

Risk Factors, Processes and Risk Management within a Public Health Context

Czynniki ryzyka, procesów i zarządzania ryzykiem w obrębie zdrowia publicznego

Tamás Szentes

*The National Public Health and Medical Officer Service,
Office of the Chief Medical Officer, Budapest*



Dr. Tamás Szentes

SUMMARY

Besides clinical medicine, which is in the process of constant and fast development, the focus is increasingly on public health services, which should be well prepared for reducing or keeping under control the dangers induced by the growing social burden of disease. Continuous risk management is represented by these services that are specially designed to prevent diseases and health damages. The grounds for the planning and implementation of public health services are constituted by risk factor management and assessment by means of adopting a unified approach.

The organisation as well as the cost-effective implementation of services – providing primary, secondary and tertiary prevention – on community and individual levels will be of utmost importance in the future, and will mean, besides risk equalisation, adopting a unified approach as to the provision of public health services.

Keywords: public health, risk management, primary, secondary and tertiary prevention, indirect risk factor, primary risk factor, secondary risk factor, chronic state of disease

INTRODUCTION

Public Health is a social activity aiming to improve the health status of the population by means of disease prevention and health promotion. Within the scope of activity of public health services, the following elements must be defined: disease prevention that is affordable to the population; science-based biological, natural and social environmental criteria of health serving as effective and available methods of health promotion; and services required to accomplish them, along with the characteristics of the institutional background necessitated by their provision [1].

So the concept of health and illness is placed in a broader context by the science of public health, and the defining factors of the concept, as well as the points of intervention where health status may be influenced, are thereby identified. This way a ho-

listic approach is used for the studied area, and attempts are made to identify as broadly as possible the factors influencing health status. Therefore the science of public health maintains extensive and active working relations with other areas of science – from genetics to sociology – in order to provide a comprehensive support to health promotion, health management, and the treatment and care of diseases.

DESCRIPTION OF HEALTH STATUS

The quality and length of life are determined by the individual's physical condition and mental status, that is the well-being thereof or the lack of it. Promoting or restoring health, as well as the stopping or the slowing down of the deterioration of health, is an ongoing task considering the changes

of an organism in response to inner and outer effects. The practice of clinical medicine usually responds to established diseases and can exert a significant influence on health status. By contrast, public health services are provided continuously, and while taken individually they are of a lesser intensity, together they may exert a significant influence on the health status of individuals and on the social disease burden related to it.

While the services of clinical medicine are determined by the onset of diseases, those of public health are determined by health promotion and the slowing down of disease progression, so the services of the two areas complement each other.

RISK FACTORS

The effects potentially damaging the biological status of the organism or the mental state of individuals are called risk factors. Their continuous examination and monitoring make it possible – by the identification of intervention points and by the planning of health services – to achieve health gains on a population level [2, 3]. Clarifying the relationship between risk factors, studying the mechanism of their impact and identifying their role [4] in the onset of certain diseases have long been the subject of studies. It is the exact definition of risk factors that makes their transparent managing possible.

Indirect risk factors – causes of the primary risk factors

Impacts which are not stressors by themselves and do not directly exert any influence on the biological status of the organism but result in the formation of primary risk factors, namely the stressors, and in this way enhance their intensity and strength [5], are considered indirect risk factors (socioeconomic factors). Their effects cumulate in the primary risk factors, the stressors. Generally speaking, a poorer socioeconomic status, involving the co-occurrence of several indirect risk factors, is usually associated with a larger number of primary risk factors of a greater strength and is more likely to cause damages in the biological status (Fig. 1). The relationship between socioeconomic status and health damages is indirect, but it is clear and empirically supported [6]. Socioeconomic status is not unequivocally associated with certain primary risk factors [7], but considering its effect, the whole life history is relevant, as certain impacts of the childhood socioeconomic status tend to become visible only later in life [8].

Socioeconomic factors include the following: age, gender, ethnicity, urban/rural residence, culture, religion, qualification, occupation, employment, income, social structure/social services (availability of welfare services: social services, education, public utilities, public transport, etc.), and a war devastating the country.

For instance, even though the impact of the lack of education is indirect, it is exerted in several ways. Income levels of people with lower education are lower too, they face difficulties in accessing certain social goods and services, their nutrition is poorer, smoking and alcohol consumption are more prevalent among them in certain societies, their housing conditions are poor, and the environment in which they live is generally highly polluted, etc.

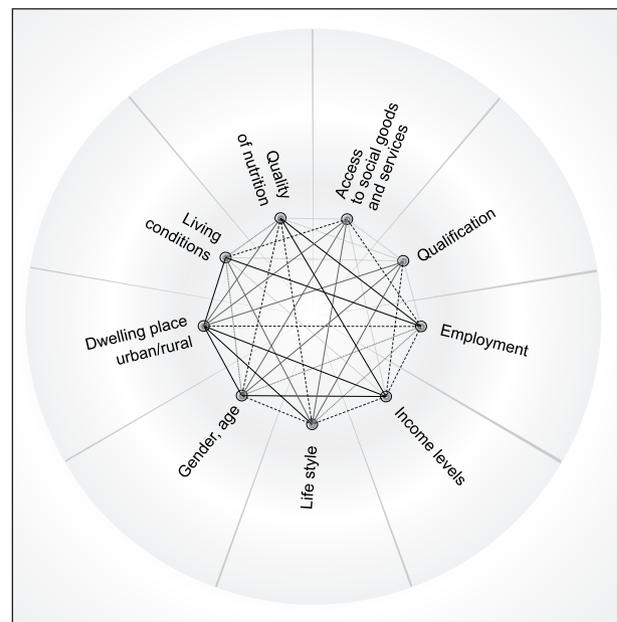


Fig. 1. The connections among indirect risk factors. Any socioeconomic factor may be a cause or an effect

The impact of indirect risk factors is complex, as it may differ from one system of relations to the other. Accordingly, their results ought to be taken into account. They come to the fore in a complex way, often through complex transmissions.

Primary risk factors – potential ways leading to the onset of diseases

Ill health is the loss of health, the impairment of the biological, mental state of health. This may occur for various reasons, with changes coming about due to stressor impacts exerted on the biological status, phenotype of the organism, producing a disease.

Stressors are called primary risk factors, as they are indirectly connected to the impairment of the biological status, the onset of a disease. They may be divided into three groups (Fig. 2).

Genetic factors may exert an influence on the biological properties of the organism in a congenital or an acquired way [9]. Genetic factors [10] may transform the biological properties of the organism (neoplastic transformation, polycystic kidney disease, etc.), or exert an impact on the response of the organism to the stressors, and in a given case weaken its homeostatic equilibrium. These are the so-called predisposing factors – e.g. in the case of diabetes mellitus, hypertonia – that is they have an impact on the susceptibility of the organism to other kinds of stressors and on the recurrence of acute conditions or on the efficiency of the treatment, as well [11, 12]. Currently there is limited knowledge on the role

and impact of genetic factors as to the predisposition to various diseases, but a rapid increase in knowledge is expected in the future. The main research track is directed to disease groups which are a priority from the point of view of public health [13, 14], as well as to the prevention of chronic diseases caused by genetic factors through the elimination of other stressors (life style, environmental impacts) [15].

These can be included in another group of stressors that are influenced by *individual behaviour* [16]. Such factors related to life style are: nutritional habits, physical activity, smoking, alcohol consumption, drug use, hygiene, etc. Indirect risk factors (socioeconomic factors) exert influence on health status mostly through stressors related to behaviour [17].

Factors independent from individual behaviour and stemming from the *external environment* [18] form the third group. The impacts of the stressors

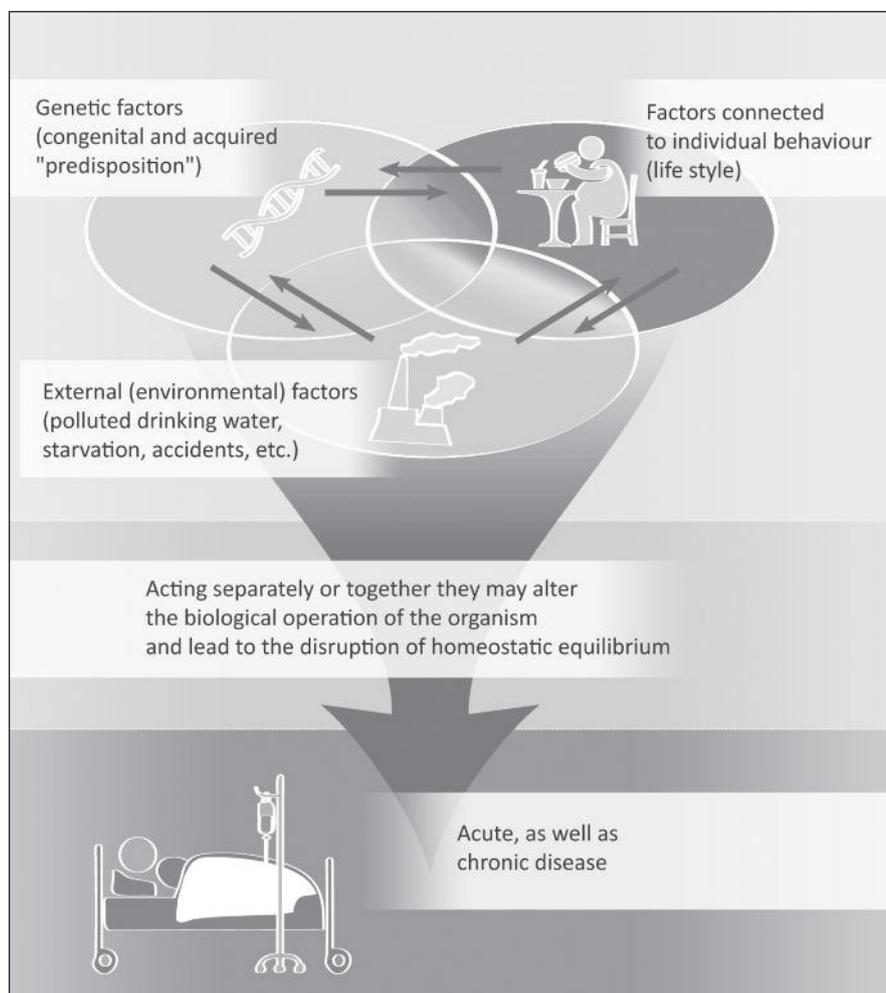


Fig. 2. Primary risk factors (stressors)

related to nutrition and environmental pollution are the focus of research activities. Unhealthy nutrition is blamed for more than 40 percent of the disease burden caused by noncommunicable diseases [19].

Difficult access to drinking water, as well as starvation, accidents, communicable diseases, etc. may also be included in this group. Some of them exert influence through epigenetic factors and form part of the concept of „soft inheritance”, in this way posing a congenital risk affecting the ascending generation [20].

The three different types of stressors may exert their influence separately, e.g. in the case of accidental injury or bacterial infection, or in the case of a potential drug use, but they usually operate jointly, especially in the case of chronic diseases. There may be dominant stressors, e.g. risk factors stemming from behaviour related to overweight, but even in this case genetic risks [21] and envi-

ronmental impacts [21, 22] may also play an important role.

Primary risk factors:

- genetic factors (congenital/acquired);
- risk factors that may be influenced by human behaviour: smoking, alcohol consumption, drug use, unhealthy nutritional habits (e.g. insufficient consumption of vegetables and fruit), physical inactivity, unsafe sexual practices, lack of contraception;
- Environmental impacts (independent from behaviour): poor sanitation, inadequate drinking water, pollution of the air, of the soil and of the water supply, climate change, occupational risk factors.

Secondary risk factors – pathological biological status of the organism

Weakened homeostatic conditions (Fig. 3), that is phenotype changes induced by stressor effects, are considered to be secondary risk factors. Such factors are, e.g., overweight, hypertension, diabetes mellitus, etc. These conditions may be reversible in some cases, e.g. homeostatic equilibrium may be restored by the disappearance of overweight, but irreversible in others: weakened homeostatic equilibrium becomes constant and chronic conditions may be developed, such as high blood pressure, diabetes mellitus, and neoplastic diseases.

These conditions are highly sensitive; therefore, they pose increased risks to the individuals. All of the chronic conditions which entail impairment in the biological operations of

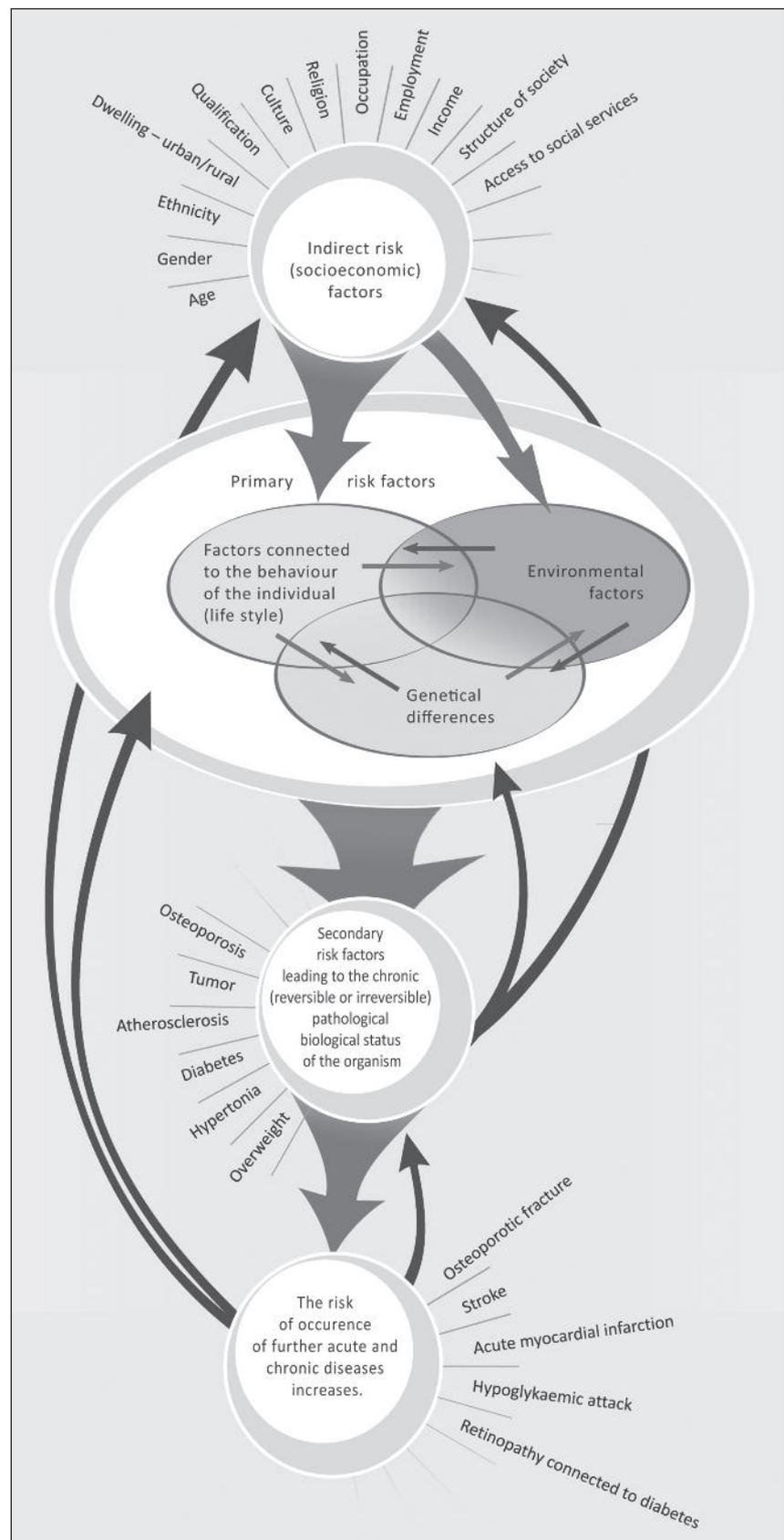


Fig. 3. Cause and effect chain of indirect, primary and secondary risk factors

the organism may be considered secondary risk factors, as they maintain an unstable homeostatic state, which is highly sensitive to stressor effects.

With the advance of age, the impact of various risk factors is more and more likely to build up, and a chronic disease will develop. Accordingly, a chronic disease proves to be a predisposing factor to the development of additional chronic conditions, and this leads to comorbidity or multimorbidity [23, 24].

Secondary risk factors (stemming from phenotype) are, for instance, high blood pressure, high blood glucose level, high blood cholesterol level, osteoporosis, AIDS, viral hepatitis, hyperthyreosis, overweight, obesity, high BMI, malnutrition, etc. Secondary risk factors are easy to measure and identify; therefore, their managing is also easier than that of the direct and primary risk factors. The diagnosis of a chronic condition is the starting point for the handling of the secondary risk factors. Due to this, the treatment of, e.g., hypertonia is considered to be the most important and the most effective way to manage a risk [25].

DEFINING DISEASE GROUPS BY A PUBLIC HEALTH APPROACH

The phenotype and the homeostasis of the organism are altered by the indirect effect exerted by the stressors. This can be reversible, and thus an acute condition or a chronic/acute condition of a transient nature may develop. For the former, an acute upper respiratory catarrh may be set as an example; for the latter one, overweight that has been resolved by weight loss.

In other cases, the biologic status of the organism is being altered in an irreversible way, and besides the weakened homeostatic status, an ongoing chronic disease comes about, or if the equilibrium can no longer be restored, death occurs.

The impact of a given stressor on a given point of attack has always been primarily localised, that is it affects an organ or a system of organs. Nevertheless, its effect may either be localised, e.g. in the case of breast cancer, which can be healed by clinical treatment, or generalised, e.g. in the case of type 2 diabetes mellitus and in the case of arteriosclerosis (Table 1).

Table 1. Groups of diseases in a public health approach

Type of disease	Definition	Example
Acute disease	A short term reversible change in the biological status of the organism. A stable homeostatic state of equilibrium is developed afterwards.	Acute, communicable diseases
Transient chronic disease or an acute disease of a longer term	A reversible change of a longer term occurs in the biological status of the organism. Afterwards a stable homeostatic state develops. During its term, it may be considered as a secondary risk factor.	tuberculosis, mononucleosis infectiosa, tick-borne encephalitis, overweight, benign tumor, discushernia, acute leukaemia
Ongoing chronic disease	An irreversible change occurs in the biological status of the organism that persists through the lifespan. It is accompanied by an unstable homeostatic equilibrium. It may be considered as a secondary risk factor.	coeliakia, viral hepatitis, cirrhosis of the liver, coagulopathia, inflammatory bowel disease, gout, cholelithiasis, coronariasclerosis, heart failure, COPD
Acute conditions or complications of chronic diseases	The organism is impaired in its biological status, its homeostatic state is unstable. A biological impairment occurs, significant in comparison to the chronic condition and stemming from the nature of the disease or emerging due to the effect of an outer stressor.	osteoporotic fracture, hypoglykaemic attack, stroke, acute myocardial infarction, acute pancreatitis, oesophagusvarix-bleeding
Death	An irreversible change occurs in the biologic state of the organism that is incompatible with life. The homeostatic state of the organism is lost.	

With the development of medicine, the boundary between reversible and irreversible processes is constantly changing. The diagnostics of diseases is predominantly based on the detection and measurement of the phenotype, but the examination of the genotype plays and will play an ever increasing role. As for treatment decisions, biological functioning of the organism was earlier treated by clinical medicine through the correction of the phenotype too; today even in this field the therapy tends to focus on the genotype (gene therapy, targeted molecular therapy) [26].

INTERPRETING THE TASKS OF PUBLIC HEALTH ON A POPULATION-LEVEL AND ON AN INDIVIDUAL LEVEL

The missions of public health cover the following: health protection and health promotion of variously defined populations and individuals pertaining to them, and prevention of diseases and disabilities, as well as delaying their manifestation. Public health represents intersectoral activities based on all the spheres and layers of society. In the course of studying the global burden of disease, risk factors which may be held responsible for its evolution have become identifiable. These risk factors can be more and more exactly determined; therefore, their management has been playing an increasingly important role in the determination of public health services, aiming primarily at the maintenance of the state of health [27].

Therefore, public health may be regarded as an *ongoing risk management*, partly resolved on the level of the population, partly on an individual level. Its classical methods may be listed in the categories of primary, secondary and tertiary prevention. The process described earlier, leading to the onset of a disease, the role of the various risk factors along with their interrelationships, and the identification of the types of disease call for a reinterpretation of the options for prevention with regard to various pathologies and risk factors, as well. In practice, the range of all the prevention categories is being significantly extended by the determination of easily identifiable intervention points, while accurately disclosing the etiology and course of disease.

The managing of various risk factors may be realised in very different ways. Indirect risk factors or socioeconomic factors exert their influence in a complex way – i.e. by transmission through primary risk factors. As for their impacts, they often present themselves as the result of complex processes taking

place in society. Accordingly, their management may be realised and prove to be efficient in an integrated way on a population level, far from individual level. For instance, the provision of services of the educational and social care system arises as a social issue, and as such needs regulation, resources and organisation on a state level.

Primary risk factors also play a complex role, partly because of their being determined by indirect risk factors, partly because of the mechanism of their impacts interfering with each other. As a consequence, their management is mainly of a social character, e.g. by means of regulation (anti-smoking law), at a population level, e.g. by education, and, finally, at an individual level, i.e. by the use of services provided by the health care system (smoking cessation). In the case of a population level risk management, the basis for the applicable strategy is created by the risks specific to a given group of society and the assessment of the frequency thereof [28]. In this field, primary care has traditionally played a key role within the health care system; in its functions the role of public health services is growing in importance, and it is there that the individual level of risk management appears [29]. Studies show that it is on a population level that the risk management of indirect and primary risk factors is definitely effective [30].

Secondary risk factors are managed primarily at the level of individuals by the health care system. The effectiveness of risk management starting from indirect risk factors through primary risk factors to secondary risk factors decreases at a population level and, conversely, increases at the level of individuals. The health care system, in turn, plays a growing role in relation to risk management at an individual level, and it has already become decisive with regard to secondary risk factors.

Appropriate levels of risk management

The identification of risks as well as the methods of their management are in constant change. The determination and categorisation of potential points of intervention vary widely, and in many cases action-type, ad hoc solutions are preferred to system-level solutions [31]. However, the objective is to achieve system-level solutions with well definable outcome expectations for managing problems on a population level.

Primary prevention

Primary prevention is the total set of activities that hinder the onset of diseases, that is the weakening of the homeostasis of the organism. The ob-

jective of primary prevention is the elimination of stressor impacts, and it may be achieved by measures

taken to eliminate indirect as well as primary risk factors [32] (Fig. 4).

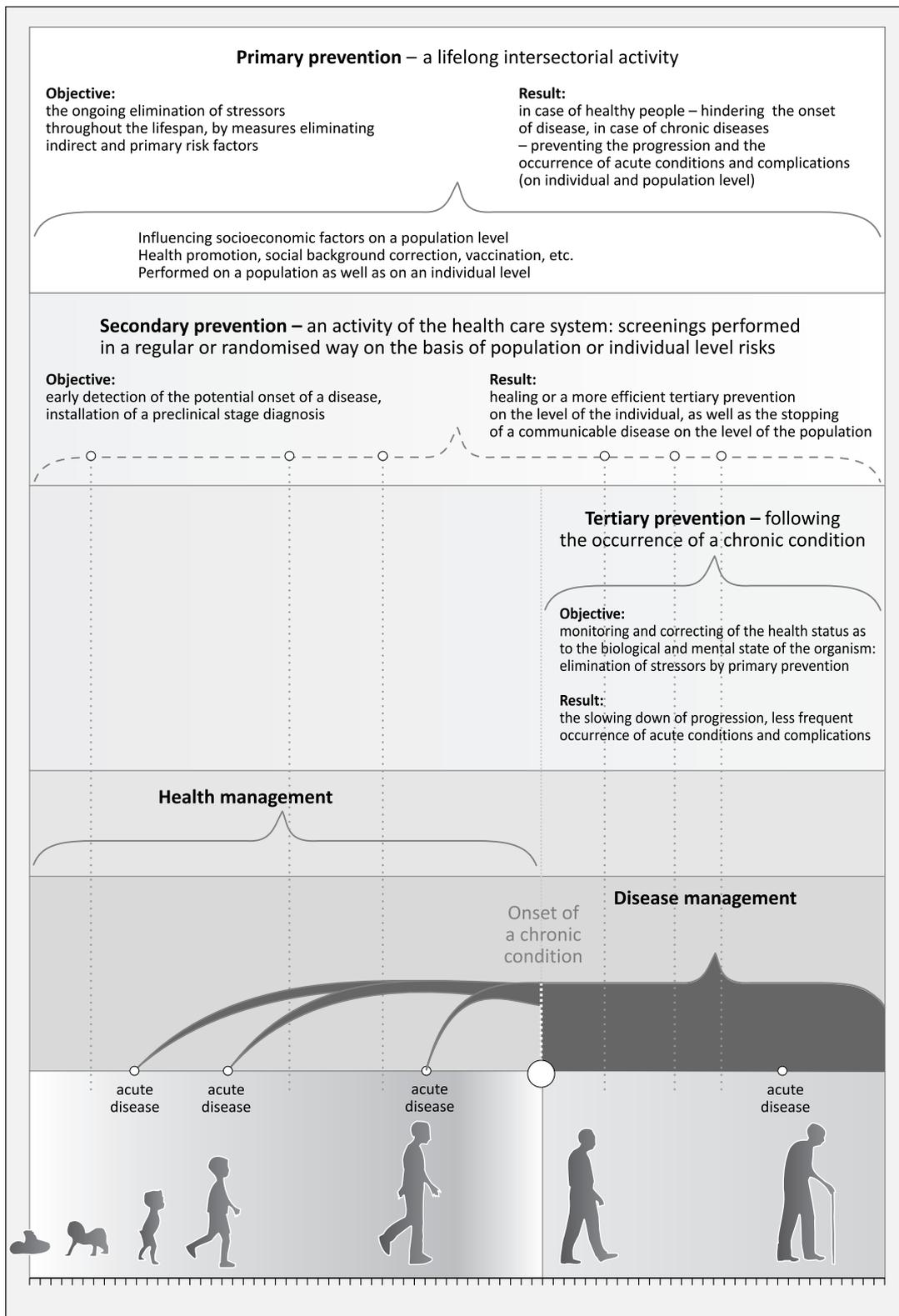


Fig. 4. Ongoing risk management

Primary prevention is a multi-faceted, inter-sectorial operation, as indirect risk factors, as well as a significant part of primary risk factors, can predominantly be influenced by external means, i.e. by means not belonging to the sector, as they are not influenced by the health care system or clinical medicine. Clinical medicine can partly resolve the management of primary risk factors, e.g. by the use of vaccines, life-style education, etc. In the future scientific results broadening the possibilities of primary prevention may be expected in the field of genetics and gene therapy closely linked to the speciality. The integration of genomics into prevention may be a future path for the evolution of primary prevention within the health care system [10, 33].

Secondary prevention

The detection of an already established disease in a preclinical stage is sought by secondary prevention. By the early detection of a disease [32, 34], the state of the organism already impaired in a biological sense may be restored, or in case of an irreversible change or chronic disease, the onset of complications or disability may be prevented or delayed by tertiary prevention. Screening is applied in such cases. Moreover, by isolating and treating a patient, the hindering of the spread of an infectious disease, which may be considered an additional primary preventive effect, is made possible by screening. This service is provided by the health care system supported by clinical medicine. Screening is a service which may be performed periodically or in a randomized way, that is determined by risk factors relevant from the point of view of an individual or that of a population.

Tertiary prevention

Tertiary prevention affects the evolution of an already established chronic state of disease. In this case the biological operation of the organism proves to be impaired and its homeostatic equilibrium is unstable, meanwhile the state of disease is either in a faster or a slower progression. Tertiary prevention is used for the maintenance of vital functions, the slowing down or restraining of progression, as well as the avoidance of acute conditions and of complications emerging in the course of progression (32). This applies to both acute/chronic diseases of a transient nature and to ongoing chronic diseases. (As for those of transient nature, caring support besides curative services is indispensable, as well.)

Tertiary prevention means the ongoing monitoring of the biological status of a patient with chronic disease. This way the maintenance of the equilibri-

um and the elimination of stressor effects are secured, thus measures are taken to integrate primary prevention continuously, as well as secondary prevention in a specified time, into the activities of tertiary prevention.

Chronic diseases affect an ever growing part of the lifespan, as the number and rate of diseases emerging in childhood or in young adulthood show an increase, which is naturally associated with greater exposure to diseases of adults, too [35]. It is a non-negligible factor contributing to the constantly increasing global burden of disease [36], which, in turn, is associated with a growing number of claims for tertiary prevention services.

POPULATIONS, INDIVIDUALS AND RISK FACTORS FOCUSED ON

The provision of services that become necessary in the course of risk management is also affected by the scarcity of resources; therefore, they should be prioritised notably with the definition of the focus areas, by the handling of which the disease burden of society can most effectively be reduced. In the United States by now, cases of death are preventable up to 85% due to effective risk management [28].

A given population and an individual may be specified by risk factors, respectively. Risk factors may be managed at a societal, as well as at smaller communities' level, the latter ones being marked by similar constituents and impacts of risk factors [37]. Groups living in different areas of the world but within a given society are also characterised by a varying burden of disease of populations, corresponding to a variety of risks [27]. In recent years, the changing image of epidemiology shows the signs of equalisation both globally and regionally, thanks to similar changes in risk factors [38]. Physical and chemical agents – spreading due to globalisation – are of a similar risk to high-, middle- or low-income countries alike, which leads to the equalisation of the prevalence of malignant diseases [39]. However, this also means that the same risk management is needed by all of them. The identification and ranking of risk factors, as well as the measurement of the burden of disease induced by them – mortality, premature mortality, etc. – and the options for intervention associated with them, as well as their cost-effectiveness are subject to ongoing studies [40].

The basis for risk management resolved on a population level is constituted by the adequate definition of communities, as well as the choice and comparison of appropriate risk factors. The risks of var-

ious countries, societies, and social groups vary widely [41], but at the same time, for instance, the underprivileged populations of high-income countries have risks and epidemiologic indicators similar to those of the inhabitants of low income countries [42]. Special populations of higher-income countries are also often featured by similar epidemiological indicators as populations living within the societies of low or middle income countries. Such is, for instance, the epidemiological image of the homeless population of highly developed countries, which is similar in many respects to the image characteristic of the societies of poor countries, but due to special risks – alcohol consumption, drug use or genetically inherited psychiatric diseases – it is still distinctly different [43]. In terms of cost-effectiveness, pathologies representing a significant disease burden are considered to be a priority [44]. The next element of risk management bearing a special importance is the selection from the population – that is from a statistical entity – of the individuals concerned and their identification [28]. Efficient risk management primarily focuses on population level, and it is only thereafter that individual level is focused on, as risk management resolved merely on an individual level is of a lesser efficiency [45]. So in risk management the population-individual sequence may be considered optimal [46]. As for the achievement of objectives related to the health promotion of the population, a broader use of strategies based on evidence is recommended [47].

It is the comparison of indirect, primary and secondary risk factors within the same group, as well as the examination of their role in the evolution of the disease burden on a population level, that we think to be justified [48], as their role in the onset of diseases varies widely by groups, so they should be treated differently.

In the future, practices that can stop or slow down the increase of the claims for clinical services are expected to be revalued, and thus it is expected that the sustainability of the health care system will be improved by the curbing of its costs [49]. One part of this strategy is that in handling the problems of aging, a tendency characterising advanced industrialized societies, health promotion and self care are increasingly treated as a priority, and the aims thereof will only be achieved if the management and elimination of corresponding risks are sought for [50].

Health and disease management

So risk management with public health implications means an ongoing risk management (Fig. 4). It starts with the management of indirect risk fac-

tors, which means on one hand their elimination, and on the other the compensation of their impacts. It is only by the combined alteration of several parameters defining socioeconomic status that indirect risk factors may be managed efficiently [7]. The aim is the direct hindering of the onset of diseases by the management of primary risk factors inducing the onset of diseases. So far, risk management was aimed at the hindering of the biological impairment of the organism, as well as the hindering of the onset of diseases, so the tools of primary prevention were used for this reason.

Recently the stage of risk management in the course of which health status may be maintained or restored – that is health management – was reevaluated, as in this field risk management offers a more efficient indicator with an increased cost-effectiveness on a population level [51]. The constituents of risk factors may be constantly changing in various communities, and this is the case on individual level, too; therefore, the monitoring of constituents on a population level and their follow up on an individual level prove to be necessary. In various societies and communities, traditional risk factors are constantly being replaced by newer ones [52].

In the next phase, risk management focuses on the application of the means and practice of secondary and tertiary prevention in the case of an already established disease, that is the application of the services of clinical medicine.

However, the use of the means of primary prevention does not stop with the onset of a disease, but may be continued either independently or as a component of tertiary prevention, as part of care, since comorbidity – when emerging diseases appear as the consequences of one another [23] – or multimorbidity – when various diseases concur [24] – occur also on stressor effects, multiplying the individual burden of disease and, in this way, that of the society (Fig. 5). In turn, the largest burden of disease caused by chronic diseases is induced by their acute phases, or complications [53–55].

Secondary prevention, in contrast to primary and tertiary prevention, is not of a constant nature, but a service performed periodically or in a randomized way. Its justification is determined by risk factors affecting individuals or populations, so it is a clinical activity requiring public health management. Risks are often posed by a prevailing chronic disease (secondary risk factor) or a complication thereof [56, 57] that has already taken place, by which the provision of secondary prevention in the case of an individual becomes justified, e.g. arteriosclerosis in re-

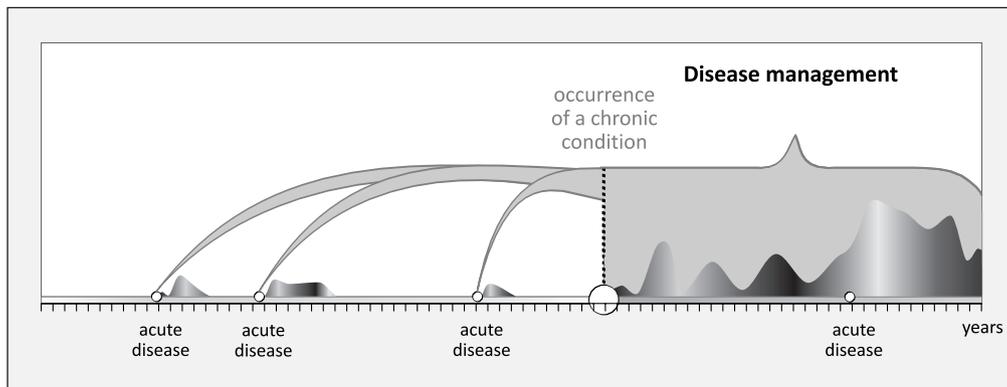


Fig. 5. Changing claim of disease management for resources

spect to stroke or acute myocardial infarction [56].

Tertiary prevention is a continuous activity and consists of the monitoring of the biological operation and its correction, as well as the elimination of stressor impacts, i.e. this is an integrated service built up of primary preventive services associated with clinical activity. Continuous risk management – defined here as a public health mission – is an ongoing activity extending from birth to death, which starts with health management, uses the means of primary prevention for the elimination of indirect and primary risk factors, and prevents thereby the impairment of the biological status of the organism and the onset of a disease. With the onset of illnesses, health management is joined by disease management, which is carried out either by the tools of secondary prevention in as many numbers and times as are made necessary by risks, or by the tools of tertiary prevention in the case of chronic diseases. In the course of these activities, the services of various specialities, including those of clinical medicine, responding to the claims of the population or those of individuals, are integrated. Thus, risk management proves to be a complex process, which applies the tools of primary, secondary and tertiary prevention, and the practice of which shows a great variety by countries. Currently there is a larger variety in the practice of risk management than in the field of risks themselves [58].

REFERENCES

- [1] <http://fogalomtar.eski.hu/index.php/N%C3%A9peg%C3%A9szs%C3%A9g%C3%BCgy>
- [2] <http://www.cdc.gov/brfss/>
- [3] <http://www.chp.gov.hk/en/behavioural/10/280.html>
- [4] Kraemer H.C., Stice E., Kazdin A., Offord D., Kupfer D.: How Do Risk Factors Work Together? Mediators, Moderators, and Independent, Overlapping, and Proxy Risk Factors. *The American Journal of Psychiatry* 2001; 158(6): 848-56.
- [5] http://www.who.int/quantifying_ehimpacts/publications/ebd10.pdf?ua=1
- [6] Kaplan G.A., Keil J.E.: Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation* 1993;88: 1973-98. doi: 10.1161/01.CIR.88.4.1973.
- [7] Evans G.W., Kim P.: Multiple risk exposure as a potential explanatory mechanism for the socioeconomic status–health gradient. *Ann NY Acad Sci* 2010;(1186): 174-89.
- [8] Griskevicius V., Tybur J.M., Delton A.W., Robertson T.E.: The Influence of Mortality and Socioeconomic Status on Risk and Delayed Rewards: A Life History Theory Approach. *Journal of Personality and Social Psychology* 2011;100(6): 1015–26.
- [9] El Hazmi M.A.: Spectrum of genetic disorders and the impact on health care delivery: an introduction. *EMHJ - Eastern Mediterranean Health Journal* 1999;5(6): 1104-13.
- [10] O'Daniel J.M.: The prospect of genome-guided preventive medicine: a need and opportunity for genetic counselors. *J Genet Couns* 2010;19(4): 315-27. doi: 10.1007/s10897-010-9302-4. Epub 2010 May 4.
- [11] Mega J.L., Stitzel N.O., Smith J.G., Chasman D.I., Caulfield M.J., et al.: Genetic risk, coronary heart disease events, and the clinical benefit of statin therapy: an analysis of primary and secondary prevention trials. *The Lancet* Published online: March 3, 2015.
- [12] Kathiresan S., Srivastava D.: Genetics of human cardiovascular disease. *Cell* 2012;148: 1242-57.
- [13] Schunkert H., König I.R., Kathiresan S., Reilly M.P., Assimes T.L., Holm H., et al.: Large-scale association analysis identifies 13 new susceptibility loci for coronary artery disease. *Nat Genet* 2011;43(4):333-8. doi: 10.1038/ng.784.
- [14] Dormandy J.A., Charbonnel B., Eckland D., Erdmann E., Massi-Benedetti M., et al.: Secondary prevention of macrovascular events in patients with type 2 diabetes in the PROactive Study (PROspective pioglitAzone Clinical Trial In macroVascular Events): a randomised controlled trial. *The Lancet* 2005;366(9493):1279-89. Published in issue: October 08, 2005.
- [15] Agboola S.O., Ball M., Kvedar J.C., Jethwani K.: The future of Connected Health in preventive medicine. *QJM* 2013;106(9):791-4. doi: 10.1093/qjmed/hct088. Epub 2013 Apr 18.
- [16] <http://apps.who.int/iris/bitstream/10665/67771/1/a78628.pdf?ua=1>
- [17] Glover J.D., Hetzel D., Tennant S.K.: The socioeconomic gradient and chronic illness and associated risk factors in Australia. *Australia and New Zealand Health Policy* 2004;1:8.

- [18] <http://www.who.int/ceh/risks/en/>
- [19] Ruland E.C., Dinca I., Curtis V., Barry M.M., Ekdahl K., Timmen A.: Learning from each other: where health promotion meets infectious diseases. *Eurohealth incorporating Euro Observer* 2015;21(1).
- [20] Hanson M.A., Low F.M., Gluckman P.D.: Epigenetic epidemiology: the rebirth of soft inheritance. *Ann Nutr Metab* 2011;58(Suppl 2): 8-15. doi: 10.1159/000328033. Epub 2011 Aug 12.
- [21] Van Hulst A., Roy-Gagnon M.H., Gauvin L., Kestens Y., Henderson M., Barnett T.A.: Identifying risk profiles for childhood obesity using recursive partitioning based on individual, familial, and neighborhood environment factors. *Int J Behav Nutr Phys Act* 2015;12(1):175. doi: 10.1186/s12966-015-0175-7. Epub 2015 Feb 15.
- [22] Huang T., Hu F.B.: Gene-environment interactions and obesity: recent developments and future directions. *BMC Medical Genomics* 2015;8(Suppl 1): S2.
- [23] Feinstein A.: The pre-therapeutic classification of co-morbidity in chronic disease. *J Chronic Dis* 1970;23: 455-69.
- [24] Fortin M., Bravo G., Hudon C., Vanasse A., Lapointe L.: Prevalence of multimorbidity among adults seen in family practice. *Ann Fam Med* 2005;3: 223-8.
- [25] Kahan T.: Hypertension: an urgent need for global control and prevention. *The Lancet* 2014;383(9932): 1861-1944.
- [26] Sheridan C.: Gene therapy finds its niche. *Nat Biotechnol* 2011;29(2):121-8. doi: 10.1038/nbt.1769.
- [27] Lim Stephen S., et al.: A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study. *The Lancet* 2010;380(9859): 2224-60.
- [28] Pearson T. A.: Recent Advances in Preventive Cardiology and Lifestyle Medicine Public Policy Approaches to the Prevention of Heart Disease and Stroke. *Circulation* 2011;124: 2560-71. doi: 10.1161/CIRCULATIONAHA.110.968743.
- [29] Harris M. (ed.): SNAP. A population health guide to behavioural risk factors in general practice. Prepared by The Royal Australian College of General Practitioners National Standing Committee – Quality Care, in conjunction with the Publications Unit of the RACGP. University of New South Wales, Published October 2004.
- [30] Hosseinpoor A.R., Bergen N., Kunst A., Harper S., Guthold R., Rekke D., d'Espaignet E.T., Naidoo N., Chatterji S.: Socioeconomic inequalities in risk factors for non communicable diseases in low-income and middle-income countries: results from the World Health Survey. *BMC Public Health* 2012;12:912.
- [31] Ross C Brownson, Debra Haire-Joshu, Douglas A Luke. Shaping the Context of Health: A Review of Environmental and Policy Approaches in the Prevention of Chronic Diseases. *Annual Review of Public Health*. 2006;27:341-70.
- [32] Mosby's Medical Dictionary, 9th edition. (2013) Elsevier Health.
- [33] Khoury M.J., Gwinn M., Burke W., Bowen S., Zimmern R.: Will genomics widen or help heal the schism between medicine and public health? *Am J Prev Med* 2007;33(4): 310-7.
- [34] Leavel H.R., E Gurney Clark as „the science and art of preventing disease, prolonging life, and promoting physical and mental health and efficiency. Preventive Medicine for the Doctor in his Community (3rd ed.). Huntington, NY: Robert E. Krieger Publishing Company: 1979.
- [35] van der Lee J., Mookink L., Grootenhuys M., Heymans H., Offringa M.: Definitions and measurement of chronic health conditions in childhood, *JAMA* 2007;297:2741-51.
- [36] Mathers C., Loncar D.: Projections of global mortality and burden of disease from 2002 to 2030. *PLOS Med* 2006;3:e442.
- [37] Rose G.: Sick individuals and sick populations. *Int J Epidemiol* 1985;14:32-8.
- [38] Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013 GBD 2013 Mortality and Causes of Death Collaborators. *The Lancet* 2015;385(9963):117-71.
- [39] Vineis P., Wild Ch.P.: Global cancer patterns: causes and prevention. 2014;383(9916):549-57.
- [40] WHO. The World Health Report 2002 – Reducing Risks, Promoting Healthy Life. World Health Organization, Geneva; 2002.
- [41] Lopez A.D., Mathers C.D., Ezzati M., Jamison D.T., Murray Ch.J.L.: Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data *The Lancet* 2006;367(9524): 1747-57.
- [42] http://www.who.int/quantifying_ehimpacts/publications/ebd10.pdf?ua=1
- [43] Fazel S., Geddes J.R., Kushel M.: The health of homeless people in high-income countries: descriptive epidemiology, health consequences, and clinical and policy recommendations. *The Lancet* 2014;384(9953):1529-40.
- [44] Hankey G.J., Warlow Ch.P.: Treatment and secondary prevention of stroke: evidence, costs, and effects on individuals and populations. *The Lancet* 1999;354(9188):1457-63. Published in issue: October 23, 1999.
- [45] European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). *European Journal of Preventive Cardiology* 2012;19(4): 585-667. <http://cpr.sagepub.com/content/early/2012/06/18/2047487312450228.full.pdf>
- [46] Geoffrey R.: Sick individuals and sick populations. *Int J Epidemiol* 2001;30(3):427-32. doi: 10.1093/ije/30.3.427.
- [47] Brownson R.C., Fielding J. E., Maylahn Ch.M.: Evidence-Based Public Health: A Fundamental Concept for Public Health Practice Annual Review of Public Health 2009;30:175-201.
- [48] Ezzati M., Lopez A.D., Rodgers A., Vander Hoorn S., Murray C.J. and the Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. *The Lancet* 2002;360: 1347-60.
- [49] Lyons R.A., Ford D.V., Moore L., Rodgers S.E.: Use of data linkage to measure the population health effect of non-health-care interventions. *The Lancet* 2014;383(9927): 1517-9.
- [50] Rechel B., Grundy E., Robine J-M., Cylus J., Mackenbach J.P., Knai C., McKee M.: Ageing in the European Union. *The Lancet* 2013;381(9874): 1312-22.
- [51] Starfield B., Hyde J., Gervas I.: Health. The concept of prevention: a good idea gone astray? *J Epidemiol Community Health* 2008;62: 580-3.
- [52] http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf
- [53] Wilson T., Buck D., Ham C.: Rising to the challenge: will the NHS support people with long term conditions? *British Medical Journal* 2005;330(7492): 657-61.

- [54] Olsson M., Lexell J., Soderberg S.: The meaning of fatigue for women with multiple sclerosis. *Journal of Advanced Nursing* 2005;49(1): 7-15.
- [55] McIntyre D., et al.: What are the economic consequences for households of illness and of paying for health care in developing country contexts? *Social Science and Medicine* 2006;62: 858-65.
- [56] Jones K., Saxon L., Cunningham W., Adams P.: Secondary prevention for patients after a myocardial infarction: summary of updated NICE guidance. *BMJ* 2013;347:f6544 doi: 10.1136/bmj.f6544
- [57] Smajlović D.: Strokes in young adults: epidemiology and prevention. *Vasc Health Risk Manag* 2015;24(11): 157-64.
- [58] Busse R., et al.: Tackling Chronic Disease in Europe: Strategies, Interventions and Challenges. World Health Organization, European Observatory on Health Systems and Policies 2010. http://www.euro.who.int/_data/assets/pdf_file/0008/96632/E93736.pdf

Address for correspondence:

Dr. Szentes Tamás

Office of the Chief Medical Officer

1097 Budapest, Albert Flórián út 2-6. Hungary

E-mail: drszentest@gmail.com