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GALI validation studies in Belgium

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Introduction

This Technical Report summarises three studies on the validity of the GALI (and self-rated health) carried out based on Belgian data:

1) Comparison of self-rated health and activity limitation as predictors of short term mortality in the older population

2) The Global Activity Limitation Indicator (GALI) and Self-Rated Health are good predictors of mortality

3) Activity limitations and health care expenditures in the general population in Belgium

1. Comparison of self-rated health and activity limitation as predictors of short term mortality in the older population

Authors: J. Van der Heyden, N. Berger, H. Van Oyen

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Introduction

Self-rated health (SRH) is a widely used and validated health measure and an excellent predictor of mortality, morbidity, functional status, disability and health care use. It has been recommended as public health indicator by the WHO since 1996.[1] Activity limitations relate to the concept of disability, which has been defined as a state of decreased functioning associated with disease, disorder, injury, or other health conditions, which in the context of one's environment is experienced as an impairment, activity limitation, or participation restriction.[2] However, the definition of disability is not unique and many frameworks exist to define disability.[3] The need for a compact and inexpensive device for public health surveillance and scientific study of disablement [4;5] resulted in the past 15 years in the development of a global activity limitation indicator (GALI), which identifies via one question subjects with longstanding limitations due to a health problem. The GALI has been compared with other disability instruments [6] and appears to measure functioning and disabilities similarly across European countries.[7] In view of the ongoing validation of the GALI we compared the predictive validity of both activity limitation and poor SRH for short term mortality in the Belgian population of 65 years and older.

Methods

Data were used from the Belgian Health Interview Survey (HIS) 2008, in which health related information was collected from 11.254 individuals living in Belgium.[8] The sampling design included an oversampling of the age group of 65 years and older, and an additional oversampling of the age group of 85 years and older. An individual linkage with health insurance data allowed to obtain detailed information on health care use up to the end of 2010. The date of death was estimated from the year of death and the date of the last contact with a health service (either ambulatory care or hospital). SRH was assessed with the question: "How is your health in general (Very good/Good/Fair/Bad/Very bad)". Activity limitations were measured with the GALI question: "For the past 6 months or more have you been limited in activities people usually do

because of a health problem? (Yes, strongly limited/Yes, limited/No, not limited)". From both questions dichotomised indicators were created distinguishing, on the one hand, individuals in good health versus individuals in moderate to bad health, and, on the other hand, people with and without activity limitations. The analyses included 1894 individuals of 65 years and older who completed the self-administered questionnaire of the survey. The predictive validity of activity limitations measured by the GALI and poor SRH for mortality was assessed by mortality rate ratios (MRR) from a Poisson regression, stratified by gender, and adjusted for age and education.

Results

Among men 41.2 % reported a poor health status and 41.5 % had an activity limitation; among women those percentages were respectively 48.4% en 53.5%. Only 29.4 % of men and 39.6% of women reported both a poor health status and an activity limitation. By the end of 2010, 7.4% of the men and 5.6% of the women who had indicated to be in good health had died. Among those who had reported not to be in good health the proportion of people who had died was 18.7% for men and 9.8% for women. Only 6.8% of the men and 3.6% of the women without activity limitations had died by the end of 2010. For people with activity limitations these percentages were respectively 19.5% and 11.2%. Results from the Poisson regression are presented in Table 1. In both men and women mortality was strongly associated with an activity limitation; also poor SRH was a good predictor for mortality in men and women, but the magnitude of the association was smaller in women. In a model including age, gender, SRH and the GALI, an independent association was found between both measures and mortality in men only. In women, the association of mortality with an activity limitation was significant, but there was no independent association with poor SRH.

Discussion

From our study it appears that the GALI is a good predictor for mortality in the older population, in both men and women; SRH is a good predictor for mortality in men only. Although the concepts measured by both instruments are related, they are not the same. A recent study concluded that in older people the GALI mainly measures functional disability, whereas SRH mainly measures physical morbidity.[9] Gender differences in the association between SRH and mortality could be due to a higher prevalence among women of nonfatal health problems, such as musculoskeletal diseases.[10] Also mental health problems, which are reported more often by women than by men, may be a cause of a poor SRH, without leading to higher mortality, and therefore reduce the association between SRH and mortality in women. The relation between functional disability and

mortality appears to be less gender dependent, which makes it a more stable indicator to predict mortality. Our results contribute to the validation of the GALI. However, the findings are restricted to short term mortality in the older population. Further studies should explore the association between activity limitation and mortality in the total population and over a longer time period by linking health survey data to mortality registers.

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2. The Global Activity Limitation Indicator (GALI) and Self-Rated Health are good predictors of mortality

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Background

Self-rated health (SRH) is a widely used and validated health measure and an excellent predictor of mortality, morbidity, functional status, disability and health consumption. It is based on one single question: "How is your health in general", and has been recommended by the WHO since 1996 (1). The need for a compact and inexpensive device for public health surveillance and scientific study of disablement (3) resulted in the past years in the development of a global activity limitation indicator (GALI), which identifies via one question subjects with longstanding (at least 6 months) limitations due to a health problem by severity level (4). The GALI is being increasingly used to calculate a health expectancy indicator known as Healthy Life Years (HLY).

The GALI has been compared with other disability instruments (4) and appears to measure functioning and disabilities similarly across European countries (5). In view of the ongoing validation of the GALI we investigated the predictive power of both the GALI and SRH on long-term mortality in a representative sample of the adult Belgian population.

Methods

Data

We used data from the Belgian Health Interview Survey 2001 in which health-related information was collected in a representative sample of the adult population living in Belgium (6). Both SRH and the GALI were included in the self-administered part of the survey. Relevant information (including health status, gender, age and the highest level of education in the household) was obtain for 8,583 individuals aged 15 years and older. Participants to the survey were followed-up for their vital status from the date of interview until 31 December 2010. For that purpose, participants were linked to mortality and migration registers using their national identification number.

Statistical methods

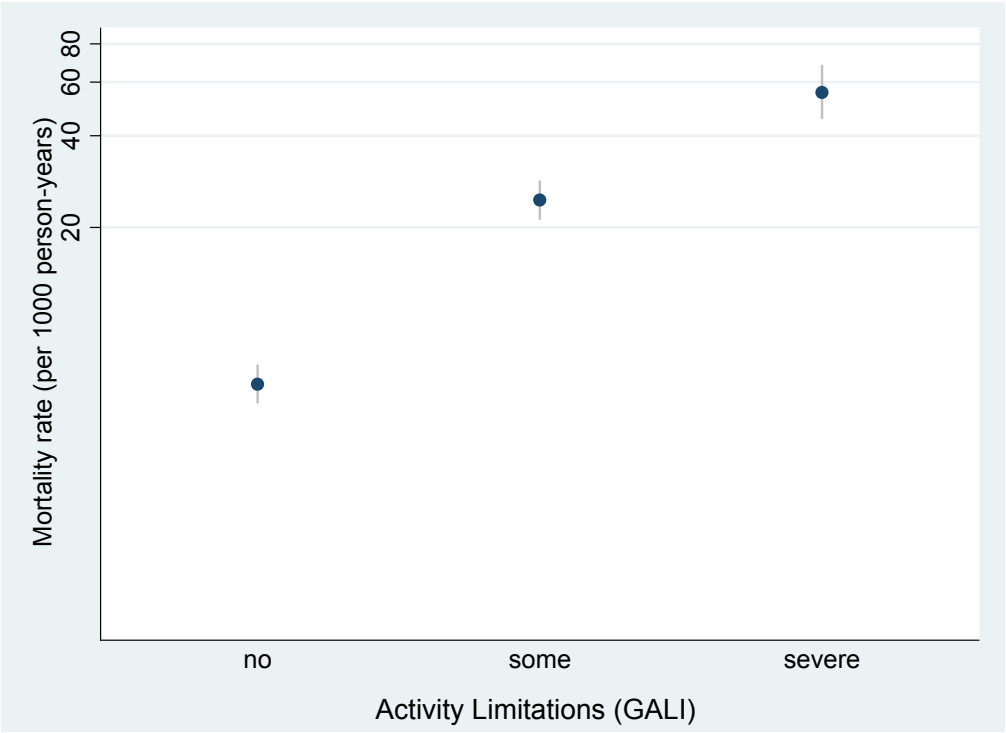
The predictive power of the GALI and SRH is assessed by Mortality Rate Ratios (MRRs) obtained from Poisson regression models. The first models estimate MRRs for the GALI and SRH separately, while the second also adjust for age (after lexis expansion), gender and education and explore interactions between each health measure and gender. A third model includes the GALI, SRH and adjusts for the other covariates. The impact of the follow-up period is assessed by comparing MRRs at different times of the follow-up, adjusting for all covariates.

Results

The GALI and SRH are associated with mortality: as the level of ill-health increases, the mortality rate increases (Figure 1). The mortality rate was about 4 times higher for individuals with

moderate limitations and more than 9 times higher for those with severe limitations, as compared to none. For SRH, the crude estimates were very similar (Table 1). When adjusting for other predictors of mortality (age (in particular), gender and education), MRRs decreased for both the GALI and SRH, but remained significant. No interaction effect was found between the health measures and gender in any of the fitted models. In a global model including the GALI, SRH and other covariates we found that both measures had a significant effect on mortality. Moderate limitations / fair health increased mortality rates by about 1.5. The effect of severe limitations was higher (MRR=1.8). The highest MRR was found for (very) bad health (2.4). The impacts of the GALI and SRH decreased over the follow-up time (Table 2). Moderate limitations and fair health did not have a significant effect on mortality in the last years (6-10 years) of the follow-up (MRRs=1.2). The effect of severe limitations decreased from 2.8 (in the first 3 years of follow-up) to 1.5 (in the last period). The impact of (very) bad health seemed less affected by the period of follow-up.

a)



b)

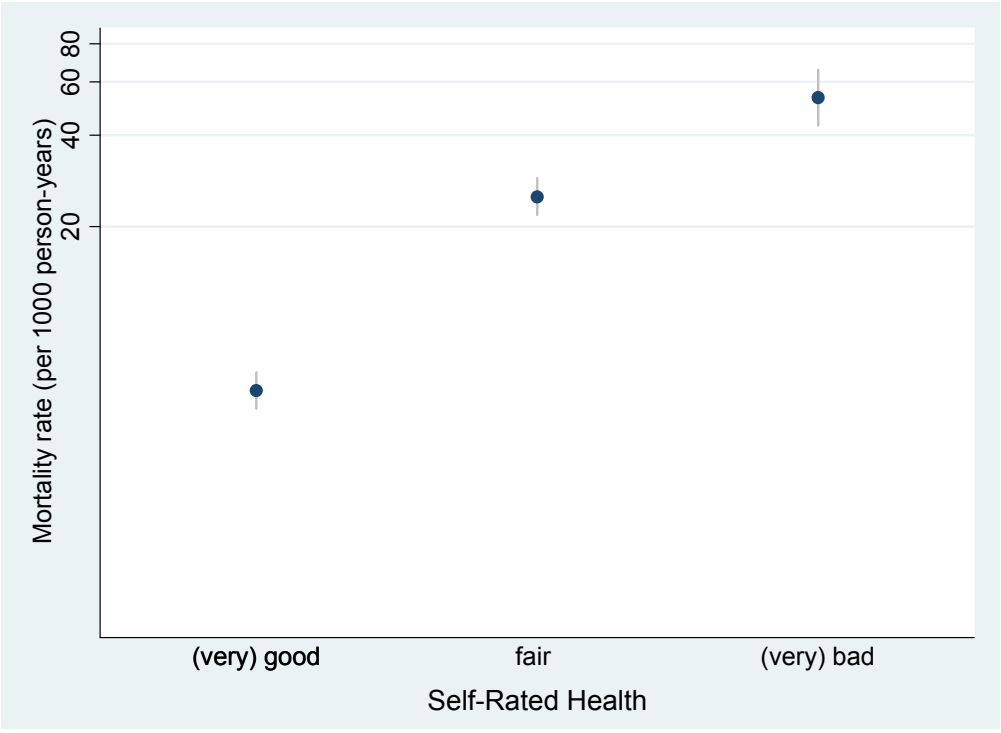


Figure 1. Mortality rate (per 1000 person-years) by (a) level of activity limitations (GALI) and (b) level of Self-Rated Health in the 10-year follow-up of the Belgian Health Interview Survey 2001.

Table 1. Impact of activity limitations (GALI) and Self-Rated Health (SRH) on long-term mortality

	crude		adj. for age, gender, edu.		adj. for age, gender, edu., health (GALI or SRH)	
	MRR	(95% CI)	MRR	(95% CI)	MRR	(95% CI)
Activity limitations (GALI)						
no limitation	1.0		1.0		1.0	
moderate limitation	4.2	(3.6-4.8)	1.7	(1.5-2.0)	1.4	(1.2-1.6)
severe limitation	9.5	(8.0-11.3)	3.0	(2.5-3.5)	1.8	(1.5-2.3)
interaction with gender	-		N.S.		N.S.	
Self-Rated Health						
(very) good	1.0		1.0		1.0	
fair	3.9	(3.4-4.5)	1.7	(1.5-2.0)	1.5	(1.3-1.9)
(very) bad	9.9	(8.2-11.9)	3.5	(2.9-4.2)	2.4	(1.9-3.0)
interaction with gender	-		N.S.		N.S.	

adj. adjusted, edu. education, CI confidence interval, MRR mortality rate ratio, N.S. not significant

Table 2. Impact of activity limitations (GALI) and Self-Rated Health (SRH) on mortality, by follow-up period

	0-3 years		3-6 years		6-10 years	
	MRR	(95% CI)	MRR	(95% CI)	MRR	(95% CI)
Activity limitations (GALI)						
no limitation	1.0		1.0		1.0	
moderate limitation	1.6	(1.0-2.3)	1.5	(1.1-2.0)	1.2	(0.9-1.6)
severe limitation	2.8	(1.7-4.5)	1.7	(1.1-2.5)	1.5	(1.0-2.1)
Self-Rated Health						
(very) good	1.0		1.0		1.0	
fair	1.7	(1.2-2.6)	1.6	(1.2-2.1)	1.2	(0.9-1.6)
(very) bad	3.0	(1.8-4.9)	1.9	(1.3-3.0)	2.5	(1.7-3.5)

CI confidence interval, MRR mortality rate ratio

Note: The models adjust for age, gender and education

Conclusion

- The Global Activity Limitation Indicator (GALI) and Self-Rated Health (SRH) are good predictors of mortality in the general population.
- The predictive power of the GALI and SRH is gender invariant.
- On the short term, the GALI and SRH are strong and comparable predictors of mortality.
- After several years of follow-up, moderate limitations and fair health do not predict mortality anymore; the impact of severe limitation is reduced.

Our study contributes to the further validation of the Global Activity Limitation Indicator.

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3. Activity limitations and health care expenditures in the general population in Belgium

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Background

Health care expenditures represent an increasing part of the GDP in all OECD countries. In Belgium the proportion of the GDP used for health care rose between 2000 and 2011 from 8.1% to 10.5% [1]. There is no doubt that apart from the development of new technologies and medicines also the aging population and the associated increase of the burden of disease have contributed to this increase. This burden of disease is to a great extent reflected in the prevalence of chronic conditions, which include both physical and mental diseases, but also cardiovascular risk factors, such as hypertension and hyperlipidaemia [2].

However, in recent years an increasing number of studies assessing the impact of ill health have focused on disability rather than on chronic conditions. Although the terms "disability" and "chronic conditions" are often linked and even mistakenly used as synonyms, the conceptual framework of disability currently preferred by researchers is one in which disability is often related to but separate from chronic conditions [3]. People with chronic conditions may experience some form of disability, but not every person with a disability experiences a chronic health problem. Therefore in public health research, a distinction should be made between 1) individuals with disabilities without any chronic condition 2) individuals with disabilities who also have chronic conditions, and 3) individuals with disabilities who developed a disability as a results of chronic conditions [4].

According to the International Classification of Functioning, Disability, and Health (ICF) disability is a difficulty in functioning at the body, person, or societal levels, in one or more life domains, as experienced by an individual with a health condition in interaction with contextual factors [5]. This definition combines a biological understanding of impairment with the social dimension of disability [6]. Although the definition of disability is not unique and many frameworks exist to define disability [7], disability measures focusing on functioning ability rather than impairment are preferable. Examples of such measures are the Washington Group General Disability Measure [8], activities of daily living (ADLs) [9] and instrumental activities of daily living (IADLs) [10]. Those instruments take usually the form of a minimum of five separate questions.

The need for a global disability indicator, which was already identified in the late nineties [11], resulted in the past years in the development of the Global Activity Limitation Indicator (GALI), which identifies subjects with longstanding (at least 6 months) limitations due to a health problem by severity level via a single question [12]. The GALI has been designed particularly for health expectancy comparisons across Europe and has been validated in Belgium and other EU countries [13-17]. In older people, activity limitations measured via the GALI appear to be an important predictor of short term mortality, both in men and women [18].

To date, no studies have looked at the impact of activity limitations on health care expenditures by making use of the GALI. Moreover, although some studies investigated the link between disability and health care expenditures, most of them were done in the US, focused on either health insurance expenses or out-of-pocket expenses and did not take into account at the same time the presence of chronic diseases and disability [19-23].

In our study we investigated the impact of activity limitations on health care expenditures in Belgium, in which the health system is quite different from that in the US. The Belgian health
system is characterised by therapeutic freedom for physicians, freedom of choice for patients, a compulsory health insurance, and remuneration based on both fee-for-service payments and direct payments via sickness funds [24]. Differences in health care expenditures by severity level of activity limitations were studied taking into account the prevalence of chronic conditions. The association between health care expenditures and activity limitations was assessed for the total health expenses, but also for reimbursed and out-of-pocket expenses separately. Furthermore it was investigated to which extent differences in health care expenditures by activity limitation could be explained by socio-demographic characteristics and chronic conditions.

Methods

Data

Data were used from the Belgian National Health Interview Survey (HIS) 2008, which was conducted between May 2008 and July 2009 among a representative sample of Belgian residents (N = 11.254). A detailed description of the design and sampling methods has been described elsewhere [25]. For 91% of participants it was possible to make an individual linkage between data from the survey and data from the Belgian compulsory health insurance. In 2008, in total 10,677,313 people were registered as beneficiaries of this health insurance, i.e. 99.5% of the total population living in Belgium [26]. Health care expenditures were calculated for a period of 12 months starting with the expenses during the month of the participation in the HIS.

Participants were eligible if they were 15 years or older, had completed the self-administered questionnaire and had answered the GALI-question. People who had died in the year of the survey were excluded from the analysis because for these persons the period during which health care expenditures could be assessed, was always shorter than 12 months. After application of the inclusion and exclusion criterions 7,286 eligible respondents remained and were included in the analysis.

Information on health care expenditures was used for the years 2008, 2009 and 2010. Separate information was available for health expenses in relation to ambulatory care (excluding the cost of pharmaceuticals), hospital care, reimbursed medicines obtained in pharmacies and a fourth group of expenses consisting of an additional reimbursement for people living in a household that had reached a certain threshold of health care expenditures within a calendar year. The database included information on health expenses covered by the health insurance, but also on out-of-pocket expenses, and supplemental payments. Supplemental payments are additional health expenses for patients who opt for extra services, e.g. a hospital bed in a private room. In Belgium, hospitals get from the health insurance also a fixed amount per admitted patient. This fixed part was not included in the health care expenditures that were investigated in this study, because this information was not available in the database.

Activity limitations were measured with the GALI. The initial version of the question was used: “For the past 6 months or more have you been limited in activities people usually do because of a health problem? (Yes, strongly limited/Yes, limited/No, not limited)”. Information on chronic diseases was derived from the year prevalence of a list of 30 specific chronic conditions and health problems. Chronic conditions were considered to be

eligible for inclusion in the multivariate model if there appeared to be, after adjustment for age, gender and the other chronic conditions, an independent association with health expenditure. A composite indicator on chronic conditions was created distinguishing persons with none of the identified chronic conditions, only one condition and two or more conditions.
Further information used in the analyses included age, gender, educational attainment, income level, household type, nationality and degree of urbanization. Educational attainment was defined at the level of the household and was based on the highest diploma that was obtained by the reference person or the partner, if any. Four categories were considered: no diploma or only primary education, lower secondary, higher secondary and tertiary education. For income level, the quintiles of the equivalent household income were calculated. Five household types where distinguished: one person households, monoparental households, couples with children, couples without children and other types of households. Nationality was regrouped into Belgian, non-Belgian from a EU country and non-Belgian from outside the EU. Degree of urbanisation was based on morphological and functional characteristics of municipalities which resulted into an indicator with three categories: urban, semi-urban and rural municipalities.

Analyses

Descriptive results on overall health expenses, and health expenses by type and reimbursement modalities, were presented in function of the prevalence of activity limitation. Multivariate linear regression models were used to explore the association of health expenses with activity limitations in relation to chronic conditions and potential socio-demographic determinants. To account for the skewedness of the health care costs the natural logarithm was used as dependent variable. One euro was added to all costs to enable a logarithmic transformation for people who had not incurred any health costs. Variability in health care expenditures was expressed as cost ratios (CR) of the logarithm of the expenses compared to a reference category [27;28]. To study the factors that contribute to the difference in health expenditure between persons with and without activity limitations, the Blinder-Oaxaca decomposition method was used [29-31]. This technique decomposes the gap between the average of the logarithm of the health expenses in people with and without activity limitations into two components. One component is related to differences in the determinants of the expenditures between populations (the explained or endowed component), such as differences in socio-demographic or health differences between the two groups, and a second component is attributable to group differences in the effects of these determinants (the unexplained or coefficient component). Further information on the Blinder-Oaxaca decomposition is presented in the Appendix.

The sampling design of the Belgian HIS 2008 included stratification, clustering and over representation of the population of 75 years and older and residents living in the Brussels' Region. Analyses were done with Stata 13 [32] taking into account the design settings of the survey.

Results

Within the study population of 15 years and older, 5461 individuals (79.0%) had no activity limitations, 1364 (14.9%) moderate activity limitations and 461 (5.1%) severe activity limitations. People with severe activity limitations accounted for 16.9% of the total health expenditure, whereas those without activity limitations, were responsible for 51.5% of the total health expenditure. On average 57.0% of the expenses where ambulatory costs,

21.8% hospital costs, 18.2% costs for reimbursed medicines obtained in pharmacies and 3.0% not specified. In those figures the proportion of hospital costs is relatively low because fixed hospital costs were not included. The large majority of expenses (84.0%) were covered by the health insurance, 10.9% were out-of-pocket payments and 5.1% supplements.

Table 1 shows descriptive results of the mean health care expenditures in the 12 months following the participation of the survey. Overall average yearly health care expenditures increased from 1220 euro per year among people with no limitation, over 3803 euro among people with moderate limitations to 7358 euro among people with limitations. Due to the skewedness of the results the mean values are highly influenced by the individuals with high expenditures. However, also when looking at median values there are huge differences; for people with no limitation the median value of health care expenditure was 506 euro; for people with moderate and severe limitations those expenditures were respectively 1965 euro and 3768 euro. The contribution of reimbursed health care expenditures increased with the limitation status: from 81.8% if of no limitations are reported to 86,3% in case of moderate and 89.9% in case of severe limitations. The differences are significant ($p < 0.001$) after adjustment for age and gender.

Among a list of 30 chronic conditions 15 where identified which were, after adjustment for age, gender and the other diseases, significantly associated with higher overall health care expenditures (Table 2). This association was highest for cancer (CR 3.77), kidney problems, other than kidney stones (CR 2.73) and diabetes (CR 2.31), but also significant, in descending order of the magnitude of the association, for coronary heart disease (CR 1.92), myocardial infarction (CR 1.90), depression (CR 1.78), peptic ulcer (CR 1.62), hypertension (CR 1.50), asthma (CR 1.44), problems of the large bowel (CR 1.43), stroke (CR 1.36), chronic bronchitis (CR 1.33), thyroid problems (1.30), neck disorder (CR 1.22) and osteoarthritis (CR 1.19).

Table 3 presents differences in health expenditure by level of activity limitation and by chronic condition after adjustment for age, gender, education, income, nationality, household type and degree of urbanisation. It is clear that both activity limitations and chronic conditions contribute independently to health expenditure. The adjusted CR of having a moderate limitation was 1.88 and of having a severe limitation 3.21. People with one chronic condition (among the 15 that were selected) had an adjusted cost ratio of 1.82 compared to those without any of those diseases; for those with more than one chronic conditions the CR was 2.84. Chronic conditions and activity limitations contributed in a cumulative way to increase health care expenditures. In the absence of an activity limitation the adjusted CR for those with one chronic condition was 1.94 and for those with two or more chronic conditions 3.01. Among persons with no chronic condition the adjusted CR was 2.46 if they had a moderate activity limitation and 4.45 in case of a severe activity limitation. However, a severe activity limitation in combination with more than one chronic condition yielded an adjusted CR of 9.60. The interaction between activity limitation and chronic condition was not significant (results not shown), which indicates that the association between activity limitation and health care expenditure did not depend on the presence of a chronic condition.

It is striking that differences in cost ratios both in function of activity limitations and chronic conditions are far more pronounced for payments covered by the health insurance than for out-of-pocket expenses and supplements. The adjusted CR for people with a severe activity limitation and more than one chronic condition compared to those with none of

both is much higher (10.22) for payments covered by the health insurance, than for out-of-pocket payments (5.31) and supplements (4.11).

When trying to explain the gap in the health care expenditure between people with activity limitation and people without activity limitation (Table 4) we observe that 20.2% (0.324/1.605) is explained by age, 3.5 % (0.056/1.605) by gender, 3.1 % (0.049/1.605) by education and 22.2 % (0.356/1.605) by chronic conditions. Other factors, such as income, nationality, household type and the degree of urbanisation of the municipality where the person lives, do not contribute significantly in explaining this gap. More than half of the gap (52.1%) cannot be explained.

The contribution of chronic conditions in explaining the gap between health care expenditures between people with and without activity limitation is higher for out-of-pocket payments than for reimbursed health care expenditures. Chronic conditions explain 27.5% of the gap for out-of-pocket payments and 22.2% of the gap for reimbursed health care expenditures. For supplements this percentage is 16.6%.

Discussion

Our findings indicate that activity limitations are a strong determinant of health care expenditures. To some extent differences in health care expenditures by level of activity limitations can be explained by chronic conditions, but also after controlling for chronic conditions, there is a strong and independent association between activity limitations and health care expenditures.

Disability in this study was assessed with the GALI, which is the measure underlying the EU structural indicator Health Life Years [12]. The GALI is included in the European Survey on Income and Living Conditions (EU-SILC) and the European Health Interview Survey (EHIS) and is therefore one of the indicators for which sustainable and comparable information is available across all EU countries. From a conceptual point of view the GALI relates to performance, rather than to capacity. It encompasses the social model of disability, which has also influenced the current WHO classification (ICF) [33].

The health care expenditures for which the research questions were investigated include the majority of health expenses, with the exception of the fixed hospital costs, representing about a fifth of the total expenditure. Information was also available for out-of-pocket and supplemental payments. Due to the compulsory nature of the Belgian health insurance and the representativeness of the sample, extrapolation of the study results to the total Belgian population is warranted.

The descriptive results clearly demonstrate the impact of activity limitations on health care expenditure in absolute terms. Although context, target group and concept of disability differed from a study that was conducted in the US in 2007-2008 [23], it is remarkable that the median overall health care expenditures reported in the latter study (4234 US$ for persistent disability, 1612 US$ for temporary disability and 748 US$ for no disability) are quite close to our findings. Also another US study in which median expenditures are presented [22] reports values that are in line with the figures in our study. Whereas the population with activity limitations represents only one fifth of the population, it accounts for almost half of the health care expenditures. If a causal relationship is assumed, considerably savings to society can be gained if the population with activity limitations can be reduced.

The mechanism through which activity limitations lead to higher health care expenses cannot solely be explained in terms of differences in chronic conditions. Most studies exploring differences in health care expenditures focus either on disability, either on chronic conditions [34]. However, the conceptual framework of disability currently preferred by most experts is one in which disability is related but separate from health [3]. Moreover, the disabling impact of different chronic conditions varies [35]. Musculoskeletal diseases, which contribute a lot to the burden of disability, may explain differences in health care expenditures less if their cost is relatively low compared to the cost of other diseases. Disentangling the impact of disability and chronic conditions helps to highlight the social dimension of disability as an explanatory factor for differences in health care expenditures. Our results clearly indicate that chronic conditions explain to a certain extent, but definitely not completely, differences in health care expenditures by level of activity limitation. Although the independent association between activity limitations and health care expenditures, observed in this study, may have been partially due to chronic conditions which were either not in the list, either not reported, the strength of the association strongly suggests that also activity limitations in the absence of chronic conditions contribute substantially to health care expenditures. This illustrates not only the multidimensional aspect of health, it also indicates that measures trying to reduce health care expenditures due to disability should not only focus on patients with known chronic conditions.

When comparing the results between reimbursed health care expenditures and out-of-pocket payments it appears that for reimbursed health care expenditures, the strength of the association between activity limitations and health care expenditures is larger than for out-of-pocket payments. This stronger association is a positive finding as it reflects that public health care resources, more than own contributions, are spent on people with activity limitations. Furthermore, the contribution of chronic conditions to explain the gap of health care expenditures by activity limitation level appears to be smaller for reimbursed health care expenditures than for out-of-pocket payments, or – to put it in another way – reimbursed health care expenditures are more often due to activity limitations without chronic conditions than out-of-pocket payments. A possible hypothesis is that the social dimension of disability is more an explanatory factor of reimbursed health care expenditures than of out-of-pocket payments.

This is to our knowledge the first study to investigate differences in health care expenditures by disability status based on a representative sample in a European country. The extent to which the type of health system interferes with the observed results is unknown. The Belgian health system is based on a Bismarckian model, as opposed to the Beveridge model which is found in the UK and the Scandinavian countries and the private insurance model of the US [36]. Probably the effect of the health system is minor. Studies in the US including disability measures that essentially measured functional status show results that are quite comparable with ours.

Some study limitations should be reported. Although the study sample was representative of the population some exclusion and inclusion criteria were applied, which may have created a bias. E.g. people who were interviewed by proxy and respondents who died in the year of the survey were excluded. However, especially those people are more likely to be disabled and have large health care expenditures.

Measuring disability is challenging. Although the GALI has been validated, it remains a self-reported item, with several crucial conceptual elements included in one question. Some concerns have been raised with respect to the accurateness in which this question is answered by respondents.

Also the definition of chronic conditions was based on self-reports. The validity of self-reported specific chronic diseases is limited and depends strongly on the type of disease [37;38]. Furthermore chronic conditions that were considered for inclusion were restricted to the list of diseases for which information was available in the Belgian HIS2008.

Some health care expenditures were not included, e.g. fixed day fees for a hospital stays. The same applies for health care expenditures that were not reported within the compulsory health insurance system, although these represent only a marginal fraction in comparison with the reported health care expenditures.

Conclusion

Although these limitations are well acknowledged it is felt that they do not jeopardise the overall findings of the study. Activity limitations are a major driver for health care expenditures and, at least in the Belgian situation, this is more pronounced for reimbursed health care expenditures than for out-of-pocket payments. Chronic conditions explain to a certain extent differences in health care expenditures by level of activity limitation, but also in the absence of chronic conditions activity limitations appear to be an important determinant of health care expenditures. Health is a broader concept than simply the presence of chronic conditions. Activity limitations due to physical, mental and social problems that are not associated with chronic conditions appear to have an important impact on health care expenditures. Future research should try to clarify this further.

Table 1 Mean annual health expenses (in euro) in function of activity limitation

	Not limited (n = 5461)		Moderately limited (n = 1364)		Severely limited (n = 461)		All (n = 7286)	
By type of health expenses	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Ambulatory care (no medicines)	713	(662-764)	2143	(1869-2417)	3989	(3342-4636)	1108	(1034-1181)
Hospital care	257	(189-326)	784	(627-941)	1748	(1221-2275)	417	(351-484)
Reimbursed medicines obtained in pharmacies	220	(201-239)	770	(668-872)	1370	(1042-1699)	366	(336-396)
Not specified	32	(27- 37)	116	(96-137)	280	(192-369)	58	(51-65)
By payment modality								
Health insurance	998	(898-1098)	3283	(2941-3624)	6614	(5658-7570)	1648	(1530-1766)
Out-of-pocket	158	(149-167)	374	(346-402)	567	(476-658)	213	(203-224)
Supplement	64	(55-74)	147	(108-185)	178	(103-254)	83	(73-94)
All health expenses	1220	(1110-1329)	3803	(3435-4170)	7358	(6309-8408)	1944	(1815-2073)

Table 2 Prevalence of chronic conditions considered in the study and cost ratio (CR) of total health expenses for persons with the disease compared to those without

		Prevalence (weighted %)	(95% CI)	CR[§]	(95% CI)
Respiratory problems					
	Asthma	4.1	(3.6-4.8)	1.44*	(1.15-1.81)
	Chronic bronchitis	3.9	(3.4-4.5)	1.33*	(1.06-1.68)
Cardiovascular problems					
	Myocardial infarction	0.7	(0.5-0.9)	1.90*	(1.28-2.84)
	Coronary heart disease	2.1	(1.7-2.6)	1.92*	(1.33-2.78)
	Stroke	1.0	(0.7-1.3)	1.36*	(1.01-1.82)
	Hypertension	15.9	(14.7-17.1)	1.50*	(1.30-1.73)
Musculoskeletal problems					
	Rheumatoid arthritis	7.2	(6.5-8.0)	1.12	(0.92-1.37)
	Osteoarthritis	16.0	(14.8-17.2)	1.19*	(1.00-1.40)
	Low back disorder	21.1	(19.7-22.4)	1.08	(0.91-1.27)
	Neck disorder	11.9	(10.9-12.9)	1.22*	(1.03-1.44)
	Osteoporosis	4.6	(4.1-5.3)	0.83	(0.64-1.07)
Neurological problems					
	Headache/migraine	10.0	(9.1-11.9)	1.15	(0.95-1.39)
	Parkinson's disease	0.4	(0.2-0.6)	2.00	(0.60-6.71)
	Epilepsy	0.6	(0.4-1.0)	1.69	(0.88-3.22)
Psychological problems					
	Chronic anxiety	5.2	(4.6-6.0)	1.23	(0.99-1.53)
	Depression	6.0	(5.3-6.8)	1.78*	(1.44-2.20)
Problems related to digestive system					
	Peptic ulcer	3.7	(3.1-4.4)	1.62*	(1.22-2.15)
	Liver problems	0.5	(0.4-0.7)	1.61	(0.76-3.39)
	Problem large bowel	3.2	(2.7-3.8)	1.43*	(1.10-1.88)
	Gall-bladder problems	0.7	(0.5-0.9)	0.96	(0.58-1.62)
Problems related to endocrine system					
	Diabetes	3.8	(3.3-4.4)	2.31*	(1.91-2.79)
	Thyroid problems	4.5	(4.0-5.2)	1.30*	(1.04-1.62)
Urinary problems					
	Urinary incontinence	3.3	(2.8-3.9)	1.24	(0.93-1.65)
	Chronic cystitis	1.3	(1.0-1.6)	1.13	(0.83-1.54)
	Kidney stones	0.7	(0.5-1.0)	0.88	(0.37-2.10)
	Other kidney problems	0.7	(0.5-0.9)	2.73*	(1.22-6.09)
Eye problems					
	Glaucoma	1.7	(1.4-2.1)	1.17	(0.86-1.58)
	Cataract	2.8	(2.4-3.3)	1.00	(0.78-1.28)
Other problems or diseases					
	Cancer (all types)	2.1	(1.7-2.6)	3.77*	(2.56-5.57)
	Allergy	14.0	(12.8-15.2)	1.04	(0.88-1.22)
	Chronic or severe skin disease	3.0	(2.4-3.7)	1.26	(0.94-1.69)

[§] adjusted for age, gender and the other diseases *significant ($p < 0.05$)

Table 3 Cost ratios (CR) of health expenses by activity limitations and chronic conditions[§], adjusted for age, gender, education, income, nationality, household type and degree of urbanisation, in function of payment modalities

	Total health expenditure		Covered by health insurance		Out of pocket		Supplement	
	CR	95% CI	CR	95% CI	CR	95% CI	CR	95% CI
Activity limitations and chronic conditions combined								
No activity limitation - no chronic condition[#]	1.00		1.00		1.00		1.00	
No activity limitation – 1 chronic condition[#]	1.94	(1.66-2.27)	1.93	(1.65-2.26)	1.86	(1.63-2.11)	1.27	(1.04-1.55)
No activity limitation – ≥ 2 chronic conditions[#]	3.01	(2.48-3.65)	3.04	(2.51-3.69)	2.59	(2.20-3.04)	1.33	(1.04-1.71)
Moderate activity limitation - no chronic condition[#]	2.46	(1.74-3.48)	2.50	(1.77-3.54)	1.82	(1.36-2.44)	1.46	(1.02-2.09)
Moderate activity limitation – 1 chronic condition[#]	3.16	(2.38-4.20)	3.21	(2.43-4.25)	2.59	(2.06-3.25)	2.06	(1.29-3.04)
Moderate activity limitation - ≥ 2 chronic conditions[#]	5.20	(4.23-6.39)	5.33	(4.34-6.55)	3.82	(3.26-4.48)	2.55	(1.87-3.48)
Severe activity limitation - no chronic condition[#]	4.45	(2.47-8.02)	4.70	(2.57-8.58)	2.82	(1.66-4.79)	1.21	(0.60-2.43)
Severe activity limitation – 1 chronic condition[#]	4.80	(2.99-7.70)	5.14	(3.20-8.25)	2.92	(1.92-4.45)	1.87	(1.00-3.51)
Severe activity limitation - ≥ 2 chronic conditions[#]	9.60	(7.41-12.44)	10.22	(7.87-13.27)	5.31	(4.24-6.64)	4.11	(2.68-6.29)
Activity limitations adjusted for chronic conditions								
No limitation	1.00		1.00		1.00		1.00	
Moderate activity limitation	1.88	(1.59-2.22)	1.91	(1.62-2.56)	1.54	(1.35-1.76)	1.64	(1.33-2.03)
Severe activity limitation	3.21	(2.57-4.02)	3.41	(2.72-4.27)	2.03	(1.67-2.48)	2.14	(1.52-3.01)
Chronic condition adjusted for activity limitations								
No chronic condition[#]	1.00		1.00		1.00		1.00	
1 chronic condition[#]	1.82	(1.57-2.11)	1.81	(1.56-2.09)	1.76	(1.56-1.99)	1.26	(1.05-1.52)
≥ 2 chronic conditions[#]	2.84	(2.41-3.35)	2.87	(2.43-3.38)	2.51	(2.19-3.87)	1.51	(1.23-1.89)

§Defined as: having suffered in the past 12 months from at least one of the following health problems: asthma, chronic bronchitis, myocardial infarction, coronary heart disease, stroke, hypertension, osteoarthritis, neck disorder, depression, peptic ulcer, problem large bowel, diabetes, thyroid problems, kidney problems except for kidney stones, cancer

[#] Limited to list of chronic conditions specified above

Table 4 Decomposition of the gap between people with activity limitations (AL) and no activity limitations in terms of the natural logarithm of the health care expenditure and the contribution of each variable in creating this gap in the explained and unexplained components

Log (health care expenditure)	Total health expenditure		Covered by health insurance		Out of pocket		Supplement	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Prediction in people with AL	7.499	< 0.001	7.319	< 0.001	5.379	< 0.001	2.245	<0.001
Prediction in people without AL	5.894	< 0.001	5.662	< 0.001	4.201	< 0.001	1.395	<0.001
Gap	1.605	< 0.001	1.657	< 0.001	1.178	< 0.001	0.850	<0.001
Explained								
Age	0.324	< 0.001	0.333	< 0.001	0.279	< 0.001	0.143	<0.001
Gender	0.056	< 0.001	0.053	< 0.001	0.053	< 0.001	0.037	<0.001
Education	0.049	0.030	0.054	0.015	0.026	0.175	-0.038	0.152
Income	-0.010	0.564	-0.005	0.751	-0.038	0.011	-0.036	0.072
Nationality	0.018	0.099	0.016	0.110	0.015	0.042	0.004	0.783
Household type	-0.025	0.265	-0.019	0.402	-0.044	0.017	0.007	0.889
Degree of urbanisation	0.002	0.706	0.001	0.749	0.002	0.549	0.001	0.256
Chronic condition	0.356	<0.001	0.356	< 0.001	0.324	< 0.001	0.141	<0.001
Total	0.768	<0.001	0.791	< 0.001	0.616	< 0.001	0.259	<0.001
Unexplained								
Age	0.882	0.023	0.871	0.026	0.586	0.033	0.605	0.109
Gender	-0.635	0.003	-0.616	0.004	-0.516	0.002	0.010	0.973
Education	0.347	0.029	0.337	0.034	0.271	0.040	0.334	0.108
Income	-0.118	0.394	-0.128	0.357	0.009	0.936	-0.007	0.966
Nationality	-0.004	0.852	-0.005	0.837	0.002	0.907	0.018	0.570
Household type	-0.284	0.035	-0.283	0.035	-0.090	0.386	-0.084	0.722
Degree of urbanisation	-0.031	0.649	-0.029	0.669	-0.036	0.502	-0.032	0.304
Chronic condition	-0.151	0.260	-0.149	0.271	-0.075	0.482	0.233	0.129
Constant	0.830	0.118	0.867	0.104	0.410	0.295	-0.486	0.385
Total	0.837	<0.001	0.866	0.000	0.562	0.000	0.591	<0.001

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APPENDIX

The Blinder-Oaxaca decomposition method

The counterfactual decomposition technique described by Blinder and Oaxaca is often used to analyse wage gaps by sex or race. It ”decomposes” outcome variables into explained and unexplained variation. This “unexplained” part is often used as a measure for discrimination, but it also subsumes the effects of group differences in unobserved predictors. Most applications of the technique can be found in the labour market and discrimination literature, but the method may also be useful in other fields. In this study it was applied to analyse differences in health care expenditures by activity limitation status.

The assumption of the Blinder-Oaxaca decomposition are that the outcome variable y is linearly related to the covariates, x, and the error term, ε, is independent of x. It is assumed that the difference in health care expenditures, y, between people with and without activity limitation is explained by a vector of determinants, x, in a regression model. First, separate regression models are constructed for people with and without activity limitation

$$y_{NAL} = \alpha_{NAL} + \beta_{NAL}\, x_{NAL} + \varepsilon_{NAL} \quad (1)$$
$$Y_{AL} = \alpha_{AL} + \beta_{AL}\, x_{AL} + \varepsilon_{AL} \quad (2)$$

To look at differentials in health care expenditures between people with and without activity limitations, a counterfactual equation is constructed by replacing the intercept and the coefficient in the first equation (1) with those from the second one (2):

$$Y_{NAL}^{*} = \alpha_{AL} + \beta_{AL}\, x_{NAL} + \varepsilon_{NAL}$$

The differential can then be split up between a difference due to characteristics effects (explained variation) and coefficient effects (unexplained variation):

$$\bar{y}_{AL} - \bar{y}_{NAL} = (\bar{y}_{AL} - \bar{y}_{NAL}^{*}) + (\bar{y}_{NAL}^{*} - \bar{y}_{NAL})$$

with the explained variation $\bar{y}_{AL} - \bar{y}_{NAL}^{*} = \beta_{NAL}\,(\bar{x}_{AL} - \bar{x}_{NAL})$
and the unexplained variation $\bar{y}_{NAL}^{*} - \bar{y}_{NAL} = (\alpha_{AL} - \alpha_{NAL}) + (\beta_{AL} - \beta_{NAL})\,\bar{x}_{NAL}$
which results in the following Blinder-Oaxaca decomposition equation:

$$\bar{y}_{AL} - \bar{y}_{NAL} = \beta_{AL}\,(\bar{x}_{AL} - \bar{x}_{NAL}) + [(\alpha_{AL} - \alpha_{NAL}) + (\beta_{AL} - \beta_{NAL})\,\bar{x}_{NAL}] \quad (3)$$

A graphical illustration is presented in Figure 1.

Often not only is the total decomposition of the outcome differential into an explained and un explained part of interest, but also the detailed contributions of the single predictors or sets of predictors are subject to investigation. Identifying

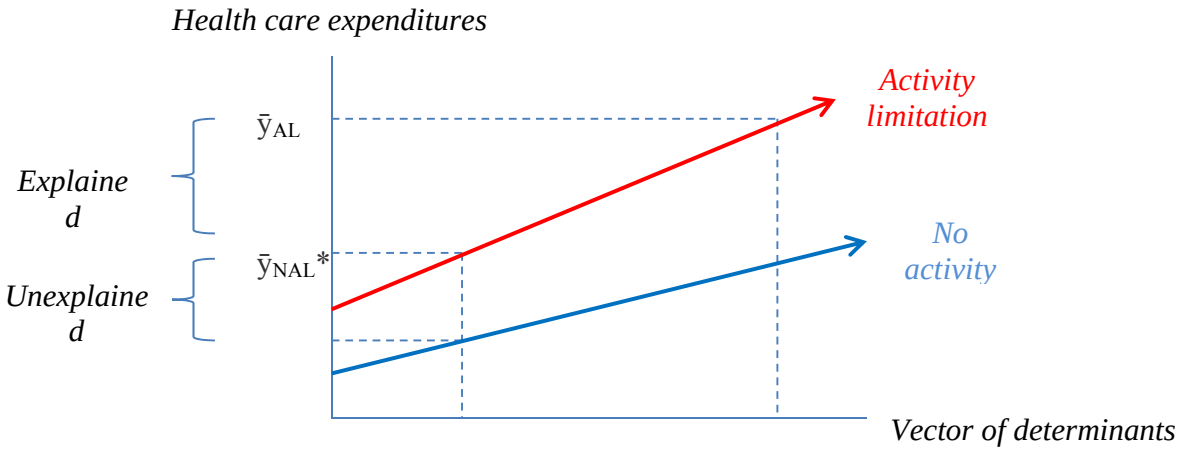
the contributions of the individual predictors to the explained part of the differential is easy because the total component is a simple sum over the individual contributions. For example, for decomposition (3),

$$\beta_{AL}\,(\bar{x}_{AL} - \bar{x}_{NAL}) = \beta_{1AL}\,(\bar{x}_{1AL} - \bar{x}_{1NAL}) + \beta_{2AL}\,(\bar{x}_{2AL} - \bar{x}_{2NAL}) + \ldots$$

where $\bar{x}_1$, $\bar{x}_2$,…. are the means of the single regressors and β_1, β_2,… are the associated coefficients. The first summand reflects the contribution of the group differences in $\bar{x}_1$,the second of differences in $\bar{x}_2$, and so on. Similarly, using decomposition (3) as an example, the individual contributions to the unexplained part are the summands in

$$(\alpha_{AL} - \alpha_{NAL}) + (\beta_{AL} - \beta_{NAL})\,\bar{x}_{NAL} = [(\alpha_{1AL} - \alpha_{1NAL}) + (\beta_{1AL} - \beta_{1NAL})\,\bar{x}_{1NAL}] + [(\alpha_{2AL} - \alpha_{2NAL}) + (\beta_{2AL} - \beta_{2NAL})\,\bar{x}_{2NAL}] + \ldots$$

Figure 1 Health care expenditures (y) in function of a vector of determinants (x) by activity limitation. Graphical illustration of the Blinder-Oaxaca decomposition



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