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A BRIEF ANALYSIS OF NONCOMMUNICABLE DISEASES IN ROMANIA, 1996-2004

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Abstract. Aim. The current paper presents a brief method focused on the identification of noncommunicable diseases (NCDs) with unfavourable evolution which need target interventions policies for diminishing the deterioration of populations' health. **Method.** A valid supervises of health needs involve at least the description of two major components: disease and death. The method proposed is based on the calculus of percentage change in the rate of standardised mortality for age group 0-64 years and in the rate of discharge from hospital for NCDs which are important causes of premature death. In the same time it is presented a simple mathematical model from time series analysis. The methodology is applied in EU and recommended by WHO. **Results**. In this paper the analysis is applied for Romania by comparing the main outcomes with the corresponding EU results. For both cases the chronic diseases with a sharply evolution were identified and for Romania an expected development of standardised premature mortality rate after 2004 and the percentage change in health over 2004-2009 estimated with 95% confidence were also proposed. **Conclusions**. The growth in the rate of hospital discharges during 1996-2004 shows in an indirect way the unfavourable evolution of a special group of diseases. The calculation of percentage change is complementary to the classical calculus of rate and brings about value-added pointing at the explosive evolution of some major diseases. The method is a useful tool for the elaboration of strategies on prevention of NCDs and a map for an optimal resource management (health units, staff, budget) according to their trend.

Key words: noncomunicable diseases, premature mortality, standardised death rate per 100000, hospital discharges, percentage change, trend analysis

Rezumat. Scop. Studiul prezintă o metodă de identificare a grupelor de boli netransmisibile (NCDs) cu evoluție nefavorabilă, care solicită intervenții țintite pentru diminuarea deteriorării stării de sănătate a populației. **Metodă**. Monitorizarea corectă a stării de sănătate a populației necesită descrierea concomitentă a celor două componente majore: boala şi decesul. Metoda propusă se referă la calculul procentului de modificare a ratei standardizate de mortalitate pentru grupa de vârstă 0-64 ani şi a ratei de externare pentru bolile netransmisibile care constituie cauze majore ale decesului prematur. De asemenea, se discută un model matematic simplu utilizat în predicția seriilor cronologice. Metodologia este aplicată în UE şi recomandată de către OMS. **Rezultate.** In cazul acestei lucrări analiza este aplicată pentru România prin raportare la evoluția din UE. Au fost identificate mai întâi grupele de boli a căror evoluție ridică probleme, iar în cazul României s-a elaborat şi o estimare a ratei standardizate de mortalitate prematură, determinând în acelaşi timp cu o încredere de 95% ritmul de îmbunătățire a stării de sănătate a populației pentru perioada 2004-2009. **Concluzii.** Creşterea ratei externărilor în perioada 1996-2004 indică indirect evoluția nefavorabilă a unor

grupe de boli. Determinarea ritmului de creştere a bolii este o metodă complementară celei clasice de calcul a ratei şi aduce informaţii suplimentare, atrăgând atenţia asupra evoluţiei explozive a unor grupe de boli. Metoda este utilă în elaborarea strategiilor de prevenire a bolilor netransmisibile fiind în acest sens şi un reper pentru alocarea corectă a resurselor (unităţi de îngrijire, personal) în funcţie de modelul de evoluţie.

Cuvinte cheie: boli netransmisibile, rata standardizată de mortalitate la 100000, mortalitate prematură, procent de modificare, rată externări, analiza seriilor cronologice

INTRODUCTION

Health is more and more seen as a driver of economic development and a strong predictor of economic growth. In this context, significant evidence relating to the potential impact of NCDs to the evolution of GDP rate has been accumulated during the last decade and mortality rate under the age of 65 has been frequently regarded as a summary indicator of the extent of avoidable deaths. According to European Commission and WHO studies there are still significant levels of preventable morbidity and mortality before the age of 65 years in EU member states and in light of these it has been proved that NCDs are the major source of preventable morbidity and cause of premature mortality in EU; they are the root causes of 86% of all deaths and accounted for about 77% of the overall burden of disease in the European Region (1,2). They are associated mainly with diseases of circulatory system (DCS), some types of cancer, external cause injury and poison, diseases of respiratory system (RSD), mental disorder and disease of the nervous system and the sense organ (MD and DSN), diseases of the digestive system (DSD). The greatest health gains could be achieved by reducing the problem of NCDs and tackling the most common risk factors such as smoking, alcohol consumption, hypertension and high cholesterol, overweight and physical inactivity. It is well known that during the last years (DCS) and cancer were the main causes of death in EU; it is estimated that 45% of women mortality and 38% of men mortality are accounted of cardiovascular diseases while one person in four dies of cancer (1,2). At national level, in 2002, the major group of NCDs caused 90% of all deaths in Romania (3). In this group, DCS accounted for 61% of the overall mortality rate (3). On the other hand the expenses associated with NCDs swallow up an important proportion of the health budget, reason for which is important to know as much as possible about the aspects of their pattern and trends. Based on the European strategy in the field many EU member states developed key areas for the health system to face NCDs challenges and the outcomes proved that they have been efficient tool for prevention and control the chronic diseases (7,8).

For effective focus interventions it is needed to establish the dynamic pattern of the preventable morbidity and premature mortality during broad time periods and look for expected developments. The statistical method

is based on the calculus of *percentage change* (PC) in the morbidity and mortality rates over a fix time period and the analysis of their expected developments (4, 5, 6). The *percentage change* is a robust measure which allows a better way to examine the trends and patterns observable in the areas of burden disease over time. It identifies the diseases which have rapid and sometimes explosive evolutions; indicate the growth rate of the phenomenon from a time period to another (past - present or more extensive past - present - future) (4,5,9). It will be the principal focus of attention in this paper. The aim is to identify those groups of diseases with unfavourable evolution, sometime explosive, which have negative consequences on health. The method allows comparing the best with the worst outcome of an indicator, the difference being the path, which has to be covered to improve health (6). The method is a common practice used by the European Commission and WHO in health studies (4, 5, 6, 9, 10, 11).
This paper envisages a section from a broad study on the dynamic model of preventable morbidity and premature mortality in Romania.

MATERIAL AND METHODS

For the time period 1996-2004, the PC is used to discuss the trend of premature mortality and hospital discharges by eight of the most important NCDs that can be held responsible for premature death. The aim is to envisage the gap among the Romanian and EU health outcomes. In the analysis of the premature mortality the PC is presented as "gaining health" throughout a longer time interval (5-10 years). During the last years "gaining health" is more frequently associated with survival with disabilities, which usually is a third age specific problem (6, 7). The calculus and estimates are based on standardised mortality rate per 100000; minus sign refers to a positive evolution of the mortality phenomenon, and in morbidity refers to a negative evolution. Gender aspects are included.
The expected development in mortality after 2004 is not intended as forecast of what will happen in the future but as projection of current and past trends based on certain explicit assumptions and on an observed historical pattern. The result is obtained with the *ARIMA*(*p,d,q*) model, also called Box-Jenkins model, where *p* is the number of auto-regressive terms, *d* is the number of nonseasonal differences, and *q* is the number of lagged forecast errors in the prediction equation. *ARIMA* models predict a variable's present values from its past values. The components of *ARIMA* model (*autoregression*, *differencing* or *integration*, moving-*average*) are based on the simple concept of random disturbances or shocks. Each of the three types of processes has its own characteristic way of responding to a random disturbance. The components are used to explain significant correlations found in the autocorrelation (ACF) and partial autocorrelation (PACF) plots and to handle trends. It is important to interpret the projection with a degree of caution commensurate with its uncertainty and to remember that it

represents a view of the future coming up from the baseline data, choice of model and the assumptions made. The statistics used in the paper come from the statistical database of the WHO and Health Statistical Centre of Public Health Minister Romania (11,12).

RESULTS AND DISCUSSION

Tables 1-2 present the dynamics of overall premature mortality model for Romania and EU accompanied by the top eight NCDs with their contribution to this phenomenon.

Table 1. Premature mortality standardized rate and percentage of change in major noncommunicable disease over the period 1996-2004 in Romania

Medical causes of death	Standardized mortality rate (per 100000)								
	1996			1999			2004		
	male	*female*	*total*	*male*	*female*	*total*	*male*	*female*	*total*
Overall causes	**739.5**	**330.9**	**528.6**	**630.4**	**289.0**	**453.3**	**585.1**	**258.4**	**415.5**
Diseases of circulator system	264.0	112.6	185.2	222.2	97.7	157.0	197.9	81.7	137.0
Cancers	128.5	77.3	101.6	127.1	74.5	99.3	129.5	74.7	100.5
Ischemic heart diseases	116.8	38.1	75.9	100.1	34.5	65.9	90.3	28.3	57.9
Accidents and poison	118.7	32.6	75.1	95.1	25.5	59.9	89.3	21.7	55.0
Cerebrovascular diseases	77.3	44.2	59.9	65.8	38.0	51.1	57.5	33.3	44.7
Digestive system diseases	75.4	30.5	52.3	62.9	25.6	43.6	61.3	24.8	42.4
Respiratory system diseases	64.8	30.6	47.2	49.7	24.0	36.4	39.9	18.1	28.6
Mental disorders and diseases of nervous system	24.9	9.9	17.2	16.6	7.6	11.9	12.8	5.7	9.1
Percentage change (%)									
Medical causes of death	**1996-1999**			**1999-2004**			**1996-2004**		
	male	*female*	*total*	*male*	*female*	*total*	*male*	*female*	*total*
Overall causes	**-14.7**	**-12.6**	**-14.2**	**-7.2**	**-10.6**	**-8.3**	**-20.9**	**-21.9**	**-21.4**
Diseases of circulator system	-15.8	-13.3	-15.2	-10.9	-16.3	-12.7	-25.0	-27.4	-26.0
Cancers	-1.1	-3.6	-2.3	1.9	0.2	1.2	0.8	-3.4	-1.1
Ischemic heart diseases	-14.3	-9.4	-13.2	-9.8	-17.9	-12.2	-22.7	-25.7	-23.8
Accidents and poison	-19.8	-21.8	-20.3	-6.2	-15.0	-8.2	-24.8	-33.5	-26.8
Cerebrovascular diseases	-14.9	-13.9	-14.7	-12.6	-12.4	-12.5	-25.7	-24.6	-25.4
Digestive system diseases	-16.6	-15.9	-16.6	-2.5	-3.4	-2.8	-18.7	-18.8	-18.9
Respiratory system diseases	-23.3	-21.7	-22.9	-19.8	-24.6	-21.4	-38.5	-40.9	-39.4
Mental disorders and diseases of nervous system	-33.3	-23.6	-30.5	-23.1	-24.9	-23.6	-48.7	-42.6	-46.9

Table 2. Premature mortality standardized rate and percentage of change in major noncommunicable diseases over the period 1996-2004 in EU

Medical causes of death	Standardized mortality rate (per 100000)								
	1996			1999			2004		
	male	*female*	*total*	*male*	*female*	*total*	*male*	*female*	*total*
Overall causes	**387.0**	**177.2**	**279.5**	**356.1**	**165.2**	**258.3**	**318.9**	**149.5**	**232.3**
Diseases of circulator system	110.2	39.7	73.8	98.0	35.2	65.6	82.7	28.8	54.9
Cancers	108.2	69.1	87.8	103.2	66.6	84.1	96.09	63.5	79.2
Ischemic heart diseases	57.4	14.1	35.1	50.6	12.4	30.9	40.69	9.7	24.7
Accidents and poison	63.7	17.9	40.7	59.2	16.5	37.8	53.3	14.6	33.9
Cerebrovascular diseases	20.0	11.5	15.6	18.2	10.5	14.1	15.1	8.5	11.6
Digestive system diseases	26.8	10.5	18.5	25.5	10.1	17.6	24.1	9.5	16.6
Respiratory system diseases	16.3	7.4	11.7	15.1	7.2	11.0	12.2	5.7	8.9
Mental disorders and diseases of nervous system	13.8	6.2	10.0	12.9	6.0	9.4	12.3	5.9	9.1
Percentage change (%)									
Medical causes of death	**1996-1999**			**1999-2004**			**1996-2004**		
	male	*female*	*total*	*male*	*female*	*total*	*male*	*female*	*total*
Overall causes	**-8.0**	**-6.8**	**-7.6**	**-10.4**	**-9.5**	**-10.1**	**-17.6**	**-15.6**	**-16.9**
Diseases of circulator system	-11.1	-11.4	-11.2	-15.6	-18.2	-16.3	-25.0	-27.5	-25.6
Cancers	-4.5	-3.7	-4.2	-6.9	-4.6	-5.9	-11.2	-8.1	-9.9
Ischemic heart diseases	-11.7	-12.0	-11.8	-19.7	-22.4	-20.1	-29.1	-31.6	-29.5
Accidents and poison	-7.0	-8.1	-7.2	-9.9	-11.6	-10.3	-16.2	-18.7	-16.7
Cerebrovascular diseases	-9.4	-9.0	-9.2	-17.1	-19.0	-17.8	-24.8	-26.3	-25.4
Digestive system diseases	-5.0	-3.8	-4.7	-5.5	-5.9	-5.6	-10.2	-9.5	-10.0
Respiratory system diseases	-7.6	-2.6	-6.1	-19.2	-20.6	-19.6	-25.3	-22.6	-24.5
Mental disorders and diseases of nervous system	-6.3	-3.5	-5.4	-5.0	-2.3	-4.1	-11.0	-5.8	-9.3

It can be noticed that the PC in these chronic diseases slowly decreases during the last decades, thing which make them public health priorities. The evolution of premature mortality in Romania is strongly influenced by the socio-economic change came about after 1989. The analysis of standardised mortality rates shows that, although registering a general decrease trend, the patterns hide peak data for Romania and have values over the EU average (11). At EU level, it has been noticed a smooth decrease in mortality levels, pointing out an effective management.

The figure shows that the mortality patterns for 2004 and 1996 are similar in Romania. *DCS*, *malignant neoplasm*, and *(IHD)* are dominating the hierarchy.

Comparing with the Romanian pattern, the EU priorities in 2004 were *malignant neoplasm* followed by *DCS*, *accidents and poison*, and *IHD*. From a gender perspective it can be noticed that for women, in Romania the highest levels of mortality are registered for *DCS, cancers* and *CD* both in 1996 and 2004, while in EU high levels are accounted to *cancers*, *DCS*, and *accidents and poison*. The PC shows the dynamic of each group of diseases and expresses *the gain or loss in health*.

In this context, the PC between 1996 and 2004 shows that although the decrease of mortality is higher in Romania (-21.4%) than in EU (-17.0%). There are major differences in its evolution so that if in EU the trend of improvement in health is smooth, (from -7,6% for 1996-1999 to -10.1% for 1999-2004), in Romania the gain in health hold in 1996 -1999 (-14.8%) sharply decreased in 1999-2004 to -8.3%. Due to influence of the PC associated with cancers (-1.1%), *DSD* (-18.9%), *IHD* (-23.8%) and *CD* (-25.4%) inside the mortality pattern, this broad group of chronic disorders could be considered a priority target for the Romanian decision makers in the elaboration of cost-effective interventions for prevention and control of NCDs.

In order to increase awareness on the magnitude of the burden of NCDs and the associated potential for their prevention and control, we have selected for this presentation eight most important causes of death from the morbidity model: DCS, CD, cancers, accidents and poison, RSD, IHD, mental disorder and diseases of nervous system and the sense organ (MD and DNS).

Figure 1 shows the significant increase in hospital discharges for *CD* (85.1%), *cancers* (58.1%), and *DCS* (38.5%) between 1996 and 2004 in Romania. These major diseases are identified as priorities and require both a development of dedicated alternative services to those provided by hospitals and a deep analysis of determinants which influence their sharply evolution. Although during the same time interval the increase in hospital discharges for *DSD* is slow (8.6%) they are still a priority considering the dramatic evolution of percentage change from -3.9% during 1996-1999 to 13.5% during 1999-2004.

Figure 2 shows the pattern of hospital discharges between 1996 and 2004 at the EU level. In this case a close look to figures reveals that priorities cluster around *CD* (12.8%), *cancers* (10.7%) and *MD and DNS* (10.2%). It also has to be noticed the smooth increase in the percentage change for all eight major diseases. The phenomenon can be encounter as a result of the good management of alternative health services at the EU level.

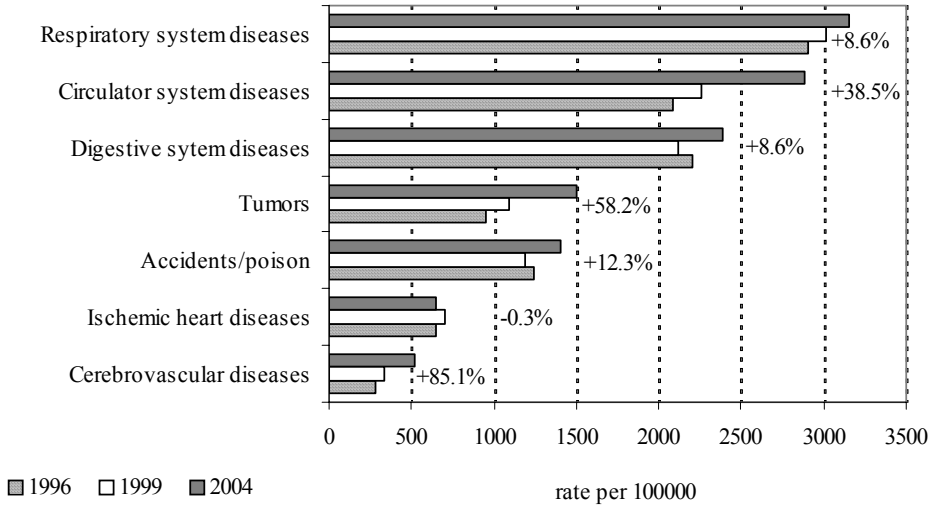

Fig. 1. Rate of hospital discharges and percentage change for the major NCDs over 1996-2004 in Romania

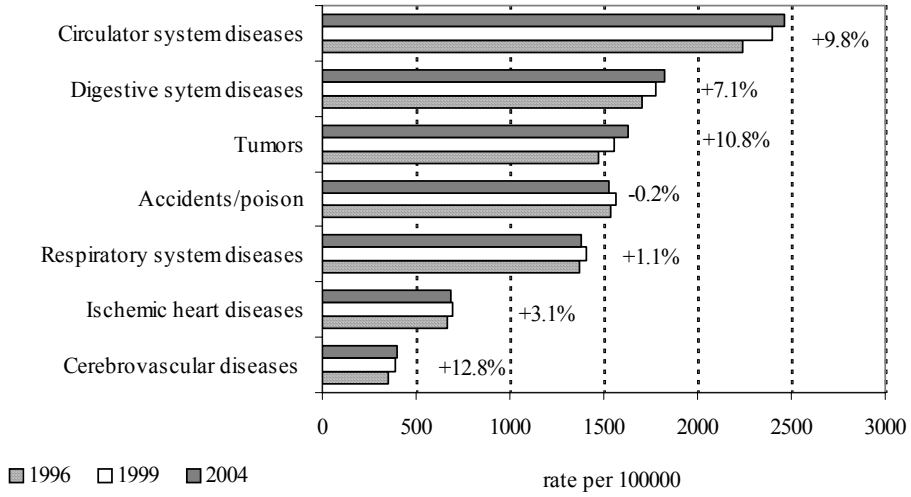

Fig. 2. Rate of hospital discharges and percentage change for the major noncommunicable diseases over 1996-2004 in EU

In the next paragraph it is presented a method, which allows the estimation of the future developments of the gaining health based on past and present figures. The projection was carried out for Romania using the standardised mortality rates from 1984 to 2004 as a base in an *ARIMA* model. The model involved three stages. *Stage 1*: Identification of the initial *p*, *d*, and *q* parameters based on autocorrelation and partial autocorrelation methods. First we established that the series has a trend, and then we determine the amount of differencing required to obtain a stationary series. In our case a stationary series is obtained for $d = 2$. No constant will be add to the model. Next the orders of autoregression (*p*) and moving-average (*q*) was identified. We identified a moving-average process with $q = 5$ (the current observations are correlated with shocks at lag 5). *Stage 2*: Estimation of the *p* (auto-regressive) and *q*(moving average) components to see if they contribute significantly to the model. In this case the estimated model is *ARIMA* (*0,2,5*). *Stage 3*: Diagnosing an *ARIMA* model is a crucial part of the model-building process and involves analysing the model residuals. If the model is a good fit for the series the residuals should be random and normally distributed. In our case the autocorrelation and partial autocorrelation functions (fig. 3 and 4) shows no significant values.

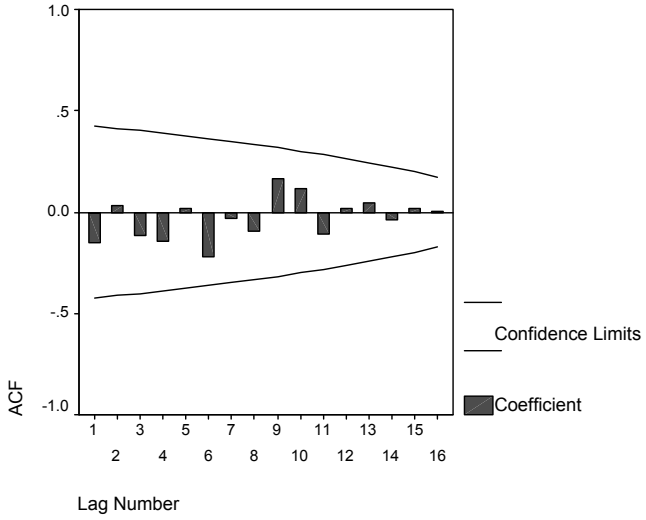

Fig. 3. Residual autocorrelation plot for *ARIMA (0,2,5)*

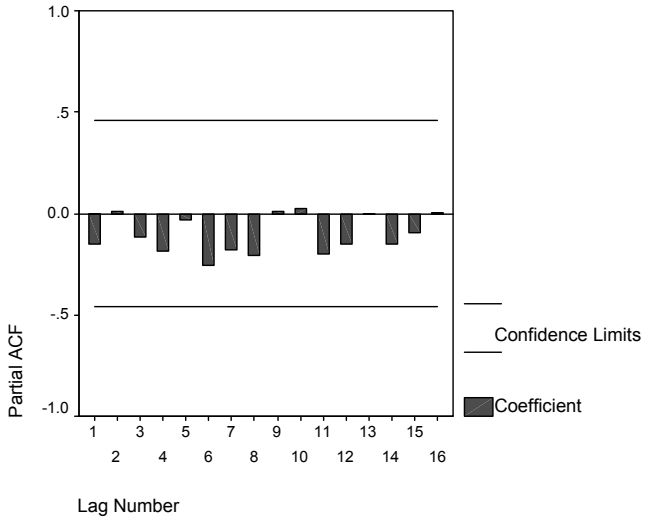

Fig. 4. Residual partial autocorrelation plot for *ARIMA(0,2,5)*

As a test of randomness the *Box-Ljung* statistic should have significance levels of .05 or better for 95% of the time periods under analysis. In this case the Box-Ljung statistic (table 3) has no significant values and this is consistent with the hypothesis that the residuals are random.

Coupled with the results from the ACF and PACF plots, we can conclude that the model provides a good fit to the data. We can conclude that the *ARIMA(0,2,5)* model developed for Romania anticipates, with a confident level of 95%, that the decreasing trend of mortality standardised rate will continue such as, in 2009 its expected value would be **345.5** with a percentage change of **(-16.8%)** for 2004-2009 (fig. 5).

Table 3. Box-Ljung test for *ARIMA*(*0,2,5*)

Test value	Prob.
.528	.467
.555	.758
.895	.827
1.465	.833
1.475	.916
3.004	.808
3.031	.882
3.352	.910
4.437	.880
5.021	.890
5.580	.900
5.601	.935
5.720	.956
5.846	.970
5.868	.982
5.870	.989

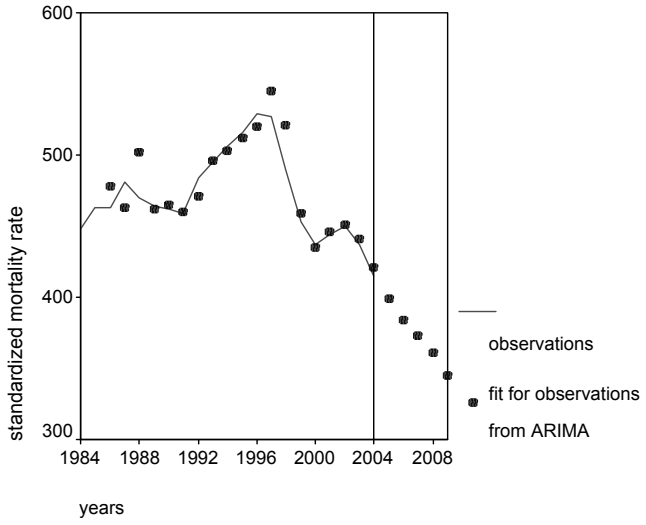

Fig. 5. Expected developments in mortality after 2004 in Romania

But the evolution of mortality rate will mainly depend on the effectiveness of preventive interventions on major risk factors. Even if the *ARIMA* model was applied to the mortality figures over the period 1984-2004 the result should be interpreted with cautious because the breaks in the trend. Fluctuations occurring in the pattern of mortality are too strong, leaving few measuring points on which to base a trend (the aim of an *ARIMA* model is precisely to eliminate fluctuations). For long-time usable results the trend-based projection of mortality has to be put on a balance with the demographic and epidemiological projections and it is necessary to bring together in the model the relationship among the determinants, disease and mortality.

CONCLUSIONS

The study presents a simple analysis method based on past and present data, easy to apply, due to professional statistical software, in order to be able to get some idea of health priorities and the health gain that can be achieved. Setting the premature death causes which have a slow evolution in percentage change on the background of a decrease in the trend of mortality standardised rate should be a valuable tool for prevention and control programs. Even in the mortality model presented, the level of the standardised mortality rate for the cerebrovascular diseases is not one of the highest, these groups of diseases becomes future priorities for health care services due to their importance in hospitalised morbidity.

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