Burden of disease attributable to physical inactivity: German and Polish evidence

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Abstract

In this study we provide an empirical evidence on sport inactivity as an important risk factor for several chronic diseases, accounting for a significant part of related economic burden of disease. Applying cost-of-illness methodology to cost data for a sample of noncommunicable diseases in Poland and Germany we present estimates for a fraction of costs (both direct and indirect) generated for national health care systems by insufficient sport activity of Polish and German populations. Discussing the results we pledge in favor of adequate public incentives and pro-healthy lifestyle initiatives at both national and EU levels as an effective tool in raising health condition.

Keywords: sport economics, health economics, cost-of-illness study, public health policy

JEL: I18, Z20

Introduction

A sedentary lifestyle is a serious societal issue in developed countries. Within a few decades, physical inactivity has become one of the leading risks to European citizens' wellbeing and a growing challenge for European societies. Unfortunately, physical inactivity, significantly increases the risk of many diseases, including forms of cancer, diabetes, coronary diseases and may also lead to obesity. The current situation is already alarming. The World Health Organization (WHO) estimates that 25% of European adults, and 80% of European adolescents, are insufficiently active (WHO, 2010); Yet, physical inactivity is the fourth leading factor of mortality (WHO, 2009). Thus, the health consequences of sedentary lifestyles are significant, and dangerous. Even individuals of normal weight who do not reach the recommended levels of physical activity are at significantly increased risk of developing cancer, type II diabetes, heart disease and suffering from premature death. Eventually, physical inactivity - through 4 major non-communicable diseases (coronary heart disease, type 2 diabetes, colorectal and breast cancer) - generates substantial economic costs for health systems and is also responsible for productivity loss in European economies. Indeed, physical inactivity has become a major public health issue.

WHO Member States have agreed on a set of nine voluntary global targets to be attained by 2025. One of them focuses on a 10 per cent reduction in the prevalence of insufficient physical inactivity while the another one concentrates on haltering the rise in diabetes and obesity - conditions for which physical inactivity remains an important risk factor. Referring to these goals, our study quantitatively evaluates the costs of diseases as a substantial burden for health systems.

Methods and study materials

In this paper, we attempt to quantify the burden of physical inactivity for the national health system in Poland and Germany. As we have mentioned before, etiopathogeneses of several noncommunicable diseases (NCDs) point out the physical inactivity. Therefore, our study is a prevalence-based top-down cost-of-illness analysis based on investigation of cost burden imposed by major NCDs: coronary heart disease (CHD), type 2 diabetes, breast and colon cancers. The associated empirical procedure is split into three steps. First, relying on WHO methodology and Lancet (2012) study, we identify the Population Attributable Fractions (PAFs) associated with physical inactivity for our series of NCDs. As a further step, we calculate direct and indirect costs of NCDs. Finally, using the PAFs, we estimate a cost burden of diseases generated by physical inactivity.

Population Attributable Fraction (PAF)

PAF is the proportional reduction in population disease that would occur if exposure to a risk factor was reduced to an alternative ideal exposure scenario (e.g. physical activity). Many diseases are caused by multiple risk factors, and individual risk factors may interact in their impact on overall risk of disease. In our case, the PAF is calculated by examining the prevalence of inactivity among Polish and German adults and the relative risk of the four diseases for which there is a strong evidence of negative impact of sport inactivity. The relative risk measures the association between physical inactivity and a particular medical condition and is determined by dividing the rate of the disease among inactive people by the rate of disease among active people. Formulae for calculation of Population Attributable Fraction (PAF) is presented in Equation 1:

$$PAF(\%) = \frac{P_e\left(RR_{unadj} - 1\right)}{P_e(RR_{unadj} - 1) + 1} * 100 \qquad (1)$$

where P_e is the proportion of inactive people in country's population, and RR_{unadj} is the relative risk of disease, comparing inactive with active people, unadjusted for confounding factors[1]. Estimation of PAF relies on availability of RRs estimates. In order to guarantee a methodological cohesion as well as data material that will enable us to undertake an international benchmarking in the future, we use the Lancet (2012) estimates for prevalence of physical inactivity, RRs and corresponding PAFs[2].

Direct and indirect costs of diseases

As mentioned by Segel (2006), a comprehensive cost-of-illness study should include both direct and indirect costs of disorders. Direct costs measure the opportunity cost of resources used for treatment of a particular disease, whereas indirect costs reflect the value of resources lost due to a particular illness. In this study, evaluation of direct costs includes: the costs of medical care (i.e. hospitalizations, physicians visits) and illness-related medication reimbursement calculated from

[1] A confounding variable is a factor (e.g. high Body Mass Index, proxy of obesity) that can cause the disease under study (e.g.type 2 diabetes) and is also associated with the exposure of interest (e.g. physical inactivity).

[2] Physical inactivity is defined as an activity level insufficient to meet present WHO recommendations (WHO, 2010); Estimates of prevalence of physical inactivity are based on cohort studies worldwide and RRs for CHD, type 2 diabetes, breast and colon cancers result from meta-analysis. For details see Sattelmair *et al.* (2011), Jeon *et al.* (2007), Wolin *et al.* (2009), Lollgen *et al.* (2009), Monninkhof *et al.* (2007).

the payer perspective[3]. Non-medical direct costs, such as transportation costs or costs of informal care, as well as intangible costs (e.g. costs associated with family separation or failures to meet professional goals) have been omitted. For Poland, the costs of medical care were calculated on the basis of National Health Fund (Narodowy Fundusz Zdrowia, NHF) data. In Poland, NHF gathers data of costs of services in compliance with WHO's ICD-10 classification (International Statistical Classification of Diseases and Related Health Problems). Consequently, we have proceeded with extraction of expenditure data incurred by health care providers in 2010 for our series of NCDs. For Germany, the cost of care were calculated upon cost-of-illness accounts compiled by the Federal Statistical Office (Statistisches Bundesamt, SB). The latest available series consists of 2008 data (Das Informationssystem der Gesundheitsberichterstattung des Bundes).

The costs of drug reimbursement in Poland are partially evaluated upon information available in NHF report[4]. Unfortunately, with the available data, we could not precisely determine the amount of reimbursement matching ICD-10 disease classification. Therefore, we only present the estimates for the group of coronary heart diseases and diabetes[5]. The costs of drug reimbursement in Germany are calculated upon the value of pharmaceuticals prescribed at the expense of the statutory health insurance and based on German Drug Index[6]. We use Eisl *et al.* (2014) study to identify drugs matching the ICD-10 classification[7].

Indirect costs evaluated in this study are based on the level of productivity loss due to work absence or inability to work and premature mortality due to CHD, type 2 diabetes, breast and colon cancers[8]. In order to calculate these costs for Poland, we used data from Central Statistical Office of Poland (GUS) and Social Insurance Institution (ZUS) and applied the human capital method. More precisely, the costs of lost productivity due to sickness absence were determined using the ZUS data on the number of days taken off due to sickness caused by CHD, type 2 diabetes, colon or breast cancers and the average daily gross wage in Poland (EUR 35,35 in 2010, EUR/PLN exchange rate as of 31/12/2010). Additionally, the indirect costs are magnified by lost productivity due to incapacity to work (handicap) and calculated upon the ZUS data on the number of claimants

[3] In Poland, due to marginal share of co-payments in public health system, calculating costs from the payer perspective constitutes a good estimate of social cost.
[4] Report available at:
http://www.nfz.gov.pl/download/gfx/nfz/pl/defaultstronaopisowa/349/14/1/refundacja_2010.pdf (accessed on 2016.07.15)
[5] In order to calculate the value of drugs reimbursement for Type 2 diabetes, we have subtracted the value of insulin-based medicines.
[6] The German Drug Index is realized as research project by the AOK Research Institute (WidO).
[7] Pharmaceuticals are classified following the WHO's Anatomical Therapeutic Chemical (ATC) Classification System.
[8] Due to data availability, calculation of indirect costs accounting for premature mortality are only possible for Germany.

for social security benefits. Available data did not allow us to estimate the value of productivity loss due to premature death caused by one of the diseases.

Indirect costs for Germany are based on the value of years lost due to sickness resulting in work incapacity, handicap or premature mortality. As a further step, the number of years lost is multiplied by the average annual gross wage in Germany (36 276 € in 2008).

Results

PAFs inform us about the reduction in a disease incidence once we eliminate the risk factor. In our study, the related risk factor is the insufficient physical activity. Estimates for Poland and Germany are presented in Table 1:

Tab. 1: Population Attributable Fraction Estimates

ICD-10 Disease classification	Estimated prevalence of physical inactivity (95% confidence interval), %		Median value for Europe*	Estimated population attributable fractions (PAFs), calculated using unadjusted relative risks and associated with physical inactivity		Median value for Europe*
	Poland	Germany		Poland	Germany	
Coronary heart disease (I20-I25)	33,1 (12,9-84,8)	33,6 (13,0–87,0)	39,7	8,4 (1,7-15,3)	8,5 (1,8–15,6)	9,8
Type 2 diabetes (E11)	33,9 (12,8-89,9)	34,4 (12,9–92,2)	40,7	14,8 (3,0-27,5)	15,0 (3,1–27,0)	17,2
Breast cancer (C50)	33,2 (11,9-92,5)	29,9 (10,4–86,2)	37,4	9,7 (2,9-16,0)	8,8 (2,4–15,0)	10,8
Colon cancer (C18)	33,7 (12,2-92,6)	34,2 (12,3–94,9)	40,3	9,5 (2,2-16,1)	9,6 (2,3–16,2)	11,2

*Europe: EU-28, Bosnia and Herzegovina, Georgia, Kazakhstan, Norway, Russian Federation, Serbia, Turkey, Ukraine. Source: Lancet (2012)

The PAF of 8,4 (Poland) and 8,5 (Grmany) means that 8,4% (and 8,5%, respectively) of CHDs cases would be avoided if the risk factor is causally related to ischemic heart diseases and is eliminated.

Table 2 summarizes direct medical costs:

Tab.2: Direct medical costs of outpatient and inpatient care for Polish and German providers of health services

ICD-10 Disease classification	Direct medical costs (in million Euros)*	
	Poland	Germany
Coronary heart disease (I20-I25)	578,48	6 202,0
Type 2 diabetes (E11)	48,46	5 073,6**
Breast cancer (C50)	123,17	1 970,0
Colon cancer (C18)	46,50	1 050,0
Total :	796,61	14 295,6
% of total statutory insurance expenditure in 2010:	9%	5,6%

*EUR/PLN exchange rate as of 31/12/2010; authors' calculation

**Type 2 diabetes costs are estimated as a fraction of total diabetes costs (E10-E11). It is estimated that type 2 diabetes generate 80% percent of total expense for diabetes.

The highest direct medical costs in both countries are generated by CHDs, followed by diabetes (in Germany) and breast cancer (in Poland).

The amount of reimbursement is based on the part of total Polish NHF drug reimbursement expense and reported in Table 3 below:

Tab.3: Reimbursement of medicines

ICD-10 Disease classification	Drug reimbursement (in million Euros)*	
	Poland	Germany
Coronary heart disease (I20-I25)	267,38	97,2
Type 2 diabetes	113,33	31,7
Breast cancer (C50)	N/A	5,1
Colon cancer (C18)	N/A	33,9
% of total drugs reimbursement expense	17,67%	27,6%

*EUR/PLN exchange rate as of 31/12/2010; authors' calculation

Total indirect costs generated by one of sample diseases are presented in Table 4a (Poland) and 4b (Germany):

Tab.4a: Estimates of indirect costs for Poland

ICD-10 Disease classification	Number of absence days	Numer of people receiving an imparied-life annuity adjusted by an employment-to-population ratio	Productivity loss due to sickness absence (in million Euros)	Productivity loss due to incapacity for work (in million Euros)	Indirect costs (in million Euros)
Coronary heart disease (I20-I25)	3 062 425	74 615	108,26	2,64	110,89
Type 2 diabetes (E11)	595 342	5 997	21,05	0,21	21,26
Breast cancer (C50)	714 113	8 932	25,24	0,32	25,56
Colon cancer (C18)	205 625	2 256	7,27	0,08	7,35
Total:	4 577 505	91 801	161,81	3,25	165,06

*EUR/PLN exchange rate as of 31/12/2010; authors' calculation

Tab.4b: Estimates of indirect costs for Germany

ICD-10 Disease classification	Total number of lost workforce years (in thousand years)				Indirect costs (in million Euros)
	Of which:	Lost workforce years due to premature mortality	Lost workforce years due to sickness absence	Lost workforce years due to incapacity for work	
Coronary heart disease (I20-I25)	124	80	22	22	4 498,22
Type 2 diabetes (E11)	36	13	9	14	1 305,94
Breast cancer (C50)	60	23	17	20	2 176,56
Colon cancer (C18)	23	N/A	N/A	N/A	834,35
Total:	243				8 815,07

Multiplying PAFs by the amount of total costs of diseases (direct and indirect) provides us with the estimates of possible cost savings due to raise in physical activity in population. The annual estimates of cost savings are presented in Table 5a (Poland) and 5b (Germany) below:

Tab. 5a: Cost burden of diseases attributable to physical inactivity in Poland

ICD-10 Disease classification	Direct costs (in million Euros)	Indirect costs (in million Euros)	Total costs (in million Euros)	PAFs	Estimated reduction in total costs due to elimination of insufficient physical inactivity in population (in million Euros)
Coronary heart disease (I20-I25)	845,86*	110,89	956,75	8,5	80,37
Type 2 diabetes (E11)	161,79*	21,26	183,05	15,0	27,09
Breast cancer (C50)	123,17	25,56	148,73	8,8	14,43
Colon cancer (C18)	46,50	7,35	53,85	9,6	5,11
Total:	1 177,32	165,06	1 342,38		127,00

*includes drugs reimbursement; EUR/PLN exchange rate as of 31/12/2010

Tab. 5b: Cost burden of diseases attributable to physical inactivity in Germany

ICD-10 Disease classification	Direct costs (in million Euros)	Indirect costs (in million Euros)	Total costs (in million Euros)	PAFs	Estimated reduction in total costs due to elimination of insufficient physical inactivity in population (in million Euros)
Coronary heart disease (I20-I25)	6 299,2	4 498,22	10 797,42	8,4	906,98
Type 2 diabetes (E11)	5 105,3	1 305,94	6 411,24	14,8	948,86
Breast cancer (C50)	1 975,1	2 176,56	4 151,66	9,7	402,71
Colon cancer (C18)	1 083,9	834,35	1 918,25	9,5	182,23
Total:	14 463,5	8 815,07	23 278,57		2 440,78

In Poland, direct costs related to CHD, type 2 diabetes, breast and colon cancers were of 1 77,32 million Euros and accounted for 87,7% of total costs. 71% of total costs are generated by CHD. The PAF ranges from 8,5 (CHD) to 15 (type 2 diabetes). Estimated cost burden of diseases attributable to physical inactivity amounted 127 million Euros, thus accounting for 9,5% of total cost burden imposed by CHD, type 2 diabetes, breast and colon cancers.

In Germany, 73% of total costs are generated by CHD and type 2 diabetes. Indirect costs associated with breast cancer exceed the direct costs. The indirect costs are mostly generated by premature mortality due to CHD. The PAF ranges from CHD (8,4) to 14,8 (type 2 diabetes). Estimated total burden of diseases attributable to physical inactivity reaches the level of nearly 2,5 billion Euros,

accounting for more than 10% of total cost burden imposed by CHD, type 2 diabetes, breast and colon cancers.

Discussion

Poland

In order to assess the estimated burden of diseases attributable to physical inactivity, we relate it to the public expenditure for physical culture and sport in 2010. Analysis of the '2010 State budget' reveals that total expenditure for physical culture and sport amounted to EUR 448,08 million (only 0,60% of total budget spending). Thus, the costs of medical conditions associated with insufficient physical inactivity accounts for slightly more than 28% of the amount spend on raising participation of Poles in sport and its promotion. It is worth mentioning that since 2007, increasing physical activity of population has been announced in national strategies for sport and public health[9]. To this day, there is no priority Health Plan focusing on sport participation for Polish citizens.

Analyzing data on sport practice in clubs, in 2012 there were 490 thousand actively practicing members of sport clubs, compared to 486 thousand in 2010 (almost a steady rate). However, 60% of those members were persons aged up to 18.
At the same, 'Participation of Poles in sports and physical recreation' study[10] delivers interesting insights about sport habits of Polish citizens. During the study period (10/2011-09/2012) 45,9% of Poles participated in any kind of sport activity (48,8% men and 43,3% women). Over one fifth of respondents (20,3%) practiced sport regularly and more than a quarter (25,6%) sporadically. Moreover, the study revealed the inverse to the age subjective evaluation of physical condition. Very good or good physical performance status has most often been declared by young people (5-9 years – 95,1%, 10-14 years – 94,4%, and 91,7% aged 15-19); people aged from 20 to 29 years more frequently reported limited shortcomings of physical fitness (13,2%). With age, self-evaluated physical condition significantly deteriorates (very good or good condition has been reported only by 40,1% of people aged 50-59 years, and 17,7% among people aged 60 and older. More than 38% of seniors (aged 60 or older) has estimated their physical condition as bad or very bad. This pyramid of physical performance corresponds to the prevalence of CHD and colorectal cancer in developed countries[11]. Therefore, public authorities should manifest more efforts in increasing health

[9] 'Strtegia rozwoju w Polsce do roku 2015' and 'Narodowy plan zdrowia 2007-2015'
[10] KiGGs German Health Interview and Examination Survey for Children and Adolescents, 1st Wave, 2009-2012, conducted by the Robert Koch Institute.
[11] See Ferreira-Gonzalez (2014)

condition of population by raising sport participation of 50+ citizens. An inclusive, senior-tailored plans based on adequate incentives (e.g. creating or subsidizing senior sport clubs) would permit not only elevate the health status of elderly people, but also decrease the incidence of costly diseases. Accidentally, raising sport participation among seniors will help fighting against social exclusion.

Germany

In Germany, the average annual revenue allocated to sport from the central government's budget in 2008 was EUR 229,91 million. Germany has a decentralized administrative organization, and the *Länders* are autonomous concerning sport. The average annual revenue allocated to sport by the local authorities was EUR 184, 5 million in 2008. [12]

In 2012, there were 23, 72 million sport clubs members, and the participation has slightly decreased since 2010. This decrease of sport participation in Germany can be partly explained by the drop in participation of youths, since the population of young people displays a decreasing trend.

According to the *2009 Eurobarometer Survey*, in Germany 31% of the persons asked declared not practicing sport at all. Young people are physically more active than remaining age groups, but do not practice enough exercise.

The young people and children health survey 2009-2012 (kiGGS) [13] collected data on the assessment of parents regarding the general health of their children, as well as on the self-assessment of 11 to 17 year olds. 93.6% of the parents assess the general health of their children as "Very good" or "Good". The proportion of children with fair or poor general health is 6.4%. No significant differences between girls and boys are apparent from the information given by parents. Moreover, approximately 5% of girls and boys of pre-school or primary school age have fair or poor general health. At the beginning of adolescence, this figure rises in both girls and boys to approximately 9% in the age group from 14 to 17.

In Germany, 51% of the adult population suffers from obesity, among which 15 % are people aged 18 years or younger. This problem decreases with income and educational levels. During the last 10 years, the obesity rate among young men increased by 8% and by 7% among girls.

[12] 'Eurostrategies, CDES, Amnyos, CDES, DSHS Köln (2011) Study on the funding of grassroots sports in the EU With a focus on the internal market aspects concerning legislative frameworks and systems of financing.
[13] Study conducted by the Central Statistical Office in October 2012 on the sample of households participating in the Household Budget Survey (HBS).

In 2008, the national Program "In form" was initiated by two ministries (for health and agriculture and for nutrition, respectively Bundesministerium für Ernährung und Landwirtschaft und Bundesministerium für Gesundheit) to improve on the long run the physical activity and the nutrition of the German population. For the 3 first years, a budget amount of EURO 15 million per year was distributed. By 2020, two objectives must be met: nutrition and physical activity have to be improved and the rate of diseases caused by the lack of physical activity or a bad nutrition has to be reduced.

Study limitations

Our study has two main limitations. First, the presented cost perspective is static. It provides the costs estimate only for 2010 (Poland) and 2008 (Germany). Due to data unavailability, we were unable to undertake a dynamic perspective. However, combining morbidity trends and NHF expenses and investigating existing studies, we can be certain of increase in the cost burden related to CHD, type 2 diabetes, breast and colon cancers. Second, complete cost-of-illness studies should include comorbidities. We have decided not to expand for complications as there are doubts about the direction of causal relationship (for instance, it is not clear whether obesity is a cause or a consequence of diabetes).

References

Eisl A., C.mert, P. Filzmoser (2014), ATC ICD 10 Evaluation, available at: http://www.hauptverband.at/portal27/portal/hvbportal/content/contentWindow?contentid=10007.730157&action=2&viewmode=content (accessed on 25.08.2015)

Eurostratégies, Amnyos, CDES [Centre de Droit et d'Economie du Sport], & Deutsche Sporthochschule Köln (2011), *Study on the funding of grassroots sports in the EU. With a focus on the internal market aspects concerning legislative frameworks and systems of financing*. Final report: Vol. I

Ferreira-Gonzalez I. (2014) , *The epidemiology of coronary heart disease*, Rev Esp Cardiol, 67:139–144

I-M Lee, EJ Shiroma, F Lobelo, P Puska, SN Blair, PT Katzmarzyk, for the Lancet Physical Activity Series Working Group Effect of physical inactivity on major non-communicable diseases

worldwide: an analysis of burden of disease and life expectancy Lancet (2012) published online July 18. http://dx.doi.org/10.1016/S0140-6736(12)61031-9

Jeon CY, Lokken RP, Hu FB, van Dam RM. (2007) P*hysical activity of moderate intensity and risk of type 2 diabetes: a systematic review*, Diabetes Care, 30: 744–52.

Lollgen H, Bockenhoff A, Knapp G. (2009), *Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories*. Int J Sports Med, 30: 213–24.

Monninkhof EM, Elias SG, Vlems FA, et al. (2007), *Physical activity and breast cancer: a systematic review*, Epidemiology 2007; 18: 137–57

Sattelmair JR, Perman J, Ding EL, Hohl HW III, Haskell WL, Lee I-M. (2011), *Dose-response between physical activity and risk of coronary heart disease: a meta-analysis*, Circulation, 124: 789–95.

Segel J. (2006), *Cost of illness studies - a primer*, Available at: http://www.rti.org/publications/abstract.cfm?pub56042. Accessed May 29, 2015

World Health Organisation (2009), *Global health risks: Mortality and burden of disease attributable to selected major risks.*

World Health organization (2010), *Global recommendations of physical activity for health.*

Wolin KY, Yan Y, Colditz GA, Lee IM. (2009), *Physical activity and colon cancer prevention: a meta-analysis*, Br J Cancer, 100: 611–16.