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Measuring burden of disease in Estonia to support public health policy

T. Lai[1], J. Habicht[2], R.-A. Kiivet[1]

Background: Many countries have an overview on mortality and morbidity but few have performed contextualized national burden of disease studies. The objective of the present study is to provide a first set of national and sub-national burden of disease estimates for Estonia. Further, we present the causes and age-gender distribution of the burden. We conclude with the description of result uptake and impact of the study in Estonian public health policy arena. **Methods**: A burden of disease estimation procedure modified for best fit to country situation was used. That included disease classification reflecting Estonian disease profile, national disease severity assessments, mortality and morbidity prevalence data. Calculations were performed on national and sub-national levels. **Results**: Estonian population lost 446 361 (327/1000 persons) disability adjusted life-years in 2002. Premature mortality caused majority of the burden and cardiovascular diseases, external causes (e.g. suicide and injuries) and cancers were main sources of burden. Working age population (16–64 years) shouldered 60% of the burden. Sub-national levels of burden range from 114 to 725 disability adjusted life-years per 1000 persons and are correlated to regional socioeconomic development. **Conclusion**: Cardiovascular disease and injuries, premature mortality, working age population, male and people from economically less developed regions should be the priority targets for public health interventions. Estonian main public health strategies now address burden of disease concerns highlighted by our study.

Keywords: burden of disease, DALY, Estonia, national estimates, population health, public health strategy.

Introduction

Previous decades saw a continuous rise of different health gap methodologies and studies that merged mortality and morbidity figures into one measure.[1] Since the World Development Report and Global Burden of Disease (GBD) study were published respectively in 1993 and 1996,[2] disability adjusted life year (DALY) methodology has been widely used to assess disease burden and health trends as well as to set priorities for health-related research and policies.[3–5] Currently, there is ongoing effort to update the global comparative estimates of burden of disease.[6]

The concept of DALY is to aggregate disease-specific mortality and morbidity data using time as a common denominator, thus enabling the comparison of total health losses by a disease, population group or any other distinctive variable. Practical usefulness of this approach for health policy making is in highlighting potential sources of health gain, setting targets for interventions, evaluation of intervention effectiveness and in assessment of risk factor impact on population health. Thus, evidence-based policy and resource allocation decisions are supported by additional information on distribution of population health.

The GBD study provides summary of GBD estimates for all regions and countries of the world from a viewpoint of global average.[2] The problems in detailed data availability, large reliance on estimation to fill data gaps and hence, complicated calculation procedures can hamper the use of standard burden of disease methodology on a country level.[7,8] All this can limit the use of burden of disease estimates on a local level because even though international data comparisons provide ample basis for policy discussion, policy makers often require assurance that these estimates are applicable in the local situation.

Contextualization to take country specifics into account is a viable option to make local adoption of the burden estimates more desirable.[9] Ideally, contextualized results take into account both local mortality and morbidity profile (e.g. by using a localized burden of disease classification), use local disability weights that convey disease severity assessments specific to the particular population and employ routinely available data as much as possible.

Country situation

Estonia is a country in European Union. Administratively, Estonia has two functioning levels—national and municipal. The national level includes 15 counties that implement national policies in the regions. There are more than 200 municipalities on the second level with large size variations. Health policy issues are mostly covered at national level, while municipalities have only a limited role in public health policy through local Health In All Policies and implementation of selected national public health programmes.

The Estonian population of 1.3 million is ageing and declining—there was 15 775 live births and 17 409 deaths in 2007. Average life expectancy at birth (LE) has increased since 1990 and reached 73 years in 2007. Male LE has constantly remained 10–12 years below female LE.[10] One of the most positive changes has been a 3-fold reduction in infant mortality since 1992, down to five infant deaths per 1000 in 2007. The rapid changes since 1992 were brought on by cardinal reforms that transformed Estonia from a post-soviet to a modern European country both society and health system wise.

Although, the best-known reforms since 1992 were economic in nature, some of the most remarkable and extensive ones took place in health system. Mandatory social health insurance, modern primary health care and fully restructured hospital network were introduced as various programmes were launched in public health. All these changes were made hand

1 Department of Public Health, University of Tartu, Estonia
2 WHO Country Office in Estonia, World Health Organization Regional Office for Europe
Correspondence: Taavi Lai, Department of Public Health, University of Tartu, Ravila 19, Tartu 50411, Estonia, tel: +372 7 374 203, fax: +372 7 374 192, e-mail: taavi.lai@ut.ee

in hand with the generation of electronic patient registries and databases containing information on every health, welfare and mortality event in the country.[11–16]

However, health behaviour of Estonian population is characterized by negative trends where there was 16 l of pure alcohol per capita consumed in the country,[17] 28% of daily smokers and 16% obese among adult population in 2006.[18]

The policy debates on Estonian public health in late 1990s did make it evident that along with such reforms and changes in health behaviour also new indicators of population health were needed.

The objective of the present study is to provide a first set of national and sub-national burden of disease estimates for Estonia. Further, we present the causes and age-gender distribution of the burden. We conclude with the description of result uptake and impact of the study in Estonian public health policy arena.

Methods

The number of years lived with disability (YLD) and the years of life lost due to premature mortality (YLL) are added by cause, age and gender to reach the total burden of disease expressed as DALY for the population under study.

Estonian national burden of disease study was based on the general approach used in GBD study[19,20] with following differences: (i) use of country specific disease classification; (ii) use of disease prevalence data derived from administrative patient databases instead of survey-based disease incidence estimation and (iii) use of national disability weights in accordance with the contextualized disease classification. The calculation steps are detailed in next paragraphs along with the descriptions of data sources.

A disease classification best to reflect the most common and relevant conditions in Estonia was developed from the ICD-10 classification (International Classification of Diseases, version 10)[21]. The data used for disease classification development was provided by Estonian Health Insurance Fund (EHIF).[22] All healthcare and welfare events in Estonia are recorded in the EHIF databases in detail e.g. cause of the encounter, care provided, procedures performed, medication prescribed along with personal characteristics of the individuals. We used individual anonymous data of all medical encounters in Estonia, stratified by gender, age, place of residence, ICD-10 code and health care cost of the encounter (latter used only for disease classification development). Data for 2002 was used as most recent, verified quality and full population coverage at that time.

Development of disease classification began with determining a threshold for a separate disease group in the classification. We considered a separate disease group warranted if the number of people affected by the condition was 0.05% or more out of the total population or if the healthcare resources allocated to treat a condition were 0.1% or more out of the total health insurance budget in 2002. The remaining conditions in the ICD-10 (8% of the medical encounters and 5% of the health care budget in 2002) were allocated between already available categories in the case of medical proximity or grouped into separate categories case by case. All in all 168 disease categories in 12 disease groups were identified (see Supplementary Appendix 1 for details of the disease grouping).

YLD estimates in our study are the result of multiplication of disease prevalence by a disease-specific duration index and disability weight. We counted once every person in contact with the health care during a year for every ICD-10 3-digit code present in the EHIF databases to reach prevalence figures. Duration index used in YLD calculation represented a fraction of a year needed for full recovery in case of mild conditions like ordinary influenza, other acute upper respiratory infections, superficial injuries, etc. The duration index had the value '1' in case of conditions which require longer than a year for full recovery or were full recovery is not expected (see Supplementary Appendix 2 for the listing of the duration index).

National disability weights to match all diseases in the country specific disease classification come from a valuation event following the examples of GBD[23] and Dutch studies.[24] A panel of 25 experts with a medical background weighed 283 health conditions, which were the result of 168 classification items with various severity levels. At the first stage, 26 indicator conditions were valuated in a one-day open session using person-trade-off (PTO) approach. These valuations were plotted to a visual analogue scale (VAS) and were used as reference points for the direct valuation of the remaining 257 conditions using VAS scale (see Supplementary Appendix 2 for the final listing of disability weights).

YLL calculations in our study are based on mortality data and on national age-gender specific LE estimates. The mortality data comes from vital registration and was provided by Statistics Estonia.[25] The life-expectancy estimates are based on Estonian standard life-tables also published by Statistics Estonia. Thus, we reached the YLL estimate for a condition by multiplying the number of deaths and LE at any particular age.

All calculations were performed in 5-year gender-age groups separately for all 168 disease groups on the national and two sub-national levels. On the first sub-national level (counties), we performed a correlation analysis between regional burden of disease estimates and socioeconomic indicators available from Statistics Estonia. Correlation analysis was not performed on the second sub-national level (municipalities) due to the lack of socioeconomic indicators for that level.

We did not apply discounting[26] or age-weighting[27] to the burden estimates as agreed by local panel due to data specific and ethical considerations.

Results

DALYs

In 2002, Estonian population lost 446 361 years of perfect health (327/1000 persons) either due to premature death or time lived with a health condition that reduces health-related quality of life. Cardiovascular diseases, cancers and external causes (e.g. injuries and suicides) are responsible for two-third of the total burden of disease in Estonia (figure 1).

The total number of DALYs for both genders was approximately the same, but for male the main source of DALYs was premature mortality while morbidity was for females. Losses in working age (16–64 years) account for 60% of the gender total for male and 43% for female. Relative accumulation of DALYs to younger age groups (especially for male) is further illustrated by the fact that 50% of the total DALYs are from the population under the age of 55.

Conditions causing the highest overall burden in Estonia are ischaemic heart disease and stroke which are responsible for 17 and 10% of DALYs, respectively. In general, the diseases with higher YLL count tend to rank high in overall rankings as well. This is explained by the fact that majority (60%) of DALYs are mortality related that is also less evenly distributed between causes compared with morbidity related burden.

YLLs

In 2002, 8973 female and 9297 male deaths resulted in 267 139 life-years lost (196/1000 persons). Most often a death

was caused by cardiovascular disease, cancer or external cause. These three disease groups have the highest numbers of YLL. Ischaemic heart disease and stroke rank highest among individual conditions both for male and female. These two conditions account for 47% of the total deaths in Estonia but only for 33% of total YLL (table 1). The other most important sources of YLL for men are external causes such as suicide, poisoning and traffic injuries while somatic diseases like cancers are more important for females. On the population level, lung cancer and liver cirrhosis also rank high which coincides with both high level of smoking and hazardous alcohol consumption in Estonia.

After stratification by both gender and age, importance of accidents and injuries as a major target for public health interventions is even more pronounced than cardiovascular conditions. A half of YLL for male under age 40 are caused by external factors, compared with only 3% by cardiovascular diseases. At the same time, >70% of lethal injuries' YLL comes from persons under age 50 and 80% from male population. The total loss from external causes for male is more than three times higher compared with female.

Thus, the number of YLL in Estonia is larger for male by one-third compared with female. The main cause for this lies in high injury and cardiovascular mortality in early ages while after age 65 both genders have roughly the same level of YLL.

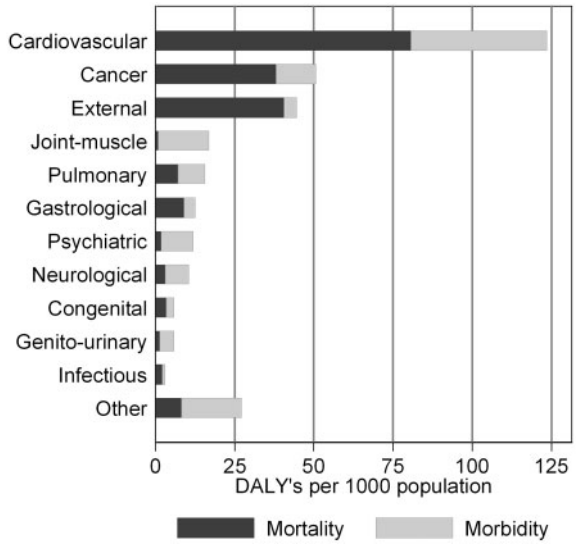

Figure 1 Burden of disease for 12 disease groups in Estonia in 2002.

YLDs

In 2002, Estonian population lost 179 222 life-years (131/1000 persons) due to medical conditions and injuries affecting quality of life. The leading category is cardiovascular, accounting for 32% of total YLD. That is followed by musculoskeletal diseases and cancer with 12 and 9.5%, respectively.

Female population contributed 62% to the YLD. Gender difference in total YLD is the result of differences in the prevalence of cardiovascular and musculoskeletal diseases. Latter also presents largest gender gap among disease groups. Gender difference dominates in ages over 40 where female loss from musculoskeletal diseases outnumbers male equivalent up to four times.

Sub-national estimates of burden of disease

Burden of disease calculations were performed on two sub-national levels—for 15 counties and 227 local municipalities. While national average was 327 DALYs/1000 persons, the regional calculations revealed considerable variations between counties (from 298 to 414) and municipalities (from 114 to 725) as detailed in figure 2. Both YLL and YLD followed largely the same pattern of regional distribution as DALYs.

Table 1 Top ten diseases, ranked according to YLLs and YLD with corresponding shares of burden by gender in Estonia in 2002

	Male			**Female**		
YLL rank	**Conditions**	**YLL**	**Total YLLs (%)**	**Conditions**	**YLL**	**Total YLLs (%)**
1	Ischaemic heart disease	30 562	20	Ischaemic heart disease	28 704	25
2	Stroke	11 512	8	Stroke	18 098	16
3	Suicide	8371	5	Breast cancer	4738	4
4	Poisonings	7979	5	Colorectal cancer	3202	3
5	Lung cancer	7617	5	Liver cirrhosis	3201	3
6	Traffic injuries	6272	4	Hypertension	2978	3
7	Cardiomyopathy	5147	3	Stomach cancer	2478	2
8	Pneumonia	4881	3	Traffic injuries	2224	2
9	Liver cirrhosis	4227	3	Cardiomyopathy	2134	2
10	Homicide	3510	2	Lung cancer	2011	2
	YLL top 10 total	90 078	59	YLL top 10 total	69 769	61
	YLL total	152 252		YLL total	114 888	
YLD rank	Conditions	YLD	Total YLDs (%)	Conditions	YLD	Total YLDs (%)
1	Ischaemic heart disease	7162	10	Stroke	9826	9
2	Stroke	5637	8	Hypertension	9808	9
3	Hypertension	4448	6	Ischaemic heart disease	9129	8
4	COPD	3407	5	Osteoarthritis	7141	6
5	Osteoarthritis	2477	4	Cardiac insufficiency	3812	3
6	Cardiac insufficiency	1881	3	COPD	3743	3
7	Epilepsy	1685	2	Cataract	3247	3
8	Paraplegia	1656	2	Renal failure	2542	2
9	Fractures	1320	2	Leiomyoma	2126	2
10	Prostate hyperplasia	1304	2	Rheumatoid arthritis	1984	2
	YLD top 10 total	30 977	45	YLD top 10 total	53 358	48
	YLD total	68 597		YLD total	110 625	

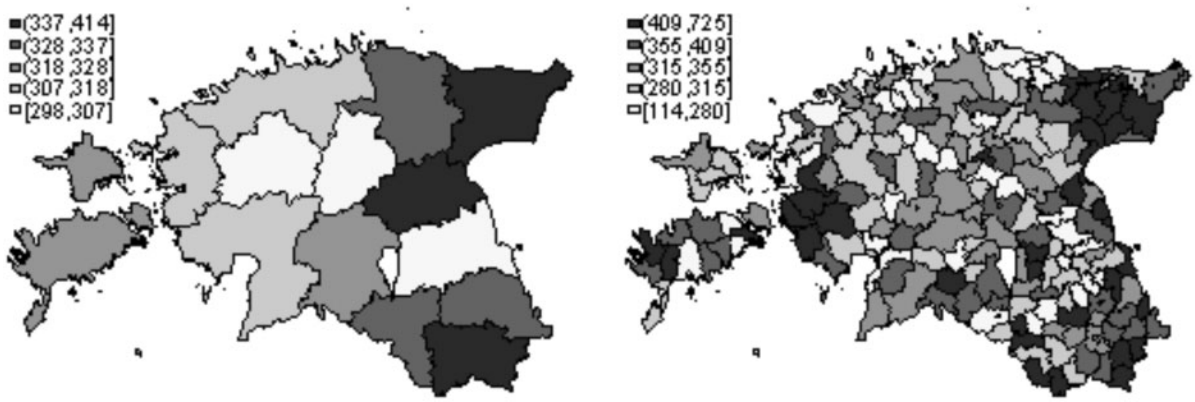

Figure 2 Disability adjusted life-years per 1000 persons in Estonian counties (left) and local municipalities (right) in 2002.

Best off are Estonian central and western counties, where as worst off are south-east, island and north-east regions. Ida-Viru county in that last region causes almost half of the overall variation between counties.

Correlation analysis showed that lower DALY levels per 1000 persons had a positive correlation to higher employment rate ($r = 0.58$), number of working hours ($r = 0.69$), hourly wages ($r = 0.65$) and negative correlation of the same strength to higher proportion of households under poverty line and other similar indicators. Regions with higher DALY count also have higher share of YLL in the total burden.

In addition, sources of burden like injuries, alcohol and other largely lifestyle related conditions tend to rank higher in the counties with higher burden levels. However, it is not possible to ascertain direct correlations as the health behaviour data is not available on county level in Estonia. Also, we do not present detailed burden of disease estimates by causing diseases in this article because of low prevalence of some of these in the regions and associated large uncertainty margins.

Discussion

Key results

Estonian population lost 446 361 years of perfect health due to mortality (60%) and lifetime disability (40%) in 2002. Total burden of disease was equally distributed between genders, but premature mortality was responsible for 69% for male and 51% for female. Cardiovascular diseases (led by ischaemic heart disease and stroke), external causes (led by suicides and poisonings) and cancers (led by lung and colorectal cancer) were the main sources of burden. Approximately, 60% of DALYs come from working age population (16–64 years) with important role of male who reach 50% of their total DALYs before age 55. There are also considerable sub-national variations in burden of disease where higher levels of burden are correlated to more unfavourable socioeconomic conditions.

Strengths and weaknesses of the study

The burden of disease concept is very attractive for its power to draw together data from different sources and present this in a systematic and generalized manner. The methodology used in GBD study is very well suited for comparison of world regions and countries but contextualized results would be more acceptable to policy makers and general public on the local level. Thus, use of disease classification corresponding to local disease profile and use of routinely collected data for dynamic monitoring of the population health would be useful to help the adoption of a measure like burden of disease. Sub-national estimates and inclusion of national disease severity assessments in the form of disability weights would increase the appeal of a new measure and its usefulness for the national health policy process even more.

Following these considerations current study provided country specific burden of disease estimates for national and sub-national health policy decision makers in a manner that enables local comparisons, continuous surveillance and use of routinely collected data.

Although, contextualization does improve national uptake of the results as described later, the ability to perform direct international comparisons is reduced. The latter can be described as one of the main weaknesses of our approach. The other possible trade-off lies in the use of prevalence data, based on health service utilization. However, this enabled us to achieve the possibility of dynamic surveillance and greater simplification of data processing. These possible concerns are addressed in the following sections.

Full country specific burden of disease estimates from the GBD study are not publicly available. However, table 2 lists 20 most important sources of DALYs from WHO estimates for Estonia (WHO, personal contact) in parallel to our findings. As noted before, direct comparisons should be made with caution (e.g. see different disease name wording) and therefore only percentages of total burden attributed to the conditions are presented. The most notable difference in the other ways similar lists is unipolar depression. There are different disability weights used which cause almost twofold divergence of the results—an average national weight for depression is 0.140 compared with 0.275 for the EurC region in the GBD study.[28] At the same time, the health service utilization based prevalence data does not influence our overall findings greatly in the situation where 60% of DALYs are caused by premature mortality from a relatively small number of causes of death. As table 2 indicates, the GBD study did find 13% share of total burden for ischaemic heart disease compared with our 17%, whereas the estimates for stroke are even closer (11% vs. 10%). Comparison of disease ranking reveals better representation of different causes of burden in our study—the top-20 in our study accounts for 61% of total burden compared with 92% in WHO estimates. That said, we recognize the need for national comparative study using classical epidemiological morbidity estimates which is already in preparation by us.

Implications for health policy

First, the contextualized burden of disease estimates have become an important part in the planning of public health strategies after the launch of our study. Availability of detailed national estimates did fuel debate on public health policy as

Table 2 Comparison of burden of disease results from national study and WHO estimates

Rank	WHO estimates	Proportion of total DALYs (%)	National estimates	Proportion of total DALYs (%)
1	Ischaemic heart disease	13	Ischaemic heart disease	17
2	Cerebrovascular disease	11	Stroke	10
3	Unipolar depressive disorders	7	Hypertension	4
4	Other unintentional injuries	6	Lung cancer	2
5	Poisonings	5	Suicide	2
6	Alcohol use disorders	5	Poisonings	2
7	Self-inflicted injuries	5	Osteoarthritis	2
8	Hearing loss, adult onset	5	Cardiomyopathy	2
9	Road traffic accidents	5	Liver cirrhosis	2
10	Violence	4	Chronic obstructive pulmonary disease (COPD)	2
11	Osteoarthritis	3	Other injuries	2
12	Inflammatory heart diseases	3	Traffic injuries	2
13	Cirrhosis of the liver	3	Other diseases of heart	2
14	Trachea, bronchus, lung cancers	3	Colorectal cancer	2
15	Lower respiratory infections	3	Pneumonia	2
16	Falls	3	Stomach cancers	1
17	Vision disorders, age related	2	Cardiac insufficiency	1
18	Alzheimer and other dementias	2	Breast cancer	1
19	Fires	1	Homicide	1
20	Stomach cancer	1	Cataract	1

sources of burden and magnitude of impact of poor health was clearly evident. The three main sources of DALYs in Estonia are covered by Estonian National Strategy for Prevention of Cardiovascular Diseases 2005–2020,[29] National Cancer Strategy 2007–2015[30] and National Strategy for Injury Prevention (currently in preparation). All these strategies make use of our results and thus link these to strategic public health actions.

Second, an important result of our study is capacity development within research and administrative institutions in Estonia. This was brought on by the use of our results in the national strategies that require regular updates of estimates for monitoring achievements in their respective fields.

Third, the study provided momentum to a more general debate on potential health gains and quality of life. Thus, the study helped to increase focus on other summary measures like health adjusted life expectancy (HALE) as well. As an example, the latter is the main indicator of population health in the recently adopted overarching National Health Strategy 2009–2020[31] in Estonia. Among other thing, the strategy sets reduction of burden of disease and health inequalities as well as increase of health-related quality of life as the intermediary goals of Estonian health system.

Fourth, the initial study described in this article, set scene for further health research in the area. Next steps have included calculation of risk factor attributable burden[32] and cost-effectiveness analysis of interventions for selected risk factors.[33] Currently, country specific investigation into avoidable burden of disease[34–36] and mortality[37,38] is carried out for improved selection of population health actions and for health policy support in general. Clear identification of the sources and sizes of avertable burden will help to target new public health activities even better and also enables improved measurement of impact, the implemented health strategies and programmes have.[39]

Conclusions

Current study provided first national and sub-national burden of disease estimates for Estonia and added a dimension to health measures already available. The study highlighted relative population impact of main diseases prevalent in Estonia, where cardiovascular disease, external causes and cancers are the biggest concern. Priority population groups for public health interventions and burden aversion are people in the working age, male under age 35 and persons living in north- and south-east regions of Estonia. Sub-national burden of disease results showed correlation to the socio-economic development of the region, where higher levels of burden were seen in less developed areas. A clear and simple manner of calculation lends itself to continuous monitoring of population health. Finally, the study has had input to national health policy development and to the increased capacity to perform similar studies in the future.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Conflicts of interest: None declared.

Key points

- Country specific study plays an important role to raise the awareness of burden of disease measures among policymakers and foster the uptake of information for health policy.
- The study clearly highlights the relative impact of chronic conditions in the Estonian society, prevalent especially among the working age population and causing premature (potentially avoidable) mortality.
- Burden of disease measures broaden the understanding of health and availability of national estimates has helped to communicate potential gains from improvement of health system performance.
- Considerable sub-national variation in burden of disease is present and has moderate correlation to socioeconomic development of the region.
- The contextualization has an added value for national and sub-national policy processes but limits international comparison and needs separate attention.

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