FORUM FOR PUBLIC HEALTH IN SOUTH EASTERN EUROPE

Programmes for Training and Research in Public Health

METHODS AND TOOLS IN PUBLIC HEALTH

A Handbook for Teachers, Researchers and Health Professionals

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CONTENTS

PREFACE

This is the sixth out of seven books planned to be published in a series as a support to teachers and trainers in teaching public health in South Eastern Europe. Originally planned to be on the internet platform only, the Forum for Public Health in South Eastern Europe (FPH-SEE) and the MetaNET project as its continuation together with the Hans Jacobs Publishing Company decided later to publish this training material also as hard copy books. The first four books were published with the support of FPH-SEE, and the last two with the support of MetaNET. Both projects are supported by the German Academic Exchange Service (DAAD - Deutsche Academic Austauschdienst) with funds from the Stability Pact for South Eastern Europe, provided by the German Ministry of Foreign Affairs.

We are proud that this book will be published on the 10th year of the Public Health Network in South Eastern Europe.

The book **Methods and Tools in Public Health** is a collection of 47 teaching modules in 5 chapters written by 53 authors from 11 countries. The teaching modules in this book cover areas of methods of studying population health, special epidemiological methods and methods of public health interventions, methods of planning and evaluation and modules as the supportive tools and technologies. Authors had autonomy in preparation the teaching modules, they were asked to present their own teaching/training materials with the idea to be as practical and lively as possible. The role of editors was to stimulate the authors in writing modules and to collaborate with them in editing the final version of the manuscripts in order to get them as much as possible to the planned format. By preparing and publishing this teaching/training modules authors and editors expect and wish to support and improve public health education and training of public health professionals.

The editors asked and encouraged authors to incorporate in their teaching modules exercises, tests, questionnaires and other practical forms of training. We will be thankful for any comments on use of them in everyday practice.

The next and the last book will be entitled “International Public Health”.

You can find all volumes on the website of the Forum of Public Health: *http://www.snz.hr/ph-see/publications.htm*, and the volumes 4-6 on the open access Literature database of the University Bielefeld: *http://biecoll.ub.uni-bielefeld.de*.

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Forum for Public Health in South Eastern Europe and Hans Jacobs Publishing Company in this series published the following books:

1. Vesna Bjegović and Doncho Donev (eds). HEALTH SYSTEM AND THEIR EVIDENCE BASED DEVELOPMENT. Lage: Hans Jacobs; 2004.
2. Silvia Gabriela Scîntee and Adriana Galan (eds). PUBLIC HEALTH STRATEGIES: A TOOL FOR REGIONAL DEVELOPMENT. Lage: Hans Jacobs; 2005.
3. Lidia Georgieva and Genc Burazeri (eds). HEALTH DETERMINANTS IN THE SCOPE OF NEW PUBLIC HEALTH. Lage: Hans Jacobs; 2005.
4. Doncho Donev, Gordana Pavleković and Lijana Zaletel-Kragelj (eds). HEALTH PROMOTION AND DISEASE PREVENTION. Lage: Hans Jacobs; 2007.
5. Luka Kovačić and Lijana Zaletel-Kragelj (eds). MANAGEMENT IN HEALTH CARE PRACTICE. Lage: Hans Jacobs; 2008.
6. Lijana Zaletel-Kragelj and Jadranka Božikov (eds). METHODS AND TOOLS IN PUBLIC HEALTH. Lage: Hans Jacobs; 2010.

All books can be found at: *http://www.snz.hr/ph-see/publications.htm*, and all modules included in volumes 4-6 on the open access Literature database of the University Bielefeld: *http://biecoll.ub.uni-bielefeld.de*.

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7. INTERNATIONAL PUBLIC HEALTH to be published in 2011.

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METHODS AND TOOLS IN PUBLIC HEALTH A Handbook for Teachers, Researchers and Health Professionals	
Title	**AGE STANDARDIZATION PROCEDURE: DIRECT METHOD**
Module: 1.2.3	**ECTS (suggested): 0.15**
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Keywords	Confounding, standardization, age standardization, direct standardization, indirect standardization, cumulative rate
Learning objectives	After completing this module students should: • understand a role confounding in epidemiologic studies; • increase knowledge about methods of controlling of confounding in epidemiologic studies; • understand principles of direct standardization; • be capable to calculate age-standardized death rates using direct method.
Abstract	Basic theoretical background of standardization as one of methods for controlling the effect of confounding in epidemiology is presented. Direct method of standardization as most common standardization method is presented in details, using a case study. Step by step the procedure is described using simple spreadsheet computer tool for facilitating it.
Teaching methods	Teaching methods include introductory lecture, exercises, and interactive methods such as small group discussions. Students after introductory lectures first carefully read the recommended sources in age standardization. Afterwards they discuss standardization as method of controlling confounding with other students. In continuation, they in practice in groups of 2-3 students perform the procedure of direct standardization using the programme tool (e.g. MS Excel) on given data. At the end they compare and discuss their results.
Specific recommendations for teachers	• work under teacher supervision/individual students' work proportion: 50%/50%; • facilities: a computer room; • equipment: computers (1 computer per 2-3 students), LCD projection, access to the Internet; • target audience: master degree students according to Bologna scheme.
Assessment of students	Assessment is based on multiple choice questionnaire (MCQ) and case-study.

AGE STANDARDIZATION PROCEDURE: DIRECT METHOD

Jadranka Božikov, Lijana Zaletel-Kragelj, Doris Bardehle

THEORETICAL BACKGROUND

Population diversity and confounding

When examining the health of populations one of the fundamentals of this process is the comparison of health indicators among across and/or across different population subgroups within the countries.

Whenever we want to compare epidemiologic measures, irrespective of what they represent: morbidity (e.g. incidence or prevalence measures), mortality or other measure, across different populations or population groups we should take into account their diversity (1). Namely, populations/population groups are heterogeneous in regard to various health related characteristics (e.g. age, gender, education, religion, genetic and geographic factors, etc.) (2).

When the epidemiological measures are calculated without taking into account this diversity, such kind of epidemiological measures are called crude measures. The potential influence of the diversity could be imagined if the procedure of calculation of crude values is taken into consideration - the value of crude population measure is in fact an average of the values for the individual subgroups within a population (e.g. subgroups according to age), weighted by their relative sizes (1). This means, the larger the subgroup (e.g. age subgroup), the more influence it will have on the crude measure. The comparison of crude measures across populations (or population groups) can be thus misleading because they can be greatly affected by the influence of such characteristics (e.g. different age distributions in the populations/population groups being compared).

In statistical terms, these characteristics are so called confounders. Confounding (from the Latin “confundere” that means to mix together) is according to Last et al. defined as an effect which appears when the measurement of the effect of an exposure on a risk is distorted by the relation between the exposure and other “extraneous” factor (or multiple factors) that also influence the outcome under study (3). In this context extraneous factors are considered as factors other than the relationships between two phenomena under study. But not every characteristic meets the criteria for being confounder. A confounding factor (or confounder) must meet three criteria:

- to be a known risk factor for the result of interest (4),
- to be a factor associated with exposure but not a result of exposure (4), and
- to be a factor that is not an intermediate variable between them.

Thus, when crude rates are interpreted, this interpretation would have been confounded by differences in the populations being compared (e.g. differences in age distribution). We therefore need to control for the effects of confounders in order to remove the confounding effect.

Controlling for the effects of confounding

There exist several procedures for controlling for the effects of confounding. Some of them could be performed in the designing and plannig phase of a study, and the others in the phase of data analysis (5-7). The first group of procedures (e.g. randomization, restriction, matching) is usually performed in experimental studies while the second group (stratification, standardization, statistical modelling) in observational studies (5-7). This concept of control of confounding in epidemiology derives from the limited opportunities for experimental control in non-experimental design of studies.

In practice, age is the factor that is most frequently controlled or adjusted for confounding. In an older population higher rates of certain diseases that more frequently appear in older age-groups (e.g.cancers) could be observed not because of the presence of risk factors, but because of the higher age itself (8). Traditionally in controlling for age confounding, standardization is applied (8).

Standardization

Definition and description

Standardization of health indicators is a classic epidemiological method defined as:

- a set of techniques used to remove as much as possible the effects of differences in age or other confounding variables when comparing two or more populations (3),
- a method that removes the confounding effect of variables that we know (or think) that they could influence the comparison between two or more populations (5,6),
- a statistical method for deriving measures that are comparable across populations that differ in age and other demographic characteristics (9).

Standardization provides an easy-to-calculate and easy-to-use summary measures e.g. standardized mortality (abbreviated sometimes as SMR[2]) or standardized death rate (abbreviated as SDR[3]) when the outcome is death, or a standardized morbidity measure when the outcome is disease occurrence (e.g. standardized incidence rate in the case the morbidity measure is incidence - abbreviated sometimes as SIR[4]). These measures can be useful for information users, such as decision-makers.

Types of standardization

Two approaches to standardization could be used, direct and indirect (1,3,5-9). They are used in different situations what will be described in continuation.

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[2] We should be aware that this abbreviation, SMR, is also used in the case of standardized mortality ratio as an outcome measure in indirect standardization procedure which is not the subject of this module.

[3] The term standardized death rate (abbreviated as SDR) is commonly used in Health for All Data Base of WHO, European Region (10).

[4] The same as under 1.

Direct standardization

Direct standardization is a procedure that forms a weighted average of age specific rates or risks, using as weights the distribution of a scpecified standard population (1,3,8,9).

The method is called “direct” because it uses the actual morbidity or mortality rates of the populations being compared (9).

In the direct standardization method, according to Last et al. (3), the directly standardized rate represents what the crude rate would have been in the observed population if that population had the same structure as the standard population with the respect to the variable (or more variables) for which the standardization was performed.

Thus, these rates are hypothetical and by themselves they are not meaningful because they are not real. These rates are useful only if they are used in comparisons of populations in the case that standardized rates in all compared populations are derived by the same procedure using the same standard population.

Direct standardization could be used to compare observed populations for which the specific crude rates are known and statistically stable. It is commonly used in reports of vital statistics (e.g., mortality) or major disease incidence trends (e.g., cancer incidence).

Indirect standardization

Indirect standardization is used to compare observed populations for which the specific crude rates are unknown or statistically unstable (3). This is frequently in small populations or when the observed phenomenon is rare.

It is different from direct standardization in both, method and interpretation. Instead of using the structure of the standard population, we utilize its specific rates and apply them to the populations under comparison, previously stratified by the variable to be controlled. The total of expected cases is obtained this way. The SDR is then calculated by dividing the total of observed cases by the total of expected cases. This ratio allows comparison of each population under study to the standard population. A conclusion can be reached by simply calculating and looking at the SDR. A SDR higher than one (or 100% if expressed in percentage) indicates that the risk of dying in the observed population is higher than what would be expected if it had the same experience or risk than the standard population. On the other hand, a SDR lower than one (or 100%) indicates that the risk of dying is lower in the observed population than expected if its distribution were the same as the reference population.

Indirect standardization plays a major role in studies of occupational disease.

Age standardization

Although age standardization is not a special type of standardization we think it is worthy to emphasize it. As already mentioned, age is the factor that is most frequently standardized for, since the age is one of the most important confounders. Compared populations could have very different age structure that can influence the interpretation of differences in crude rates of observed phenomenon.

Age-standardized rates calculated using the direct method represent what the crude rate would have been if the population had the same age distribution as the standard population.

Age-standardization is particularly used in comparative mortality studies, since the age structure has an important impact on a population's overall mortality.

Limitations of standardization

It is important to know that standardization as method for controlling confounding has some limitations. Any summary measure can hide patterns that might have important public health implications. For example, with age standardization, one might fail to detect age-specific differences in risk across time or place. This might arise if a disease is displaying an increasing incidence due to a birth cohort effect (people at younger ages might have a higher risk in recent years compared to previous years, while older people could have the opposite pattern). An age-standardized rate could hide these trends. Despite this risk, standardized rates have proved to be very useful summary measures.

The procedure of direct age standardization

Entry data for the procedure

For accomplishing the procedure of direct age standardization we need three sets of data:

1. Number of cases of a health phenomenon (death, disease) to be standardized.
   We need absolute frequency (number of cases) of a health phenomenon to be standardized across the age groups.

   These data are usually derived from registration of health phenomena (mortality, morbidity data) - health statistics of a country. Usually are administered by national public health institutes. Mortality data are usually available, while morbidity data (e.g. cancer incidence) are more difficult to obtain. In Slovenia for example cancer incidence for several sites could be obtained from a high quality Cancer Registry of the Republic of Slovenia. The Registry's annual reports, Cancer Incidence in Slovenia, are one of the regular ways of disseminating information of this registry. They are publicly available from their homepage as PDF files (11).
2. Observed population data.
   Next set of data that is needed for direct standardization is distribution of population according to age.

   These data are usually derived from on-going registration of population and/or population censuses. They are usually provided by every country's statistical office. For example, for Slovenia these data are provided by the Statistical Office of the Republic of Slovenia. They are publicly available in Office's annual reports, Statistical Yearbook, from their homepage as PDF files (12).

   For most of countries of the world these data could also be obtained from the U.S. Census Bureau International Data Base Entry (13).
3. Standard population data.

An important step in direct standardization is the selection of a standard population (4), since value of the adjusted rate depends on the standard population used.

The standard population may come from the populations under study - average for example. In this case however, it is important to ensure that the populations do not differ considerably in their size, since a larger population may influence the adjusted rates (14). The standard population may also be a population without any relation to the data under study, but in general, its distribution with regard to the adjustment factor should not be radically different from the populations we wish to compare.

In European region of World Health Organization, for comparison across countries within this region, age-standardized death rates are calculated using the European standard population while in other regions other standard populations. The detailed description of the European standard population could be obtained from the European Health for All Database manual (15). The age distribution of four different hypothetical standard populations is presented in Table 1 (15,16).

Table 1. Some standard populations. Adapted from Health for All database Manual (15) and Surveillance, Epidemiology and End Results (SEER) Program homepage (16).

Age group	European standard population (100,000)	European standard population (million)	World standard population (million)	1996 Canadian standard population (million)	2000 US standard population (million)
0	1,600	16,000	24,000	12,342	13,818
1-4	6,400	64,000	96,000	53,893	55,317
5-9	7,000	70,000	100,000	67,985	72,533
10-14	7,000	70,000	90,000	67,716	73,032
15-19	7,000	70,000	90,000	67,841	72,169
20-24	7,000	70,000	80,000	67,761	66,478
25-29	7,000	70,000	80,000	72,914	64,529
30-34	7,000	70,000	60,000	87,030	71,044
35-39	7,000	70,000	60,000	88,510	80,762
40-44	7,000	70,000	60,000	80,055	81,851
45-49	7,000	70,000	60,000	71,847	72,118
50-54	7,000	70,000	50,000	55,812	62,716
55-59	6,000	60,000	40,000	44,869	48,454
60-64	5,000	50,000	40,000	40,705	38,793
65-69	4,000	40,000	30,000	37,858	34,264
70-74	3,000	30,000	20,000	32,589	31,773
75-79	2,000	20,000	10,000	23,232	26,999
80-84	1,000	10,000	5,000	15,424	17,842
85+	1,000	10,000	5,000	11,617	15,508
Total	100,000	1,000,000	1,000,000	1,000,000	1,000,000

The European standard population which will be used in our case study is also presented in Figure 1.

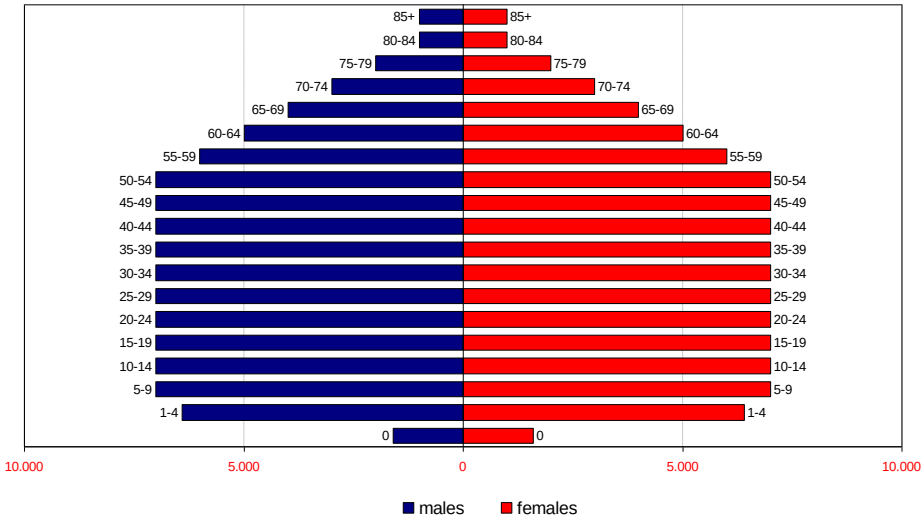


Figure 1. European standard population (100,000). Adapted from Health for All database Manual (15).

For all three sets of enty data the same age distribution is needed.

The procedure

Directly standardized rate is, in general, calculated by dividing the number of deaths by the actual local population in a particular age group multiplied by the standard population for that particular age group and summing across the relevant age groups. The rate is usually expressed per 100,000. The exact procedure for calculating standardized death rates in 4 steps is as follows:

1. Step 1 - calculation of the specific crude death rate for every (specific) age group. The crude specific death rate for every age group is obtained by dividing the number of deaths in every specific age group by the observed (actual local) population in this age group multiplied by a multiplier (usually 100,000) (Equation 1):

$$_{crude}DR_{(spec.group)} = \frac{N_{deaths(\,spec.group)}}{N_{pop(\,spec.group)}} \times 100{,}000 \qquad \textbf{Equation 1.}$$

$_{crude}DR_{(spec.\ group)}$ = *crude death rate in a specific population group*
$N_{deaths(spec.\ group)}$ = *number of deaths in a specific population group*
$N_{pop(spec.\ group)}$ = *number of population in a specific population group*

2. Step 2 - calculation of the crude rate for total population.
   The crude rate for total population is calculated using the similar formula as in calculating specific death rate for every age group (Equation 1), except that in this calculation totals of number of cases and population are used (Equation 2).

$$_{crude}DR_{(total\ pop)} = \frac{N_{deaths(total\ pop)}}{N_{pop(total\ pop)}} \times 100{,}000 \qquad \textbf{Equation 2.}$$

$_{crude}DR_{(total\ pop)}$ = *crude death rate in a total population*
$N_{deaths\ (total\ pop)}$ = *number of deaths in a total population*
$N_{pop\ (total\ pop)}$ = *number of population in a total population*

   These totals need to be calculated prior calculation of the crude rate for total population.
3. Step 3 - calculation of the expected number of deaths in the standard population for every specific age group.
   The expected number of deaths in a specific age group is calculated by multiplying the result obtained in step 1 by the number of population in standard population in this specific age group and dividing it by the multiplier used in step 1 (usually 100,000) (Equation 3):

$$N_{exp.deaths(spec.group)} = \frac{_{crude}DR_{(spec.group)} \times N_{stand.pop(spec.group)}}{100{,}000} \qquad \textbf{Equation 3.}$$

$N_{exp.deaths\ (spec.\ group)}$ = *number of expected deaths in the standard population in a specific population group*
$_{crude}DR_{(spec.\ group)}$ = *crude death rate in a specific population group*
$N_{stand.\ pop(spec.\ group)}$ = *number of population in a specific population group of a standard population*

   The result of this step, the expected number of deaths in every specific age group, is in fact the standardized death rate in this particular age group.
4. Step 4 - calculation of the standardized death rate in a total population.
   Finally, the standardized death rate is obtained by summation of expected number of deaths in a specific age group across all age groups (Equation 4).

$$_{stand}DR_{(total\ pop)} = \sum N_{exp.deaths(spec.group)} \qquad \textbf{Equation 4.}$$

$_{stand}DR_{(total\ pop)}$ = *standardized death rate in a total population*
$N_{exp.\ deaths\ (spec.\ group)}$ = *number of expected deaths in the standard population in a specific population group*

CASE STUDY: THE PROCEDURE OF DIRECT AGE STANDARDIZATION OF DISEASE D MORTALITY IN CROATIA

Entry data

For accomplishing the procedure of direct age standardization of disease D mortality in Croatia we need following sets of data:

1. Number of deaths of a disease D to be standardized.
   In table 2 the number of cases of the disese D in every age group for the male population for year 2000 is presented. The data were obtained from National Health Institute of Croatia (17).

Table 2. Number of death cases (absolute incidence) of the disese D in Croatia for male population for every age group for year 2000. Source: National Health Institute of Croatia (17).

Age group	Number of cases	Age group	Number of cases
0	0	45-49	80
1-4	0	50-54	143
5-9	0	55-59	237
10-14	2	60-64	258
15-19	3	65-69	249
20-24	4	70-74	200
25-29	15	75-79	253
30-34	14	80-84	159
35-39	36	85+	68
40-44	52	Total	1773

2. Observed population data.
   In Table 3 the number of population in every age group of the Croatian population is presented. The 1991 census data are used (Table 3, Figure 2). The data were obtained from Central Bureau of Statistics of Republic of Croatia (18).

Table 3. Croatian population (census 1991) in figures. Source: Central Bureau of Statistics of Republic of Croatia (18).

Age group	Males	Females	Age group	Males	Females
0	26361	26361	45-49	147304	148308
1-4	130000	148272	50-54	155474	161793
5-9	168031	159688	55-59	146177	162304
10-14	166573	159218	60-64	105909	146527
15-19	162383	155564	65-69	69655	113449
20-24	169107	164779	70-74	43815	71653
25-29	179330	175245	75-79	44536	75999
30-34	192397	184039	80-84	23986	44564
35-39	184654	174497	85+	12844	27651
40-44	142937	139918	Total	2271473	2439829

Tha same data are presented also in Figure 2.

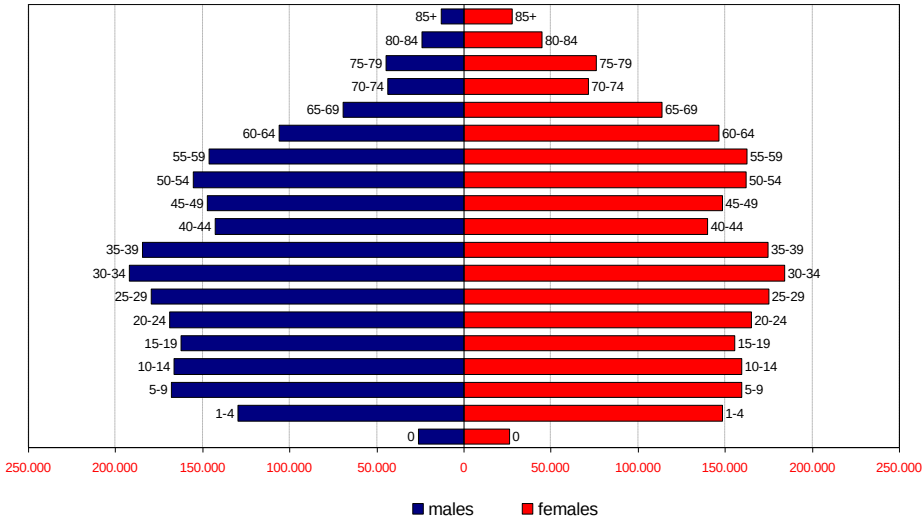


Figure 2. Number of population by sex in nineteen age groups of the Croatian population, the 1991 census data. Source: Central Bureau of Statistics of Republic of Croatia (18).

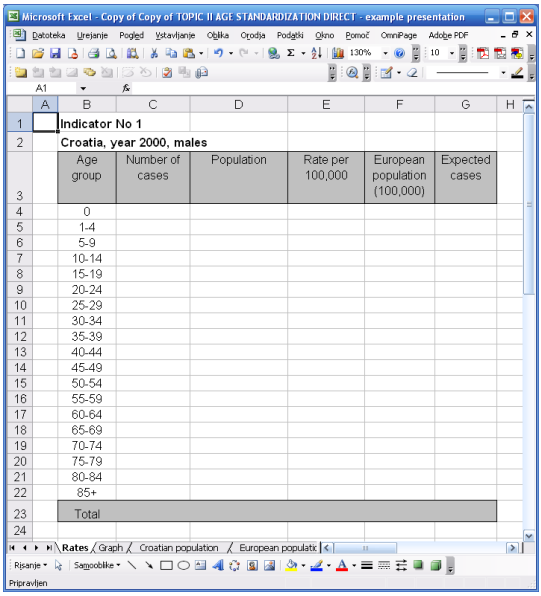
3. Standard population data.
   Given the fact that we want to compare the mortality rate of disease D in Croatia to other countries of World Health Organization (WHO) European region mortality rates, the European standard population is the best choice for standard population. This standard population has been already presented (Table 1, Figure 1).

Setting the frame table for the standardization procedure

The procedure for standardization of rates could be authomatised by using an appropriate computer programmes. Spreadsheet programme like Microsoft Excel could be used. The frame table for the procedure should contain following columns:

- Age group,
- Number of cases of deaths,
- Population (observed),
- Rate per 100,000,
- European standard population, and
- Expected cases of deaths (in European standard population).

In Figure 3 this frame is presented while in Figure 4 in this frame entry data are already filled in.



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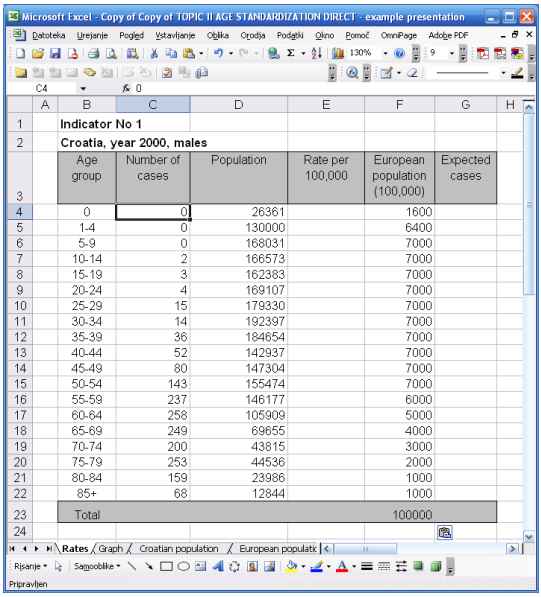
Indicator No 1

Croatia, year 2000, males

Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases
0					
1-4					
5-9					
10-14					
15-19					
20-24					
25-29					
30-34					
35-39					
40-44					
45-49					
50-54					
55-59					
60-64					
65-69					
70-74					
75-79					
80-84					
85+					
Total					

Figure 3. The frame table for the standardization procedure in Microsoft Excel computer programme.



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Indicator No 1

Croatia, year 2000, males

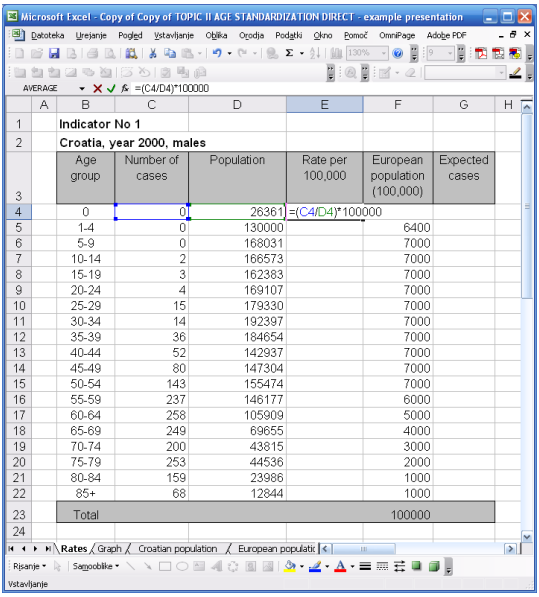
Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases
0	0	26361		1600	
1-4	0	130000		6400	
5-9	0	168031		7000	
10-14	2	166573		7000	
15-19	3	162383		7000	
20-24	4	169107		7000	
25-29	15	179330		7000	
30-34	14	192397		7000	
35-39	36	184654		7000	
40-44	52	142937		7000	
45-49	80	147304		7000	
50-54	143	155474		7000	
55-59	237	146177		6000	
60-64	258	105909		5000	
65-69	249	69655		4000	
70-74	200	43815		3000	
75-79	253	44536		2000	
80-84	159	23986		1000	
85+	68	12844		1000	
Total				100000	

Figure 4. The frame table for the standardization procedure in Microsoft Excel computer programme filled in with entry data.

The procedure

The four steps are as follows:

1. Step 1 - calculation of the specific crude death rate for every (specific) age group.
   The crude specific death rate for every age group is calculated by using the Equation 1. In Figure 5 the equation for calculating the crude specific death rate for the age group 0 using corresponding cells for number of deaths and the observed (actual local) population in this age group in a spreadsheet is presented.



	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	=(C4/D4)*100000			
5		1-4	0	130000		6400		
6		5-9	0	168031		7000		
7		10-14	2	166573		7000		
8		15-19	3	162383		7000		
9		20-24	4	169107		7000		
10		25-29	15	179330		7000		
11		30-34	14	192397		7000		
12		35-39	36	184654		7000		
13		40-44	52	142937		7000		
14		45-49	80	147304		7000		
15		50-54	143	155474		7000		
16		55-59	237	146177		6000		
17		60-64	258	105909		5000		
18		65-69	249	69655		4000		
19		70-74	200	43815		3000		
20		75-79	253	44536		2000		
21		80-84	159	23986		1000		
22		85+	68	12844		1000		
23		Total				100000		
24								

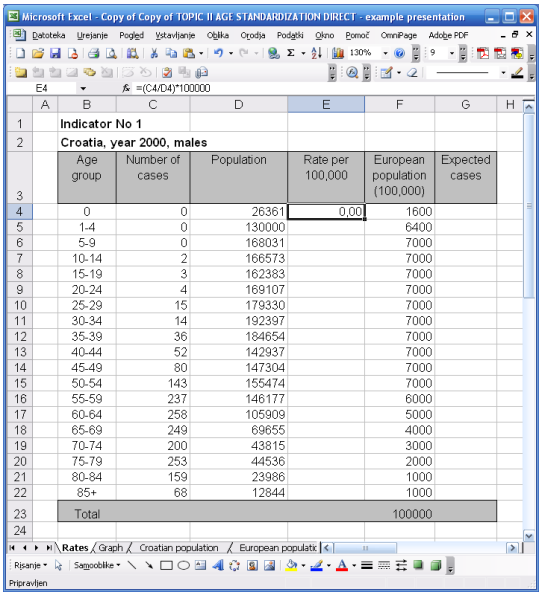
Figure 5. Calculation of the specific rate for age group 0 using corresponding cells for number of deaths, and the observed (actual local) population in this age group in a spreadsheet.

In Figure 6 the results of this step in the procedure is presented.

In Equation 5 the procedure for calculating the crude specific death rate for the age group 40-44 is presented, as well as the result.

$$_{crude}DR_{age\,40\text{-}44} = \frac{52}{142{,}937} \times 100{,}000 = 36.38 \qquad \textbf{Equation 5.}$$

In continuation, the formula from the cell containing the function for calculating the crude specific death rate for the age group 0 is copied to other cells in the same column by dragging the right lower corner of the cell and extending it to the last age group cell (Figure 7).



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E4 =(C4/D4)*100000

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600		
5		1-4	0	130000		6400		
6		5-9	0	168031		7000		
7		10-14	2	166573		7000		
8		15-19	3	162383		7000		
9		20-24	4	169107		7000		
10		25-29	15	179330		7000		
11		30-34	14	192397		7000		
12		35-39	36	184654		7000		
13		40-44	52	142937		7000		
14		45-49	80	147304		7000		
15		50-54	143	155474		7000		
16		55-59	237	146177		6000		
17		60-64	258	105909		5000		
18		65-69	249	69655		4000		
19		70-74	200	43815		3000		
20		75-79	253	44536		2000		
21		80-84	159	23986		1000		
22		85+	68	12844		1000		
23		Total				100000		
24								

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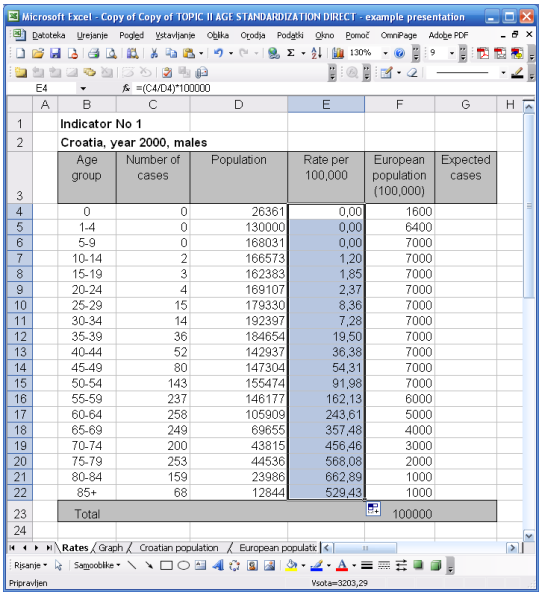
Figure 6. The result of calculation of the specific rate for age group 0.



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E4 =(C4/D4)*100000

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600		
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total				100000		
24								

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Pripravljen Vsota=3203,29

Figure 7. Copying of the function used for calculation of the specific rate for age group 0 to all age groups by dragging the right lower corner of the cell and extending it to the last age group cell.

In Figure 7 we can verify if the result of calculation of the crude specific death rate for the age group 40-44 is correct.

2. Step 2 - calculation of the crude rate for total population.
   Prior calculating the crude rate for total population, the totals of number of cases and population need to be calculated. Figure 8 presents the procedure for calculating the totals by using the SUM function.

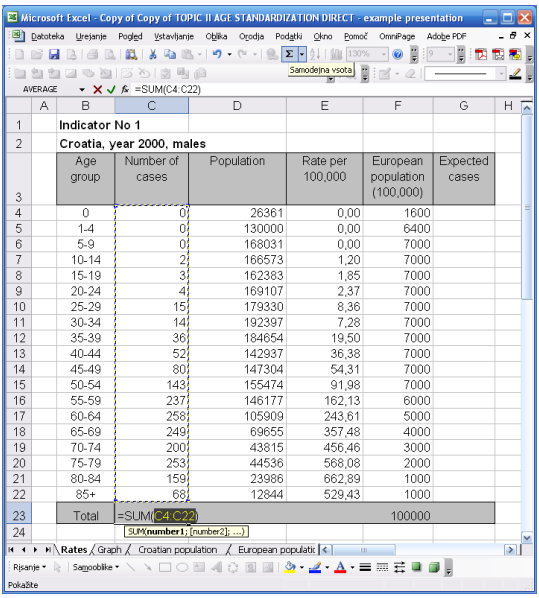


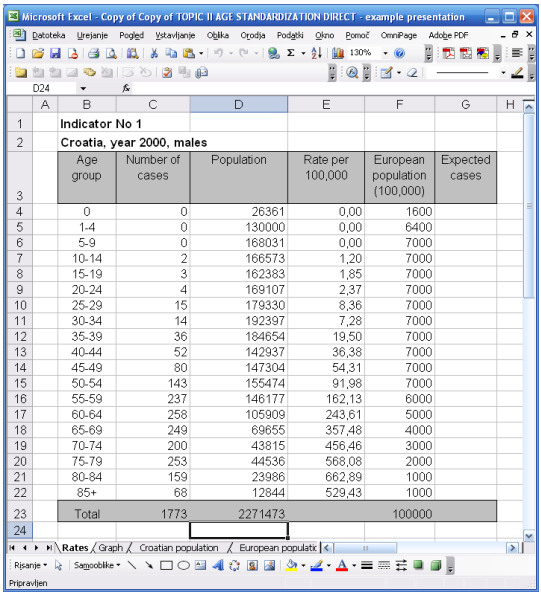
Figure 8. The procedure of calculation of totals for number of deaths and for Croatian population.

In Figure 9 the results of this procedure are presented. By comparing the totals in Tables 2 and 3 we can verify if they are correct.

In continuation, the crude rate for total population is calculated by using the Equation 2 (Equation 6).

$$_{crude}DR_{(total\ pop)} = \frac{1,773}{227,1473} \times 100,000 = 78.06 \qquad \textbf{Equation 6.}$$

The procedeure of calculation of the crude rate for total population using corresponding cells for number of deaths and the observed (actual local) total population in the spreadsheet is presented in Figure 10, while the result in Figure 11.



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D24

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600		
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total	1773	2271473		100000		
24								

Rates / Graph / Croatian population / European populatic

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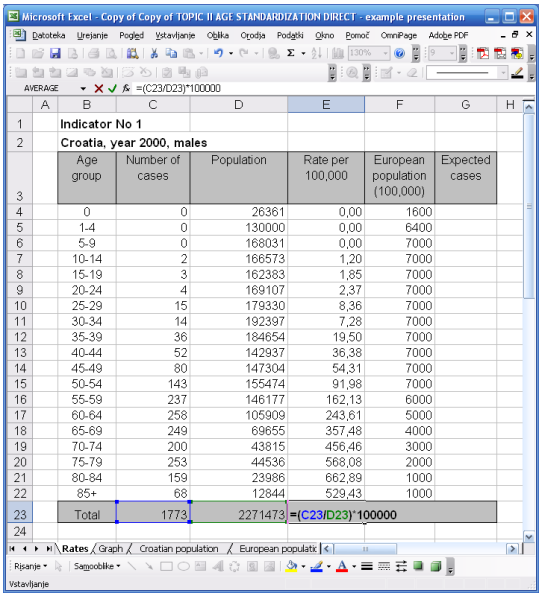
Figure 9. The result of the procedure of calculation of totals for Croatian population, number of cases and European standard population.



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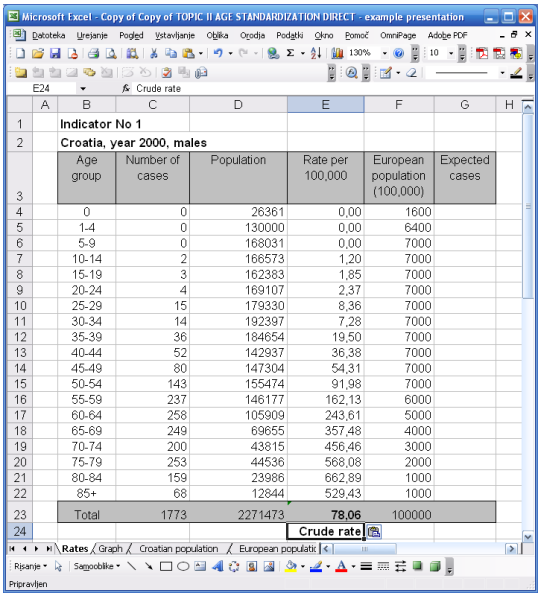
AVERAGE =(C23/D23)*100000

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600		
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total	1773	2271473	=(C23/D23)*100000			
24								

Rates / Graph / Croatian population / European populatic

Vstavljanje

Figure 10. The procedeure of calculation of the crude rate for total population using corresponding cells for number of deaths and the observed (actual local) total population.



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E24 Crude rate

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600		
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total	1773	2271473	78,06	100000		
24					Crude rate			

Rates / Graph / Croatian population / European populatic

Pripravljen

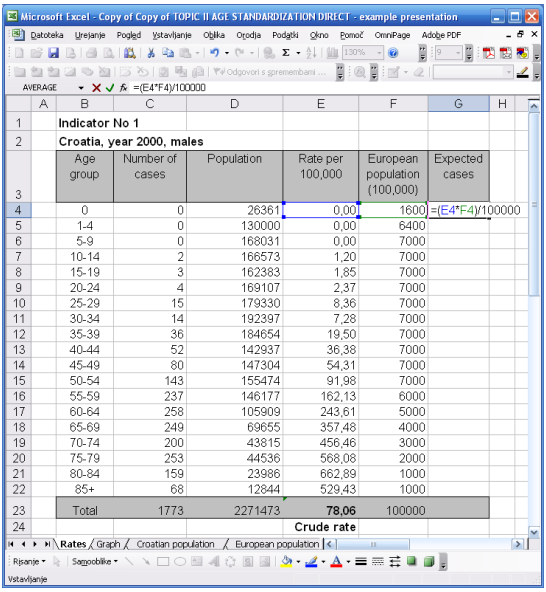
Figure 11. The result of calculation of the crude rate for total population Calculation of the specific rate for age group 0.

3. Step 3 - calculation of the expected number of deaths in the standard population for every specific age group.
   In the next step, the expected number of deaths in a specific age group is calculated by using Equation 3. In Figure 12 the equation for calculating the expected number of deaths in the standard population for the age group 0 using corresponding cells for crude death rate and the standard population in this age group in a spreadsheet is presented. In Figure 13 the results of this step in the procedure is presented.

   In Equation 7 the procedure for calculating the expected number of deaths in the standard population for the age group 40-44 is presented, as well as the result.

$$N_{expected_{age\,40\text{-}44}} = \frac{36.38 \times 7{,}000}{100{,}000} = 2.55 \qquad \textbf{Equation 7.}$$

In continuation, the equation from the cell containing the function for calculating the crude specific death rate for the age group 0 is copied to other cells in the same column by dragging the right lower corner of the cell and extending it to the last age group cell (Figure 14).



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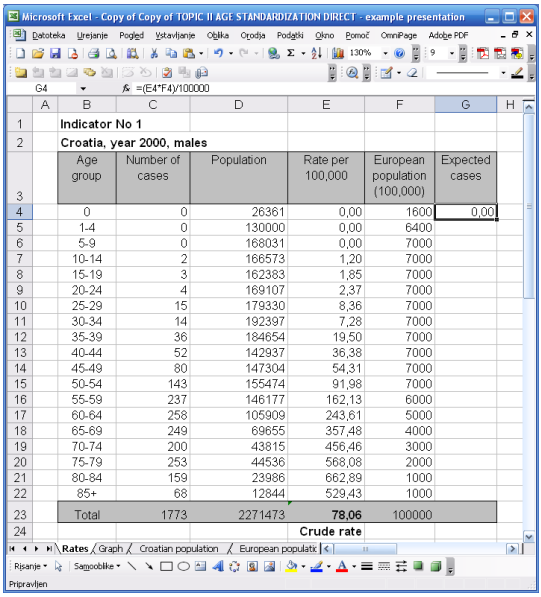
AVERAGE =(E4*F4)/100000

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600	=(E4*F4)/100000	
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total	1773	2271473	78,06	100000		
24					Crude rate			

Figure 12. Calculation of the number of expected number of deaths in the standard population for age group 0 by using corresponding cells for crude death rate and the standard population in this age group in a spreadsheet.



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G4 =(E4*F4)/100000

	A	B	C	D	E	F	G	H
1		Indicator No 1						
2		Croatia, year 2000, males						
3		Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases	
4		0	0	26361	0,00	1600	0,00	
5		1-4	0	130000	0,00	6400		
6		5-9	0	168031	0,00	7000		
7		10-14	2	166573	1,20	7000		
8		15-19	3	162383	1,85	7000		
9		20-24	4	169107	2,37	7000		
10		25-29	15	179330	8,36	7000		
11		30-34	14	192397	7,28	7000		
12		35-39	36	184654	19,50	7000		
13		40-44	52	142937	36,38	7000		
14		45-49	80	147304	54,31	7000		
15		50-54	143	155474	91,98	7000		
16		55-59	237	146177	162,13	6000		
17		60-64	258	105909	243,61	5000		
18		65-69	249	69655	357,48	4000		
19		70-74	200	43815	456,46	3000		
20		75-79	253	44536	568,08	2000		
21		80-84	159	23986	662,89	1000		
22		85+	68	12844	529,43	1000		
23		Total	1773	2271473	78,06	100000		
24					Crude rate			

Figure 13. The result of calculation of expected number of deaths in the standard population for age group 0.

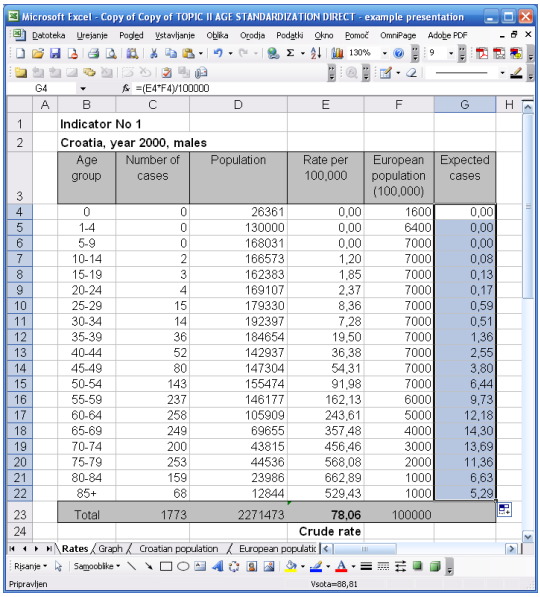


Figure 14. Copying of the function used for calculation of the number of expected number of deaths in the standard population for age group 0 to all age groups by dragging the right lower corner of the cell and extending it to the last age group cell.

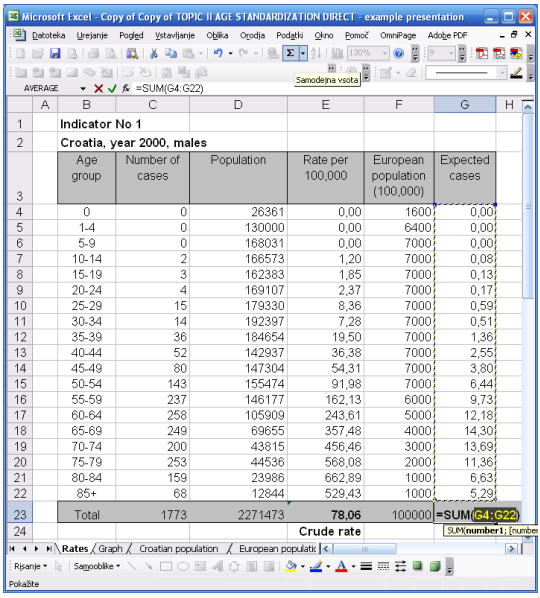
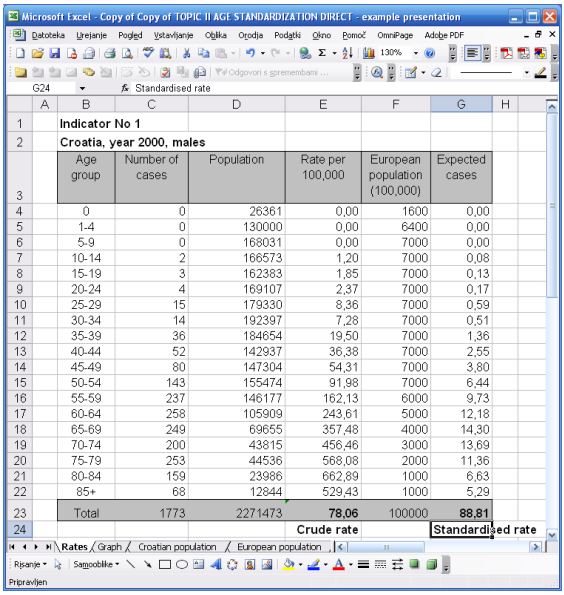


Figure 15. The procedeure of calculation of the crude rate for total population using the SUM function in MS Excel programme.

4. Step 4 - calculation of the standardized death rate in a total population.
   Finally, the standardized death rate is obtained by summation of number of expected cases in standard population across all age groups. Figure 15 presents the procedure for calculating the totals by using the SUM function in MS Excel programme, while Figure 16 presents the final result of the procedure.



Indicator No 1

Croatia, year 2000, males

Age group	Number of cases	Population	Rate per 100,000	European population (100,000)	Expected cases
0	0	26361	0,00	1600	0,00
1-4	0	130000	0,00	6400	0,00
5-9	0	168031	0,00	7000	0,00
10-14	2	166573	1,20	7000	0,08
15-19	3	162383	1,85	7000	0,13
20-24	4	169107	2,37	7000	0,17
25-29	15	179330	8,36	7000	0,59
30-34	14	192397	7,28	7000	0,51
35-39	36	184654	19,50	7000	1,36
40-44	52	142937	36,38	7000	2,55
45-49	80	147304	54,31	7000	3,80
50-54	143	155474	91,98	7000	6,44
55-59	237	146177	162,13	6000	9,73
60-64	258	105909	243,61	5000	12,18
65-69	249	69655	357,48	4000	14,30
70-74	200	43815	456,46	3000	13,69
75-79	253	44536	568,08	2000	11,36
80-84	159	23986	662,89	1000	6,63
85+	68	12844	529,43	1000	5,29
Total	1773	2271473	78,06	100000	88,81
			Crude rate		Standardised rate

Figure 16. Final result of the procedure of calculating standardized death rate.

EXERCISE

Task 1

Carefully read the theoretical background of this module and discuss the confounding phenomenon with other students.

Task 2

Compare and interpret the crude rate and the SDR for disease D for male population of Croatia (Figure 16) given the disease is cancer (all sites). What do you think such a result mean?

Task 3

Perform the standardization procedure for female population for the disese D mortality in Croatia. Number of death cases (absolute incidence) is presented in Table 4.

Table 4. Number of death cases (absolute incidence) of the disese D in Croatia for female population for every age group for year 2000 (8). Source: National Health Institute of Croatia

Age group	Number of cases	Age group	Number of cases	Age group	Number of cases
0	0	30-34	10	65-69	270
1-4	0	35-39	29	70-74	240
5-9	0	40-44	24	75-79	330
10-14	1	45-49	67	80-84	238
15-19	0	50-54	136	85+	102
20-24	2	55-59	158	Total	1825
25-29	9	60-64	209		

Follow the procedure presented in this paper from Step 1 to Step 4 (Figures 3 thru 16)[5].

Task 4

Compare:

- your results obtained in the Task 3 to results of other students,
- the results of female part of the population (Task 3) to the male part of the population (Case study),
- try critically to discuss the differences.

Task 5

Critically discuss strengths and limitations of standardization procedure in controlling the confounding phenomena.

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[5] The answer:
Crude death rate: 74.80
Standardized death rate: 62.53

http://www.ihs.gov/medicalprograms/portlandinjury/pdfs/principlesofepidemiologyinpublichealthpractice.pdf. Accessed: June 24, 2009.
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RECOMMENDED READINGS

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