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Journal of Clinical Epidemiology 64 (2011) 436−443

Journal of Clinical Epidemiology

Future disability projections could be improved by connecting to the theory of a dynamic equilibrium

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Accepted 22 April 2010

Abstract

Objective: Projections of future trends in the burden of disability could be guided by models linking disability to life expectancy, such as the dynamic equilibrium theory. This article tests the key assumption of this theory that severe disability is associated with proximity to death, whereas mild disability is not.

Study Design and Setting: Using data from the GLOBE study (Gezondheid en Levensomstandigheden Bevolking Eindhoven en omstreken), the association of three levels of self-reported disabilities in activities of daily living with age and proximity to death was studied using logistic regression models. Regression estimates were used to estimate the number of life years with disability for life spans of 75 and 85 years.

Results: Odds ratios of 0.976 (not significant) for mild disability, 1.137 for moderate disability, and 1.231 for severe disability showed a stronger effect of proximity to death for more severe levels of disability. A 10-year increase of life span was estimated to result in a substantial expansion of mild disability (4.6 years) compared with a small expansion of moderate (0.7 years) and severe (0.9 years) disability.

Conclusion: These findings support the theory of a dynamic equilibrium. Projections of the future burden of disability could be substantially improved by connecting to this theory and incorporating information on proximity to death.

Keywords: Activities of daily living; Age factors; Longevity; Projections; Death; Compression of morbidity

1. Introduction

In the coming decades, human life expectancy is likely to further increase [1,2]. The issue whether this increase of life expectancy will correlate with either compression of disability [3] or expansion of disability [4,5] has been the subject of debate ever since the publication of Fries' [3] seminal article on compression of morbidity. A compression, that is, a decrease in the number of years that people may expect to live with disability, can only occur when the increase in life expectancy is surpassed by a stronger increase in the mean age of the onset of disability. When the increase in the age of the onset of disability will not keep pace with rising life expectancy, expansion will occur, that is, an increase in the number of years that people may expect to live with disability. Explorative analyses of future compression or expansion in disability are needed to prepare future health care systems to cope with the health effects of ageing of the population.

Projections of future trends in the total burden of disability have been applied that were based on past trends of disability [6,7]. Unfortunately, application of these methods involved some difficulties. Past trends of disability were often not unambiguously pointing toward one direction and therefore constituted a weak basis for projections [6,8]. Furthermore, studies do not present univocal methods to extrapolate trends, as it is not clear to what extent past trends will keep pace in the future [6,7]. The complex mechanisms that simultaneously drive the life expectancy and the expectancy of life with disability are still not fully understood. This complicates the modeling of the effect of increasing life expectancy on the future burden of disability [9].

The extent to which gained life years will be spent in disability will greatly be determined by the relative part of disability in the population that is specifically related to end-of-life processes and will therefore shift to older ages as life expectancy increases. Assuming that most severe disability is reserved to the end of life [10−12], but that mild disability mostly occurs independent to the end-of-life processes, it is to be expected that with increase of life expectancy most severe disability will shift to older ages, but that mild disability will mostly expand. This scenario, which is expressed in the theory of a dynamic equilibrium, is

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0895-4356/$ - see front matter
doi: 10.1016/j.jclinepi.2010.04.018

What is new?

- This article tests the assumption derived from the theory of a dynamic equilibrium that severe disability is related to proximity to death, whereas mild disability is not.
- By means of analysis of disability in relationship to time to death, we demonstrated that moderate and severe disabilities were indeed related to proximity to death, whereas mild disability was not.
- Based on these associations, it was calculated that a 10-year increase of life span would result in substantial expansion of mild disability (4.6 years) but small expansion of moderate (0.7 years) and severe disability (0.9 years).
- These findings support the theory of a dynamic equilibrium and imply that projections of the future burden of disability could be improved by connecting to this theory and incorporating information on proximity to death.

graphically represented in Fig. 1 [13]. Severe disability is fully dependent on proximity to death and, consequently, with increase of life expectancy, the onset of severe disability equivalently shifts to older ages. Mild disability is fully dependent on age and, therefore, the onset of mild disability does not change as life expectancy increases. The years spent in severe disability did not change, whereas the years in mild disability expanded.

The present article aims to assess whether the theory of a dynamic equilibrium [13] provides a valid framework for projections of the future burden of disability. We will test the key assumption of this theory that the occurrence of severe disability is associated with proximity to death, whereas the occurrence of mild disability is not. Based on estimates of associations of disability with age (time since birth) and proximity to death, we will calculate to what extent the lifetime burden of mild, moderate, and severe disability will expand in the hypothetical case of a 10-year increase of life span.

2. Methods

2.1. Study population

We used data from the GLOBE study (Gezondheid en Levensomstandigheden Bevolking Eindhoven en omstreken), a prospective cohort study investigating the explanation of inequalities in health in The Netherlands [14]. The study comprised a baseline postal survey in 1991, conducted among a stratified random sample of 27,070 inhabitants of the city of Eindhoven (40%) and surrounding municipalities (60%). The age range was set at 15–74 years with overrepresentation

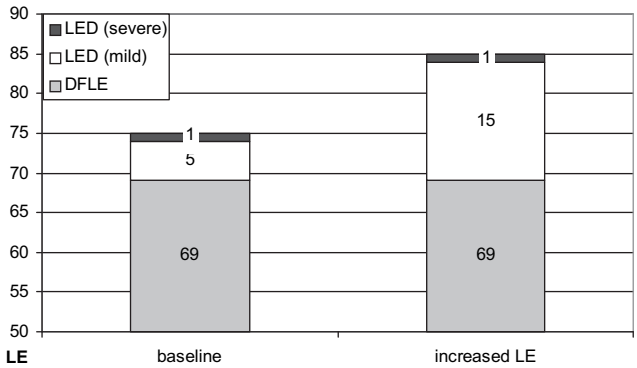

Fig. 1. Effects of increasing life expectancy on LED ^{mild} and LED ^{severe} according to the theory of a dynamic equilibrium.

of 45 years and older. Institutionalized persons were excluded in Eindhoven but not in the surrounding municipalities. The response to the baseline questionnaire was 70.1% (n = 18,973).

A subsample (n = 3,968) of the initial cohort was invited for an oral interview and received annual follow-up questionnaires until 1997 (except for 1996). The subsample overrepresented subjects suffering from asthma/chronic obstructive pulmonary disease (COPD), heart disease, and diabetes mellitus. The response to the oral interview was 72.2% (n = 2,867). All analyses in the present article were based on data from the subsample.

The mean age of the subsample at baseline was 52.6 years, and 34% of the subjects had mild, moderate, or severe activities of daily living (ADL) disability. At the moment of the last administrative follow-up in 2004, 16% of the sample had died. Among subjects being ADL disabled at baseline, this was 26% compared with 11% among nondisabled subjects.

2.2. Attrition and item nonresponse

The maximal number of questionnaires that could have been obtained during follow-up of the GLOBE subsample was six waves times the 2,867 initial respondents = 17,202 questionnaires. However, 3,337 questionnaires were not returned during follow-up, leaving a total of 13,865 questionnaires.

Among questionnaires that were returned, 572 had incomplete data on ADL disability. Information was missing for only one item of ADL disability in 226 cases. In these cases, we imputed the missing item with the value of the preceding year or (for 1991) the next year. Single instead of multiple imputation was justified because of the small amount of missing values. Three hundred forty-six cases with information missing for more than one item were excluded from the analysis. In total, 13,519 questionnaires with information on ADL disability were available.

2.3. Disability measure

Disability was measured by means of 10 ADL items. The items were ‘‘walking down/upstairs, moving outdoors,