage of total energy available from fat.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
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% total energy available form fat	1	2.35	1.28	0.068
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Public sector exp. on health as % of total gov. exp. * Tot. health exp. per capita		0.01	0.003	< 0.001
Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Negative association between CSD Mortality and percentage of total energy available from protein.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
% population aged 65+, male	1	7.08	2.41	0.003
% total energy available form fat	1	2.35	1.28	0.068
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Hospitals	1	-2.19	9.12	0.810
Hospital beds	1	0.20	0.04	< 0.001
General practitioners	1	-1.01	0.15	< 0.001
Gross Domestic Product, per capita (US $)	2	0.01	0.002	< 0.001
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Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Negative interaction between hospitals and number of hospital beds. An increase in the number of beds is protective only if hospital are in satisfactory number.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
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Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Negative association between CSD Mortality and number general practitioners.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

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Hospitals * Hospital beds		-0.03	0.01	< 0.001
Hospitals * GDP per capita		0.001	0.0002	< 0.001

Negative association between CSD Mortality and GDP per capita only if hospitals are not in a satisfactory number.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
% population aged 65+, male	1	7.08	2.41	0.003
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Hospitals * Hospital beds		-0.03	0.01	< 0.001
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Positive association between CSD Mortality and diabetes prevalence.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Social, economic and lifestyle factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
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Positive association between CSD Mortality and percentage of regular daily smokers, aged 15+.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Health expenditure factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
Year	1	-5.10	0.84	< 0.001
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Negative association between CSD Mortality and total health expenditure per capita.

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Health expenditure factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
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Positive association between CSD Mortality and public sector health expenditure as percent of total health expenditure: *those countries that spend a lot for public health may have negative general conditions.*

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Health expenditure factors

FACTORS	LEVEL	COEF.	SE	P-VALUE
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Negative association between CSD Mortality and total pharmaceutical expenditure as percent of total health expenditure.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

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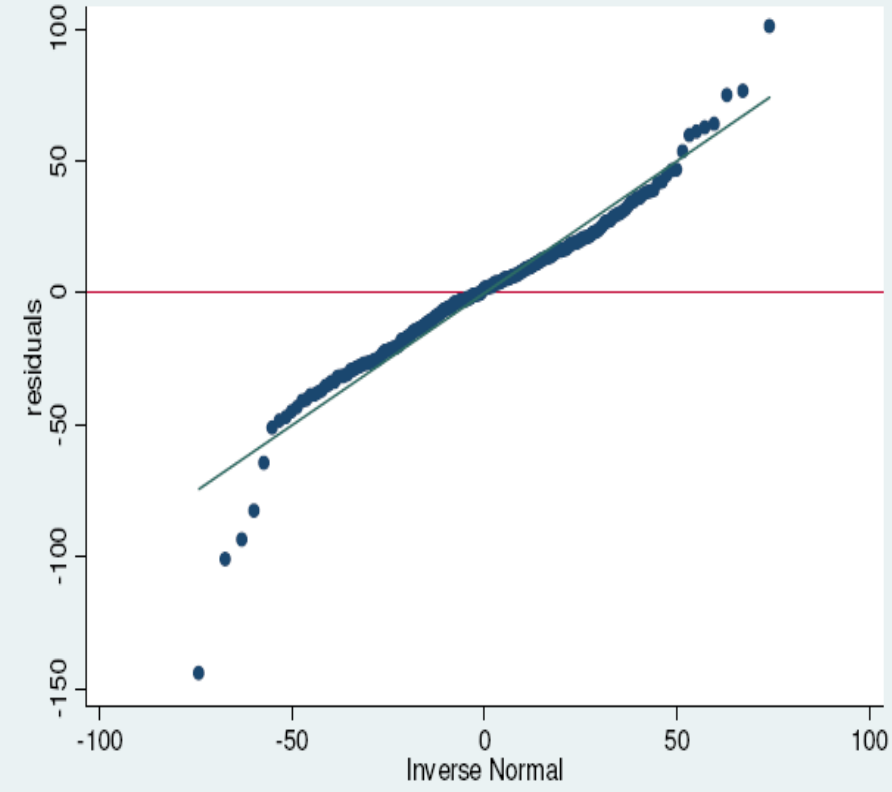
Negative association between CSD Mortality and public sector expenditure on health as percent of total government expenditure. This factor is protective only in those countries with a low total health expenditure per capita.

Table 1. Results of the multi-level linear regression between circulatory system diseases mortality rates and those factors that emerged as statistically significant

Residuals Analysis



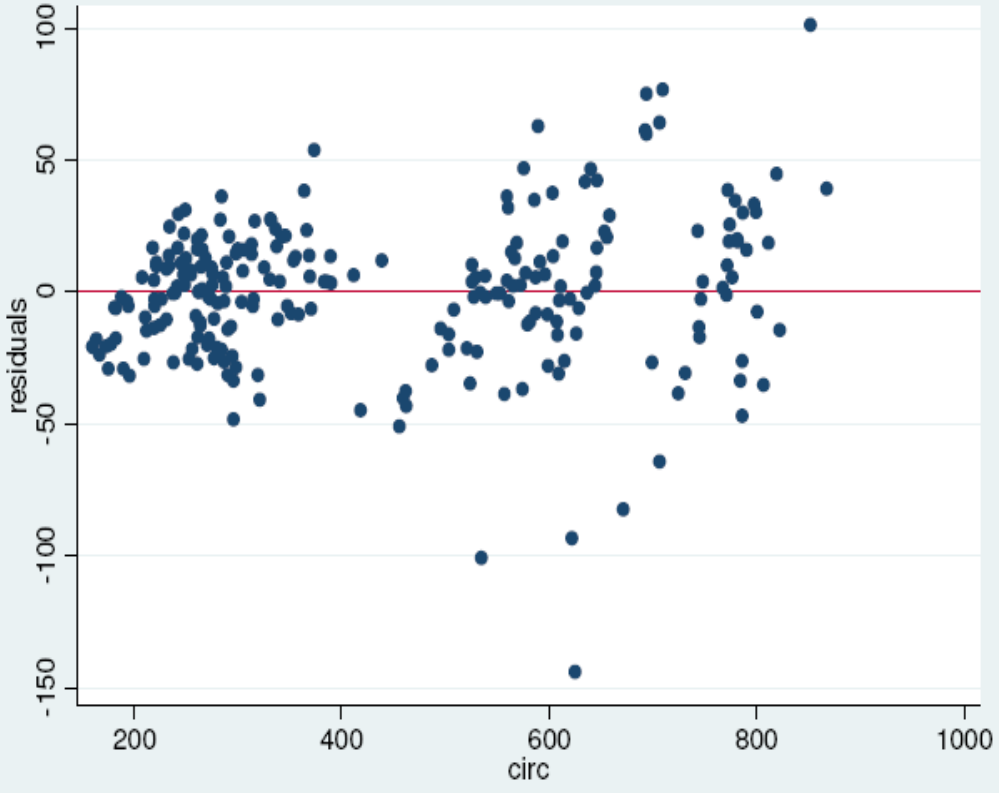


Figure 4. Plot of the standardised residuals against Normal scores and scatter plot of circulatory system diseases SDR versus residuals

Conclusions

• Previous knowledge about risk and protective factors for Circulatory System Mortality are confirmed by this study conducted on 20 European countries divided in 5 different geographical areas.

• An epidemiological transition is now occurring in Europe: western countries are leading with a lower and decreasing level of circulatory system mortality while eastern countries and former soviet republics show opposite trends.

• Present knowledge about risk factors for circulatory system mortality, confirmed also by this study, may help eastern Europe countries in reducing the gap with the western part of the continent.

• It was an interesting attempt to treat this kind of data with a multi-level approach, considering that the WHO “Health for All” database is not structured and created for that purpose.

Conclusions

• This study underlines how researches based on free on-line institutional databases (such as WHO, EUROSTAT, OECD) may help health policy makers, often requiring accurate information with limited fiscal resources.

Finally it's important to underline the didactical relevance of this work, born in an advanced course of health statistics at Bologna University. Exposing students to concrete research problems may be an alternative and more stimulating way of teaching them well-known statistical techniques.

A greater effort is needed both from professor and students...
...but results may be really satisfying!