Demographic Research a free, expedited, online journal
of peer-reviewed research and commentary
in the population sciences published by the
Max Planck Institute for Demographic Research
Konrad-Zuse Str. 1, D-18057 Rostock · GERMANY
www.demographic-research.org

DEMOGRAPHIC RESEARCH

VOLUME 20, ARTICLE 5, PAGES 37-64
PUBLISHED 03 FEBRUARY 2009
http://www.demographic-research.org/Volumes/Vol20/5/
DOI: 10.4054/DemRes.2009.20.5

Research Material

A systematic literature review of studies analyzing the effects of sex, age, education, marital status, obesity, and smoking on health transitions

Gabriele Doblhammer, Rasmus Hoffmann,

Elena Muth, Christina Westphal, and

Anne Kruse

Table of Contents

A systematic literature review of studies analyzing the effects of sex, age, education, marital status, obesity, and smoking on health transitions

Gabriele Doblhammer[1]

Rasmus Hoffmann[2]

Elena Muth[3]

Christina Westphal[4]

Anne Kruse[5]

Abstract

Sex, age, education, marital status, obesity, and smoking have been found to affect health transitions between non-disabled, disabled, and death. Our aim is to review the research literature on this topic and provide structured information, first on the availability of results for each risk factor and transition, and then on detailed study characteristics and disability measures. We use expert recommendations and the electronic databases Medline, PsycINFO, and SOCA. The search is confined to the years 1985–2005, and produced a total of 7,778 articles. Sixty-three articles met the selection criteria regarding study population, longitudinal design, risk factors, transition, and outcome measures.

[1] Rostock Center for the Study of Demographic Change, Konrad-Zuse-Straße 1, 18057 Rostock, Germany. Institute for Sociology and Demography, University of Rostock, 18057 Rostock, Germany.
[2] European University Institute,Via delle Fontanelle 10, 50014 San Domenico di Fiesole, Italy.
[3] Rostock Center for the Study of Demographic Change, Konrad-Zuse-Straße 1, 18057 Rostock, Germany
[4] Rostock Center for the Study of Demographic Change, Konrad-Zuse-Straße 1, 18057 Rostock, Germany
[5] Rostock Center for the Study of Demographic Change, Konrad-Zuse-Straße 1, 18057 Rostock, Germany

1. Introduction

It is well known that the risk of disability increases exponentially with age, that higher education reduces the risk of disability, that married people are less likely to experience disability than unmarried people, and that smoking is a clear risk factor for disability. Results are less clear regarding the impact of sex and body mass index (BMI) on the onset of disability, as well as for the interaction between age and sex and the various risk factors. In general, the effects of risk factors tend to become smaller with age, which is partly caused by selection effects (Hoffmann 2008). However, there are exceptions. For example, a series of studies report positive effects of being overweight on the health of the elderly, while effects at younger ages are generally negative (Losonczy et al. 1995, Himes 2000, Greenberg 2001).

In order to make reliable projections for the population, and to promote and influence political decision processes regarding health care and health systems, an instrument that provides reliable information must be available. Despite the presence of a large and complex body of literature on the effects of various socio-demographic factors, as well as of particular risk factors on disability, a suitable instrument for summarizing and using this knowledge does not yet exist. The ongoing EU-financed project "MicMac - Bridging the Micro-Macro Gap in Population Forecasting" (www.micmac-projections.org) is seeking to overcome this problem. MicMac is a multistage population projection approach aimed at European countries that combines cohort data, usually by age and sex (macro), with individual biographic data (micro). With this approach it is possible to make detailed demographic forecasts that give reliable information about the development of health care and pension systems. MicMac consists of a methodology, a set of algorithms, and user-friendly software. Within this framework we conducted a systematic literature review, focusing on the effects of age, sex, education, marital status, smoking, and obesity on various indicators of disability and mortality. The literature review serves as a source of background information for the forecasts and scenarios within the project. The present collection of research material shows the search procedure and offers structured information, first on the availability of results for each risk factor and transition, and then on detailed study characteristics and disability measures of the selected studies.

The following paper presents details and results of our review approach. In the following three sections we introduce our search strategy, outlining the processing of the articles and the underlying criteria for the choice of articles. After providing in Section 5 a detailed description of outcome variables and measurement issues, as well as a definition of transitions and their measurement, we offer in Section 6 a theoretical discussion of considered risk factors. Section 7 is devoted to the overview of specific study characteristics of the 63 selected articles, and is based on the table in the appendix.

2. Literature review

We started our literature search by analyzing the article, "Risk Factors for Functional Status Decline in Community-Living Elderly People: A Systematic Literature Review" by Stuck et al. (1999). Stuck and his colleagues were conducting a systematic literature review of longitudinal studies, published between 1985 and 1997, that reported statistical associations between individual baseline risk factors and subsequent functional status in community-living older persons. We ordered and analyzed all articles that Stuck et al. incorporated in their analysis (78 articles). Of these 78 articles, 47 met our initial search criteria (see Section 4) and were processed further. Finally, 12 articles from Stuck et al. were included in our literature review.

We considered three possible sources for the literature review: (1) recommendations by Dr. Wilma Nusselder (Erasmus University, Rotterdam), who is member of the MicMac project, (2) electronic databases, and (3) references in existing articles. The electronic search is based on three databases and constitutes the biggest part of our search. The databases we used are MEDLINE, PsycINFO, and SOCA (Sociological Abstracts).

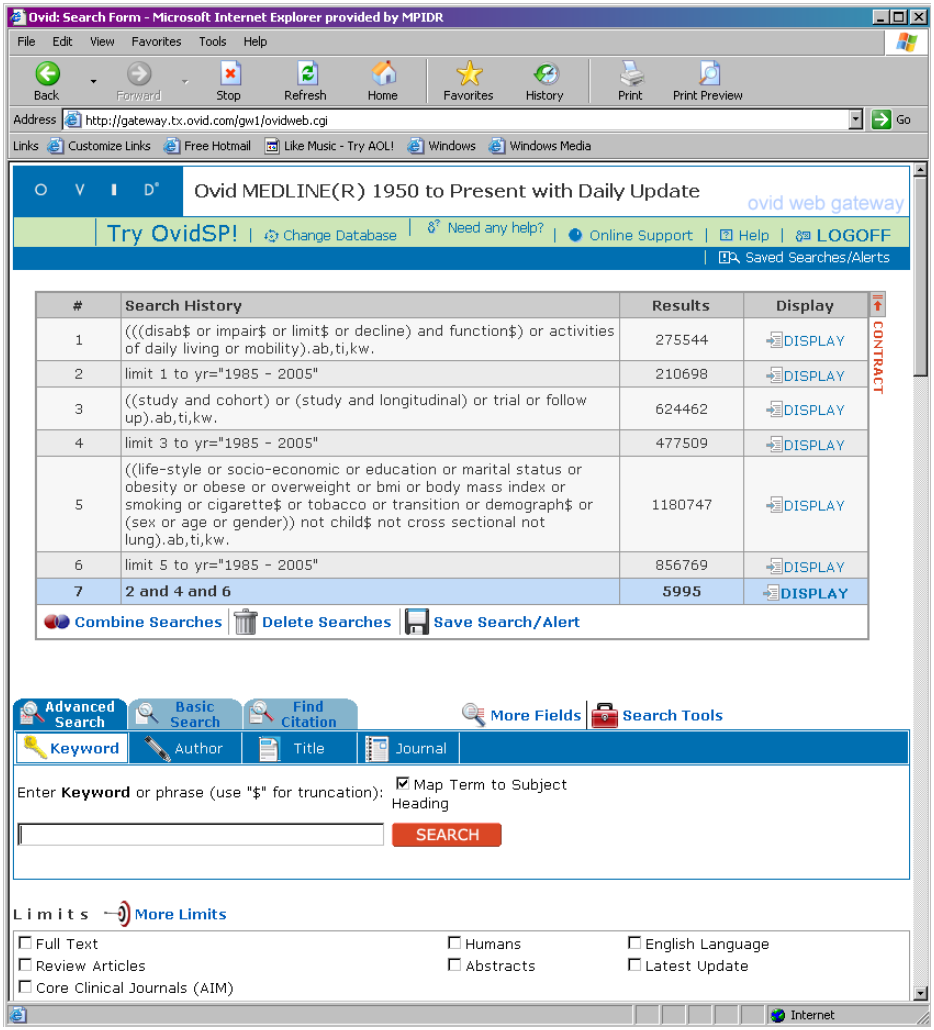
Produced by the United States National Library of Medicine, MEDLINE focuses on the fields of medicine, nursing, dentistry, veterinary medicine, allied health, and pre-clinical sciences, as well as topics relating to biomedicine and health care. The database covers bibliographic citations and author abstracts from more than 4,600 biomedical journals.

PsycINFO provides abstracts and citations in the fields of psychological, social, behavioral, and health sciences, and covers more than 1,800 journals, book chapters, books, theses and dissertations, and technical reports.

Finally, SOCA presents international literature in sociology and related disciplines in the social and behavioral sciences, and covers abstracts of journal articles and citations, book reviews from more than 1,800 serials publications, as well as abstracts of books, book chapters, dissertations, and conference papers.

Literature from MEDLINE was used as the basis of our search. The search was then completed by literature from PsycINFO and SOCA. Double entries were only considered once. The database search was performed over six months from September 2005 to February 2006. Most articles included in the analysis were taken from MEDLINE.

Figure 1: Search history of the literature search conducted in Medline



Our search is confined to the publication years 1985–2005. Our systematic search logic contains the following terms: "disability," "impairments," "limitation," "decline," "function," "activities of daily living," and/or "mobility." We restricted our search to

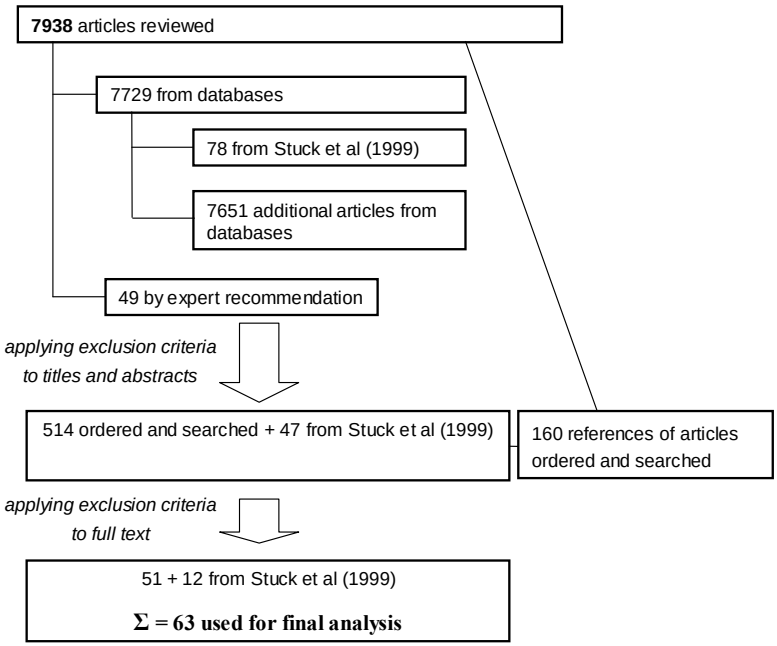
cohort and longitudinal studies. The term "trial" was also used for the term "study", and the term "follow-up" was used for "longitudinal study".

To further restrict the search to our risk factors, we were looking for the terms "life style," "socio-economic status," "education," "marital status," "obesity," "overweight," "body mass index," and "smoking" (including cigarettes or tobacco). We also included the term "transition," as well as demographic characteristics (comprising age, sex or gender). We explicitly excluded children and cross-sectional studies. The search was performed in titles, keywords, and abstracts. Articles were displayed if they matched at least one of the keywords in these domains. Figure 1 shows a screenshot of the search history performed in MEDLINE. Lines 1, 3, and 5 show the syntax of different search criteria, i.e., keywords that should be looked up in the abstract (ab), title (ti) and in the keywords (kw). The first line addresses the health outcome measures, the third line the study design, and the fifth line the risk factors. Lines 2, 4, and 6 limit the searches to the period 1985 to 2005. Line 7 is the combination of all three limitations, which finally leads to 5,995 results.

3. Processing the articles

In all, we reviewed 7,938 articles. Applying the above search strategy in the electronic databases we got 7,729 potential results, including the 78 articles from Stuck et al. (1999). These were all shown as abstracts, and were read by two persons independently. This approach helped to ensure that no potential article was overlooked, and that we ordered only those articles that were useful to our topic. In addition to these 7,729 articles, 49 articles were expert recommendations. Of these 7,778 articles, 561 met our criteria, and were thus ordered using the library of the Max Planck Institute for Demographic Research, or were, if possible, directly printed from the journals' homepages (for processing criteria see Section 4). These 561 articles were read in their entirety. Checking all references, we identified 160 additional articles that were also ordered and read in their entirety. Applying our exclusion criteria to the full text, we finally declared 63 articles to be useful for our own analysis (see Figure 2). We processed these 63 articles in Excel, entering all data into an Excel worksheet. This table can be seen in the appendix.

Figure 2: Article selection process



4. Criteria of included and excluded articles

In the following we describe our selection criteria for the choice of articles. The scope of our review is strongly influenced by the MicMac project objectives, and has the same choice of risk factors and the same requirements regarding the design of the selected studies. In spite of this predetermination, our own study design constitutes a sensible and logical way to deal with a great variety of approaches and designs in the literature. The two main criteria that we apply are as follows: first, data should be longitudinal to assess the effect of the selected factors on the incidence of disability and mortality; and, second, the impact of the factors should be assessed based on the general population, and not on specific population (specific diseases, specific sub-group, etc.) .

Hence, we included all studies examining either community-dwelling or institutionalized people older than 25 years of age, and those studies that analyze both groups combined. We also tried to include hospitalized people, but studies concentrating on this risk group are either short in follow-up time – mostly not more

than six weeks after hospital release – or they consider hospitalization as a risk factor for predicting disability. Moreover, they often focus on chronic conditions and clinical outcomes, like knee impairments, arthritis, surgeries, etc.

MicMac focuses on European countries and populations, which is one reason why studies on ethnicities have been excluded from our literature review. However, since there are not enough studies focusing on our topic, we also included whites from other industrialized countries, i.e., Americans, Australians, as well as Japanese, because it is expected that the medical standards in industrialized western countries have developed similarly. Nevertheless, there are some studies that include non-whites, mostly blacks and Hispanics. But since their proportion is relatively small compared to the white population (less than 20%), we included them in our analysis if they could not be clearly distinguished from the pure baseline population. Entirely non-white populations were excluded from our analysis. Furthermore, children, veterans, and people living in a convent or monastery were excluded, as were studies that used specific chronic conditions as a selection criteria for the baseline sample.

We only consider studies which clearly distinguish the disability status at baseline, and which explore the following four transitions: (1) not disabled to disabled, (2) not disabled to death, (3) disabled to not disabled, and (4) disabled to death. Studies that look at mixed populations at baseline, i.e., disabled and non-disabled people together in one examination unit, are excluded from our analysis because transition rates can only be computed if the initial status is known and is the same for all individuals in one examination unit. This also means that studies using Event-History-Analysis, where the health status is controlled for by a variable, are not included.

Applying these criteria, we selected 561 potential articles that were further processed. Keeping in mind the criteria mentioned above, we excluded studies that did not contain any transitions. We searched for the right outcome, appropriateness of risk factors, kind of disability measure, and kind of statistical measure. We only considered articles in which the outcome was general disability. Consequently, we excluded studies that focus on disability caused by injuries or surgeries, or where the study design is focused on persons with a specific disease, and this disease is measured at follow-up, e.g., arthritis, diabetes, or hip fracture. This review also excludes studies based on specific diseases, thus we also excluded studies looking at disability in connection with Alzheimer's disease, Parkinson's disease, stroke, or other specific mental or acute conditions. We acknowledge, however, that many disability situations, especially in old age, are actually linked to such diseases, even if the studies do not focus on them specifically.

Moreover, we only incorporated studies that contained at least one of our six risk factors: age, sex, education, marital status, smoking, and obesity. We only considered longitudinal studies with at least a one year follow-up wave. All studies that did not contain odds ratios (OR), rate ratios, relative risks (RR), or incidences as statistical measures were excluded as well. This is because we do not only want to show the

general outcome of selected studies. However, this review also collects empirical results for further use in a meta-analysis.

Finally, it is important to mention that we considered articles written in German, French, and English. However, only one French and no German article are included.

5. Description of outcome

> *'Disablement' refers to impacts that chronic and acute conditions have on the functioning of specific body systems and on people's abilities to act in necessary, usual, expected and personally desired ways in their society. (Verbrugge and Jette 1994, p. 3)*

The main outcome measure of our analysis is age-related disability. While disability may be caused by chronic conditions, we do not focus on specific conditions, but on disability. The existence of disability is either established through self-reported data or through objective measurements. Disability is an often-used concept that is not restricted to a single definition. The measures and definitions are often modified, combined and/or developed further. As a result, a multitude of disability measures arises, which are hard to relate to a single basic disability definition. Therefore, we generated four categories of disability measures that represent the most frequently used concepts in our analysis: ADL, IADL, mobility/physical performance (M/PP), and combined disability measure (CDM) as a residual category.

5.1 ADL (Katz)

Activities of daily living (ADL) are, according to Katz (Katz et al. 1963, Katz et al. 1970, Katz and Akpom 1976), a set of basic human functions, or activities that people perform habitually and universally. The index of ADL measures the ability to perform without help the six basic activities of daily living: bathing, dressing, toileting, transferring, continence, and feeding. The performance of these functions is divided into a scale ranging from A to G, with A marking the most independent grade (independent in all functions), and G the most dependent grade (dependent in all six functions). In contemporary studies, a person is considered to be disabled if she or he is dependent in even one of the above functions. In our analysis the concept of activities of daily living is used most frequently.

5.2 IADL (Lawton & Brody)

The ability to perform certain instrumental activities of daily living (IADL) can, according to Lawton and Brody (1969), be used as an indicator of everyday functional competence. The scale includes the following items: using the telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for own medication, and ability to handle finances. In this measure, as well, being unable to perform one or more of these activities counts as disability. However, disabilities in IADLs occur relatively rarely in our analysis.

5.3 Mobility (Rosow & Breslau)/Physical Performance (Nagi)

Mobility is a concept that, according to Rosow and Breslau (1966), measures health scale items of self-reported functional health. The items include the ability to go out to a movie, a church service, a meeting, or a visit; to walk up and down to the second floor; to walk half a mile; or to perform heavy work around the house. Physical performance refers, according to Nagi (1976), to sensory-motor functioning of the organism, as indicated by limitations in such activities as walking, climbing, bending, reaching, hearing, etc.

Looking at the concrete operationalization in the selected articles, in some studies Nagi's concept of physical performance and Rosow and Breslau's concept of mobility cannot be clearly distinguished. Several studies include items that are taken from the physical performance concept, as well as from the mobility concept. Often the concepts of lower and upper body function are also included. For that reason, for our analysis, we created the combined mobility/physical performance category (M/PP) as a third category. This category includes items such as walking several blocks or half a mile, climbing one flight of stairs (approximately 10) without resting, or walking up and down stairs to the second floor. Items also include lifting or carrying 10 or 25 pounds, stooping, crouching, kneeling, prolonged sitting/standing, moving large objects, and standing or being on one's feet for about two hours. It should be mentioned that not all studies measuring physical function/mobility consider all of the above-mentioned disability items. Rather, they combine some of the items or focus more on one or another aspect of mobility or physical function. Because the concept of mobility/physical function is relatively flexible, it is one of the criteria most frequently used in our analysis.

5.4 Combined Disability Measure (CDM)

In some studies, the underlying disability category is not clearly distinguishable. Often these studies employ a mixture of elements of the basic disability concepts. Some studies combine elements of IADL and ADL, some combine ADL, IADL, and mobility, and some studies use elements of all four disability concepts. Thus, the fourth disability category we created is called combined disability measure (CDM), which brings together the basic disability concepts of Katz, Nagi, Lawton and Brody, and Rosow and Breslau. This measure does not indicate which kind of disability or which element of a certain disability is emphasized more. But, since it was not practical to create more reasonable categories that combine all the different aspects of the disability measures applied in the studies analyzed, we decided to create one category that integrates all mixed measurements. The information about all the measured items is given in the table in the appendix.

From this description of four groups of disability definitions it becomes clear that they are related to each other. They overlap in their meaning, and sometimes measure similar health problems. Because the numerous disability measures that we try to group in the above categories are used in the selected studies, we cannot change or harmonize them, or analyze further how independent or correlated they are.

Mortality is the outcome of two of our four transitions, i.e., from not disabled to death, and from disabled to death. But this outcome does not need a special description here. The measurement for mortality will be addressed in the following section.

5.5 Transitions

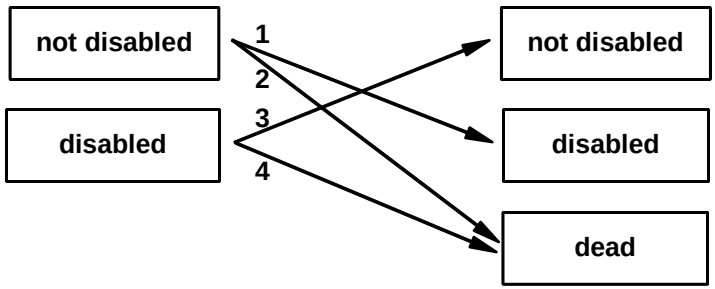
Morbidity and mortality rates are expressed through transitions. Transitions describe the change of functional status between baseline measurements and follow-up. There are two possible initial positions: disabled or not disabled. The possible positions at follow-up are disabled, not disabled, and death.

Figure 3 shows the possible transitions of functional status in the risk populations. We only looked at pure transitions, such as the transition from being not disabled to being disabled. That means articles that contain a mixed population at baseline (disabled and non-disabled people together in an examination unit) are not included in our analysis.

Altogether we worked with four possible transitions (see Figure 3). The most frequent transition was from not disabled to disabled, examined in 58 of our 63 articles. This transition describes people who were disability-free at baseline, but whose functional status worsened during follow-up so that they were identified as having at least one indication of disability, all depending on the particular disability criteria of the

underlying study. Other transitions identified are not disabled to death (16 articles), recovery from disability to no disability (23 articles), and disabled to death (18 articles). It should be noted that, because some articles examine more than one health transition, the frequencies for each transition do not add up to the total number of articles (63).

Figure 3: Transitions



6. Description of risk factors and their measurement

> *Risk factors are demographic, social, life-style, behavioral, psychological, and biological characteristics of an individual that can affect the presence and severity of impairment, functional limitation and disability. They are predisposing; that is, they exist at or before the outset of the disablement process. They are usually long-term or permanent features of individuals, because those are the sorts of causes that prompt chronic conditions and enduring impacts. (Verbrugge and Jette 1994, p. 8)*

A distinction can be made between proximate and distal determinants, with the former being those risk factors that lead to a disease, and the latter being those factors that cause exposures and determinants. In our literature review we were looking at the influence of two proximate determinants (obesity/BMI and smoking), two distal determinants (education and marital status) and two controls (sex and age) on disability. Obesity and smoking are the two most important behavioral risk factors (Cutler et al. 2007). Education and marital status are indicators for the socioeconomic status, which is responsible for substantial health differences. Sex and age the two most important

risk factors for mortality. In the framework of this review, it was not possible to include other important determinants, such as drinking and physical inactivity, because the MicMac project itself had to limit the number of factors included.

Further, a distinction can be made between discrete and continuous variables. Discrete variables are depicted with a reference group, while continuous variables give information about the gradual increase of the risk factor.

6.1 Sex

It has become a well-established fact that there are gender differences in health and mortality (see, for example, Case and Paxson 2005). While women generally live longer than their male counterparts (Nathanson 1977), they are more likely to become disabled, and to remain in that state for a longer period (Sternfeld et al. 2002; Grundy and Sloggett 2003). Women are also more likely to be institutionalized. There are various reasons for these gender differences. Men have higher rates of common fatal diseases, such as heart disease and cancer, and are more likely to die from these diseases before disabling chronic conditions can progress to disability in old age. Women, meanwhile, have higher rates of disabling non-fatal chronic conditions, like arthritis and osteoporosis. Therefore, women remain in a disabled state for a longer period of time (Leveille et al. 2000). Additionally, women have higher comorbidity, which is a factor that contributes to higher rates of disability in women (ibid.).

The composition of the female body also accounts for different disability rates and durations between men and women. For example, a higher risk of osteoporosis is linked to lower peak bone mass in women and accelerated bone loss beginning at menopause. Since muscle strength plays an important role in preventing disability, and since women typically have less muscle strength than men, they may be predisposed to disability in later life (ibid.). Moreover, women not only have a naturally higher percentage of body fat than men, they also have higher levels of obesity, which puts them at a higher risk for chronic conditions associated with disability (ibid.:111). Another important factor associated with a greater disability risk is a more inactive life style among women than among men. This lack of physical activity increases the risk of disability in women. Sex is a dichotomous variable, with men serving as the reference group in our analysis.

6.2 Age

It is generally known that disability and mortality are age-related. It is a natural phenomenon that, the older individuals grow, the more likely they are to suffer from disabling health conditions (House et al. 1994, Grundy and Sloggett 2003, Kaplan and Kronick 2006), like chronic or fatal conditions (Manton et al. 1997). Likewise, their

mortality risk increases exponentially with age (Vaupel 1998, Thatcher et al. 1998) by approximately 10% every year of age. With life expectancy still generally increasing, it is important to know at what age people face particular health risks. When the most important risk factors, and the age when they are most likely to occur, are known, adequate health care and social policies can be implemented.

Age is either coded as a continuous variable or divided into age groups (e.g., ages 70–79, ages 80+). In our analysis the categories were kept and identified accordingly. The reference group is, where applicable, the youngest age group.

6.3 Education

Education as an indicator for the socioeconomic status (SES) of a person is associated with many health-related factors and behaviors over the life cycle. Generally, distinctions can be made between behavioral and material factors that cause socioeconomic inequalities in morbidity and mortality. Behavioral explanations focus on the behavior and lifestyles adopted by people from different socioeconomic groups, like smoking, dietary habits, and physical activities. The material role emphasizes the importance of economic factors that differ among socioeconomic groups, e.g., income, housing conditions, employment status, and access to health care (Schrijvers et al. 1999).

For a number of reasons, education as a part of the multi-dimensional construct of SES is a measure that is often used for reflecting socioeconomic influences on health status and mortality. Education is an objective variable that is easily measured and generally fixed early in life. Unlike occupation or income, education can be determined for all individuals. Although in many studies the effect of education is largely reduced when controlling for income (Menchik 1993, Hoffmann 2008), education is chronologically and causally prior to occupation and income. Therefore, the attained educational level anticipates future occupational chances and income. Moreover, education affects potential earnings, and thus access to material sources. The level of education also influences health behavior, providing better knowledge and access to information about health risks and healthy behaviors, as well as the cognitive ability to deal with such information (Hoffmann 2008). Thus, the educational level provides material resources and facilitates the implementation of health-promoting behaviors.

It is generally agreed that people with lower levels of education tend to have a higher probability of becoming functionally disabled, and face a higher mortality risk, than people with higher educational levels (Elo and Preston 1996, Freedman and Martin 1999, Minicuci and Noale 2005). Individuals with higher educational levels are often found to smoke fewer cigarettes and exercise more than individuals with lower levels of education. Increased levels of educational attainment are also associated with higher levels of self-control, efficacy, and happiness.

Education is either coded dichotomous, (e.g., high versus low, ≤8 years, >8 years), as an ordinal variable (e.g., <8 years, 8–12 years, >12 years), or as a continuous variable. In any case, the variable is depicted with the categories used in the study. The highest educational group is always used as the reference group.

6.4 Marital status

Research indicates that marriage has health-promoting effects. Married persons tend to live longer and are generally healthier than unmarried persons (Ward and Leigh 1993, Goldman et al. 1995, Waldron et al. 1997). Marriage is said to have a protection effect due to greater financial and material resources, greater social support, and better health-related behavior.

> *The increased social ties and networks that typically result from marriage may facilitate access to medical information and services, constrain risk-taking behavior and encourage healthy behavior, act as a buffering mechanism in stressful situations, substitute for formal health care, and provide economic resources that affect the frequency and quality of health care services. (Goldman et al. 1995, p. 1718)*

Although marriage has a beneficial effect for both sexes, it seems that the advantages of marriage are greater for men than for women. This can be explained through the different traditional role models men and women adopt in marriage. While wives often serve as caretakers, providers of information, and inhibitors of unhealthy behaviors, they are also more likely to suffer from stress because of their restricted gender role. On the other hand, husbands often provide greater financial support to their wives, which might reduce stress concerning material well-being.

Becoming a widow or a widower, or getting divorced, is often associated with worse health outcomes than never having been married. This is due to the fact that becoming widowed is a stress-provoking crisis that may lead to worse health and higher mortality rates (Goldman et al. 1995). It also appears that widows cope better with their new situation than widowers because they can more often rely on social relationships.

Besides the protective effect of marriage, there might also be another direction of causality. It is not clear whether married persons are healthier because of the partnership, or if they are married because they have better general health than those who do not marry (selection into marriage). The majority of findings and arguments support a higher impact of causation compared to selection into marriage (Hoffmann 2008).

Marital status is also a variable depending on the different ways categories are constructed. Very often, two groups are compared (e.g., married vs. not married) or one

group is contrasted with two or more other groups (never married vs. divorced vs. widowed). But in our analysis, being not married is recalculated as reference group. If necessary we accepted the categories "living with others" versus "living alone" as a sufficient approximation to marital status.

6.5 Obesity

It is an established finding that the incidence of obesity in adults and children is increasing. In the United Kingdom in 2000, over half of women and about two-thirds of men were either overweight or obese (Campbell 2003). While men are more likely to be overweight, women are more frequently obese (Himes 2000, Jensen and Friedmann 2002). Low social status groups and less educated persons have a higher BMI. This relationship is more pronounced for women (Smith and Kington 1997).

Generally, excess weight is considered to have consequences for health status, functional ability, and life expectancy. Overweight and obesity are said to cause several chronic conditions, like arthritis, osteoporosis, hypertension, high blood cholesterol, type 2 diabetes, coronary heart disease, etc. Obese persons may have mobility problems, and are more likely to develop disabilities than non-obese persons. For that reason, weight-losing behaviors as a part of healthy life styles are promoted.

At young ages, the relationship between obesity and disability or mortality is U-shaped or J-shaped. That means that people in both the high and the low BMI percentiles face increased disability and mortality risks. In general, a BMI of 18.5 to 25 is considered to be normal, while people below or above this range face increased health and mortality risks. People who are slightly obese or light obese at older ages are at relatively lower risk than people at younger ages (Fontaine et al. 2003). It seems that the prevalence of overweight and obesity is at its peak between 40 and 65 years of age, and declines with age (Flegal et al. 1998, Ferraro et al. 2003). Furthermore, the maximum limits for a healthy BMI increases with age (Himes 2000), and the relationship between obesity and health seems to be reversed in old age, i.e., obesity may not be harmful, or may even be negatively correlated with mortality. It is very likely that this is due to the fact that weight loss in old age is mostly unintentional, and reflects health problems or an existing disease. Thus, in old age, those at the lower extreme of body mass index are at higher risk of disability and mortality (Diehr et al. 1998).

Concerning the measurement of obesity, people with a body mass index below 18.5 kg/m^2 are regarded as underweight, people with a body mass index (BMI) between 18.5 kg/m^2 and 25 kg/m^2 are considered normal weight, people with a BMI ranging from 25 kg/m^2 to 29.9 kg/m^2 are considered overweight, and people with a BMI of 30 kg/m^2 and more are regarded as obese, although different categorizations are possible. Thus, the variable body mass index is divided into four categories. For our analysis we

recalculated the reference groups into standardized groups, with normal body mass index used as the reference group.

6.6 Smoking

In many studies, smoking is associated with higher levels of disability and a higher probability of dying. Smoking frequently leads to cancer, cardiovascular diseases, respiratory diseases, or cerebrovascular diseases. Compared to non-smokers, current smokers show higher levels of disability, and heavy smokers (more than one pack per day) are in poorer health than light smokers. Likewise, smoking until death can produce a difference in age at death of about 10 years compared to lifelong non-smokers (Doll et al. 2004). But negative effects can be reversed through smoking cessation (Ostbye et al. 2002, Doll et al. 2004, Mitra et al. 2004). Accordingly, the probability for ill health decreases with every year of smoking cessation. It is supposed that the negative effects of smoking will be outbalanced after 15 years of a smoking-free life. Thus,

> *smokers who quit by their mid-40s will be no more likely to suffer from ill health than lifelong never smokers when they reach their late 50s and early 60s, contingent upon surviving at that age. (Ostbye et al. 2002, p. 342)*

Yet recent former smokers (who quit less than three years ago) show higher disability rates than current smokers (Ostbye et al. 2002). This is very likely due to the fact that smoking cessation reflects a preexisting illness. Consequently, if past smoking behavior is not taken into account, this can bias the measurement of disability and mortality differences between smokers and former smokers.

For the smoking variable, there are different kinds of categorization. Most frequently, people who have never smoked are compared with current smokers and former smokers. But it also happens that smoking is coded as a dichotomous variable. In this case, smokers are often compared to non-smokers. Where applicable, in our analysis never smokers are used as a reference group.

7. Results and concluding remarks

The table in the appendix gives detailed information about the 63 selected studies. The table identifies the authors, year of publication, the country, and the name of the study. We then describe the study population (if not indicated otherwise, this is the share of women), the baseline year, and the length of follow-up. We give information about the baseline age, the sample size, the transition under study, and the type of disability. The

categories for the latter are described in Section 5, but in the subsequent column we describe all measured health items in detail. The next six columns simply contain indicators for the risk factors that are the focus of the study. The last two columns describe the method and list all control variables of the models.

Our literature review shows that the four transitions and the six risk factors are studied to a very different degree. The transition from healthy to disabled received much more attention than the other transitions, thus opening future areas of research. Our review also provides information about the methodological and statistical characteristics of each of the 63 studies.

Within a transition, we find different numbers of results for our six risk factors. For example, we find there are more studies on the risk factor sex than on the risk factors obesity and smoking. We assume that the latter are rarely analyzed because appropriate data is difficult to find. It should be noted that, in the design of our literature analysis, we set high standards for the quality of the studies, including the standard for a longitudinal perspective, which, by definition, requires longitudinal, and therefore more expensive and rare data sets. Obesity and smoking are more often analyzed in shorter clinical cross-sectional studies, which are excluded from our specific literature review. In addition, the measurement of health behavior, such as smoking and personal information or the body mass index, is more difficult. Interpreting the relative frequency of our risk factors, we come to the conclusion that there is a lack of representatives of proximate and modifiable risk factors, such as smoking and obesity.

The transition from the status of not disabled to death (Transition 2) certainly requires more attention in future research. The transition from the status of disabled to death (Transition 4) is also understudied.

We consider the existence of a large and sometimes confusing number of different approaches to measuring disability as a problem which complicates all attempts to unify research findings, and to make the existing findings easier to use and to interpret. Our literature review is an attempt to summarize the variety and the large volume of research findings. It allows us to identify areas where more research is needed. In the future, research should concentrate on the harmonization of the different health and disability concepts, rather than on capturing specific aspects. Our review shows that more studies of risk factors on transition probabilities are needed, particularly on transitions other than from health to disability. In general, more thought should be given to the state-space that exists in disability studies. Many studies that we did not consider eligible for this review, particularly in the area of mortality, are based on populations where at baseline no distinction between disabled and not disabled is made.

Although the transition from not disabled to disabled is the most challenging to public policy makers in terms of prevention measures, we need more information on recovery and the transition from either not disabled, or disabled to death. Particularly the latter seems to be under-explored, given the important issue of compression or

expansion of disability in light of increasing life expectancy. We generally need more studies on risk factors of transitions other than sex and age.

Literature

Literature in the text

Campbell, I. (2003). The obesity epidemic: can we turn the tide? *Heart.* 89:22-24. doi:10.1136/heart.89.suppl_2.ii22.

Case, A. and Paxson, C. (2005). Sex differences in morbidity and mortality. *Demography.* 42(2): 189-214. doi:10.1353/dem.2005.0011.

Cutler, D.M., Glaeser, E.L., and Rosen, A. (2007). Is the US Population Behaving Healthier? *NBER Working Paper.*13013.

Diehr, P., Bild, D.E., Harris, T.B., Duxbury, A., Siscovick, D., and Rossi, M. (1998). Body mass index and mortality in nonsmoking older adults: The Cardiovascular Health Study. *American Journal of Public Health.* 88(4): 623-629. doi:10.2105/AJPH.88.4.623.

Doll, R., Peto, R., Boreham, J., and Sutherland, I. (2004). Mortality in relation to smoking: 50 years' observations on male British doctors. *British Medical Journal.* 58(11): 930.

Elo, I.T. and Preston, S.H. (1996). Educational differentials in mortality - United States, 1979-85. *Social Science and Medicine.* 42(1): 47-57. doi:10.1016/0277-9536(95)00062-3.

Ferraro, K.F., Thorpe, J.R.J., and Wilkinson, J.A. (2003). The life course of severe obesity: does childhood overweight matter? *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 58B(2): 110-119.

Flegal, K.M., Carroll, M.D., Kuczmarski, R.J., and Johnson, C.L. (1998). Overweight and obesity in the United States: prevalence and trends 1960-1994. *International Journal of Obesity.* 22: 39-47. doi:10.1038/sj.ijo.0800541.

Fontaine, K.R., Redden, D.T., Wang, C., Westfall, A.O., and Allison, D.B. (2003). Years of life lost due to obesity. *Journal of the American Medical Association.* 289(2): 187-193. doi:10.1001/jama.289.2.187.

Freedman, VA. and Martin, L. G. (1999). The role of education in explaining and forecasting trends in functional limitations among older Americans. *Demography.* 36(4): 461-473. doi:10.2307/2648084.

Goldman, N., Korenman, S., and Weinstein, R. (1995). Marital status and health among the elderly. *Social Science and Medicine.* 40(12): 1717-1730. doi:10.1016/0277-9536(94)00281-W.

Greenberg, J.A. (2001). Biases in the mortality risk versus body mass index relationship in the NHANES-1 epidemiologic follow-up study. *International Journal of Obesity.* 25: 1071-1078. doi:10.1038/sj.ijo.0801648.

Grundy, E. and Sloggett, A. (2003). Health inequality in the older population: the role of personal capital, social resources and socio-economic circumstances. *Social Science and Medicine*. 56: 935-947. doi:10.1016/S0277-9536(02)00093-X.

Himes, C.L. (2000). Obesity, disease and functional limitation in later life. *Demography*. 37(1): 73-82. doi:10.2307/2648097.

Hoffmann, R. (2008). *Socioeconomic differences in old age mortality*. Springer Series on Demographic Methods and Population Analysis, Vol. 25. Dordrecht: Springer.

House, J.S., Lepkowski, J.M., Kinney, A.M., Mero, R.P., Kessler, R.C., and Herzog, A.R. (1994). The social stratification of aging and health. *Journal of Health and Social Behavior*. 35(3): 213-234. doi:10.2307/2137277.

Jensen, G.L. and Friedmann, J.M. (2002). Obesity is associated with functional decline in community-dwelling rural older persons. *Journal of the American Geratrics Society.* 50(5): 912-917. doi:10.1046/j.1532-5415.2002.50220.x.

Kaplan, R.M. and Kronick, R.G. (2006). Marital status and longevity in the United States population. *J Epidemiol Community Health.* 60(9): 760-765. doi:10.1136/jech.2005.037606.

Katz, S. and Akpom, C.A. (1976). Index of ADL. *Medical Care.* XIV(5, Supplement): 116-118.

Katz, S., Downs, T.D., Cash, H.R., and Grotz, R.C. (1970). Progress in development of the index of ADL. *The Gerontologist.* 10(1): 20-30.

Katz, S., Ford, A.B., Moskowitz, R.W., Jackson, B.A., and Jaffe, M.W. (1963). Studies of illness in the aged - The index of ADL: A standardized measure of biological and psychosocial function. *Journal of the American Medical Association.* 94-99.

Lawton, M.P. and Brody, E.M. (1969). Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist.* 9(3): 179-186.

Leveille, S.G., Resnick, H.E., and Balfour, J. (2000). Gender differences in disability: Evidence and underlying reasons. *Aging Clinical and Experimental Research.* 12(2): 106-112.

Losonczy, K.G., Harris, T.B., Cornoni, H.J, Simonsick, E.M, Wallace, R.B., Cook, N.R., Ostfeld, A.M., and Blazer, D.G. (1995). Does weight loss from middle age

to old age explain the inverse weight mortality relation in old age? *American Journal of Epidemiology.* 141(3): 312-321.

Manton, K.G., Stallard, E., and Corder, L.S. (1997). Changes in the age dependence of mortality and disability: Cohort and other determinants. *Demography.* 34(1): 135-157. doi:10.2307/2061664.

Menchik, P.L. (1993). Economic status as a determinant of mortality among black and white and older men: Does poverty kill? *Population Studies.* 47: 427-436. doi:10.1080/0032472031000147226.

Minicuci, N. and Noale, M. (2005). Influence of level of education on disability free life expectancy by sex: The ILSA Study. *Experimental Gerontology.* 40: 997-1003. doi:10.1016/j.exger.2005.08.011.

Mitra, M., Chung, M.C., Wilber, N., and Klein Walker, D. (2004). Smoking status and quality of life - A longitudinal study among adults with disabilities. *American Journal of Preventive Medicine.* 27(3): 258-260. doi:10.1016/S0749-3797(04)00125-4.

Nagi, S.Z. (1976). An epidemiology of disability among adults in the United States. *The Milbank Memorial Fund Quarterly: Health and Society.* 54(4): 439-467. doi:10.2307/3349677.

Nathanson, C.A. (1977). Sex, illness, and medical care. A review of data, theory, and method. *Social Science & Medicine.* 11: 13-25. doi:10.1016/0037-7856(77)90141-X.

Ostbye, T., Taylor, D.H., and Jung, S.-H. (2002). A longitudinal study of the effects of tobacco smoking and other modifiable risk factors on ill health in middle-aged and old americans: Results from the Health and Retirement Study and Asset and Health Dynamics among the Oldest Old Survey. *Preventive Medicine.* 34(3): 334-345. doi:10.1006/pmed.2001.0991.

Rosow, I. and Breslau, N. (1966). A Guttman Health Scale for the aged. *Journals of Gerontology.* 21: 556-559.

Schrijvers, C.T.M., Stronks, K., van de Mheen, H.D., and Mackenbach, J.P. (1999). Explaining educational differences in mortality: The role of behavioral and material factors. *American Journal of Public Health.* 89(4): 535-540. doi:10.2105/AJPH.89.4.535.

Smith, J.P. and Kington, R. (1997). Race, socioeconomic status, and health in late life. In: Martin, L.G. and Soldo, B.J. (eds.). *Racial and ethnic differences in the health of older Americans.* Washington, DC: National Academy Press: 105-162.

Sternfeld, B., Ngo, L., Satariano, W.A., and Tager, I.B. (2002). Associations of body composition with physical performance and self-reported functional limitation in elderly men and women. *American Journal of Epidemiology.* 156(2): 110-121. doi:10.1093/aje/kwf023.

Stuck, A.E., Walthert, J.M., Nikolaus, T., Bula, C.J., Hohmann, C., and Beck, J.C. (1999). Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Social Science & Medicine.* 48(4): 445-469. doi:10.1016/S0277-9536(98)00370-0.

Thatcher, A.R., Kannisto, V., and Vaupel, J.W. (1998). The Force of Mortality at Ages 80 to 120. *Odense Monographs on Population Aging.* 5.

Verbrugge, L.M. and Jette, A.M. (1994). The disablement process. *Social Sciences and Medicine.* 38(1): 1-14. doi:10.1016/0277-9536(94)90294-1.

Waldron, I., Weiss, C.C., and Hughes, M.E. (1997). Marital status effects on health: Are there differences between never married women and divorced and seperated women? *Social Science and Medicine.* 45(9): 1387-1397. doi:10.1016/S0277-9536(97)00065-8.

Ward, M.M. and Leigh, J.P. (1993). Marital status and the progression of functional disability in patients with rheumatoid arthritis. *Arthritis and Rheumatism.* 36(5): 581-588. doi:10.1002/art.1780360502.

Studies in the review

Aguero-Torres, H., Fratiglioni, L., Guo, Z., Viitanen, M., von Strauss, E., and Winblad, B. (1998). Dementia is the major cause of functional dependence in the elderly: 3-year follow-up data from a population-based study. *American Journal of Public Health.* 88(10): 1452-1456. doi:10.2105/AJPH.88.10.1452.

Armenian, H.K., Pratt, L.A., Gallo, J., and Eaton, W.W. (1998). Psychopathology as a predictor of disability: a population-based follow-up study in Baltimore, Maryland. *American Journal of Epidemiology.* 148(3): 269-275.

Avlund, K., Damsgaard, M.T., and Osler, M. (2004). Social position and functional decline among non-disabled old men and women. *European Journal of Public Health.* 14(2): 212-216. doi:10.1093/eurpub/14.2.212.

Avlund, K., Damsgaard, M.T., Sakari-Rantala, R., Laukkanen, P., and Schroll, M. (2002). Tiredness in daily activities among nondisabled old people as

determinant of onset disability. *Journal of Clinical Epidemiology.* 55: 965-973. doi:10.1016/S0895-4356(02)00463-8.

Avlund, K., Lund, R., Holstein, B.E., Due, P., Sakari-Rantala, R., and Heikkinen, R.L. (2004). The impact of structural and functional characteristics of social relations as determinants of functional decline. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 59B(1): S44-S51. doi:10.1093/eurpub/14.2.212.

Avlund, K., Pedersen, A.N., and Schroll, M. (2003). Functional decline from age 80 to 85: influence of preceding changes in tiredness in daily activities. *Psychosomatic Medicine.* 65(5): 771-777. doi:10.1097/01.PSY.0000082640.61645.BF.

Beckett, L., Brock, D., Lemke, J.H., Mendes de Leon, C.F., Guralnik, J.M., Fillenbaum, G.G., Branch, L.G., Wetle, T.T., and Evans, D.A. (1996). Analysis of change in self-reported physical function among older persons in four population studies. *American Journal of Epidemiology.* 143(8): 766-778.

Béland, F. and Zunzunegui, M.V. (1999). Predictors of functional status in older people living at home. *Age & Ageing.* 28(2): 153-159. doi:10.1093/ageing/28.2.153.

Boult, C., Kane, R.L., Louis, T.A., Boult, L., and McCaffrey, D. (1994). Chronic conditions that lead to functional limitations in the elderly. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences.* 49(1): M28-M36.

Boult, C., Murphy, J., Sloane, P., Mor, V., and Drone, C. (1991). The relation of dizziness to functional decline. *Journal of the American Geriatrics Society.* 39(9): 858-861.

Branch, L.G. (1985). Health practices and incident disability among the elderly. *American Journal of Public Health.* 75(12): 1436-1439. doi:10.2105/AJPH.75.12.1436.

Brill, P.A., Macera, C.A., Davis, D.R., Blair, S.N., and Gordon, N. (2000). Muscular strength and physical function. *Medicine and Science in Sports and Exercise.* 32(2): 412-416. doi:10.1097/00005768-200002000-00023.

Clark, D.O., Stump, T.E., Hui, S.L., and Wolinsky, F.D. (1998). Predictors of mobility and basic ADL difficulty among adults aged 70 years and older. *Journal of Aging and Health.* 10(4): 422-440. doi:10.1177/089826439801000402.

Clark, D.O., Stump, T.E., and Wolinsky, F.D. (1998). Predictors of onset of and recovery from mobility difficulty among adults aged 51-61 years. *American Journal of Epidemiology.* 148(1): 63-71.

Crimmins, E.M., Hayward, M.D., and Saito, Y. (1996). Differentials in active life expectancy in the older population of the United States. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 51B(3): S111-S120.

Cronin-Stubbs, D., Mendes de Leon, C.F., Beckett, L.A., Field, T.S., Glynn, R.J., and Evans, D.A. (2000). Six-year effect of depressive symptoms on the course of physical disability in community-living older adults. *Archives of Internal Medicine.* 160(20): 3074-3080. doi:10.1001/archinte.160.20.3074.

Dunlop, D.D., Manheim, L.M., Sohn, M.W., Liu, X., and Chang, R.W. (2002). Incidence of functional limitation in older adults: The impact of gender , race and chronic conditions. *Archives of Physical Medicine and Rehabilitation.* 83(7): 964-971. doi:10.1053/apmr.2002.32817.

Elgar, F.J., Worrall, G., and Knight, J.C. (2002). Functional assessment of elderly clients of a rural community-based long-term care program: A 10-year cohort study. *Canadian Journal on Aging.* 21(3): 455-463.

Ferrucci, L., Guralnik, J.M., Simonsick, E., Salive, M.E., Corti, C., and Langlois, J. (1996). Progressive versus catastrophic disability: A longitudinal view of the disablement process. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences.* 51(3): M123-M130.

Ferrucci, L., Harris, T.B., Guralnik, J.M., Tracy, R.P., Corti, M.C., Cohen, H.J., Penninx, P.M., Wallace, R., and Havlik, R.J. (1999). Serum IL-6 level and the development of disability in older persons. *Journal of the American Geriatrics Society.* 47(6): 639-646.

Flacker, J.M. and Kiely, D.K. (2003). Mortality-related factors and 1-year survival in nursing home residents. *Journal of the American Geriatrics Society.* 51: 213-221. doi:10.1046/j.1532-5415.2003.51060.x.

Flacker, J.M. and Kiely, D.K. (1998). A practical approach to identifying mortality-related factors in established long-term care residents. *Journal of the American Geriatrics Society.* 46(8): 1012-1015.

Gill, T.M. and Kurland, B.F. (2003). Prognostic effect of prior disability episodes among nondisabled community-living older persons. *American Journal of Epidemiology.* 158(11): 1090-1096. doi:10.1093/aje/kwg237.

Grundy, E. and Glaser, K. (2000). Socio-demographic differences in the onset and progression of disability in early old age: A longitudinal study. *Age and Ageing.* 29: 149-157. doi:10.1093/ageing/29.2.149.

Haga, H., Shibata, H., Ueno, M., Nagei, H., Suyama, Y., Matsuzaki, T., Yasumury, S., Koyano, W., and Hatano, S. (1991). Factors contributing to longitudinal changes

in activities of daily living (ADL): The Koganei Study. *Journal of Cross-Cultural Gerontology.* 6: 91-99.

Hardy, S.E. and Gill, T.M. (2005). Factors associated with recovery of independence among newly disabled older persons. *Archives of Internal Medicine.* 165(1): 106-112. doi:10.1001/archinte.165.1.106.

Huang, Y., Macera, C.A., Blair, S.N., Brill, P.A., and Kohl, A.W. (1998). Physical fitness, physical activity and functional limitation in adults aged 40 and older. *Medicine and Science in Sports and Exercise.* 30(9): 1430-1435. doi:10.1097/00005768-199809000-00013.

Huisman, M., Kunst, A., Deeg, D., Grigoletto, F., Nusselder, W., and Mackenbach, J. (2005). Educational inequalities in the prevalence and incidence of disability in Italy and the Netherlands were observed. *Journal of Clinical Epidemiology.* 58(10): 1058-1065. doi:10.1016/j.jclinepi.2004.12.011.

Ishizaki, T., Kai, I., Kobayashi, Y., and Imanaka, Y. (2002). Functional transitions and active life expectancy for older Japanese living in a community. *Archives of Gerontology and Geriatrics.* 35(2): 107-120. doi:10.1016/S0167-4943(02)00002-X.

Ishizaki, T., Watanabe, S., Suzuki, T., Shibata, H., and Haga, H. (2000). Predictors for functional decline among nondisabled older Japanese living in a community during a 3-year follow-up. *Journal of the American Geriatrics Society.* 48(11): 1424-1429.

Jagger, C., Spiers, N.A., and Clarke, M. (1993). Factors associated with decline in function, institutionalization and mortality of elderly people. *Age and Ageing.* 22: 190-197. doi:10.1093/ageing/22.3.190.

Kivelä, S.L. and Pahkala, K. (2001). Depressive disorder as a predictor of physical disability in old age. *Journal of the American Geriatrics Society.* 49(3): 290-296. doi:10.1046/j.1532-5415.2001.4930290.x.

LaCroix, A.Z., Guralnik, J.M., Berkman, L.F., Wallace, R.B., and Satterfield, S. (1993). Maintaining mobility in later life II: Smoking, alcohol consumption, physical activity and body mass index. *American Journal of Epidemiology.* 137(8): 858-869.

Lamarca, R., Ferrer, M., Andersen, P.K., Liestol, K., Keiding, N., and Alonso, J. (2003). A changing relationship between disability and survival in the elderly population: differences by age. *Journal of Clinical Epidemiology.* 56(12): 1192-1201. doi:10.1016/S0895-4356(03)00201-4.

Launer, L.J., Harris, T., Rumpel, C., and Madans, J. (1994). Body mass index, weight change and risk of mobility disability in middle-aged and older women. *Journal of the American Medical Association.* 271(14): 1093-1098. doi:10.1001/jama.271.14.1093.

Leveille, S.G., Penninx, B.W., Melzer, D., Izmirlian, G., and Guralnik, J.M. (2000). Sex differences in the prevalence of mobility disability in old age: The dynamics of incidence, recovery and mortality. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 55B(1): S41-S50.

Liu, X., Liang, J., Muramatsu, N., and Sugisawa, H. (1995). Transitions in functional status and active life expectancy among older people in Japan. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 50(6): S383-S394.

Maddox, G.L., Clark, D.O., and Steinhouser, K. (1994). Dynamics of functional impairment in late adulthood. *Social Science and Medicine.* 38(7): 925-936. doi:10.1016/0277-9536(94)90425-1.

Manton, K.G. (1988). A Longitudinal study of functional change and mortality in the United States. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 43(5): S153-161.

Matthews, R.J., Smith, L.K., Hancock, R.M., Jagger, C., and Spiers, N.A. (2005). Socioeconomic factors associated with the onset of disability in older age: A longitudinal study of people aged 75 years and over. *Social Science and Medicine.* 61(7): 1567-1575. doi:10.1016/j.socscimed.2005.02.007.

McCurry, S.M., Gibbons, L.E., Bond, G.E., Rice, M.M., Graves, A.B., Kukull, W.A., Teri, L., Higdon, R., Bowen, J.D., McCormick, W.C., and Larson, E.B. (2002). Older adults and functional decline: A cross-cultural comparison. *International Psychogeriatrics.* 14(2): 161-179. doi:10.1017/S1041610202008360.

Melzer, D., Izmirlian, G., Leveille, S.G., and Guralnik, J.M. (2001). Educational differences in the prevalence of mobility disability in old age: the dynamics of incidence, mortality and recovery. *Journal of Gerontology.* 56B(5): S294-S301.

Mendes de Leon, C.F.M., Beckett, L.A., Fillenbaum, G.G., Brock, D.B., Branch, L.G., Evans, D.A., and Berkman, L.F. (1997). Black-white differences in risk of becoming disabled and recovering from disability in old age: A longitudinal analysis of two EPESE populations. *American Journal of Epidemiology.* 145(6): 488-497.

Minicuci, N. and Noale, M. (2005). Influence of level of education on disability free life expectancy by sex: The ILSA Study. *Experimental Gerontology.* 40: 997-1003. doi:10.1016/j.exger.2005.08.011.

Mor, V., Murphy, J., Masterson-Allen, S., Willey, C., Razmpour, A., Jackson, M.E., Greer, D., and Katz, S. (1989). Risk of functional decline among well elders. *Journal of Clinical Epidemiology.* 42(8): 895-904. doi:10.1016/0895-4356(89)90103-0.

Moritz, D.J., Kasl, S.V. and Berkman, L.F. (1995). Cognitive functioning and the incidence of limitations in activities of daily living in an elderly community sample. *American Journal of Epidemiology.* 141(1): 41-49.

Nusselder, W.J., Looman, C.W.N., Marang-van de Mheen, P.J., van de Mheen, H., and Mackenbach, J.P. (2000). Smoking and the compression of morbidity. *Journal of Epidemiology and Community Health.* 54: 566-574. doi:10.1136/jech.54.8.566.

Oman, D., Reed, D., and Ferrara, A. (1999). Do elderly women have more physical disability than men do? *American Journal of Epidemiology.* 150(8): 834-842.

Penninx, B.W., Guralnik, J.M., Onder, G., Ferrucci, L., Wallace, R.B., and Pahor, M. (2003). Anemia and decline in physical performance among older persons. *American Journal of Medicine.* 115(2): 104-110. doi:10.1016/S0002-9343(03)00263-8.

Penninx, B.W., Leveille, S., Ferrucci, L., van Eijk, J.T., and Guralnik, J.M. (1999). Exploring the effect of depression on physical disability: Longitudinal evidence from the Established Populations for Epidemiologic Studies of the Elderly. *American Journal of Public Health.* 89(9): 1346-1352. doi:10.2105/AJPH.89.9.1346.

Péres, K., Verret, C., Alioum, A., and Barberger-Gateau, P. (2005). The disablement process: Factors associated with progression of disability and recovery in French elderly people. *Disability and Rehabilitation.* 27(5): 263-276. doi:10.1080/09638280400006515.

Porock, D., Oliver, D.P., Zweig, S., Rantz, M., Mehr, D., Madsen, R., and Petroski, G. (2005). Predicting death in the nursing home: development and validation of the 6-month Minimum Data Set mortality risk index. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences.* 60 A(4): 491-498.

Reynolds, S.L. and Silverstein, M. (2003). Observing the onset of disability in older adults. *Social Science and Medicine.* 57(10): 1875-1889. doi:10.1016/S0277-9536(03)00053-4.

Romoren, T.I. and Blekeseaune, M. (2003). Trajectories of disability among the oldest old. *Journal of Aging and Health.* 15(3): 548-566. doi:10.1177/0898264303253633.

Sarkisian, C.A., Liu, H., Ensrud, K.E., Stone, K.L., and Mangione, C.M. (2001). Correlates of attributing new disability to old age. *Journal of the American Geriatrics Society.* 49(2): 134-141. doi:10.1046/j.1532-5415.2001.49033.x.

Sauvaget, C., Tsuji, I., Aonuma, T., and Hisamichi, S. (1999). Health-life expectancy according to various functional levels. *Journal of the American Geriatrics Society.* 47(11): 1326-1331.

Sauvel, C., Barberger-Gateau, P., Dequae, L., Letenneur, L., and Dartigues, J.F. (1994). Facteurs associés a l'évolution a un an de l'autonomie fonctionelle des personnes âgées vivant a leur domicile. Factors associated with one-year change in functional status of elderly community dwellers. *Revue d'Épidémiologie et Santé Publique.* 42: 13-23.

Seeman, T.E., Bruce, M.L., and McAvay, G.J. (1996). Social network characteristics and onset of ADL disability: Mac Arthur Studies of Successful Aging. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences.* 51(4): S191-S200.

Strawbridge, W.J., Kaplan, G.A., Camacho, T., and Cohen, R.D. (1992). The dynamics of disability and functional change in an elderly cohort: results from the Alameda County Study. *Journal of the American Geriatrics Society.* 40: 799-806.

van Dijk, P.T., Mehr, D.R., Ooms, M.E., Madsen, R., Petroski, G., Frijters, D.H., Pot, A.M., and Ribbe, M.W. (2005). Comorbidity and 1-year mortality risk in nursing home residents. *Journal of the American Geriatrics Society.* 53(4): 660-665. doi:10.1111/j.1532-5415.2005.53216.x.

Wannamethee, S.G., Ebrahim, S., Papacosta, O., and Shaper, A.G. (2005). From a postal questionnaire of older men: Healthy lifestyle factors reduced the onset of and may have increased recovery from mobility limitation. *Journal of Clinical Epidemiology.* 58(8): 831-840. doi:10.1016/j.jclinepi.2005.01.007.

Wolff, J.L., Boult, C., Boyd, C., and Anderson, G. (2005). Newly reported chronic conditions and onset of functional dependency. *Journal of the American Geriatrics Society.* 53(5): 851-855. doi:10.1111/j.1532-5415.2005.53262.x.

Zimmer, Z. and House, J.S. (2003). Education, income, and functional limitation transitions among American adults: contrasting onset and progression. *Int. J. Epidemiol.* 32(6): 1089-1097. doi:10.1093/ije/dyg254.