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Abstract

Aim: Although working life issues are subject to European health monitoring schemes not many routine data sources include information on occupations or working conditions. Additional in-depth-analysis is therefore necessary for diseases with high public health impact. Aim of this paper is to introduce a multidimensional ranking procedure for priority setting of diseases based on European and national data.

Methods: Multidimensional ranking was carried out on ten disease specific indicators. First, suitable data sources are identified and information on indicators is retrieved. Second, the diseases are sorted by their ranks according to each indicator. Third, all ranks are added to a rank sum. Finally, the diseases are sorted by their rank sum.

Results: Diseases of the circulatory system account for the highest rank sum. The high public health impact is visible in regard to most criteria, particularly to mortality, hospital discharges, and costs. Diseases of the digestive system rank second mainly because of high ranks for hospital discharges and costs. The third place is assigned to diseases of the musculoskeletal system.

Conclusion: A multidimensional ranking procedure has advantages when used for priority setting of diseases. The procedure leads to an overall rank as a summary measure for the public health impact but information for each indicator is still retrieved. Furthermore, the procedure uses ranks and is therefore scale invariant. However, ranking procedures do not lead to a selection of diseases but a rank order. So, there is still a decision rule required which diseases are selected e.g. for in-depth health reporting.

Key words:
priority setting of disease, multidimensional ranking, health reporting, European data

Introduction

Health reporting is an instrument in pinpointing priority fields in public health policy. Considerable efforts have been undertaken in the European Union to establish a European monitoring system at all public health areas including the working life (EU Commission 2009). The strength of work-related health monitoring is that it can point to the most important fields for workplace health promotion and disease prevention and can serve as a tool for policy implementation (Boedeker and Kreis 2003).

Work-related health reporting aims to study associations between diseases and working life indicators in order to highlight potential new risk factors and conditions or to explore specific demands for workplace health promotion. Unfortunately, this can rarely be done in routine health monitoring as routine data sources on morbidity and mortality do not include information on work and working conditions. E.g. the EU funded project WORKHEALTH identified a great number of necessary generic and operational indicators for a work-related public health reporting. Only a very limited number however, could be shortlisted for immediate use as data for most indicators were not available (Kreis and Boedeker 2004). This is common for indicators which carry no direct information on the working environment (like work accidents) but have to get related e.g. by occupational stratification (like sickness absence).

Given the limited data availability, work-related health reporting relies on in-depth-analysis utilizing specific data sources and scientific studies. However, such an in-depth-analysis can not be carried out on all diseases but has to follow a priority setting scheme. Usually, diseases with a high public health impact are considered good candidates for an in-depth-analysis.

The public health impact of diseases can not be assessed by a single indicator. In contrast, diseases may be especially important to societies because they are highly prevalent, cause high costs for medical treatment, are accompanied by long-term absence from work, lead to preterm mortality or to significant reduction of living quality in patients. Furthermore, a high public health impact may arise when certain populations are more affected than others or from good preventability of diseases. Identifying diseases with high public health impact therefore requires an overall comprehensive approach taking the multidimensionality of diseases into account.

Different perspectives have been taken to priority setting of diseases and health conditions. So called summary measures of population health mainly focus on life expectancy and various definitions and indicators have been used (Molla et al. 2003). E.g. following a proposal of the World Bank and WHO Disability-Adjusted Life Years (DALYs) meanwhile are in widespread use (van der Maas 2003). DALYs link life expectancy information with disability information thereby combining two dimensions of diseases (Murray et al. 2000). However, all summary measures have in common that the public health impact is expressed by aggregating multidimensional information into just one figure. Summary measures of population health may therefore not provide a suitable basis for an informed choice taking into account different values of persons or institutions (Greenland 2002).

Ranking procedures in contrast, preserve the information of every disease dimension considered. Druss et al. (2002) e.g. aim at the most costly condition in the US by studying ranks with respect to costs, work-loss days, and impairment. However, by this approach ranks were considered separately only.

Aim of this paper is to introduce a simple multidimensional ranking procedure for priority setting of diseases for in-depth-analysis in work-related health reporting. This ranking

procedure based on European and national data prioritizes diseases by calculating rank sums across all indicators included.

Methods

The introduced multiple ranking procedure integrates information on several indicators simultaneously. The first step therefore is to identify suitable data sources and indicators. Second, the diseases are sorted by their ranks according to each indicator. Third, all ranks are added to a rank sum. Finally, the diseases are sorted by their rank sum showing a sequence of decreasing integral public health importance.

Data sources and indicators: To review the availability of indicators for work-related health monitoring international data sources were reviewed by the project WORKHEALTH (Kreis and Boedeker 2004). We followed this review and included data sources and indicators which provide disease specific information according to ICD-10. Data were taken from international respective European datasets. In case, no international data were available, we included information from data bases of German umbrella organisations of the social insurance sector. The data sources used (table 1) as well as the indicators included are describe in more detail in what follows. As a rule, all indicators were included which provide information on different public health issues and therefore - taken together - map the multidimensionality of public health relevance rather than increase redundancy. Although the number of selected indicators will be arbitrary to some extent this applies to all diseases and therefore will not affect the rank order.

- *table 1 about here* –

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WHO: European mortality database (MDB)

The WHO European mortality database (MDB) contains exclusively mortality-based indicators and is a supplement to the generic European health for all database (HFA-DB). The mortality indicators are presented for selected causes or groups of causes of death by sex and several age groups. The raw mortality data are submitted by the European WHO Member States to the WHO Regional Office for Europe or to the WHO Headquarters.

Indicator 1: Mortality under 65 years

In contrast to the mortality rates for the whole population this variable rather indicates the mortality for the employable population. The provided age-standardized death rates were used for ranking.

OECD: Health Data 2004

This dataset includes systematically collected data on a great number of key aspects of the health care systems in 30 OECD Member countries within their general demographic, economic and social context. Key aspects covered are: health status (includes mortality and morbidity), health care resources, health care utilisation, health care expenditure, financing and remuneration, social protection, pharmaceutical market, non-medical determinants of health, demographic and economic references. The data provided are from various national statistics (statistics by ministries, social insurance institutions and other sources in the OECD Member countries) as well as from databases run by OECD itself.

Indicator 2: Potential years of life lost (PYLL)

This indicator is a summary measure of premature mortality which provides an explicit way of weighting deaths occurring at younger ages, which are, a priori, preventable. It represents the total number of years not lived by an individual who died before a specified age, here 70 years. The calculation of PYLL involves summing up

deaths occurring at each age and multiplying this with the number of remaining years to live up to the age limit of 70 years.

Indicator 3: Hospital discharges

Hospital information gives a broad picture of the general health of and the healthcare provision for the population. It has to be pointed out that hospital discharges for a particular disease do not equate with the incidence of this disease. However, this indicator could be used as an estimate of "a burden" of given diseases on health services. Discharge is the formal release of an in-patient from an acute care institution after a period of hospitalisation. It includes deaths in hospitals, but excludes same-day separations and transfers to other care units within the same institution.

Indicator 4: Average length of stay (ALOS)

The length of stay in a hospital indicates the severity of a disease. This variable is calculated by dividing the number of days stayed (from the date of admission in an in-patient institution) by the number of discharges (including deaths)

Federal Statistical Office Germany: Federal Health monitoring system

The Federal Statistical Office provides in co-operation with the Robert Koch-Institute the Federal health monitoring system in Germany. In the *health expenditure accounts* all health related expenditures of a reporting year are represented. These expenditures are classified by sources of funding, functions and providers. Health related cash benefits are indicated separately, for example, payments of sickness benefits or early pensions. The *cost of illness accounts* provides information to what extent the German economy is burdened with diseases and their consequences. The medical treatment of patients is related to a use of resources at the health care providers. In a multi-stage top-down process the causes of treatments are assigned to diseases which stand behind these treatments.

Indicator 5: Change in hospital discharges 1994-2003

The indicator allows the analysis of trends of specific diseases over time.

Indicator 6: Direct costs

This indicator is an integral measure, which quantifies all direct costs for health care utilisation (i.e. costs for therapy, prevention, rehabilitation and care).

Indicator 7: Costs per case

The direct costs are divided by the number of cases. Thus this indicator also measures the economic importance of rare but expensive diseases.

Federal Association of Company Health Insurance Funds: BKK Health Report

In Germany, membership in a health insurance fund is compulsory for more than 95% of the German workforce. Data on sickness absence and disability-rates are provided by the health insurance funds and their federal associations. Since 1976 the Federal Association of Company Health Insurance Funds compiles a work-related health report. Beside detailed analyses of sickness absence by industrial sectors and branches the results were differentiated by age, sex, region and social situation. The Health Report gives data on the sickness absence of app. 7 Mio. employed BKK-members representing about 25% of the insured German workforce.

Indicators 8,9: Sickness absence

Sickness absence is an indicator which provides information on the health status of the employees. Sickness absence figures are often used for example to reveal the need for preventive activities if the absence rates are high. The effectiveness of health promotion activities is then often evaluated by the changes in sickness absence rates. The ranking procedure includes two indicators on sickness absence: the duration and the number of cases.

The Federation of German Pension Insurance Institutes (DVR Bund): early retirements

The DVR pension insurance institute of the Federal Republic of Germany, has structured an extensive statistical report system informing annually about e.g. the number of insured persons, pensions and rehabilitative interventions. Membership in a pension insurance system is compulsory in Germany as long as one's income is lower than a certain limit. More than 95% of the German workforce is a member of statutory pension insurance. While the main focus of the pension insurance is on old-age retirement, the system also covers work disability pensions. The collected data on early retirement comprises all pensions which have been granted to employees because of permanent work disability due to a specific disease.

Indicator 10: Early retirement due to reduced ability to work

Data on early retirements gives further information about the morbidity of the workforce and the direct and indirect costs of illness. Although in most cases the disability keeps the employees from taking up any kind of job, also those pensions that allow staying at work at a reduced level are included.

As we utilized the priority setting of diseases with respect to work-related health reporting, we restricted the data – when possible - to the population of a working age.

Ranking procedure: Ranking procedures are sensitive against bias due to missing data. Ranking was therefore done by fractional ranks which are calculated by dividing the crude rank by the number of diseases with non missing data. Each disease is assigned its fractional ranks with respect to each indicator. Consequently, the highest rank per indicator is always 1 and the total rank sum is limited to the number of indicators. In case of ties the largest of the

corresponding ranks is assigned. Ranking was done by the SAS Procedure Proc Rank. Finally, the diseases are sorted by their rank sum.

Results

Table 2 gives the data used in the ranking procedure; the rank orders are presented in table 3.

- table 2 about here -

Diseases of the circulatory system show the highest rank sum respectively the highest overall rank. This ICD main-group of diseases achieves a high importance in regard to most criteria, particularly in view of "mortality", "hospital discharges" and the "costs per case". Diseases of the digestive system rank second. This relative high rank sum is mainly caused by the high ranks for "hospital discharges" and the "costs off illness". In comparison to the diseases of the circulatory system the „average length of stay" and „early retirements" are less important. However, it has to be pointed out that dental treatments are included. The third place of the ranking order is assigned to diseases of the musculoskeletal system. The result bases especially on the high ranks of the criteria "sickness absence", "early retirements" and "costs of illness". Malignant neoplasms rank fourth. The rank sum is primarily caused by the high rank for "mortality", "potential years of life lost" and the "average length of stay" in a hospital. The fifth and sixth place are assigned to mental and behavior disorders and external causes of injury and poising. Mental and behavior disorders achieve a high importance in regard to the criteria "duration of hospitalisation" and "early retirements". The result for external causes of injury and poising is based upon the high ranks for "potential years of life lost" and "hospital discharges".

- table 3 about here -

The ranking procedure allows for a quantitative interpretation of rank orders. E.g. diseases of the circulatory system account for a rank sum of app. 8 which is 80 % of the highest possible rank sum as ten indicators were included.

Discussion

Aim of this paper is to introduce a simple multidimensional ranking procedure for priority setting of diseases for in-depth analysis in work-related health reporting. This ranking procedure based on European and national data prioritizes diseases by calculating rank sums across all indicators included. The disease with a higher rank sum is then considered having higher public health impact than those of smaller rank sums. Advantage of this approach is the integral prioritization. A disease can be highlighted as of high impact even if it takes only average ranks with respect to many indicators. On the opposite, a disease with highest rank concerning one indicator might get downgraded when other indicator specific ranks are low. As a rule, diseases ranking high on several indicators will get a high overall rank also. The ranking procedure highlights diseases of the circulatory, the digestive as well as the musculoskeletal system as of particular public health impact.

The multidimensional ranking procedure has advantages and weaknesses when used for priority setting of diseases. First, the procedure is considered as scientifically neutral as no weighing of indicators is done. This means that the public health impact is assessed after the ranking rather than preferring certain indicators at the selection stage. However, the results of the ranking procedure may be influenced by the choice and selection of indicators. Usually, data on mortality and morbidity are considered to address the public health impact of diseases

thereby implicitly emphasizing the economic burden. However, indicators reflecting the perceived burden of individuals, like e.g. life quality, may lead to other prioritisations.

Second, the procedure leads to an overall rank which can be taken as a summary measure of the public health impact of diseases at the same time retrieving the information for each indicator considered. As a consequence, selection of diseases for in-depth-analysis in work-related health monitoring does not rely on overall ranks only. E.g. diseases of the digestive system were ranked higher than musculoskeletal disorders. However, considering that the overall rank is influenced by a maximum rank with respect to direct costs resulting from dental care might open the discussion for an alternative selection.

Third, the procedure uses ranks and is therefore scale invariant in the sense that indicators can be considered on very different measurement scales. E.g. mortality is included as standardized rates, change in hospital discharges in percent and costs in Euro. Furthermore, national data can be used for pointing to international public health impact of diseases as only relations between diseases (ranks) are informative in this procedure not the raw nation specific figures. However, there might be national differences in the rank order of diseases due to different morbidity profiles (like CVD in "old" vs. some "new" European countries) and also due to cultural valuing of diseases and treatment priorities.

In general, rank order procedures depend on the indicators included. Information gain is optimal when indicators provide supplementary contents rather than just address the same generic indicator by different data sources. A ranking procedure relies on the availability of data. Furthermore, all indicators must be operational for the same disease category. E.g. if mortality information is available for cardio-vascular diseases (ICD chapter IX) and information on costs refer to ischemic heart diseases only (ICD I20-I25) an integral ranking could be questionable. These different levels of information are especially common for

indicators hard to measure or with a missing operational definition. This might especially be a limitation of ranking procedures when single diseases are of interest as most data sources use grouping categories like ICD main groups. All this again points to the need of a high quality European health monitoring system.

Multiple ranking procedures can be used for priority setting in various fields although rank orders do not provide any decision rule. They can support the selection of diseases which is considered best to be a more step approach (Zaza et al. 2000). With respect to priority goals in prevention e.g. Bindzius et al. (2005) combine data based ranking with expert's counselling and participatory elements in a general method. In a similar more step approach cardiovascular diseases and mental ill health were selected for in-depth-analysis in work-related European public health reporting based on the ranking results given in table 2 (Boedeker and Klindworth 2007).

Conclusion

The proposed multidimensional ranking procedure serves for priority setting of diseases which should be selected for work-related in-depth-analysis and health reporting. Ranking procedures do not end up with a selection of diseases considered most important but a rank order. So, there is still a decision to be taken which should additionally be based on considerations on past or ongoing European public health activities and policies. E.g. diseases which were already subject to health reporting or scientific reviews might be excluded from selection in order to prefer disease so far not well addressed. However, good availability of data and established knowledge on risk factor relations could on the other hand be seen as a strong argument for selection.

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The authors declare that they have no conflict of interest.

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Table 1: Data sources for ranking procedure

Database	**Dataholder**
European Mortality Database On-line version Updated 2005	World Health Organisation Regional Office for Europe http://www.euro.who.int
OECD Health Data 2004 A comparative analysis of 30 countries	OECD 2004 http://www.oecd.org/health/
Gesundheitsberichterstattung des Bundes Krankheitskosten 2002	Statistisches Bundesamt Deutschland 2004 http://www.destatis.de
BKK Gesundheitsreport 2003	BKK Bundesverband 2004 http://www.bkk.de
VDR-Statistik: Rentenzugang 1995-2002 CD ROM VDRSY Version 1.01	Verband Deutscher Renten- versicherungsträger (VDR) 2003 http://www.deutsche-rentenversicherung- bund.de

Table 2: Data on public health indicators by ICD-10 main groups

		Ind #1	Ind #2	Ind #3	Ind #4	Ind #5	Ind #6	Ind #7
		mortality	pot. years of life lost	hospital discharges	average length of stay	change in hospital discharges 1994-2003	direct costs	costs/ per case
		EU-25	EU-19	EU-19	EU-19	G	G	G
ICD-10-Code	**Diseases**	SDR / 100.000 < 65	lost years / 100.000 < 70	cases / 100.000	days	in Percent	Mio. Euro	Euro per inhabitant
A00-B99	Infectious / parasitic diseases	3.8	92.1	398.1	8.4	40.4	2,102	50
C00-C97	Malignant neoplasms	79.7	1,056	1351.6	10.2	5.1	7,119	180
D50-D89	Dis. of the blood / blood forming organs / certain immunity disorders	0.8	13.4	154.3	7.7	19.7	602	10
E00-E90	Endocrine / nutritional / metabolic diseases	4.2	94.5	395.7	9.2	10.7	6,375	160
F00-F99	Mental / behavioral disorders	3.8	71.8	1050,3*	23,8*	29	11,664	270
G00-H95	Dis. of nervous system / sense organs	5.5	123.3	1094.5	6.8	100.8	5,113	130
I00-I99	Dis. of the circulatory system	51.7	762.1	2539.4	9.7	16.4	11,739	430
J00-J99	Dis.of the respiratory system	8.1	153.9	1406.8	7.9	2.8	6,297	150
K00-K93	Dis. of the digestive system	15.7	247.7	1732.9	6.8	18.9	22,163	380
L00-L99	Dis. of skin / subcutaneous tissue	0.1	1.8	265.9	8.8	1.6	2,420	50
M00-K99	Dis. of musculoskeletal system / connective tissue	0.7	11.8	1196.1	8.8	36.5	13,792	310
N00-N99	Dis. of genitourinary system	1.5	25.2	1157.1	5.7	-10.7	5,602	110
P00-P96	Perinatal conditions		288.1	230.6	9.6	-21.1	61	10
Q00-Q99	Congenital malformations	3.7	227.7	142.2	6.3	-6.4	584	20
R00-R99	Symptoms / signs / abnormal findings / ill-defined causes	8.8	194.1	988.5	5.6	40.7	4,280	150

		Ind #1	Ind #2	Ind #3	Ind #4	Ind #5	Ind #6	Ind #7
		mortality	**pot. years of life lost**	**hospital discharges**	**average length of stay**	**change in hospital discharges 1994-2003**	**direct costs**	**costs/ per case**
V01-Y89	External causes of injury and poising	34.1	1,061	1556.1	7.9	4.2	5,083	130

* EU-25, EU-19: data include 25 resp. 19 European Member States; G: data from Germany;
ind #: for definition of indicators see text; data sources specified in table 1

Table 3: Diseases in order of rank sums based on fractional ranks of 10 public health indicators

				Ind #1	**Ind #2**	**Ind #3**	**Ind #4**	**Ind #5**	**Ind**
ICD-10-Code	**Disaease**	**Overall rank**	**Rank sum**	mortality	Pot years of life lost	Hospital discharges	Average length of stay	Change in hospital discharges	Dir cos
I00-I99	Dis. of the circulatory system	1	8.01	0.93	0.88	1.00	0.88	0.56	0.8
K00-K93	Dis. of the digestive system	2	7.40	0.80	0.75	0.94	0.31	0.63	1.0
M00-M99	Dis. of musculoskeletal system / connective tissue	3	7.12	0.13	0.13	0.69	0.69	0.81	0.9
C00-C97	Malignant neoplasms	4	6.98	1.00	0.94	0.75	0.94	0.44	0.7
F00-F99	Mental / behavioral disorders	5	6.96	0.47	0.31	0.50	1.00	0.75	0.8
V01-Y89	External causes of injury and poising	6	6.79	0.87	1.00	0.88	0.50	0.38	0.4
J00-J99	Dis.of the respiratory system	7	6.71	0.67	0.56	0.81	0.50	0.31	0.6
R00-R99	Symptoms / signs / abnormal findings / ill-defined causes	8	5.31	0.73	0.63	0.44	0.06	0.94	0.3
G00-H95	Dis. of nervous system / sense organs	9	5.26	0.60	0.50	0.56	0.31	1.00	0.5
A00-B99	Infectious / parasitic diseases	10	4.76	0.47	0.38	0.38	0.56	0.88	0.2
E00-E90	Endocrine / nutritional / metabolic diseases	11	4.62	0.53	0.44	0.31	0.75	0.50	0.6
N01-N99	Dis. of genitourinary system	12	3.40	0.27	0.25	0.63	0.13	0.13	0.5
L00-L99	Dis. of skin / subcutaneous tissue	13	2.51	0.07	0.06	0.25	0.69	0.25	0.3
P00-P96	Perinatal conditions	14	2.13		0.81	0.19	0.81	0.06	0.0
Q00-Q99	Congenital malformations	15	2.02	0.33	0.69	0.06	0.19	0.19	0.1
D50-D89	Dis. of the blood / blood forming organs / certain immunity disorders	16	2.01	0.20	0.19	0.13	0.38	0.69	0.1

ind #: for definition of indicators and calculatio9n of fractional ranks see text; data sources specified in table 1