Chapter 8
Changes in Functional Ability with Ageing and Over Time

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Introduction

The steady increase in life expectancy in most European countries implies that a growing number of citizens reaches higher ages increasingly. For decades now, this development has been a cause for concern to policy makers and the general public because of the expected increase in costs of health and social care. This concern has given rise to the need for population-based data to monitor health and daily functioning of older persons, and to obtain insight into trajectories leading to the utilisation of care services. For projections of health and social care costs, it is furthermore of interest to monitor trends in the prevalence of ill-health and disability at the population level to see how this changes over time.

The concept of disability, in this chapter, is defined as a consequence of ill-health or illness, generally chronic diseases. Disability is established as a powerful indicator of health status at older age (Guralnik et al. 1996). Some theoretical models have been developed with the aim of conceptually linking ill-health to disability, including the model adopted by the World Health Organisation (WHO 2002), which defines functional ability as encompassing all body functions, tasks, or actions, and disability as including impairment, limited capacity or restricted performance of activities. Measurement of disability usually entails self-reports of difficulty or need of help in performing everyday tasks needed for independent living. The term disability is often used to include mobility impairment, which is considered to precede disability in

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activities of daily living (Verbrugge and Jette 1994). In a growing number of studies, performance-based tests are used to capture early stages of disability (Guralnik et al. 1994).

If prevalences of ill-health and disability rise or fall, factors responsible for these changes need to be traced. Thus, determinants of the onset and course of disability, as well as consequences of disability, need to be studied using longitudinal data. This chapter reviews empirical data on trends in the prevalence of disability, on changes in functional ability and on determinants and consequences of such changes.

Availability of Data

Comparison of morbidity and disability across European countries is difficult, because each country shapes its health policy using its own concepts and measurement of health indicators. The first international studies started in the 1960s and 1970s in a few European countries, but were limited in scope or included only a selection of the older population (Appels et al. 1996; Jylhä et al. 1998; Knoops et al. 2004).

Since the 1980s, epidemiological studies of health and functioning in older age have boomed. Although the initial focus of epidemiological studies was mainly on ageing-related chronic diseases, their focus shifted to independence in daily functioning as this was increasingly considered to be an essential aspect of healthy ageing. Several of these studies, moreover, were interdisciplinary in scope, because there was an understanding that with ageing, physical, mental and social aspects of functioning are closely related. Most were confined to smaller geographic areas such as one city or county.

Only in the 1990s, a number of cross-national surveys became available that used common instruments and sampling methods. The best known is the European Community Household Panel survey, conducted in the non-institutionalised population in 13 countries. For the assessment of health in older age, however, this survey is less suitable, because in many countries a sizeable proportion of older persons live in institutions.

In the early 1990s, in various countries across Europe, longitudinal studies on ageing were started that were in part or fully funded by national governments. A decade later, the European Union started to fund consortia that performed cross-national longitudinal studies, either making use of existing cohort studies, or setting up identical data collection in a number of countries (e.g. Minicuci et al. 2003; Börsch-Supan et al. 2005). In the Netherlands, the Ministry of Welfare, Health and Culture in 1991 initiated a nation-wide, interdisciplinary, longitudinal study to monitor changes in daily functioning in the older Dutch population, the Longitudinal Aging Study Amsterdam (LASA), with data collection cycles every 3 years. It includes more than 4,000 participants aged 55–102 years (Huisman et al. 2011). This study now spans almost 20 years and is one of the longest running nationally representative studies in Europe. This chapter will draw predominantly on findings from this study.

Daily Functioning: Morbidity and Disability

Daily functioning in ageing in the first place is dependent on the presence of chronic diseases, also termed morbidity. Although their prevalences vary across European countries, there is a fair agreement in the top five of chronic conditions. First in rank are musculoskeletal diseases, including arthritis and osteo-porosis, with a prevalence ranging from 40 % to 70 %, depending on the country. Heart diseases, including myocardial infarction, angina pectoris, heart failure and peripheral artery disease, rank second. Respiratory diseases, including chronic bronchitis, emphysema and asthma, rank next. Diabetes ranks fourth, and stroke and cancer share the fifth rank with prevalences from 5 % to 11 % (Minicuci et al. 2003).

Although morbidity itself may not profoundly affect daily functioning, it may have consequences in terms of functional ability and ultimately, disability (WHO 2002). Severity levels of disability are distinguished, depending on the tasks of daily living in which difficulty is present. More complex activities such as shopping, preparing a meal and doing housework are termed instrumental activities of daily living (IADLs), and disability in IADLs is considered mild disability. More basic, and at the same time more obligatory activities, such as bathing, dressing and toileting, are termed activities of daily living (ADLs), and disability in ADLs is considered severe disability. The latter are less likely to be affected by socio-cultural factors than the former. Nevertheless, a surprising variety is observed in prevalence of ADL disability across European countries, ranging from 6 to 35 %. ADL disability turns out to have highest prevalence in Italy and Spain, and lowest in Finland, suggesting a north-south gradient (Pluijm et al. 2005; Van den Brink et al. 2003).

Trends in the Prevalence of Morbidity and Disability

In all western countries, there is ample evidence of an increase in the age-specific prevalence of chronic diseases in the past 20 years (Freedman and Martin 2000; Fleming et al. 2005). This increase may partly be explained by earlier diagnosis and improved medical treatment. As a result, persons with a chronic disease may live longer with their disease, thus raising the prevalence of chronic diseases.

For the Netherlands, based on data from LASA, Fig. 8.1 shows changes in the prevalence of several common chronic diseases among 65–85-year olds during the period 1992–2009. In general, a rise in the prevalence of diseases is observed. Detailed calculations show that these increases are greater than 10 % for heart diseases, diabetes, cancer and joint disorders. Thus, also for the Dutch older population, a substantial increase in the prevalence of chronic diseases is seen.

The prevalence of disability may also change over time as it is linked to chronic diseases, but the trend in disability prevalence may not correspond to the trend in chronic disease prevalence. Indeed, according to the dynamic equilibrium theory (Manton 1982), morbidity or mild disability may show a trend that is different from severe disability. Following the course of a chronic disease, we will first encounter
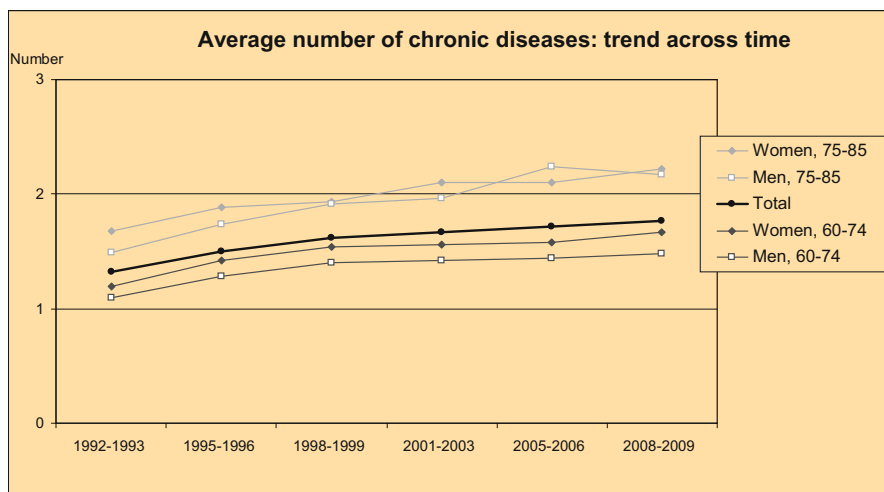
Average number of chronic diseases: trend across time

Number

Legend:
- Women, 75-85
- Men, 75-85
- Total
- Women, 60-74
- Men, 60-74

X-axis: 1992-1993, 1995-1996, 1998-1999, 2001-2003, 2005-2006, 2008-2009

Fig. 8.1 Time trend of average number of diseases by age and gender. (Longitudinal Aging Study Amsterdam, 1992–2009)

mild disability, and later on, severe disability. This would mean that the prevalence of disability rises parallel to the development of the disease. Of course, improvements in the treatment of chronic diseases can delay the onset of disability, but so far no cure exists for the major chronic conditions. Thus, unless improvement in the treatment of diseases can delay the onset of disability enough to compensate for the increase in disease prevalence, it is likely that the prevalence of disability increases along with the growing prevalence of chronic diseases. However, persons with a chronic disease may have fewer disabilities because their disease is diagnosed at an earlier stage or because improved medical care and increased use of assistive devices have reduced its deleterious effects (Wolf et al. 2005). Several studies, including European ones, showed that specific chronic diseases have become less disabling during the last decades of the twentieth century (Deeg et al. 1994; Puts et al. 2008; Robine et al. 1998). However, in the most recent decade, the association between chronic diseases and disability did not show significant changes (Hoeymans et al. 2012).

There is a host of recent evidence on population trends in disability showing different results across countries and periods (Robine and Michel 2004). Most studies show a decline in the prevalence of disability since the 1980s (Freedman et al. 2004), the majority of which have been conducted in the United States. In European countries, reported trends include both decreases and increases in disability (Parker et al. 2005; Sagardui-Villamor et al. 2005). In a recent report or the Organisation for Economic Cooperation and Development (OECD), in many western countries an increase in the prevalence of severe disability was observed, but equally in many western countries a decline in this prevalence was seen (Lafortune et al. 2007).

Notably, disability trends may differ across gender and socio-economic status. Although women have been found to have more disability than men in several
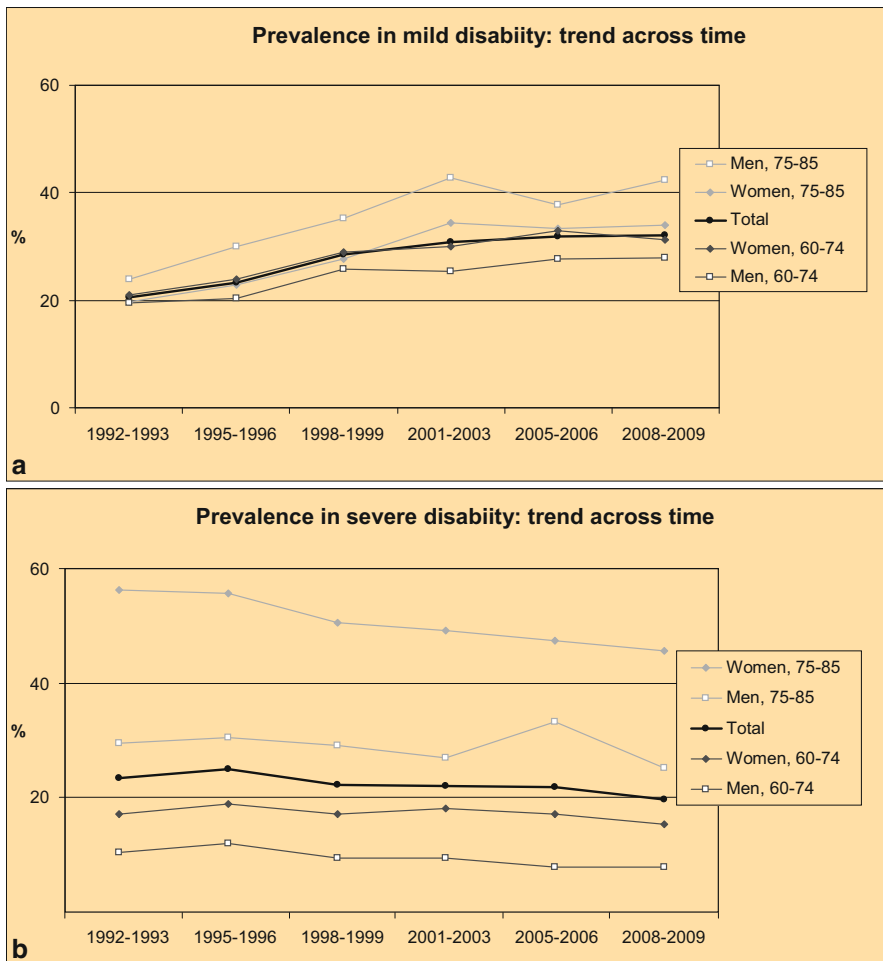
Fig. 8.2 Time trend of mild disability (**a**) and severe disability (**b**) by age and gender. (Longitudinal Aging Study Amsterdam, 1992–2009)

countries, the trend in disability in women was not different from that in men (Fors et al. 2008). In contrast, disability in population groups with higher education is higher than in groups with lower educaiiton, but prevalence of disability in the higher educated tends to be declining, whereas this is not always the case in population groups with lower education (Crimmins and Saito 2001).

Several reports based on LASA data show that the prevalence of self-reported disability in the Netherlands has increased since 1992. This increase is seen in older ages (65 and over; Portrait et al. 2010; Sonnenberg et al. 2008) as well as in late midlife (ages 55–64; Hoogendijk et al. 2008). The increase in the prevalence of disability is observed only in mild, but not in severe disability (Fig. 8.2a, b). Whereas

in the age group of 65–84 years the prevalence of mild disability rose from 21 % in 1992 to 32 % in 2009, the prevalence of severe disability showed a slight decline of 3 % points (Deeg and Broese van Groenou 2007; Galenkamp et al. in press). Also, in the Netherlands, trends differ across sub-groups of the older population. A more unfavourable trend is seen in women as compared with men, and in those with a low education level as compared with the higher educated.

The increase in the prevalence of mild disability may be partly attributed to the increase in the prevalence of chronic diseases, as described, but also to a worsening of lifestyle factors such as physical activity, nutrition and alcohol use (Visser et al. 2005), and to psychosocial factors such as a lower sense of mastery (Deeg and Huisman 2010). These are individual characteristics, which are essentially amenable for intervention. These are discussed in detail in the paragraph on longitudinal change. Other factors responsible for changes in the prevalence of disability are less easily influenced. These may be demographic factors related to changes in the composition of the population, such as the relatively fast increase in the proportion of the oldest-old (Robine and Michel 2004).

Changes in prevalence may also stem from societal developments that are occurring in the period monitored (period factors), or from characteristics of the particular generations or cohorts that constitute the older population, which can be traced to factors that influenced how they grew up (cohort factors). Portrait et al. (2010) examined a large number of period and cohort factors, such as the business cycle during the childhood of current older generations (an example of a cohort factor) or changes in the availability of care during the study period (an example of a period factor). The authors found no explanatory value for cohort factors, but did find one clear period factor: the decrease in the number of hospital days was associated with the increase in the prevalence of disability. During the study period 1992–1999, the hospital length of stay had fallen steadily for a number of reasons such as greater efficiency. It appears that policy-driven changes in care may affect daily functioning of older people.

Longitudinal Change in Functional Ability

For a better understanding of factors influencing trends in the prevalence of disability, we now turn to factors determining the onset and course of disability in individuals as they age. When following the group of older people who have no difficulty in any of six daily activities at baseline, we can examine which percentage develops disability (i.e. incidence of disability). In the course of 6 years, this incidence amounted to 45 % for a cohort aged 58–88 years (Broese van Groenou et al. 2006). Of course, the incidence rose with age, and amounted to 68 % in the age group of 75–88 years. The incidence showed differences across gender (men: 40 %, women: 52 %) and even more so across levels of education (high: 31 %, low: 56 %).

Recovery from disability was observed as well, but to a much lesser extent. Among older people with disability at baseline, 20 % did not report disability at 6 years

follow-up. This percentage decreased with age and was only 10 % in the age group of 75–88 years. Recovery did not show significant differences across gender and level of education.

The reported incidence should be regarded with caution, as it may not be very relevant when an older person develops difficulty with only one activity. Hence, it may be more important to examine a change in functional ability that can be defined as relevant, regardless of the level of disability at baseline. This was done by Puts et al. (2005), who reported a relevant function loss in self-reported and performance-based physical functioning of 25 and 23 %, respectively, across 3 years. Again, in women and in the lower educated a greater functional loss was observed than in men and in the higher educated. Moreover, regardless of age or gender, older people living alone showed more functional loss than older people living with their partner: 30 and 20 %, respectively (Puts et al. 2005).

Predictors of Change in Functional Ability

Chronically ill older people were found to have a 3.5 times larger risk of onset of disability than older people without chronic diseases. This risk rate was found to rise to even 4.6 when chronically ill older people were diagnosed with an additional disease (Broese van Groenou et al. 2006). Multi-morbidity, the co-occurrence of two or more chronic diseases, is present in as many as two-thirds in the age group of 65 and over (Schram et al. 2008). In a detailed study of pairs of co-occurring diseases, an additional disease was shown to have an extra effect on function loss only when it affects a body system that is different than the one affected by the first disease (Kriegsman et al. 2004). An example is the onset of osteo-arthritis (affecting the musculoskeletal system) in an individual who already is suffering from heart disease (affecting the cardiovascular system). Cognitive decline is also an important cause of function loss and disability onset in older adults. It was found that older persons declining in cognitive function had a twofold increased risk of function loss (Comijs et al. 2005). Thus, regardless of somatic morbidity, cognitive impairment contributes to complexity of health problems and ensuing need of care.

Frailty is a concept increasingly used by geriatricians and gerontologists, and is defined as the multi-system decline as a consequence of ageing-related changes in the neuromuscular, endocrine and immune systems (Fried et al. 2001). Frailty can be conceived as a measure of taxability and recovery potential. Fried defined it using five indicators: weight loss, weakness, slowness, lack of energy and inactivity. There is, however, a debate whether the concept of frailty should be narrowly defined to include only physiological aspects, or if it should be broader defined to include psychological aspects as well (Morley et al. 2002). In a series of studies based on data from LASA, we adopted the broad concept and included nine indicators: low weight, poor lung function (as a measure of weakness), physical inactivity, cognitive impairment, poor vision, poor hearing, incontinence, depressive symptoms (including lack of energy

and slowness) and a poor sense of mastery. Subjects were defined as frail when they scored poorly on three of the nine indicators. Puts et al. (2005) showed that frail subjects ran a more than twofold risk of function loss more than 3 years, as compared with non-frail subjects. This increased risk proved independent of age, sex, education and especially of the presence of chronic diseases. Moreover, it concerned both self-reported and performance-based functional decline.

The predictive ability of frailty for function loss emphasises that maintenance or decline in functional ability depends on multiple factors. Some of these factors may be causal, such as a decreased lung function or the onset of a chronic disease, whereas other factors may accelerate or slow down the rate of function loss. Van Gool et al. (2005) reported that depressive symptoms—one of the frailty indicators commonly used—are an example of the latter: older people with depressive symptoms showed accelerated functional decline. Geerlings et al. (2001) demonstrated that the influence of depression was especially strong for decline in functioning in daily activities, and less strong for decline in mobility, which generally precedes onset of disability. It is conceivable that depression is a causal factor in functional decline through its underlying pathology of diminished interest and motivation.

In addition to chronic diseases, causal factors for functional decline are usually sought in physiological parameters. Various so-called biomarkers are independent determinants of decline in functional ability. Markers of inflammation (interleukin-6, C-reactive protein, and alpha1-antichymotrypsin) were shown to be predictive of function loss (Schaap et al. 2006). As these markers are implicated in the pathogenesis of a number of chronic diseases, they are indicative of sub-clinical disease. Raised levels of inflammation furthermore decrease the level of serum albumin and total cholesterol, which biomarkers can be easily determined in general practice. Serum albumin is involved in the transport of various substances through the bloodstream, and cholesterol has a role in the production of hormones and in cell membrane permeability. Low levels of both markers proved predictive of functional decline, especially in combination with each other (Schalk et al. 2004). Both albumin and total cholesterol are synthesised in the liver, and it is suggested that an overall deterioration in the liver function might be associated with a poor health status, and might therefore contribute to functional decline. With proper nutrition, adequate levels of albumin and cholesterol can be maintained. Other nutrition-related biomarkers such as vitamin D are more difficult and thus more expensive to assess, but also were found to predict decline in functioning (Wicherts et al. 2007). Vitamin D deficiency is common among older people and can cause bone loss and muscle weakness. Genetic make-up was found to be of additional importance: the e4 variant of the apolipoprotein-E gene (ApoE), well-known for its predictive ability for cognitive decline and dementia, was also found to be predictive of physical decline, regardless of cognitive functioning (Henderson et al. 1995; Melzer et al. 2005). ApoE has a role in the clearance of lipoproteins such as cholesterol. The predictive ability of biomarkers appears to be stronger for objective, performance-based mobility impairment than for disability in daily activities, i.e. for the earlier stages of disability.

From the social factors that have been examined in relation to functional decline, socio-economic status plays an important role. Both a low educational level and

a low income increase the risk of incident disability in 3 years time (Broese van Groenou et al. 2003; Huisman et al. 2005). The chance of recovery, however, proved not to be influenced by socio-economic status. In searching for explanations for socio-economic differences in functional decline, Koster et al. (2006) found different explanatory factors in subjects younger and older than 70 years. In the younger age group, lifestyle proved to be of predominant importance, whereas in the older age group lifestyle appeared to have no explanatory value. In contrast, psychosocial factors such as a low sense of mastery and lack of social engagement proved to contribute to the explanation of socio-economic differences in physical function loss in the older age group. In particular in men, a low sense of self-efficacy was shown to be associated with functional decline (Cooper et al. 2011).

Of lifestyle factors, especially physical inactivity and poor nutrition resulting in obesity were important predictors of function loss. Smoking and excessive alcohol use did not play a significant role. It was noted that physical inactivity was an equally important predictor of functional decline in chronically ill and in healthy older adults (Visser et al. 2002). Moreover, not only current intensity of physical activity, but also physical activity intensity during young adulthood proved to be predictive of functional decline in later life (Pluijm et al. 2007). A similar life course effect was found for body weight: obesity at middle age was equally predictive of functional decline in later life as obesity in late life itself.

In addition to the physical and psychosocial factors already discussed, one LASA-based study showed that lack of social support was predictive of function loss (Bisschop et al. 2003). Social support was detailed as partner support and support by other relatives and by non-kin. If present, the partner is generally the most important source of support, so that partner support would be expected to protect against function loss. However, partner support appeared to be protective only in those older people who did not yet have a chronic disease at baseline, i.e. in the case of first-onset disease and disability. In contrast, those who already had chronic diseases at baseline benefited from contacts with daughters and non-kin in terms of better maintenance of functioning.

Consequences of Changes in Functional Ability

Decline in functional ability may have a range of adverse consequences. It means having more difficulty moving about, moving more slowly and being less able to compensate in unexpected circumstances. The risk of fall accidents is therefore strongly increased in the presence of function loss (Stel et al. 2004; Pluijm et al. 2006). In addition, function loss may lead to decreased self-rated health, more psychological distress and loneliness (Dykstra et al. 2005; Jonker et al. 2008; van de Kamp et al. 2008). Moreover, in spouses one partner's function loss increases the feelings of loneliness in the other partner (Korporaal et al. 2008). Longitudinal analyses showed that physical function loss increases the probability of chronic depression (Beekman

et al. 2002; Geerlings et al. 2000). Depressive symptoms proved to decrease, however, when older people who had experienced function loss were admitted to a care institution (Thomése and Broese van Groenou 2006). Physical function loss also affects social functioning: social networks become smaller, disabled older adults receive more instrumental support but provide less support to others and participation in social activities decreases (Van Tilburg and Broese van Groenou 2002; Aartsen et al. 2004; Broese van Groenou and Deeg 2006). Especially, sport activities were reported to decline in the face of function loss.

Considering the effects of function loss on the utilisation of health and social services, a distinction can be made between acute care, i.e. out-patient care and hospital admission, and long-term care, i.e. informal or formal care in the home and institutionalised care. Although function loss is associated with the use of acute care (Pot et al. 2009), this association is temporary in many cases as the aim of hospital care is to treat the health condition, and recovery is mostly achieved. However, the use of long-term care is often permanent, so that when people start using some type of long-term care, we can speak of a 'transition' to this type of care.

In older people who in a 3-year period experienced a first onset of function loss, 17 % made a transition to informal care, 5 % to subsidised professional home care, 9 % contracted home help paid for out-of-the-pocket and 2 % were admitted to a care institution (Geerlings et al. 2004, 2005). It was thus demonstrated that at first onset of function loss, older people generally look for care in their own informal network or pay for help out of their pockets, and only a small minority look for government-provided care. A different picture arises for older people who have experienced function loss for a longer period of time. Among them, 25 % made a transition to informal care, 15 % to subsidised professional home care, 11 % contracted home help paid for out-of-the-pocket and 6 % were admitted to a care institution. At this stage, informal care is still the type of care used most often. However, subsidised professional home care takes a second place, while the transition to a care institution is more often made than among those with a recent onset of function loss.

An ultimate consequence of decline in functional ability is mortality. Disability, in particular performance-based functional impairment, is a powerful predictor of mortality (Smits et al. 1999; Deeg and Kriegsman 2003). However, not all older people experience a similar decline in functioning prior to death (Deeg 2005). Klinkenberg (2004) showed that in the last phase of life of older persons, four different trajectories can be distinguished. Nineteen per cent died without experiencing any disability and 26 % experienced disability only in the last week before death. A gradual, protracted decline was experienced by another 24 %. The largest group, 31 %, experienced disability at the severest level measured already more than 3 months before death. This group was on average older, had a larger share of women, and was more often institutionalised than the other groups. Moreover, this group relatively often had suffered a stroke or had osteo-arthritis, and more often was cognitively impaired. Thus, this high-cost group with severe, long-standing disability was characterised by notoriously disabling chronic conditions.

Conclusions

In this overview of findings concerning changes in functional ability in the older population over time and in individuals as they age, functional ability was shown to be influenced by and to have influence on many factors, from the micro to the macro level. From the data on trends in the prevalence of disability, it can be concluded that the extent of disability in the older population is not a fixed fact, but changes over time. Similar to several other studies in Europe, the LASA study indicates that the prevalence of mild disability increases over time, whereas the prevalence of severe disability stays the same or slightly decreases. These trends are not observed in all European countries, as recent data show that, for example, in Norway, mild disability decreased in prevalence, and in France, severe but not mild disability showed increasing prevalences (Moe and Hagen 2011; Cambois et al. 2008). Moreover, in Sweden a reversal from a positive to a negative trend in the prevalence of mobility disability was seen in the late 1990s (Parker et al. 2008). To explain such discrepancies, cross-national research is needed with exactly the same measures of disability as well as of potential explanatory factors. Although such studies now exist, they are relatively recent and cannot yet address time trends over a period of sufficient length.

From the longitudinal findings, it can be concluded that a sizeable proportion of the older population experiences function loss, especially at higher ages. Several factors, such as a decreased lung function, may be considered as causal factors. Other factors, such as depressive symptoms or a low level of education, may be regarded as factors accelerating function loss. This accelerating effect may be due to an unhealthy lifestyle, for example, malnutrition or non-compliance with treatment regimens, such as intake of medications that are prescribed to counteract the consequences of a disease. Regarding depression, it is, nevertheless, conceivable that this is a causal factor in functional decline through underlying pathology. In either case, the findings emphasise that depressed older adults and older adults with a low level of education are risk groups with increased probability of function loss.

In light of the absolute and relative increase of older people in the populations of European countries, it is paramount to prevent onset and further decline of function loss, or at least to postpone these to older ages than the ages at which they now occur. To this end, causal factors such as lifestyle, chronic diseases or biomarkers can be targeted. Sufficient physical activity is a likely candidate to postpone function loss, especially in chronically ill older people. Also, better disease management is highly likely to postpone functional decline. Several biomarkers found to predict function loss are indicative of undernutrition. Thus, the nutritional status of older people needs due attention. However, it is at least as productive to identify groups of older people with increased risk of function loss. Improvement of the recognition of depression in older people is an example. Finally, helping older people to improve their sense of mastery or to maintain a social network of sufficient diversity are other interventions highly likely to have a beneficial effect on their level of daily functioning.

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