ORIGINAL RESEARCH

New Disability in a Cohort Study of Older Men—The Manitoba Follow-Up Study*

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ABSTRACT

Background

There is a large literature on the prevalence of disability in older men, but less data on the incidence of new disability.

Objectives

1. To determine the incidence of moderate-to-severe disability in a prospective cohort study of aging men; and 2. To determine predisposing risk factors for new moderate to severe disability.

Design & Setting

The Manitoba Follow-up Study is a closed cohort study. In 1948, the initial sample was 3,983 men who qualified for air crew training in the Royal Canadian Air Force. In 2004, there were 796 men who were still alive and responded to the annual questionnaire with no missing data, and who did not have disability. The mean age at that time was 84.

Methods

We calculated the incidence of new moderate-to-severe disability from 2004 to 2017, calculated the time to disability, and constructed survival analysis models to determine factors which predicted disability.

Results

The incidence of disability increased with the aging of the cohort and ranged from 4% to 12% per year. In unadjusted models, poor self-rated health (SRH), low life satisfaction, a low score on the Physical Component Score (PCS) of the Short Form–36, and the number of chronic conditions were all associated with new disability. In adjusted models, SRH, the PCS, and the number of chronic conditions were associated with new disability.

Conclusions

Global measures of well-being, as well as multimorbidity, predict new disability.

Key words: disability, functional impairment, aging, cohort study, incidence

INTRODUCTION

Functional impairment is common in older adults and the prevalence increases with age.(1) Functional decline is associated with increased depressive symptom,(2) modestly reduced life satisfaction (LS),(3) higher mortality,(4) and increased health-care utilization.(5) Moreover, most older adults value maintaining a high level of independence.(6) Understanding the process by which older adults acquire disability is important in understanding interventions which could reduce the risk of disability. There is a considerable literature on the prevalence of disability in older adults. These studies demonstrate that disability is fairly common in late life,(1) that women have a higher prevalence of disability than men,(1) and that chronic illness(7) and cognitive impairment(8,9) are closely related to the prevalence of disability. There is also a growing literature on the trajectory of disability. This literature shows that functional status is a dynamic process, that there are multiple trajectories of functional decline, and that these trajectories are related to underlying chronic illness and acute medical events.(10)

The incidence of new disability in an older population is less well established. The epidemiological study of the incidence of disability in late life is complicated, since it requires close and frequent monitoring of a large population over an extended time frame. There must be frequent measurement

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*The incidence calculations were presented at the annual meeting of the Canadian Geriatrics Society in 2023, and the risk factors for new disability are to be presented at the Gerontological Society of America in 2024. These results have not been previously published, and are not under consideration at another journal.

of both risk factors for disability, as well as reliable, valid measures of functional status. Moreover, both risk factors and function may vary over time; and the measurements of risk factors and outcomes must allow for temporal analyses to determine which event occurred first. Moreover, disability may be recurrent or permanent,(10,11) which further complicates our understanding of late-life disability. There are, therefore, relatively few studies which report the incidence of new disability in a population of older adults. Hebert *et al*. reported an incidence of about 11% over a short time frame.(12) Fong(13) has reported an analysis of the AHEAD cohort study, and found a steady increase in new disability with advancing age, and that those with a chronic illness had an earlier onset of new disability than those without. Lee *et al*.(14) considered pooled data from several countries, and found that there was a higher incidence of disability amongst women, and that there was considerable variation between countries. They also found an increase in the incidence of disability with advancing age. Jagger *et al*.(15) showed that there are educational gradients in the risk of new disability—however, the follow-up waves were fairly far apart. In the PEP cohort,(16) new disability was common, but recovery was also fairly frequent. There are some studies which investigate the association between multimorbidity and the risk of disability, which generally show that multimorbidity is associated with new disability.(17,18,19,20,21) However, these studies are all conducted over a short term, or have long sampling intervals. Because of these methodological difficulties, there remains uncertainty about the risk of disability and the predictors of disability in older populations.

The Manitoba Follow-Up Study (MFUS) is a fixed, closed prospective cohort study of men which began collecting data on functional status on an annual basis beginning in 2004. MFUS offers an opportunity to study the development of disability in a group of aging men, since there are measures of disease coupled with an annual survey of functional status. The objectives of these analyses are:

1. To determine the incidence of moderate to severe disability in a prospective cohort study of aging men; and
2. To determine predisposing risk factors for incident moderate to severe disability.

METHODS

MFUS is a prospective closed cohort study of men who qualified for air crew training in the Royal Canadian Air Force (RCAF) during the Second World War. The original sampling frame was from approximately 7,000 men who were examined by Dr. F.A.L. Mathewson during the war. Dr. Mathewson was the Deputy Director of Medical Services for the RCAF and the initial primary investigator of MFUS. All the men qualified for air crew training, although not all served as pilots. Specifically, they were free of heart disease, seizures, and poor vision, and were otherwise fit for service.(22,23,24)

Between 1946 and 1948, attempts were made to contact the surviving men, and those who could be contacted were invited to participate in the study. The cohort was sealed on July 1, 1948 and consisted of 3,983 who have been followed to the present day. The data are housed at the University of Manitoba, but the participants came from across Canada. The majority have lived in Canada, but many have also lived in other countries. After the war, some men continued as pilots, but occupations have varied considerably. Data collection continues, but data curation has been interrupted by the pandemic, and electronic data entry is current to 2017, which we consider the end date. At the current time, data on vital statistics are missing for less than one per cent. Details on the methods have been previously published.(25)

Data come from several sources. First, a medical survey is mailed out to the members. Throughout the analysis time of 2004 to 2017, this survey was sent annually. If there have been health-care contacts or hospital admissions, then these records are retrieved. These records include primary care notes, consultant reports, hospital reports, and long-term care reports which are then reviewed and coded by study physicians. Diseases and the date of diagnosis are coded. The date and cause of death are also coded. Second, a Successful Aging Questionnaire (SAQ) is sent to each member who resides in the community. The SAQ is not sent to those living in nursing homes, but is sent to those living in assisted living facilities. If there is no response, there are two subsequent mailings. The SAQ was mailed in 1996, 2000, 2002, and annually since 2004. Prior to 2015, the annual response rate has always exceeded 80 per cent. The SAQ contains a variety of measures, including functional status, age-referenced self-rated health (SRH), marital status, and the Short Form-36 (SF-36).(26) Basic ADLs (activites of daily living [BADLs]) and instrumental ADLs (IADLs) are also measured. For these analyses, we consider the starting time of analysis to be the date of the mail-out for the 2004 SAQ, and the end date to be the date that the 2017 questionnaire was sent out.

Population for Analyses

The initial cohort was 3,983 participants in 1948. By the spring of 2004, 2,709 men had died. Among the remaining 1,274, 60 had no current address or were in long-term care in 2004. The survey was sent to the 1,214 men who were assumed alive and living in the community with a known address. No response was received from 293. Among the 921 responses, we learned 22 men had died or were too ill to complete the survey, 103 had disability (defined below), and 796 were disability free. The inclusion for these analyses was therefore those participants who survived to 2004, were living in the community, who had no missing data in 2004, and who did not have moderate-to-severe disability.

Measures

Outcome Measure and Consideration of Population at Risk

Our outcome measure was moderate or severe disability. Functional status was measured using a measure similar to the Older American Resource Survey.(27) The SAQ considers

15 BADL and 9 IADL measures. For these analyses, we did not consider all possible BADLs or IADLs. The BADLs we included were: getting about the house; washing or bathing or grooming; getting in and out of bed; dressing and putting on shoes; eating; and using the toilet. The IADLs we considered were: doing light housework; preparing a hot meal; shopping; finances; laundry; taking medications; and using the telephone. We considered a disability as an impairment in two or more BADL or three or more IADL. We also considered those who were admitted to a nursing home or chronic care facility as being functionally impaired, since functional impairment is a criteria for admission to NHs and chronic care facilities across Canada.(28) We did not consider a relocation to an assisted living facility in our definition of disability, since the SAQ is sent to these participants, and disability is not an admission criteria for assisted living.

We used the subsample of participants who were alive and who responded to the survey with no missing data, and who did not have disability in 2004 (N=796). For incidence calculations,(29,30) we considered the unit of analysis to be the individual, rather than the event of disability. As events can be recurrent,(11) we only consider the first event in a participant. We considered the date of an incident case of disability to be the date that the survey was returned by the member, with the first episode of disability. That is, if there was no disability in the previous survey, and disability was present at the time of the next survey wave with complete data, we considered them to be an incident case of disability at the time of the follow-up survey wave. Once an individual became an incident case, he was considered to have prevalent disability—regardless of whether he recovered—and was thus removed from the "at risk" study population. We considered the time at risk to be the year interval between survey waves.

Data could be missing for one of three reasons: the participant could be one of the participants lost to follow up entirely; the survey may not have been returned by the participant; or the survey may have been returned with incomplete data on the functional status items. This can lead to interval censoring.(31,32,33,34) However, few participants had consistently missing responses, and less than one per cent of the sample have been lost to follow up for medical and vital statistics data. For proportional hazards models, we used the time to the first episode of disability, and if a survey year was missing, we used their status on the next subsequent wave with complete data. We used SAS (SAS Institute Inc., Cary, NC) for all analyses, and Excel for graphs. The study receives annual approval from the Bannatyne Campus Research Ethics Board of the University of Manitoba. The study adheres to the Declaration of Helsinki.

Other Measures

We considered chronic diseases which were prevalent at the time of the 2004 survey—namely Ischemic Heart Disease (IHD); Peripheral Artery Disease (PAD); Congestive Heart Failure (CHF); Cerebrovascular Disease/Accident (CVA); Renal Disease; Chronic Obstructive Pulmonary Disease (COPD); non-skin Cancer; alcohol misuse; and Diabetes. Self rated health (SRH) was measured on an age-referenced Likert Scale and rated as: "Excellent, very good, good, fair, and poor/bad".(35) Life Satisfaction (LS) was also measured on five-point scale and rated as: "Excellent; Good; and Fair/Poor/Bad." Since there were very few members who rated their LS or SRH in the lower categories, we collapsed fair, poor and bad into one group. Finally, we considered the Short Form–36 (SF-36).(26) This is a Health Related Quality of Life (HRQoL) measure which is valid and reliable in the North American population. We considered the Mental Component Scale (MCS) and the Physical Component Scale (PCS) separately, as we have previously shown that relationship between these two subscales lessens over time in this cohort.(36)

Analysis

Since the incidence rate was not constant over the study period, we calculated the new cases of disability per year, rather than for the overall time period. To determine the factors which were associated with incident disability, we constructed survival analysis models, as explained here. We calculated the median time to disability for each factor, and compared groups using Log Rank tests. We considered the time at risk to be the period of observation prior to death or the outcome of new disability. We then constructed proportional hazards models(37) for the variable of interest in 2004, and adjusted for age. We then constructed a full proportional hazards model with all factors included. Finally, we constructed a model by backward selection of variables, comparing the model fit and statistical significance at each step, choosing the most parsimonious model.

RESULTS

Baseline characteristics are shown in Table 1. Those included in the analysis were less likely to report poor SRH and poor LS, and had a lower burden of chronic illness. Over the study interval, 670 of the participants died and 291 acquired new disability. There were 62 participants who survived and remained free of disability throughout the analysis time frame. The status of the sample at each time point is shown in Figure 1. As the study progressed and the cohort aged, most participants had died and/or acquired disability by the end of the observation window. The proportion of those with new disability increased over this time frame, up until about 2015. Figure 2 demonstrates the status of the sample who survived. Early in the study, there were few participants with missing data, but this increased as the members aged. Each year, between 4% and 12% of the at-risk population had a new episode of disability. This increased year on year, but reached a plateau in 2015. The number of missing participants (shown in Figure 1 and Figure 2) influences any incidence rate calculation—even in this cohort study with a relatively low percentage of missing responses. Thus, these estimates should be considered cautiously. The Kaplan-Meier plots are shown in the Appendix, which shows the hazard of disability over the study duration for each factor.

TABLE 1.
Characteristics of participants and those excluded from analyses; those who did not develop disability may have died without disability, or survived the study period

Characteristics In 2004	*Participants With No Disability*	*Participants Who Developed Disability*	*Participants With Disability (Excluded)*	*Participants Who Did Not Return 2004 Survey*
Number of men	505	291	103	293
Age (years, SD)	83.6 (3.1)	84.0 (3.2)	85.4 (3.5)	84.6 (3.5)
MCS (mean, SD)	54.9 (7.6)	55.5 (7.6)	N/A	N/A
PCS (mean, SD)	44.1 (9.7)	41.6 (9.6)	N/A	N/A
Married (N, percent)	359 (71%)	224 (77%)	N/A	N/A
Self Rated Health (N, percent)				
Excellent	86 (17%)	30 (10%)	N/A	N/A
Very Good	186 (37%)	112 (39%)	N/A	N/A
Good, Fair, Poor	228 (46%)	146 (51%)	N/A	N/A
Life Satisfaction (N, percent)				
Excellent	140 (28%)	81 (28%)	N/A	N/A
Good	297 (59%)	168 (58%)	N/A	N/A
Fair, Poor, Bad	65 (13%)	41 (14%)	N/A	N/A
Number of Chronic Diseases (N, percent)				
None	186 (37%)	93 (32%)	25 (24%)	93 (32%)
One	189 (37%)	112 (38%)	38 (37%)	105 (36%)
Two	93 (18%)	64 (22%)	30 (29%)	57 (19%)
Three or more	37 (7%)	22 (8%)	10 (10%)	35 (12%)
Specific Chronic Diseases (N, percent)				
IHD	130 (26%)	79 (27%)	32 (31%)	83 (28%)
Stroke	79 (16%)	61 (21%)	30 (29%)	58 (20%)
Cancer	132 (26%)	80 (27%)	34 (33%)	84 (29%)
COPD	31 (6%)	24 (8%)	10 (10%)	23 (8%)
Diabetes	64 (13%)	33 (11%)	15 (15%)	50 (17%)
PAD	61 (12%)	33 (11%)	11 (11%)	33 (11%)
Alcohol Misuse	21 (4%)	14 (5%)	8 (8%)	36 (12%)
CHF	35 (7%)	30 (10%)	17 (17%)	27 (9%)
Renal Disease	18 (4%)	10 (3%)	11 (11%)	18 (6%)

SD = standard deviation; N = number; MCS = Mental Component Score; PCS = Physical Component Score; IHD = ischemic heart disease; COPD = chronic obstructive pulmonary disease; PAD = peripheral arterial disease; CHF = congestive heart failure; N/A = not available.

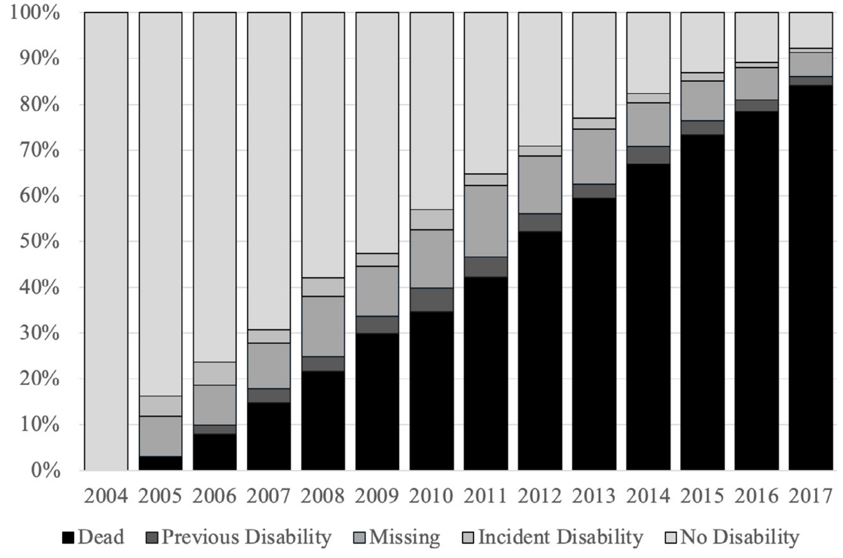

FIGURE 1. Status of the sample of the study time frame

The median time to disability is shown in Figure 3. Note that this is not the time lived free of disability; those who died were censored. When we consider the risk factors for new disability, low SRH, a lower HRQoL, and a higher chronic disease burden emerged as important risk factors for new disability in models only adjusting for age. Figure 3 and Table 2 show the effect of the PCS on the risk of disability, with a clear gradient in risk across the PCS. MCS was not associated with disability after adjusting for age (Table 2). Low SRH was a strong predictor of new disability; those with poor SRH had a hazard of disability about three times higher than those with excellent SRH (Figure 3 and Table 2). Similarly, lower levels of LS were associated with new disability, and this was also a gradient across the measurement of LS, although this risk was not seen after adjusting for chronic disease (Figure 3 and Table 2).

The effect of chronic diseases was also seen, with several chronic conditions being associated with a higher hazard of disability. Generally, each chronic disease was associated with an increased hazard of about 20 to 30%. However, some conditions were not associated with the development of disease: IHD, non-skin cancer, alcohol misuse, diabetes, PAD, and renal disease were not associated with new disability (Table 2). Conditions causing overt organ failure (CHF and COPD) generally showed

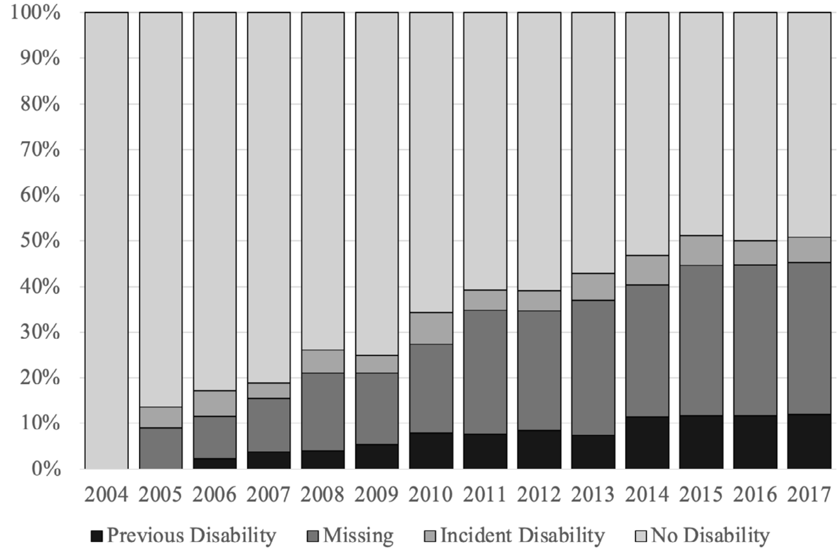

FIGURE 2. Disability status of surviving members throughout the study period
PCS = Physical Component Scale; MCS = Mental Component Scale, SRH =self-rated health; LS = life satisfaction.

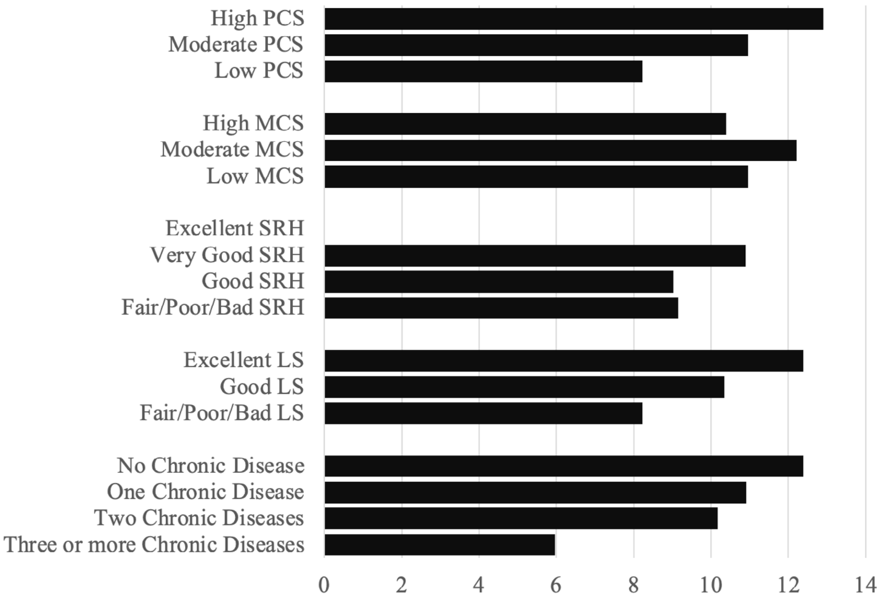

FIGURE 3. Median time to disability (in yrs)

TABLE 2.
Results of proportional hazards models; the adjusted Hazard Ratio is shown for the factors which are associated with incident disability

	Model 1: Adjusted for Age	*Model 2: Full Model with All Variables*	*Model 3: Reduced Model*
Age	*N/A*	*1.12 (1.09, 1.17)*	*1.12 (1.08, 1.17)*
Marital Status (Ref=married)	1.09 (0.83, 1.44)	1.21 (0.90, 1.62)	N/S
PCS (ref=highest tertile)			
Middle tertile	1.47 (1.07, 2.01)	1.20 (0.86, 1.68)	1.21 (0.87, 1.69)
Lowest tertile	2.67 (1.96, 3.63)	2.01 (1.40, 2.88)	2.05 (1.44, 2.92)
MCS (ref=highest tertile)			
Middle tertile	0.81 (0.61, 1.08)	0.85 (0.63, 1.15)	N/S
Lowest tertile	1.31 (0.97, 1.76)	1.22 (0.87, 1.70)	N/S
SRH (ref=Excellent)			
Very Good	1.79 (1.19, 2.68)	1.48 (0.94, 2.33)	1.39 (0.90, 2.13)
Good	2.87 (1.91, 4.30)	2.24 (1.35, 3.37)	2.04 (1.23, 3.22)
Fair/Poor/Bad	2.40 (2.04, 5.65)	1.35 (0.69, 2.71)	1.45 (0.79, 2.67)
Life Satisfaction (ref=Excellent)			
Good	1.26 (0.97, 1.64)	0.86 (0.62, 1.19)	N/S
Fair/Poor/Bad	2.01 (1.38, 2.94)	1.04 (0.61, 1.77)	N/S
Chronic Disease (Ref=none)			
One	1.30 (0.98, 1.71)	1.34 (0.99, 1.80)	1.31 (0.98, 1.76)
Two	1.56 (1.13, 2.14)	1.55 (1.09, 2.19)	1.51 (1.08, 2.12)
Three or more	2.60 (1.62, 4.18)	2.09 (1.22, 3.59)	2.14 (1.25, 3.67)
Specific Chronic Diseases			
IHD	1.16 (0.89, 1.50)		
Stroke	1.65 (1.24, 2.18)		
Cancer	1.19 (0.92, 1.55)		
COPD	2.00 (1.31, 3.04)		
Diabetes	1.22 (0.85, 1.77)		
PAD	1.17 (0.82, 1.69)		
Alcohol Misuse	1.58 (0.92, 2.70)		
CHF	2.40 (1.60, 3.46)		
Renal Disease	1.32 (0.70, 2.47)		

a stronger association. Importantly, there was a cumulative risk seen with these conditions, with each additional disease contributing additional risk. In models adjusting for all factors, some factors emerged as important predictors of disability: low PCS, poor SRH, and the number of chronic conditions were all associated with the development of disability (Table 2).

DISCUSSION

We have analyzed a prospective cohort study of aging men to determine the incidence of new moderate-to-severe disability, and found that new disability is fairly common and increases with age. While this is not surprising, it is important for health-care planning and preventive services. We noted a very strong association between simple global measures of well-being and disability. While the association between SRH and mortality,(35) and LS and mortality are well established,(38) there is less evidence of an association between these measures and incident disability. At both clinical and population levels, these simple measures may be useful in identifying those at risk of both death and disability—they are easily measured, easily interpreted, and yet yield important information. Secondly, we noted a strong association between the burden of chronic illness and the risk of disability. This reinforces the importance of multimorbidity in clinical practice and health-care policy. Interestingly, we did not find that some diseases were associated with new disability. For instance, in this data set, IHD is closely associated with mortality,(39) but a considerable proportion of those deaths were sudden deaths. Thus, some of those with IHD may have died suddenly or rapidly with minimal time spent with disability. The lack of association between cancer or renal disease and incident disability may similarly be due to a fairly rapid functional decline to death. Another related explanation may be that we measured prevalent conditions in 2004, rather than incident conditions. Those with a previous diagnosis of cancer may have survived their initial diagnosis and treatment, and were consequently not at a higher risk of disability than those without cancer. Finally, some conditions were rare—notably alcohol misuse—so there may be a low power to detect a risk of disability.

Any analysis of disability in late life is complicated, and there are limitations to our analyses. First, we considered only new disability. Individuals can experience multiple episodes of disability. Indeed, in this data set, a substantial proportion of the members sustained and then recovered from disability and/or relapsed.(40) We hope to study this recovery and/or relapsing pattern more closely in future analyses. Furthermore, many of the participants we considered free of disability at the initial time point may have experienced an episode of disability at some point in the past from which they recovered; so the initial sample may not have been free of disability to that point in their life. Second, there may be bias from interval censoring. We cannot know the state of the participants between survey waves, or the exact time of disability onset. Some of the participants may have become disabled and recovered within this window. Our analyses assume that they were disability-free throughout this period. Thus, we may underestimate the true incidence of disability. However, there are very few large epidemiological studies with frequent sampling intervals available for analyses, particularly amongst very old men. Third, there are missing data for some survey waves, which can also lead to interval censoring. Some of the missing data is due to non-response to the survey, while some is due to incomplete answers to the functional status questionnaire. We believe that data are not missing randomly, but that non-response may be related to both disability and the independent variables in our analyses. While the non-response rate is lower than most cohort studies, it still presents a major challenge. We would advise considerable caution in the interpretation of the incidence rates, since our results were influenced by missing data. However, most of the data are missing on only one survey wave, with data available on the next survey wave. Thus, disability status is usually noted within our data set, even if disability onset is noted later than it truly occurred. A fourth limitation is our measurement of disability. Any definition of disability is somewhat arbitrary. For these analyses, we considered moderate-to-severe disability, which we defined as two or more BADL impairment or three or more IADL impairments. This is different from previous definitions we have used,(40) since we are interested in the incidence of moderate-to-severe disability rather than mild impairment. We may have observed different findings if we had considered more mild disability or more severe disability, or a change in disability severity. Finally, our population of study consists of men who lived most of their lives in Canada and share some common life experiences. Thus, the findings cannot be generalized to other populations, particularly women. Others have shown different patterns of functional impairment in men compared to women,(41) and we caution against a broad generalization of our findings.

There are also strengths to our approach. The MFUS is a cohort which has been followed over a long time frame, and there are very few participants who have been lost to follow up. Vital statistics data and medical data are very complete. Less than one per cent of the original cohort have been lost to follow up. Thus, we have a very low rate of censorship due to non-death attrition. Missing data on the SAQ surveys—while problematic—is lower than most large epidemiological studies.

In spite of the above limitations, we feel that our results are important for several reasons. One important finding is that the incidence of new disability is correlated with advancing age—even in a population starting at the age of 84. While this is expected, it is relevant in policy and clinical care. As men age, health and functional status should be assessed frequently, and services put in place to support disability as it becomes apparent. Those with poor SRH and a higher disease burden likely should be more closely followed. We also found that the presence of chronic conditions is associated with disability. Moreover, the effect is cumulative. This finding reinforces the importance of multimorbidity in clinical practice and in health-care policy. There are also other studies with short time intervals, or infrequent survey waves, showing that multimorbidity is associated with new disability.(17,18,19,20,21) Clinicians and health-care systems must adapt to this complexity in caring for older adults by considering the totality of the medical status, rather than simply addressing one discrete disease at a time. Finally, our findings reinforce the importance of global self reports of well-being—the SRH in particular. This simple, straightforward question is strikingly predictive of mortality,(35,42) health-care utilization,(43) and other adverse outcomes.(44,45,46) In clinical practice, it can serve as a useful introduction to a review of systems, or a functional inquiry, and provides useful information in its own right. Simply listening to patients has long been central to Geriatric Medicine. With our current focus on advanced tests, biomarkers, and streamlined assessments, we should not lose track of the importance of simply asking people how they are doing.(47)

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal*'s policy on conflicts of interest disclosure and declare the following interests: Mr Nowicki reports no conflicts of interest; Drs. Tate and St John receive funding from CIHR; Dr. St John has received speaking fees from McMaster University and the Regional Geriatric Program of Eastern Ontario, management consulting fees from the University Health Network (Toronto), and is a member of the board of Age and Opportunity (Manitoba).

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REFERENCES

1. Courtney-Long EA, Carroll DD, Zhang QC, Stevens AC, Griffin-Blake S, Armour BS, *et al*. Prevalence of Disability and Disability Type Among Adults--United States, 2013. *Morb Mortal Wkly Rep*. 2015 Jul 31;64(29):777–83.
2. Stegenga BT, Nazareth I, Torres-González F, Xavier M, Švab I, Geerlings MI, *et* al. Depression, anxiety and physical function: exploring the strength of causality. *J Epidemiol Commun Health*. 2012 Jul 1;66(7):e25.
3. Boccaccio DE, Cenzer I, Covinsky KE. Life satisfaction among older adults with impairment in activities of daily living. *Age Ageing*. 2021 Nov;50(6):2047–54.
4. Reuben DB, Rubenstein LV, Hirsch SH, Hays RD. Value of functional status as a predictor of mortality: results of a prospective study. *Am J Med*. 1992 Dec 1;93(6):663–69.
5. Fried TR, Bradley EH, Williams CS, Tinetti ME. Functional disability and health care expenditures for older persons. *Arch Intern Med*. 2001 Nov 26;161(21):2602–07.
6. Fried TR, Bradley EH, Towle VR, Allore H. Understanding the treatment preferences of seriously ill patients. *N Engl J Med*. 2002 apr 4;346(14):1061–66.
7. Fried LP, Bandeen-Roche K, Kasper JD, Guralnik JM. Association of comorbidity with disability in older women: the Women's Health and Aging Study. *J Clin Epidemiol*. 1999 Jan 1; 52(1):27–37.
8. Mehta KM, Yaffe K, Covinsky KE. Cognitive impairment, depressive symptoms, and functional decline in older people. *J Am Geriatr Soc*. 2002 Jun;50(6):1045–50.
9. St John PD, Tyas SL, Montgomery PR. Cognition, even in the normal range, predicts disability: cross-sectional and prospective analyses of a population-based sample. *Int J Geriatr Psychiatry*. 2015 Oct;30(10):1008–16.
10. Gill TM. Disentangling the disabling process: insights from the precipitating events project. *Gerontologist*. 2014 Aug 1;54(4):533–49.
11. St John PD, Swift AU, Tate RB. Patterns of functional impairment over time amongst older men—the Manitoba Follow-up Study. *Can Geriatr J*. 2021 Jan;24(2):144–50.
12. Hébert R, Brayne C, Spiegelhalter D. Incidence of functional decline and improvement in a community-dwelling, very elderly population. *Am J Epidemiol*. 1997 May 15;145(10):935–44.
13. Fong JH. Disability incidence and functional decline among older adults with major chronic diseases. *BMC Geriatr*. 2019 Dec;19(1):323.
14. Lee J, Meijer E, Phillips D, Hu P. Disability incidence rates for men and women in 23 countries: evidence on health effects of gender inequality. *J Gerontol A Biol Sci Med Sci*. 2021 Feb 76(2):328–38.
15. Jagger C, Matthews R, Melzer D, Matthews F, Brayne C. Educational differences in the dynamics of disability incidence, recovery and mortality: findings from the MRC Cognitive Function and Ageing Study (MRC CFAS). *Int J Epidemiol*. 2007 apr 1;36(2):358–65.
16. Gill TM, Han L, Gahbauer EA, Leo-Summers L, Murphy TE. Risk factors and precipitants of severe disability among community-living older persons. *JAMA Netw Open*. 2020 Jun 1; 3(6):e206021.
17. Aubert CE, Kabeto M, Kumar N, Wei MY. Multimorbidity and long-term disability and physical functioning decline in middle-aged and older Americans: an observational study. *BMC Geriatr*. 2022 Nov 28;22(1):910.
18. Ho HE, Yeh CJ, Wei JC, Chu WM, Lee MC. Multimorbidity patterns and their relationships with incident disability and frailty among older adults in Taiwan: a 16-year, population-based cohort study. *Arch Gerontol Geriatr*. 2022 Jul 1;101:104688.
19. Marengoni A, Akugizibwe R, Vetrano DL, Roso-Llorach A, Onder G, Welmer AK, *et al*. Patterns of multimorbidity and risk of disability in community-dwelling older persons. *Aging Clin Exp Res*. 2021 Feb;33(2):457–62.
20. St John PD, Tyas SL, Menec V, Tate R, Griffith L. Multimorbidity predicts functional decline in community-dwelling older adults: prospective cohort study. *Can Fam Physician*. 2019 Feb 1;65(2): e56–e63.
21. Zhou J, Wei MY, Zhang J, Liu H, Wu C. Association of multimorbidity patterns with incident disability and recovery of independence among middle-aged and older adults. *Age Ageing*. 2022 Aug;51(8).
22. Mathewson FA, Brereton CC, Keltie WA, Paul GI. The University of Manitoba follow-up study: a prospective investigation of cardiovascular disease. II. Build, blood pressure and electrocardiographic factors possibly associated with the development of coronary heart disease. *Can Med Assoc J*. 1965 May 5; 92(19):1002–06.
23. Mathewson FA, Brereton CC, Keltie WA, Paul GI. THE University of Manitoba follow-up study: a prospective investigation of cardiovascular disease. I. General description—mortality and incidence of coronary heart disease. *Can Med Assoc J*. 1965 May 5; 92(18):947–53.
24. Mathewson FA. Medical aspects of aircrew selection. *Can Med Assoc J*. 1942 Oct;47(4):318–22.
25. Tate RB, Cuddy TE, Mathewson FA. Cohort profile: the Manitoba Follow-up Study (MFUS). *Int J Epidemiol*. 2015 Oct 1; 44(5):1528–36.
26. Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992 Jun;30(6):473–83.
27. Fillenbaum GG, Smyer MA. The development, validity, and reliability of the OARS multidimensional functional assessment questionnaire. *J Gerontol*. 1981 Jul 1;36(4):428–34.
28. CIHI. How many long-term care beds are there in Canada? 2021. Available from: https://www.cihi.ca/en/how-many-long-term-care-beds-are-there-in-canada
29. Spronk I, Korevaar JC, Poos R, Davids R, Hilderink H, Schellevis FG, *et al*. Calculating incidence rates and prevalence proportions: not as simple as it seems. *BMC Public Health*. 2019 Dec;19(1):512.
30. Breslow NE, Day NE. Statistical methods in cancer research, Vol. 1 (1980) & Vol. 2 (1987). Lyon: International Agency for Research on Cancer.
31. Singh RS, Totawattage DP. The statistical analysis of interval-censored failure time data with applications. Open J Statistics. 2013;3(2):155–66.
32. Leung K-M, Elashoff RM, Afifi AA. Censoring issues in survival analysis. *Ann Rev Public Health*. 1997 May;18(1):83–104.
33. Zhang Z, Sun J. Interval censoring. *Stat Methods Med Res*. 2010 Feb;19(1):53–70.
34. Lindsey JC, Ryan LM. Methods for interval-censored data. *Statist Med*. 1998 Jan 30;17(2):219–38.
35. Mossey JM, Shapiro E. Self-rated health: a predictor of mortality among the elderly. *Am J Public Health*. 1982 Aug;72(8):800–08.
36. St John PD, Jiang D, Tate RB. Quality of life trajectories predict mortality in older men: the Manitoba Follow-Up Study. *J Aging Health*. 2018 Feb;30(2):247–61.

37. Cox DR. Regression models and life-tables. *J Royal Statist Soc: Series B* (Methodological). 1972 Jan;34(2):187–202.
38. Martín-María N, Miret M, Caballero FF, Rico-Uribe LA, Steptoe A, Chatterji S, *et al*. The impact of subjective well-being on mortality: a meta-analysis of longitudinal studies in the general population. *Psychosom Med*. 2017 Jun 1;79(5):565–75.
39. Tate RB, Michaels L, Cuddy TE, Bayomi DJ. Clinical diagnoses before age 75 and men's survival to their 85th birthday: the Manitoba Follow-Up Study. *Gerontologist*. 2013 Feb 1;53(1):133–41.
40. Hanson CR, St John PD, Tate RB. Self-rated health predicts mortality in very old men—the Manitoba Follow-Up Study. *Can Geriatr J*. 2019 Dec;22(4):199–204.
41. Melzer D, McWilliams B, Brayne C, Johnson T, Bond J. Socioeconomic status and the expectation of disability in old age: estimates for England. *J Epidemiol Commun Health*. 2000 Apr 1; 54(4):286–92.
42. DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P. Mortality prediction with a single general self-rated health question: a meta-analysis. *J Gen Intern Med*. 2006 Mar;21(3):267–75.
43. DeSalvo KB, Fan VS, McDonell MB, Fihn SD. Predicting mortality and healthcare utilization with a single question. *Health Serv Res*. 2005 Aug;40(4):1234–46.
44. Stephan Y, Sutin AR, Luchetti M, Aschwanden D, Terracciano A. Self-rated health and incident dementia over two decades: replication across two cohorts. *J Psychiatr Res*. 2021 Nov 1;143:462–66.
45. St John P, Montgomery P. Does self-rated health predict dementia? *J Geriatr Psychiatry Neurol*. 2013 Mar;26(1):41–50.
46. Montlahuc C, Soumaré A, Dufouil C, Berr C, Dartigues JF, Poncet M, *et al*. Self-rated health and risk of incident dementia: a community-based elderly cohort, the 3C Study. *Neurology*. 2011Oct 11;77(15):1457–64.
47. Blazer DG. How do you feel about...? Health outcomes in late life and self-perceptions of health and well-being. *Gerontologist*. 2008 Aug 1;48(4):415–22.

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APPENDIX

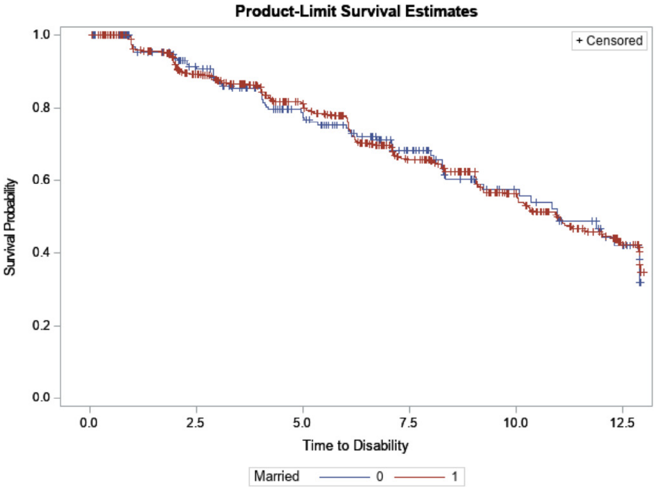

Figure A1. Kaplan-Meier plot of disability in those who are married versus those who are not

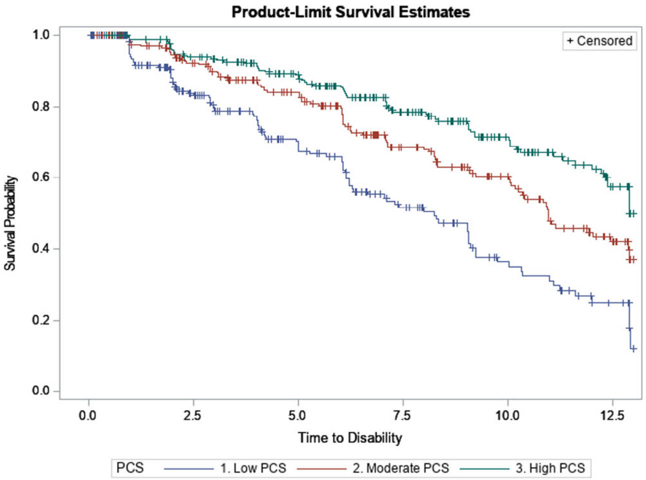

Figure A2. Kaplan Meier plot of disability for the Physical Component Score (PCS) of the SF-36 by tertile of PCS

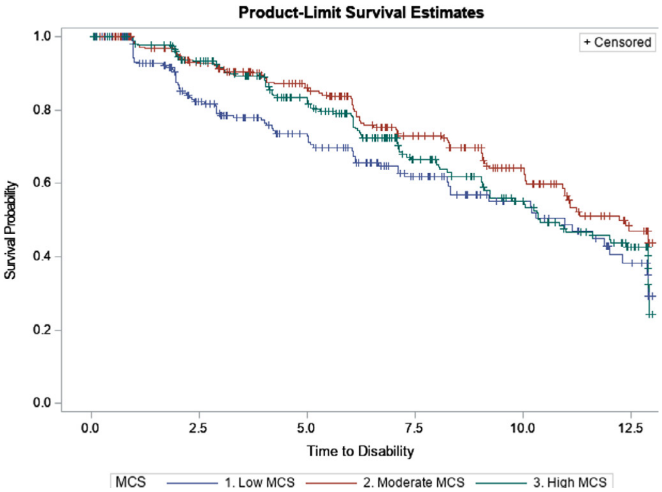

Figure A3. Kaplan Meier plot of survival for the Mental Component Score (MCS) of the SF-36 by tertile of MCS

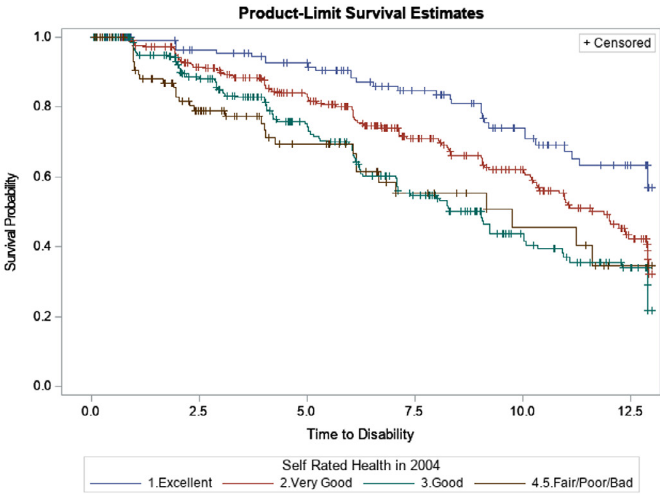

Figure A4. Kaplan Meier plot of disability for self-rated health

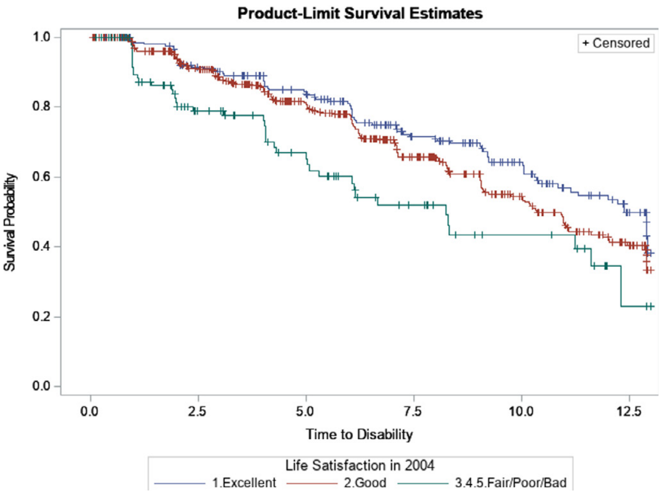

Figure A5. Kaplan Meier plot of disability for life satisfaction

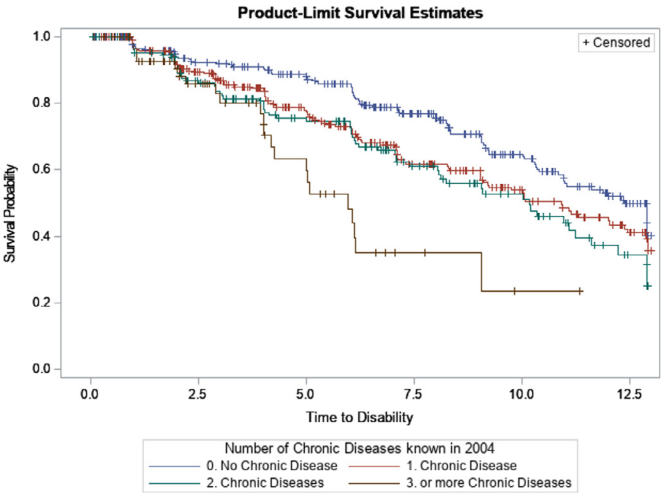

Figure A6. Kaplan Meier plot for disability in those with multiple chronic conditions

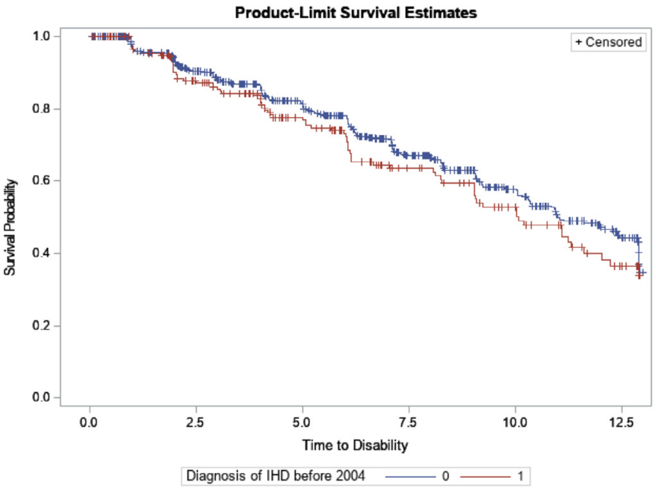

Figure A7. Kaplan Meier plot of disability for those with and without IHD

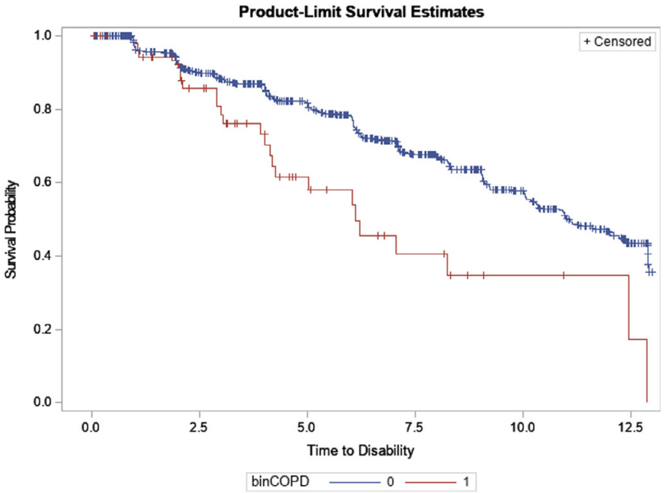

Figure A8. Kaplan Meier plot of disability for those with and without COPD

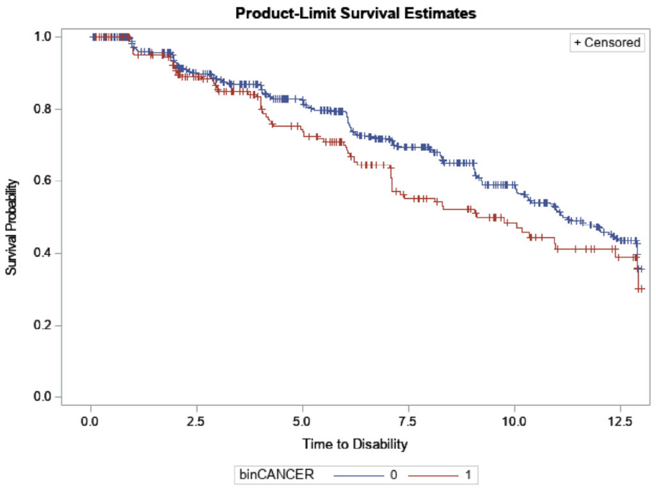

Figure A9. Kaplan Meier plot of disability for those with and without cancer

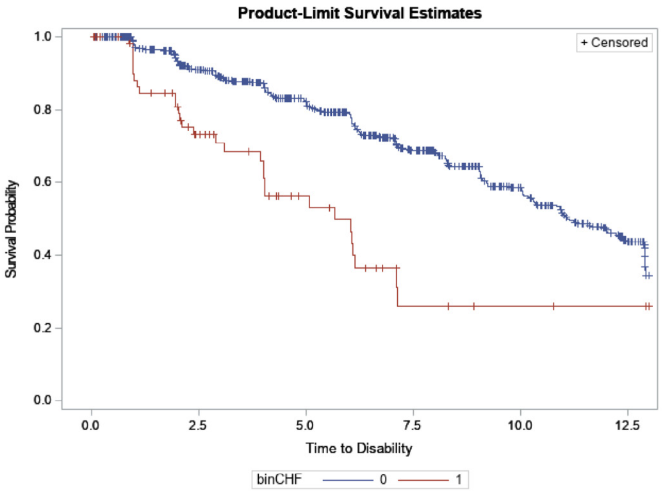

Figure A10. Kaplan Meier plot of disability for those with and without CHF

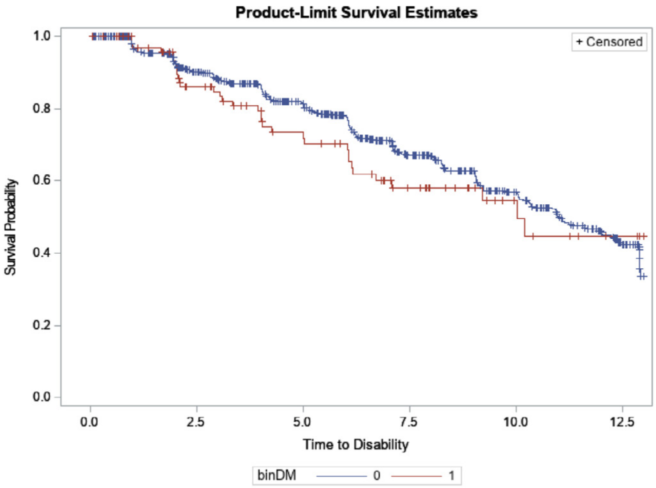

Figure A11. Kaplan Meier plot of disability for those with and without diabetes

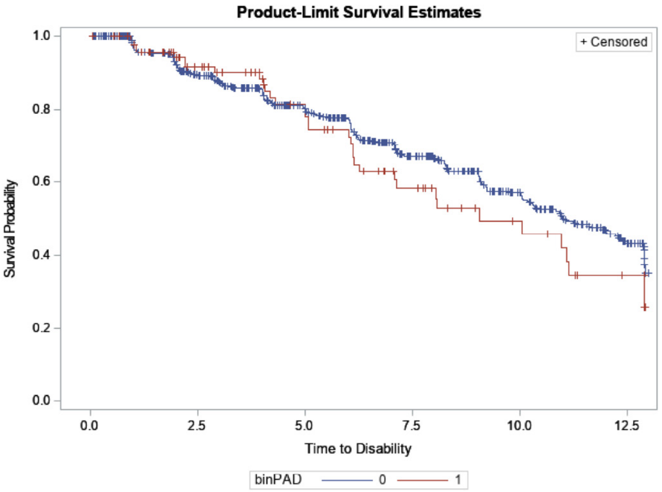

Figure A12. Kaplan Meier plot of disability for those with and without PAD

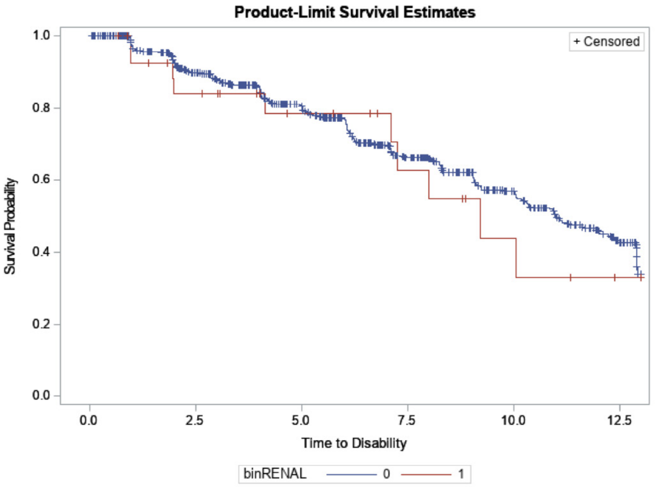

Figure A13. Kaplan Meier plot of disability for those with and without renal disease

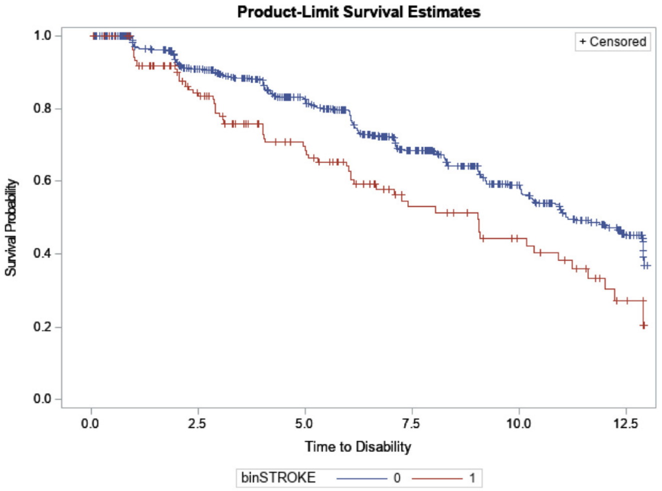

Figure A14. Kaplan Meier plot of disability for those with and without stroke