RESEARCH ARTICLE

Comparison of Cardiac Mortality Rates in the European Countries and Territories in Hungary Producing Red or White Wines

Sándor Sipka*[1], Andrea Nagy[1], János Nagy[1]

[1] Division of Clinical Immunology, University of Debrecen, Hungary

*Correspondence to: sipka.sandor45@gmail.com

Abstract

The goal of this work was to elucidate the potential role of "red wine producing background" in the prevention of cardiac mortality. In 20 European countries with the lowest cardiac mortality rates it was found that in South-Europe producing mainly red wines and showing low cardiac mortality rates the type of drinking waters were hard everywhere. This fact could have a greater impact on the good results than the role of red wines. Besides, the higher values of "general domestic product" had a protective role against cardiac mortality in general. In a further study, also on large populations, five Hungarian wine territories were divided in two groups on the basis of similarities in the values of mortality rates, hardness of drinking waters and social backgrounds. Group I: Tokaj and Hódmezővásárhely: with higher cardiac mortality, soft drinking waters and worse social backgrounds; Group II: Szekszárd-Villány, Balaton, Eger: with lower cardiac mortality, hard drinking waters and better social backgrounds. In Group II the white wine producing Balaton region also presented low (good) cardiac mortality rates together with the two red wine producing territories (Szekszárd and Eger), they all had similarly hard drinking waters and good social backgrounds. It could be concluded that the red or white characters of wines produced in these territories did not make any differences in the data of cardiac age-adjusted death rates. On the other hand, the positive roles of similarly hard drinking waters and better social conditions had a greater impact on cardiac prevention than the red or white types of wines produced and supposedly consumed here. In the case of Tokaj, the soft drinking waters plus the worse social backgrounds and not the type of wines involved the bad results. The difference in the red or white types of wines produced in a region seemed negligible in the prevention of cardiac mortality compared to the roles of harder drinking waters and wealthier social backgrounds. Thus, neither the red or white wines were found to be special antidotes for cardiac diseases. However, they will remain crucial parts of the general gastronomic culture of mankind.

Keywords: cardiac mortality; red wine; white wine; hardness of drinking water; social -economic deprivation

1. Introduction

The cardiovascular diseases (CVD) represent the leading cause of death in the countries of European Union. The less rates of mortality were found in Spain, France, Italy, Cyprus, as well as in Luxemburg and Sweden [1]. This order can be explained from two approaches. First, in Mediterranean countries, Spain, France, Italy and Cyprus, etc., the inhabitants are known to eat the traditional "Mediterranean diet" rich of vegetables, fruits completed with drinking of red wines. Second, the high level of living standard, social development existing in Luxemburg and Sweden also can be protective factors against CVD. The association between social deprivation and CVD mortality was observed also in USA [2]. Regarding CVD, the protective effects of red wines rich in anti-oxidants was suggested [3]. In the positive cardio-protective effects of "Mediterranean diet" the role of red wine and slight alcohol consumption was found to be more important than that of vegetables, fruits, fish and dairy products [4]. Even the newer observations were showing accumulated evidence that the moderate red wine consumption correlated with the prevention of cardiovascular diseases[5]. In addition, the positive role of hard drinking waters was confirmed in the prevention of CVD repeatedly [6, 7, 8, 9].

Our scientific group published an article on 206159 persons in 2019 declaring that the "Hardness of drinking water negatively while socio-economic deprivation positively correlate with the age-adjusted mortality rates due to cardiovascular diseases in Hungarian wine regions" [10]. These data were collected within 2000-2010. In the current study, the evaluation of these earlier data was taking place from additional, new aspects. The analysis of mortality results due to region specific (red or white) wine types occurred using two Groups (Groups I and Group II) with similar and comparable backgrounds related to the hardness of drinking waters and socio- economic states. Additionally, an international comparison was carried out in 20 European countries showing the lowest age-adjusted mortality rates (AADR) due to cardiac diseases [11] from the aspects of production of red wines, hardness of drinking waters and the values of gross domestic product (GDP) per capita [12]. This is the first publication in such topic.

2. Methods

2.1. The collection of international data on the European cardiac mortality rates, values of gross domestic product (GDP) and hardness of drinking waters occurred via the available Google internet systems [11-32].

2.2. Dominant Types of Wines and Settlements of Hungarian Regions

The wine regions and the types of dominant wines were as follows: Tokaj – special, partly *Botrytis cinerea* related "white" wines, named as "Tokaj wines"; Eger – mostly commercial "red" wines; Balaton – mostly commercial "white" wines; Szekszárd-Villány – mostly commercial "red" wines; Hódmezővásárhely (HMV) - "control" territory, not a wine region. The data derived from 12 settlements, all representing a more developed "city" state.

2.3. Age- adjusted death rates due to cardiac diseases

The data of persons who died in Hungary during the studied 11 years long period of 2000-2010 were provided by the Central Bureau of Public and Electronic Administration and the Hungarian Central Statistical Office (HCSO). The data were grouped according to settlements, sex and diagnosis. The CVD diagnoses took place according to The International Statistical Classification of Diseases and Related Health Problems (ICD). The age-adjusted death rates (AADR values) due to cardiac diseases were calculated for 100 000 subjects in every region focusing on the whole period, and not on the annual changes or differences [33].

"AADR value" = total number of dead persons due to CVD/100,000 inhabitants/11 years.

2.4. Measurement of the Indicators of Hardness of Drinking Waters

The data containing several hundreds of items on the hardness of drinking waters were provided by the experts of National Institutes of Health (Budapest). The classification of regions according to the grades in the total hardness of drinking waters was as follows: HMV and Tokaj "soft", Balaton, Eger and Szekszárd/Villány "hard" drinking waters.

2.5. Calculation of the Index of Socio-Economic deprivation (ID)

The comparison of the socio-economic states of five regions occurred by the calculation of the index of deprivation (ID) using the data of HCSO gained by the latest national census in 2011. Deprivation means retardation, underdevelopment. The negative sign meant a better social state. It was important in the choice of regions that only comparable urban populations were tested representing living standards higher than the

average of Hungary. They all showed negative ID values but with small numeric differences [34].

2.6. Statistical analysis

The AADR values calculated annually during the 11 years were summarised then adjusted to the population sizes of the five different regions [33]. For calculations of significance in the differences was used the IBM SPSS ver. 24 program (IBM Corp, Armonk, NY, USA). $p < 0.05$ values were regarded to be significant.

3. Results

3.1. The values of age-adjusted death rates due to cardiac diseases, gross domestic products, hardness of drinking waters and productions of red wines in the European countries

Table 1. demonstrates the data from 2020 on those 20 European countries which showed the best (the lowest) AADR values due to cardiac diseases. Besides, their GDP values, red wine productions and the hardness of their drinking waters were also documented. It was of note that 8 of them: France, Spain, Portugal, Italy, Cyprus, Malta, Greece and Slovenia were located in South Europe, and they represented mostly the "typical Mediterranean areas". Besides, they all were

traditionally great producers of red wines mainly, and the type of their drinking waters was dominantly hard. The average of AADR values was in this group 2776 ± 631, whereas in the other 12 countries 2658 ± 650, showing no significant difference. On the other hand, there was a highly significant difference (p = 0.003) between the averages of GDP values (48493 ± 6774 *versus* 88147 ± 39966). These results seemed to confirm the earlier observations on the potential preventive roles of social richness, hard drinking waters and red wine backgrounds in cardiac mortality. Although, the good effects of hard drinking waters and red wine backgrounds (production and consumption) seemed to be parallel. In these positive results the single role of red wines was not exclusive. Conversely, these results could rather be explained without considering the role of red wines. Namely, in South Europe the hard drinking waters, in West and North Europe the high living standards or their simultaneous actions could result in the beneficial effects. The role of "red wine background" could be questionable. For example, in the cases of Ireland and Austria the hard drinking water components and the high GDP values could act together without the "red wine factor".

Table 1. Age-adjusted mortality rates due to cardiac diseases and the values of gross domestic product per capita in Europe

Order of AADR	Countries	AADR (2019)	GDP ($) (2022)	Order of GDP
1	Switzerland	1893	84,468	4
2	Belgium	1922	62,065	11
3	FRANCE	2015	56,199	14
4	Norway	2131	78,127	5
5	Luxemburg	2186	141,587	2
6	SPAIN	2191	46,351	18
7	Denmark	2223	69,845	6
8	Nederlands	2296	69,714	7
9	PORTUGAL	2372	42,066	19
10	IRELAND	2620	131,034	3
11	CIPRUS	2722	49,504	17
12	ITALY	2783	51,061	15
13	Sweden	2797	63,877	9
14	MALTA	2925	56,337	18
15	GREECE	3197	36,465	20
16	Finland	3263	58,659	12
17	Liechtenstein	3317	167,877	1
18	Germany	3534	63,834	10
19	AUSTRIA	3714	66,680	8
20	SLOVENIA	4004	49,967	16

Red colour: countries producing red wines mainly
CAPITAL: countries with hard drinking waters mainly

3.2 The number of populations, age-adjusted death rates due cardiovascular diseases evaluated according to the similarities in the values of hardness of drinking waters and indexes of deprivation in five Hungarian wine regions forming Group 1 and Group II

In order to get a more complex analysis of "the red wine issue" we compared the AADR values due to cardiac diseases in four traditional Hungarian wine regions producing mainly red or white wines (in 2-2 wine regions plus in a "control," not wine region) but representing similar values for the hardness of drinking waters and socio-economic (ID) backgrounds. These results were documented in Table 2. It was important that the numbers of population were rather great, they exceeded 30,000 in every region. The highest cardiac mortality rates were found in Tokaj (5955) in a "white wine" region and in the not wine region, HMV (5178) forming Group I. These data were higher than that of nationwide value: 4800. In both places were similar the values of "soft drinking waters" and "low" socio-economic states. On the other hand, in Szekszárd/Villány (3907), Eger (4191) and Balaton (4034), forming Group II, the mortality

rates were not only similarly lower than those in the earlier two regions, but they all showed similarities in the "hard drinking waters" and "numerically high but negative ID values". These results clearly showed that the "hard drinking waters" and the "more developed social economical states" (numerically higher but negative ID values) could play the really important roles in the prevention of CVD. Furthermore, it was still a remarkable recognition on the rather large population of Eger, Szekszárd-Villány and Balaton that the "red" or "white" types of their characteristic wines did not make almost any significant differences in the cardiac mortality rates of regions. Of course, it should be a plausible reality that the wine makers were also consumers of their products in this population died in the period of 2000-2010. Anyhow, no special protective benefit of red wine consumption (Eger, Szekszárd Villány) was found compared to that of whites wines (Balaton) if the values of hard drinking waters and the good social backgrounds were similar. These findings are in partial contrast to the results of some earlier international publications on red wine consumption [3,4].

Table 2. The number of populations, age-adjusted death rates due to cardiovascular diseases, grouping according to the values of hardness of drinking waters and indexes of deprivation in the five regions between 2000 and 2010

Parameters	Eger	Balaton	Szekszárd/Villány	Tokaj	Hódmezővásárhely
Population	56,981	30,833	37,268	33,917	47,160
AADR	4191	4034	3907	5955	5178
Drinking water total hardness (CaO mg/L)	194.90	249.20	294.20	138.60	81.90
Index of deprivation	−1.1	−1.22	−1.17	−0.36	−0.43
Groups	Group II			Group I	

Explanations to the colours:

AADR: the colours of wines in the regions = red and white wines (yellow and light brown)

 blue = not wine region

Drinking waters: red = hard water, green = soft water

Index of deprivation: *worse values*

3.3. Age-adjusted death rates due to cardiac diseases demonstrated on column diagrams

The cardiac AADR values of five regions forming Group I and Group II are demonstrated on the column diagrams of Figure 1.

Figure 1. The age adjusted death rates due to cardiovascular diseases are presented from the aspect of "red" or "white" characters of dominant types of wines in the regions
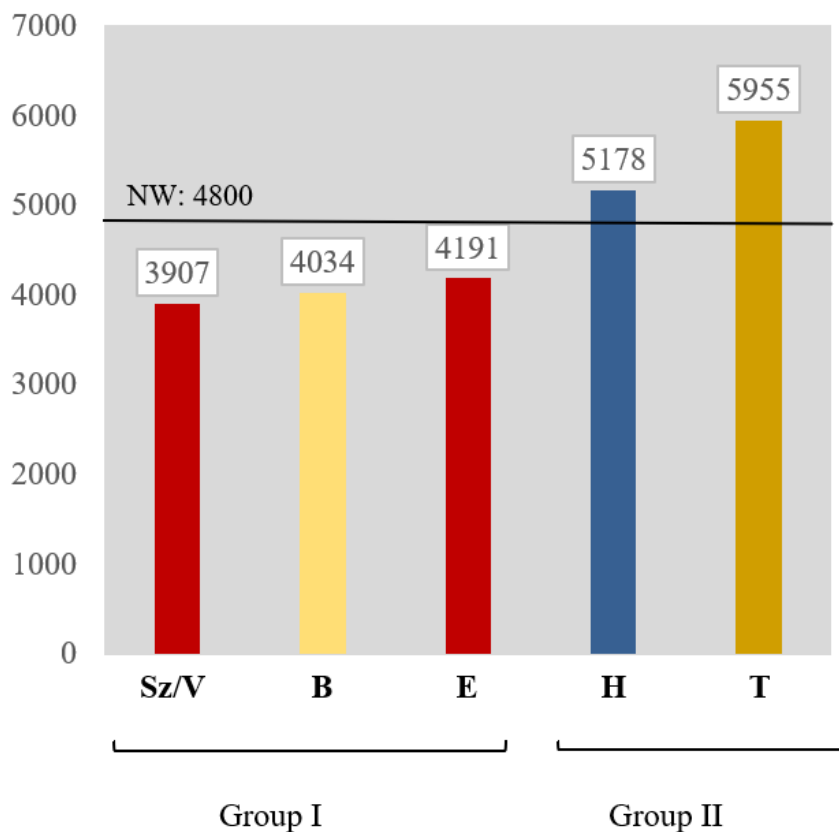

Sz/V: Szekszárd, Villány; B: Balaton; E: Eger; H: Hódmezővásárhely; T: Tokaj
NW: nation wide

3.4. The distribution of areas with hard and soft drinking waters on the hydrologic map of Hungary
This map confirmed that we really worked with official hydrologic data concerning the values of hardness of drinking waters in the five regions. Besides, the location of these territories could be recognized in Hungary. These data can be shown in Figure 2.

Figure 2. Hydrologic map of Hungary showing the areas with hard and soft drinking waters
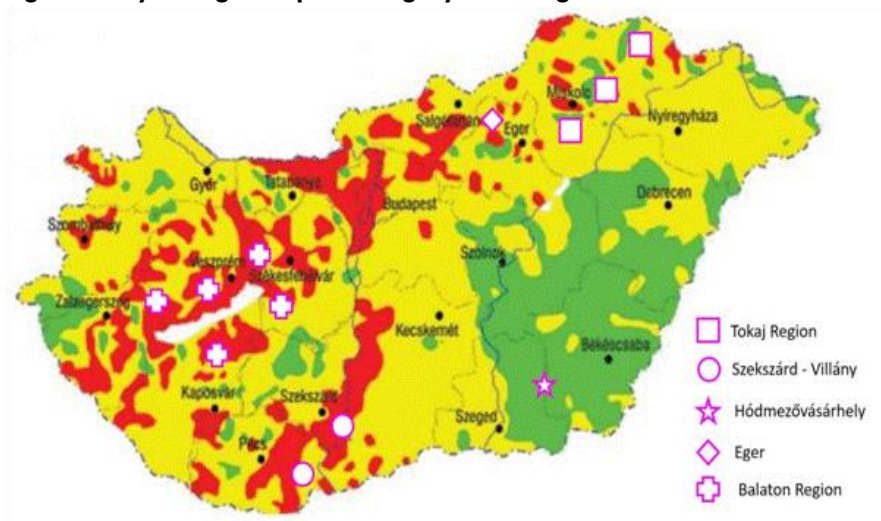
Colours: red = hard water area; green = soft water area

4. Discussion

The main results of this study were as follows: a.) In the South European countries the good effects of hard drinking waters and red wine backgrounds (production and consumption) seemed to be parallel in the low cardiac mortality rates. However, in these positive results the single role of red wines was not exclusive. Conversely, these results could rather be explained without considering the role of red wines. Namely, in South Europe the hard drinking waters, in West and North- Europe the high living standards or their combinations had the real beneficial effects. The single role of "red wine background" could be questionable. b.) Also in the five Hungarian regions the positive roles of similarly hard drinking waters and better social-economic conditions could have a greater impact on CVD prevention than the red or white type of wines produced in a region. c.) In the case of similar values in the hard drinking waters and socio-economic backgrounds, the red or white characters of wines did not make any significant differences in the cardiac mortality rates of regions. d.) These are new observations worth taking in account in the reconsideration of previous opinions, "dogmas" on the special protecting role of red wines in cardiac diseases. e.) It was the common effect of soft drinking waters and worse social backgrounds in HMV and Tokaj that the cardiac mortality rates were the highest here, and not that of the wines produced in Tokaj.

It was also of note that these Hungarian data were valid only for a defined period of time and population living in these five territories of Hungary. Since the time when these results were collected the circumstances have changed a lot. However, the period of the analysed 11 years was a very fortunate choice to study the potential effects of wines. The majority of people who died between 2000 and 2010 was born between 1930 and 1950, and belonged to a generation which already lived in small cities but was still engaged very strongly with their relatives living in villages. Their wine consumption was traditionally and continuously tied to their own production at home or to the small family cellars according to the "goulash cooking" fashion. The "amount/person/ year value" of pure ethyl-alcohol consumption was also similar in the four wine territories estimated by the results of mortality rates in alcoholic liver cirrhosis [35]. Nevertheless, these people mainly drank the piped drinking waters of their settlements during their whole life. Additionally, they were mainly wine and not beer drinkers. They did not know yet the newly dominating bottled commercial/mineral waters and various soft drinks. Since that the consumption of beer also increased in whole Hungary.

The insertion of newest data on cardiac mortality and the values of GDP from the European countries gave us an outstanding possibility to approach the "red wine issue" from a wider dimension. One could say that the last 30 years could be regarded in cardiology that "the golden age of red wines" when the praising of red wine consumption became almost a dogma generally offered for cardiac prevention [5]. However, the epidemiological data were rather contradictory both earlier [36,37] and became now. For example, we also found very good results related to the great red wine producing countries of South Europe including the great Mediterranean nations, Portugal, Spain, France Italy etc. Still, the focusing of results on the hardness of drinking waters and the values of GDP was a more plausible explanation of phenomenon than to take in account the role of red wines, too. In South Europe the hard drinking waters, in West and North- Europe the great GDP or they together could help the prevention. In Ireland and Austria with hard drinking waters and great GDP values the cardiac mortalities were low without any "red wine effect". The Hungarian results confirmed these conclusions and still added a very important new recognition. Namely, if the values of hardness of drinking waters and socio-economic backgrounds were similar (comparable), there was no significant difference in the cardiac mortality rates.

Additionally, during the Hungarian study we also collected data on the mineral contents of soils in the regions, consumption of vegetables and occurrence of diabetes mellitus type II. There were no significant differences in these parameters. These data are not documented.

It was a very important question whether the production of wines in a region or in a country could be related to the consumption or not. The answer: YES could be based mainly on the data of various countries. These results clearly showed that strong and natural connections could exist between the wine production and consumption in a country. It could be hardly believable that in France, Spain, Portugal or Italy beside the great volumes of wine production, the consumption, the drinking of wines would have been small.

Finally, these results can encourage further the epidemiologic studies to deal with the vital roles of all types of wines. Concerning the cardiac effects of red wines, however, the simultaneous consideration of the values of hardness of drinking waters [38] and social-economic backgrounds (GDP) should be recommended.

Conclusions

In conclusion, these results demonstrated statistical facts on large populations of European countries and special Hungarian wine regions concerning the roles of "red" and "white" wines in cardiac mortality rates helping to avoid any positive or negative preconceptions. Therefore, an "alternating, intermittent and moderated" consumption of all these wines [39] independently of their "red" or" white" types, may remain further a crucial part of general gastronomic and human culture, but not as potent antidotes of existing cardiac diseases [39]. At the same time, these results draw the attention to the really positive roles of greater hardness of drinking waters and better living standards in the prevention of cardiac mortality.

5. Conflict of interest statement

There is no conflict of interest among the authors. Sándor Sipka has been the corresponding author also in the previous common work with János Nagy (Int. J. Environ. Res. Public Health, 2019). The ideas and the preparation of both manuscripts were based mainly on his activities. In the present paper Andrea Nagy gave an important technical help.

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