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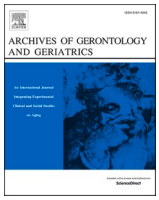

Disability transitions in Dutch community-dwelling older people aged 75 years or older

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HIGHLIGHTS

- Of the participants, 65% were younger than 80 years, 50% were married or cohabiting, 87% reported a healthy lifestyle, and 63% had no diseases or chronic disorders.
- Each year, more participants changed from status not disabled to disabled than vice versa.
- The transition of the disability score is strongly influenced by lifestyle and diseases or disorders.
- For health care professionals, our study provides starting points for interventions focused on the prevention of worsening disability and for community-dwelling older people 75 year or older.
- The most important recommendation is: live healthy!

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ABSTRACT

Background: Recent world population predictions show that the world population aged >=65 years will increase from 10% in 2022 to 16% in 2050. Population aging is accompanied by an increase in people with disability. It is important to pay special attention to people with disability, as these people are at high risk of adverse outcomes. Our study aimed to investigate the transitions of disability among Dutch community-dwelling older people aged 75 years or older, using a follow-up of nine years. We used socio-demographic factors gender, age, marital status, education, and income, but also lifestyle, diseases, and life events to predict the disability transitions over time.
Methods: We used a sample of 484 people that was randomly drawn from the municipality of Roosendaal (the Netherlands), a municipality with 78,000 inhabitants. A subset of people who completed part A of the Tilburg Frailty Indicator (TFI) at baseline and the Groningen Activity Restriction Scale (GARS) questionnaires was used with a nine-year follow-up. Paired Wilcoxon tests were used to compare the consecutive measurements. Socio-demographic factors gender, age, marital status, education, and income, but also lifestyle, diseases, and life events were included to predict the disability transitions over time. For the univariable and multivariable analysis of the measurements over time with the predictor variables, we used generalized estimation equations (GEE). A p-value <0.05 was considered significant. R version 3.4.4 was used for all analyses.
Results: Of the participants, 65% were younger than 80 years, 50% were married or cohabiting, 87% reported a healthy lifestyle, and 63% had no diseases or chronic disorders. Each year, more participants changed from status not disabled to disabled than vice versa. The GEE analyses showed that lifestyle ('not healthy') and diseases or chronic disorders ('two or more') were significant in the multivariable analysis for the disability score and only diseases or chronic disorders ('two or more') was significant in the multivariable analysis for the dichotomous disability score.
Conclusions: The transition of the disability score is strongly influenced by lifestyle and diseases or disorders. This applies to a lesser extent to the dichotomous disability score. There, only diseases or disorders are an important predictor. For health care professionals our study provides starting points for interventions focused on the

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prevention of worsening disability and for community-dwelling older people >= 75, the most important recommendation is: live healthy!

1. Introduction

Recent world population predictions show that the world population aged >=65 years will increase from 10% in 2022 to 16% in 2050. This trend is driven by a combination of lower mortality, increased survival, and a decline in fertility rates (United Nations Department of Economic and Social A airs, P D 2022). Population aging is accompanied by an increase in people with disability.

Among Dutch community-dwelling people aged >=75 years, prevalence rates of disability have been shown to vary from 25.2% to 34.8% (Gobbens et al., 2010; Gobbens, 2018). It is important to pay special attention to people with disability, as these people are at high risk of adverse outcomes. Well-known outcomes are low quality of life (Den Ouden et al., 2013; Gobbens, 2018), increase in healthcare utilization and associated costs (Fried et al., 2004), and premature death (Gobbens and Van Der Ploeg, 2020; Majer et al., 2011). Therefore, early effective intervention is important so that these adverse outcomes are prevented or at least delayed.

According to the World Health Organization (WHO), three dimensions can be distinguished in disability. The rst dimension refers to impairment in a person's body structure of function (e.g., loss of vision), or mental functioning (e.g., loss of memory). The second dimension involves activity limitation (e.g., difficulty in walking), and the third dimension of disability refers to participation restrictions in normal activities such as obtaining health care and preventive services (World Health Organization 2001). Irrespective of these three dimensions, disability is often defined narrowly, with the WHO dimension 'activity limitation' being the starting point. Disability is frequently defined as having difficulty in performing activities of daily living (ADL) or instrumental activities of daily living (IADL). Examples of ADL are 'wash your face and hands' and 'go up and down the stairs'. Activities such as 'prepare breakfast and lunch' and 'wash and iron your clothes' are part of IADL. In general, IADL disability is less severe than ADL disability and usually precedes it. This is evidenced by the prevalence rates of IADL and ADL disability.

Previous studies have shown that disability has a dynamic nature. Transitions between disability states over time occur frequently (Castro et al., 2021; Casasnovas and Nicodemo, 2016; De Leon et al., 1999; Gill et al., 2006; Hardy et al., 2005; Myers et al., 2020; Raˆche et al., 2012; Van Houwelingen et al., 2014; Yong and Saito, 2012). Several socio-demographic factors influence disability transitions. These transitions have been predicted by age (Gill et al., 2006), gender (Gill et al., 2006; Gill et al., 2013; Hardy et al., 2008; Lamarca et al., 2003), ethnicity (Dong et al., 2019), income (Casasnovas and Nicodemo, 2016; Taylor, 2010) and education (Yong and Saito, 2012; Taylor, 2010). In addition, diseases can be considered an important influencing factor in disability transitions (Nikolova et al., 2011). Only the Leiden 85-plus Study investigated disability transitions among Dutch community-dwelling people using a sample of 597 people aged 85 years (Van Houwelingen et al., 2014) and a follow-up period of ve years. The Leiden 85-plus Study examined the transitions between no disability in ADL and IADL, and ADL and IADL disability, and mortality, and established predictors of these disability transitions.

The aim of our study was twofold. Firstly, we examined the transitions of total disability (ADL and IADL disability) among Dutch community-dwelling older people aged 75 years or older, using a follow-up of nine years. Besides the fact that the age of the participants and the years of follow-up di ered from the previously mentioned study (Van Houwelingen et al., 2014), our study also di ered in that we always compared the total disability between two consecutive years. Secondly, we determined predictors for total disability transitions. We included the socio-demographic factors gender, age, marital status, education, and income, but also lifestyle, diseases, and life events.

2. Methods

2.1. Study population and data collection

In June 2008, a questionnaire including the Tilburg Frailty Indicator (TFI), the Groningen Activity Rating Scale (GARS), and questions about socio-demographic characteristics was sent to a sample comprising 1154 community-dwelling people aged >=75 years. For the TFI, we refer to Appendix A and for the GARS, we refer to Appendix B.

The sample was randomly drawn from the municipality of Roosendaal (the Netherlands), a municipality with 78,000 inhabitants. A total of 484 people completed the questionnaire, of which 479 were usable for analysis. Until June 2017, the people who belonged to the sample were invited annually to ll in the same questionnaire. We were therefore able to present the results of nine consecutive measurements. The sample was previously used for frailty studies, e.g. focusing on the psychometric properties of the TFI (Gobbens et al., 2010; Gobbens et al., 2012), the relationship between frailty and quality of life in older people (Gobbens et al., 2010), and the use of Bayesian techniques in predicting frailty (Van Der Ploeg et al., 2023).

2.2. Disability

The GARS is a self-reported questionnaire that contains two subscales. One subscale focuses on ADL disability with eleven items. The other subscale measures IADL disability with seven items. Each of the eighteen items has four response categories: 1) able to perform the activity without any difficulty, 2) able to perform the activity with some difficulty, 3) able to perform the activity with great difficulty, and 4) unable to perform the activity independently. The score for total disability (ADL and IADL disability) ranges from 18 (no disability) to 72 (maximum disability). For the ADL and IADL subscales, the score ranges from 11 to 44 and from 7 to 28, respectively. A cut-o point of 29 has been established for total disability (<29: 'not disabled', >=29: 'disabled') (Ormel et al., 2002). No cut-o points are known for the ADL and IADL subscales. The GARS has been validated in the Netherlands and demonstrated to have good psychometric properties to assess disability among older people (Kempen et al. 1996; Suurmeijer et al., 1994).

2.3. Predictors

Part A of the TFI consists of socio-demographic factors gender, age, marital status, country of birth, education, income, lifestyle, diseases, life events, and satisfaction living environment as predictor variables. For our analysis, these variables were dichotomized.

2.4. Statistical analyses

For the analyses, we used a subset of participants who completed part A of the TFI at baseline (T1) and the GARS questionnaires for the rst nine years (T1 to T9). We also dropped the variables country of birth and satisfaction living environment due to low frequencies. This resulted in a subset of 69 participants. We used counts and percentages to describe the categorical variables. For the description of the continuous variables, we used quartiles, mean, and standard deviation. Paired Wilcoxon tests were used to compare the consecutive measurements. For the comparison of the subset of participants who completed part A of the TFI at baseline (T1) and the GARS questionnaires for the rst nine years with

the subset of participants who had one or more missing values for the variables of part A of the TFI at baseline (T1) and the GARS questionnaires for the rst nine years, we used logistic regression. For the univariable and multivariable analysis of the measurements over time with the dichotomized predictor variables, we used generalized estimation equations (GEE) (Hardin, 2005; Twisk, 2013). For the multivariable analyses, a variable was included if the p-value of that variable in the univariable analysis was <0.30. We performed a power analysis for the comparison of the nine repeated measurements (Cohen, 2013; WebPower 2021). Further, a p-value <0.05 was considered significant (Twisk, 2013). We used R version 3.4.4 (R Core Team 2019) for all analyses.

3. Results

Table 1 presents the number of missing values and the number of valid cases for the GARS scores at each time point. At time point T9, there were 97 cases left with valid values for the GARS scores at the time points T1 to T9. Due to missing values for the predictor variables, this number was reduced to 69 cases with valid values for all predictor variables and valid values for all GARS scores at the time points T1 to T9.

Multivariable logistic regression analysis for the comparison of the subset of participants who completed part A of the TFI at baseline (T1) and the GARS questionnaires for the first nine years (n = 69) with the subset of participants who had one or more missing values for the variables of part A of the TFI at baseline (T1) and the GARS questionnaires for the first nine years (n = 415) concerning the predictor variables showed that the predictor variables age and lifestyle were significant (p-values 0.007 and 0.027 respectively). The other predictor variables had p-values > 0.05.

Unfortunately, we did not know the reasons for not completing the survey at one or more time points. The power analysis for the comparison of the GARS scores at the time points T1 to T9 with = 0:05 (type I error), = 0:20 (type II error), and medium effect size f = 0:5 showed that a sample size of 62 participants was needed (WebPower 2021).

Table 2 shows the distribution of the predictor variables at time point T1. Notable is that 87% of the participants reported a healthy lifestyle.

Table 3 shows the characteristics of the GARS scores at the time points T1 to T9. The p-values of the Wilcoxon test are also presented in Table 3. The changes of the GARS scores in the period T4 to T7 showed p-values < 0.05.

The development of the GARS scores over time is visualized in Fig. 1. It can be seen that up to T3, the GARS scores were stable. From T4, the GARS scores increased slightly.

Table 4 shows the distribution of the dichotomous GARS scores (GARS score < 29: 'not disabled', GARS score >=29: 'disabled') over time. The percentage 'disabled' increased steadily over time, although there were no significant changes in distribution from time point to time point (all p-values > 0.05).

The transition of participant status ('not disabled', 'disabled') over time is visualized in Fig. 2.

We performed GEE analyses for the GARS score and the dichotomous GARS score. For the univariable and the multivariable GEE analyses, the coefficients of the GEE model and the corresponding p-values are presented in Table 5. For the GARS score in the multivariable analysis, lifestyle ('not healthy') and diseases or chronic disorders ('two or more') showed p-values < 0.05 (0.029 and 0.002, respectively). In the multivariable analysis for the dichotomous GARS score, only diseases or chronic disorders ('two or more') was significant at the 0.05 level (p-value 0.011).

Table 1
Missing values GARS scores.

Time point	Missing	Valid
T1	39	445
T2	170	314
T3	229	255
T4	251	233
T5	293	191
T6	324	160
T7	354	130
T8	355	129
T9	387	97

Table 2
Frequencies predictors.

	n	%
Gender		
man	35	50.7
woman	34	49.3
Age		
younger than 80	45	65.2
80 or older	24	34.8
Marital status		
married or cohabitating	36	52.2
not married and not cohabitating	33	47.8
Education		
primary or secondary	55	79.7
higher	14	20.3
Net monthly income		
more than 1800	28	40.6
1800 or less	41	59.4
Lifestyle		
healthy	60	87.0
not healthy	9	13.0
Diseases or chronic disorders		
none or one	44	63.8
two or more	25	36.2
Life events		
none	34	49.3
one or more	35	50.7

4. Discussion

In this study, we investigated the transitions of disability among Dutch community-dwelling older people aged 75 years or older, using a follow-up of nine years. We determined predictors for disability transitions. We included the socio-demographic factors gender, age, marital status, education, and income, but also lifestyle, diseases, and life events. We used a random sample from the municipality of Roosendaal (the Netherlands), a municipality with 78,000 inhabitants. A total of 484 people completed the questionnaire, of which 479 were usable for analysis. Until June 2017, the people included in the sample were annually invited to ll in the same questionnaires (GARS and TFI, Appendices A and B). We were therefore able to present the results of nine consecutive measurements.

4.1. Principal findings

Of the participants, 65% were younger than 80 years, 50% were married or cohabiting, 87% reported a healthy lifestyle, and 63% had no diseases or chronic disorders, see Table 2.

The boxplots in Fig. 1 show the transitions over time of the GARS score. The increases in GARS score from T4 to T7 were significant (p-values 0.004, 0.038, and 0.004, respectively), see Table 3. The transition plots of the dichotomous GARS score over time are shown in Fig. 2. Each year, more participants changed from status not disabled ('ND') to disabled ('D') than vice versa. However, none of the p-values were below 0.05, see Table 4.

The GEE-analysis with the GARS score showed that lifestyle ('not healthy') and diseases or chronic disorders ('two or more') were significant in the multivariable analysis (p-values 0.029 and 0.002, respectively), see Table 5. The GEE-analysis with the dichotomous GARS score showed that only diseases or chronic disorders ('two or more') was significant (p-value 0.011), see Table 5.

Table 3
Characteristics GARS score.

	Minimum	25%	Median	Mean	75%	Maximum	n	From to	p-value*
T1	18	19	21	23.2	27	42	69		
T2	18	18	21	23.7	27	45	69	T1-T2	0.452
T3	18	19	21	24.2	28	51	69	T2-T3	0.250
T4	18	20	22	24.9	28	48	69	T3-T4	0.132
T5	18	19	24	26.2	29	50	69	T4-T5	0.004
T6	18	20	24	27.3	33	50	69	T5-T6	0.038
T7	18	21	25	28.8	35	64	69	T6-T7	0.004
T8	18	22	27	30.1	37	67	69	T7-T8	0.054
T9	18	22	27	30.9	40	70	69	T8-T9	0.309

* =Paired Wilcoxon test

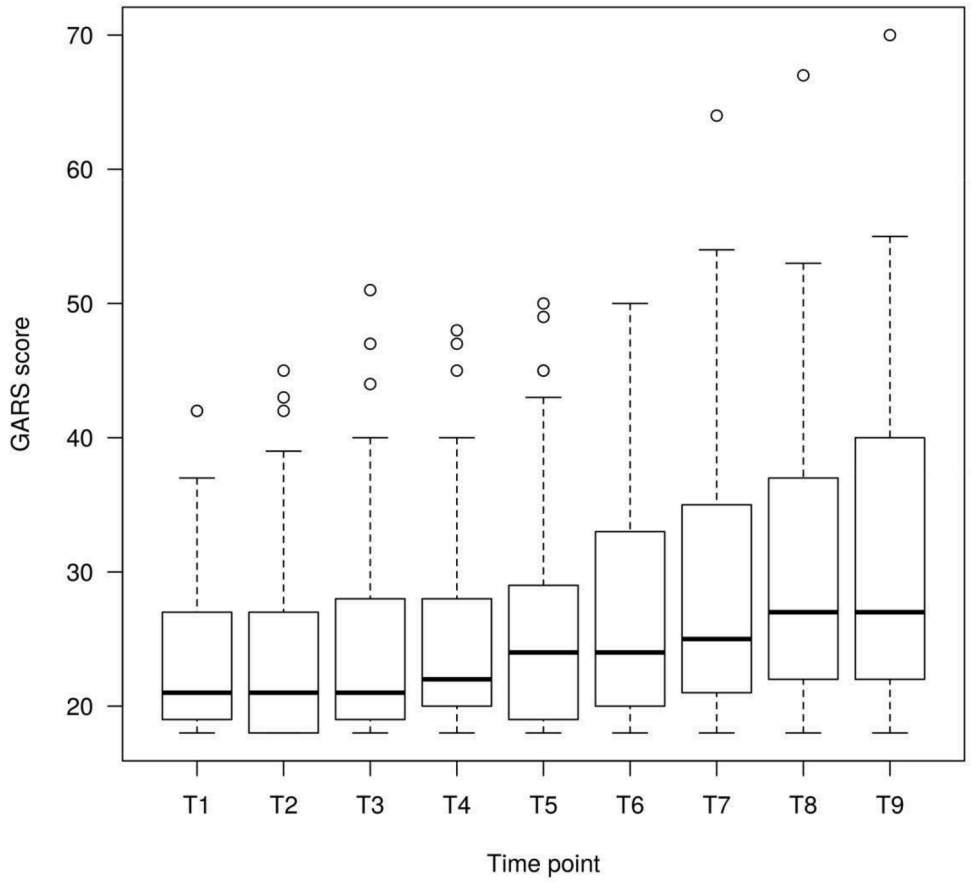

Fig. 1. Boxplots GARS score.

Table 4
Frequencies dichotomous GARS score.

	Not disabled		Disabled			
	n	%	n	%	From to	p-value*
T1	59	85.5	10	14.5		
T2	57	82.6	12	17.4	T1-T2	0.494
T3	52	75.4	17	24.6	T2-T3	0.112
T4	52	75.4	17	24.6	T3-T4	1.000
T5	51	73.9	18	26.1	T4-T5	0.780
T6	44	63.8	25	36.2	T5-T6	0.055
T7	42	60.9	27	39.1	T6-T7	0.616
T8	41	59.4	28	40.6	T7-T8	0.805
T9	39	56.5	30	43.5	T8-T9	0.624

* =Chi-square test

Although lifestyle and diseases or chronic disorders emerged as independent predictors for the transition in GARS score, there is also a relationship between the two (Al-Maskari, 2010; Artaud et al., 2013). Well-established evidence shows that the incidence of cancer, cardiovascular disease, chronic respiratory disease and diabetes share modifiable risk factors such as alcohol consumption, body mass index (BMI), cigarette smoking, unhealthy diet and physical inactivity, which account for more than two-thirds of these diseases (Beaglehole et al., 2011; Organization et al., 2014; Kearns et al., 2014).

The significance of diseases or chronic disorders alone as a predictor for the dichotomous GARS score seems to confirm this. This result was also a conclusion in other studies (Al-Maskari, 2010; Artaud et al., 2013).

4.2. Comparison to prior work

Our finding that total disability (ADL and IADL) increased among

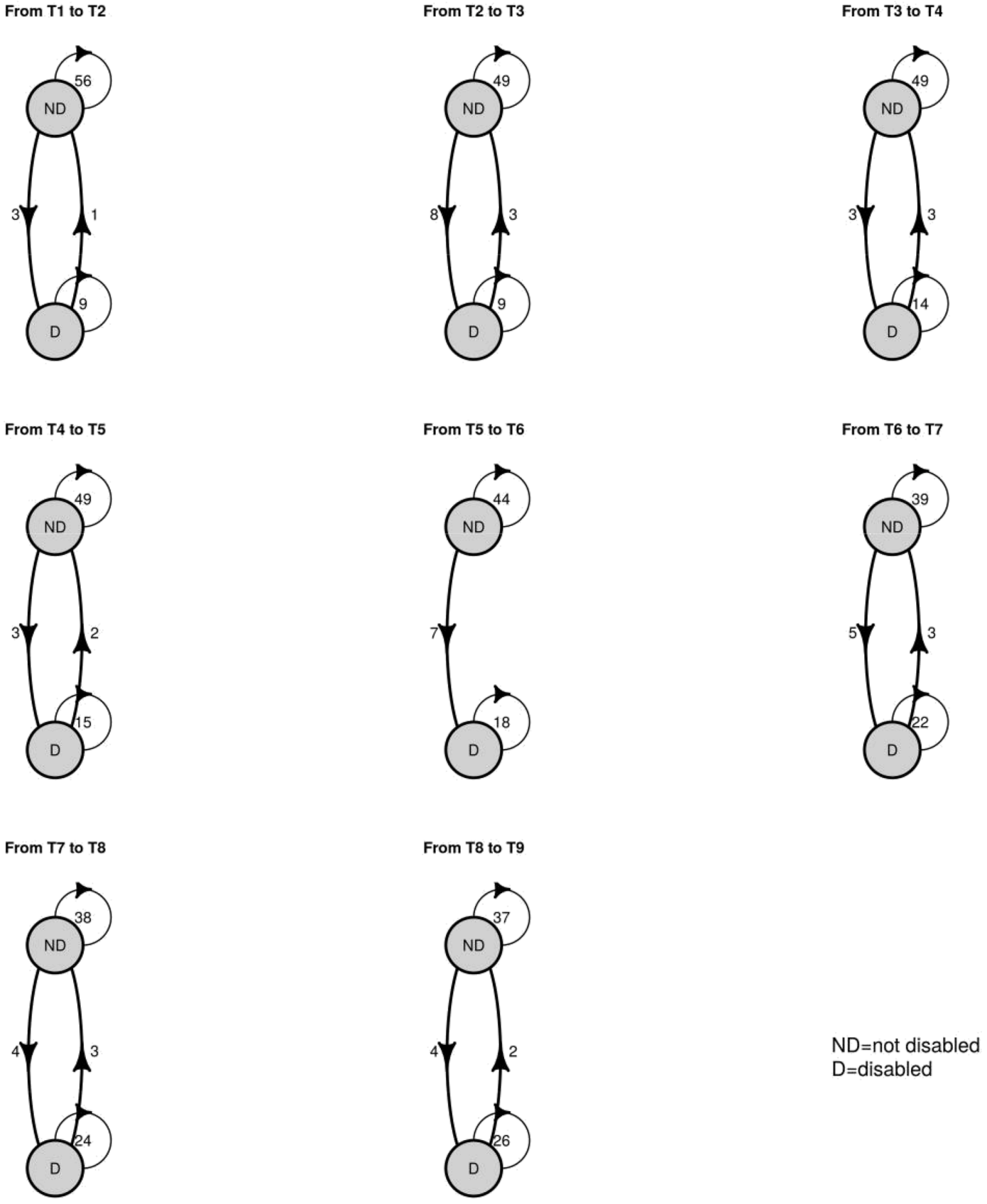

Fig. 2. Transition plots.

Table 5
GEE output GARS scores.

	univariable*		multivariable*		univariable**		multivariable**	
	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Gender ('woman')	1.9	0.294	1.2	0.435	0.3	0.498		
Age ('80 or older')	-1.1	0.567			-0.5	0.320		
Marital status ('not married and not cohabitating')	2.2	0.240	0.5	0.747	0.5	0.244	0.2	0.588
Education ('higher')	1.4	0.539			0.4	0.521		
Monthly income ('1800 or less')	2.4	0.192	2.1	0.193	0.7	0.139	0.8	0.128
Lifestyle ('not healthy')	8.8	0.004	6.6	0.029	1.6	0.014	1.3	0.096
Diseases or chronic disorders ('two or more')	7.3	0.000	5.3	0.002	1.5	0.001	1.2	0.011
Life events ('one or more')	0.2	0.909			0.0	0.962		

* =GARS score
** =dichotomous GARS score

people aged 75 years and older using a follow-up of nine years is not surprising. In our study, transitions occurred between disability states, from no disability to disability and vice versa, in particular the transition from no disability to disability. However, all these transitions were not significant (all p-values > 0.05). In previous studies, these transitions were significant (Castro et al., 2021; Casasnovas and Nicodemo, 2016; De Leon et al., 1999; Gill et al., 2006; Hardy et al., 2005; Myers et al., 2020; Raˆche et al., 2012; Van Houwelingen et al., 2014; Yong and Saito, 2012). This may be due to the operationalization of disability. In our study, this was a sum of impairments in ADL and IADL, assessed with the GARS. Several previous studies only assessed ADL disability (Castro et al., 2021; Hardy et al., 2005; De Leon et al., 1999). In addition, eight of the previously mentioned studies used a different measurement instrument to assess ADL or IADL disability. The only study that also used the GARS was conducted by Van Houwelingen et al. (2014).

Our study showed that participants who rated their lifestyle as not healthy and participants with two or more diseases or chronic disorders made transitions to disability. Although it should be noted that in the multivariable analyses using the dichotomous GARS score, lifestyle did not appear to be a significant predictor of disability transitions. An unhealthy lifestyle can be characterized by factors such as smoking, excessive alcohol consumption, physical inactivity, and poor dietary habits. In a sample consisting of 5050 Norwegian people aged 60 to 69 years, physical inactivity was an important lifestyle risk factor for ADL and IADL disability (Storeng et al., 2018). Lee et al. (2013) came to the same conclusion in a sample of Koreans aged >=65 years (N = 3511). In China, it was demonstrated that a high Body Mass Index (BMI), which may re ect poor dietary habits, predicted ADL disability among 34,349 older people aged >=65 years using a six-year follow-up period (Zhou et al., 2022). In another country (Japan), it was observed that a two-year multidomain lifestyle intervention including the elements physical activity, nutritional counseling, social activity, cognitive training, and vascular risk monitoring ensured that people (mean age 69 years at baseline) at risk of cognitive decline maintained performing their ADL and IADL (Lisko et al., 2021). The finding that lifestyle is a significant predictor of disability transitions is important because many of the well-known predictors (age, gender, ethnicity, income, education) are not very changeable. However, if a poor lifestyle is present, this gives healthcare professionals entry points for interventions.

The important role of having more than two diseases or chronic disorders, so-called multimorbidity, regarding the development of disability has also been recognized in previous studies (Friedman and Shorey, 2019; Ho et al., 2022; Jedrzejczyk et al., 2022). For instance, Peng et al. (2021) showed that the presence of multimorbidity was associated with developing ADL disability in 3951 Chinese adults aged 45 years or older. Another study including hospitalized patients conducted in Poland, showed that an increase in the number of diseases contributed to a decrease in the performance level of IADL (Jedrzejczyk et al., 2022). Using data from the Taiwan Longitudinal Study on Aging (Ho et al., 2022) showed that distinct multimorbidity patterns (cardiometabolic group, arthritis-cataract group, multimorbidity group, relatively healthy group) among older people in Taiwan were associated with an incidental disability using a follow-up of sixteen years. Instruments other than the GARS were used in all studies to assess disability. We recommend a future longitudinal study focusing on the association between combinations of diseases or chronic disorders and disability using the GARS. The GARS includes eleven ADL disability items and seven IADL disability items. More knowledge about the prediction of individual disability items of the GARS due to multimorbidity is also relevant.

4.3. Limitations

Several limitations of this study should be addressed.

First, the TFI and the GARS are self-reported data, so both are subjectively assessed. However, the construct validity of the TFI has been determined in detail using objective measurements (Gobbens et al., 2010) and also the construct validity of the GARS has also been demonstrated (Suurmeijer et al., 1994). The use of other frailty measures instead of the TFI, such as the phenotype of frailty by Fried et al. (2001), would probably have led to different results.

Second, due to the relatively long follow-up period (nine years) and the inclusion criterion for age (>=75), the remaining number of participants who completed the questionnaires was low. As a result, 69 participants were included in our analyses. In addition, we are not well informed about the reasons for dropouts. However, a previous study using the same sample at baseline and a follow-up of seven years (2008–2015) has shown that 162 individuals died (Gobbens and Van Der Ploeg, 2021).

5. Conclusions

The transition of the GARS score is strongly influenced by lifestyle and diseases or disorders. This applies to a lesser extent to the dichotomous GARS score. There, only diseases or disorders are an important predictor. For health care professionals our study provides starting points for interventions focused on the prevention of worsening disability and for community-dwelling older people >= 75, the most important recommendation is: live healthy!

Ethics approval and consent to participate

All procedures performed in studies involving human participants followed the ethical standards of the institute or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For the present study, medical ethics approval was not necessary because treatments or interventions were not o ered or withheld from respondents. Moreover, the integrity of respondents was not encroached upon because of participating in this study, which is the main criterion in medical-ethical

procedures in the Netherlands (Central Committee on Research Involving Human Subjects 2016). Informed consent related to detailing the study and maintaining confidentiality was observed.

Consent for publication

Not applicable.

Data availability

The dataset used and analyzed during the current study is available from the corresponding author upon reasonable request.

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CRediT authorship contribution statement

Tjeerd van der Ploeg: Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis. **Robbert J.J. Gobbens:** Writing – review & editing, Writing – original draft, Supervision, Data curation.

Declaration of Competing Interest

The authors declare that they have no competing interests.

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Supplementary materials

Supplementary data associated with this article can be found, in the online version, at 10.1016/j.archger.2023.105165.

Appendices

A. Tilburg Frailty Indicator (TFI) (Gobbens et al., 2010)

Part A Determinants of frailty

1. What is your gender?
   - ☐ male
   - ☐ female
2. What is your age?

   ... years

3. What is your marital status?
   - ☐ married or living with partner
   - ☐ unmarried
   - ☐ separated or divorced
   - ☐ widow or widower
4. In which country were you born?
   - ☐ The Netherlands
   - ☐ Former Dutch East Indies
   - ☐ Suriname
   - ☐ Netherlands Antilles
   - ☐ Turkey
   - ☐ Morocco
   - ☐ Other, namely.....
5. What is the highest level of education you have completed?
   - ☐ none or primary education
   - ☐ secondary education
   - ☐ higher professional or university education
6. Which category indicates your net monthly household income in euro?
   - ☐ 600 or less
   - ☐ 601 - 900
   - ☐ 901 - 1200
   - ☐ 1201 - 1500
   - ☐ 1501 - 1800
   - ☐ 1801 - 2100
   - ☐ 2101 or more
7. Overall, how healthy would you say your lifestyle is?
   - ☐ healthy
   - ☐ not healthy, not unhealthy
   - ☐ unhealthy
8. Do you have two or more diseases and/or chronic disorders?
   - ☐ yes
   - ☐ no
9. Have you experienced one or more of the following events during the past year?
   - ☐ the death of a loved one
   - ☐ serious illness yourself
   - ☐ a serious illness in a loved one
   - ☐ a divorce or ending of an important intimate relationship
   - ☐ a traffic accident
   - ☐ a crime
10. Are you satisfied with your home living environment?
    - ☐ yes
    - ☐ no

Part B Components of frailty

B1 Physical components.

11. Do you feel physically healthy?
    - ☐ yes
    - ☐ no

12. Have you lost a lot of weight recently without wishing to do so? ("a lot" is: 6 kg or more during the last six months, or 3 kg or more during the last month)
    - ☐ yes
    - ☐ no

13. Do you experience problems in your daily life due to difficulty in walking?
    - ☐ yes
    - ☐ no

14. Do you experience problems in your daily life due to difficulty maintaining your balance?
    - ☐ yes
    - ☐ no

15. Do you experience problems in your daily life due to poor hearing?
    - ☐ yes
    - ☐ no

16. Do you experience problems in your daily life due to poor vision?
    - ☐ yes
    - ☐ no

17. Do you experience problems in your daily life due to lack of strength in your hands?

☐ yes
☐ no

18. Do you experience problems in your daily life due to physical tiredness?
☐ yes
☐ no

B2 Psychological components.

19. Do you have problems with your memory?
☐ yes
☐ sometimes
☐ no

20. Have you felt down during the last month?
☐ yes
☐ sometimes
☐ no

21. Have you felt nervous or anxious during the last month?
☐ yes
☐ sometimes
☐ no

22. Are you able to cope with problems well?
☐ yes
☐ sometimes
☐ no

B3 Social components.

23. Do you live alone?
☐ yes
☐ no

24. Do you sometimes miss having people around you?
☐ yes
☐ sometimes
☐ no

25. Do you receive enough support from other people?
☐ yes
☐ no

B. Groningen Activity Restriction Scale (GARS) (Kempen et al., 1993)

The following questions refer to daily activities which should be performed frequently. In each question it is asked whether you are able toperform the activity at this moment. It is not intended to assess whether you are actually performing the activities, but if you can do them if necessary.

1. Can you dress yourself?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
2. Can you get in and out of bed?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
3. Can you stand up from sitting in a chair?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
4. Can you wash your face and hands?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
5. Can you wash and dry your whole body?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
6. Can you get on and off the toilet?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
7. Can you feed yourself?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
8. Can you get around in the house (if necessary with a cane)?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
9. Can you go up and down the stairs?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
10. Can you walk outdoors (if necessary with a cane)?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
11. Can you take care of your feet and toenails?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
12. Can you prepare breakfast or lunch?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help
13. Can you prepare dinner?
☐ Yes, I can do it fully independently without any difficulty
☐ Yes, I can do it fully independently but with some difficulty
☐ Yes, I can do it fully independently but with great difficulty
☐ No, I cannot do it fully independently, only with someone's help

14. Can you do "light" household activities (for example, dusting and tidying up)?
    - ☐ Yes, I can do it fully independently without any difficulty
    - ☐ Yes, I can do it fully independently but with some difficulty
    - ☐ Yes, I can do it fully independently but with great difficulty
    - ☐ No, I cannot do it fully independently, only with someone's help
15. Can you do "heavy" household activities (for example mopping, cleaning the windows and vacuum- ing)?
    - ☐ Yes, I can do it fully independently without any difficulty
    - ☐ Yes, I can do it fully independently but with some difficulty
    - ☐ Yes, I can do it fully independently but with great difficulty
    - ☐ No, I cannot do it fully independently, only with someone's help
16. Can you wash and iron your clothes?
    - ☐ Yes, I can do it fully independently without any difficulty
    - ☐ Yes, I can do it fully independently but with some difficulty
    - ☐ Yes, I can do it fully independently but with great difficulty
    - ☐ No, I cannot do it fully independently, only with someone's help
17. Can you make the beds?
    - ☐ Yes, I can do it fully independently without any difficulty
    - ☐ Yes, I can do it fully independently but with some difficulty
    - ☐ Yes, I can do it fully independently but with great difficulty
    - ☐ No, I cannot do it fully independently, only with someone's help
18. Can you do the shopping?
    - ☐ Yes, I can do it fully independently without any difficulty
    - ☐ Yes, I can do it fully independently but with some difficulty
    - ☐ Yes, I can do it fully independently but with great difficulty
    - ☐ No, I cannot do it fully independently, only with someone's help

References

Al-Maskari, F. (2010). *Lifestyle diseases: An economic burden on the health services, 5* pp. 1–2). UN Chronicle The Magazine of the United Nations.

Artaud, F., Dugravot, A., Sabia, S., Singh-Manoux, A., Tzourio, C., & Elbaz, A. (2013). Unhealthy behaviours and disability in older adults: Three-City Dijon cohort study. *Bmj*, 347.

Beaglehole, R., Bonita, R., Horton, R., Adams, C., Alleyne, G., Asaria, P., et al. (2011). Priority actions for the non-communicable disease crisis. *The Lancet, 377*(9775), 1438–1447.

Casasnovas, G. L., & Nicodemo, C. (2016). Transition and duration in disability: New evidence from administrative data. *Disability and Health Journal, 9*(1), 26–36.

Castro, J. E. C., Garc a-Pe~na, C., & Aldana, R. R. (2021). Transitions of disability, disability-free life expectancy and health insurance among adults aged 50 and older in Mexico: A multistate life table analysis. *BMJ Open, 11*(8), Article e045261.

Central Committee on Research Involving Human Subjects. Research involving human subjects; 2016. Accessed: June 20, 2016. https://english.ccmo.nl/investigators/legal-framework-for-medical-scientic-research/your-research-is-it-subject-to-the-wmo-or-not.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Academic press.

De Leon, C. F. M., Glass, T. A., Beckett, L. A., Seeman, T. E., Evans, D. A., & Berkman, L. F. (1999). Social networks and disability transitions across eight intervals of yearly data in the New Haven EPESE. *The Journals of Gerontology: Series B, 54*(3), S162–S172.

Den Ouden, M. E., Schuurmans, M. J., Mueller-Schotte, S., Brand, J. S., & van Der Schouw, Y. T. (2013). Domains contributing to disability in activities of daily living. *Journal of the American Medical Directors Association, 14*(1), 18–24.

Dong, L., Freedman, V. A., Sanchez, B. N., & Mendes De Leon, C. F. (2019). Racial and ethnic differences in disability transitions among older adults in the United States. *The Journals of Gerontology: Series A, 74*(3), 406–411.

Fried, L. P., Ferrucci, L., Darer, J., Williamson, J. D., & Anderson, G. (2004). Untangling the concepts of disability, frailty, and comorbidity: Implications for improved targeting and care. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 59*(3), M255–M263.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., et al. (2001). Frailty in older adults: Evidence for a phenotype. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 56*(3), M146–M157.

Friedman, E., & Shorey, C. (2019). Inflammation in multimorbidity and disability: An integrative review. *Health Psychology, 38*(9), 791.

Gill, T. M., Allore, H. G., Hardy, S. E., & Guo, Z. (2006). The dynamic nature of mobility disability in older persons. *Journal of the American Geriatrics Society, 54*(2), 248–254.

Gill, T. M., Gahbauer, E. A., Lin, H., Han, L., & Allore, H. G. (2013). Comparisons between older men and women in the trajectory and burden of disability over the course of nearly 14 years. *Journal of the American Medical Directors Association, 14*(4), 280–286.

Gobbens, R. J., Van Assen, M. A., Luijkx, K. G., & Schols, J. M. (2012). The predictive validity of the Tilburg frailty indicator: Disability, health care utilization, and quality of life in a population at risk. *The Gerontologist, 52*(5), 619–631.

Gobbens, R. J., Van Assen, M. A., Luijkx, K. G., Wijnen-Sponselee, M. T., & Schols, J. M. (2010). The Tilburg frailty indicator: Psychometric properties. *Journal of the American Medical Directors Association, 11*(5), 344–355.

Gobbens, R. J., & Van Der Ploeg, T. (2020). The prediction of mortality by disability among Dutch community-dwelling older people. *Clinical Interventions in Aging*, 1897–1906.

Gobbens, R. J., & Van Der Ploeg, T. (2021). The prediction of mortality by quality of life assessed with the WHOQOL-BREF: A longitudinal analysis at the domain and item levels using a seven-year follow-up period. *Quality of Life Research, 30*(7), 1951–1962.

Gobbens, R. J. (2018). Associations of ADL and IADL disability with physical and mental dimensions of quality of life in people aged 75 years and older. *PeerJ, 6*, e5425.

Hardin, J. W. (2005). Generalized estimating equations (GEE). *Encyclopedia of statistics in behavioral science*.

Hardy, S. E., Allore, H. G., Guo, Z., & Gill, T. M. (2008). Explaining the effect of gender on functional transitions in older persons. *Gerontology, 54*(2), 79–86.

Hardy, S. E., Dubin, J. A., Holford, T. R., & Gill, T. M. (2005). Transitions between states of disability and independence among older persons. *American Journal of Epidemiology, 161*(6), 575–584.

Ho, H. E., Yeh, C. J., Wei, J. C. C., Chu, W. M., & Lee, M. C. (2022). Multimorbidity patterns and their relationships with incident disability and frailty among older adults in Taiwan: A 16-year, population-based cohort study. *Archives of Gerontology and Geriatrics, 101*, Article 104688.

Jedrzejczyk, M., Forys, W., Czapla, M., & Uchmanowicz, I. (2022). Relationship between multimorbidity and disability in elderly, patients with coexisting frailty syndrome. *International Journal of Environmental Research and Public Health, 19*(6), 3461.

Kearns, K., Dee, A., Fitzgerald, A. P., Doherty, E., & Perry, I. J. (2014). Chronic disease burden associated with overweight and obesity in Ireland: The effects of a small BMI reduction at population level. *BMC Public Health, 14*(1), 1–10.

Kempen, G. I., Miedema, I., Ormel, J., & Molenaar, W. (1996). The assessment of disability with the Groningen activity restriction scale. Conceptual framework and psychometric properties. *Social Science & Medicine, 43*(11), 1601–1610.

Kempen, G. I. J. M., Miedema, I., Ormel, J., & Molenaar, W. (1993). Groningen activity restriction scale. *Social Science & Medicine*.

Lamarca, R., Ferrer, M., Andersen, P. K., Liestol, K., Keiding, N., & 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.

Lee, Y., Kim, J., Back, J. H., Kim, S., & Ryu, M. (2013). Changes in combined lifestyle risks and disability transition in older adults: Korean Longitudinal Study of Aging, 2006{2008. *Preventive Medicine, 56*(2), 124–129.

Lisko, I., Kulmala, J, Annetorp, M., Ngandu, T., Mangialasche, F., & Kivipelto, M. (2021). How can dementia and disability be prevented in older adults: Where are we today and where are we going? *Journal of Internal Medicine, 289*(6), 807–830.

Majer, I. M., Nusselder, W. J., Mackenbach, J. P., Klijs, B., & Van Baal, P. H. (2011). Mortality risk associated with disability: A population-based record linkage study. *American Journal of Public Health, 101*(12), e9–e15.

Myers, A., Ward, B., Wong, J., & Ravesloot, C. (2020). Health status changes with transitory disability over time. *Social Science & Medicine, 244*, Article 112647.

Nikolova, R., Demers, L., Beland, F., & Giroux, F. (2011). Transitions in the functional status of disabled community-living older adults over a 3-year follow-up period. *Archives of Gerontology and Geriatrics, 52*(1), 12–17.

Organization, W. H., et al. (2014). *Global status report on noncommunicable diseases 2014. WHO/NMH/NVI/15.1*. World Health Organization.

Ormel, J., Rijsdijk, F. V., Sullivan, M., Van Sonderen, E., & Kempen, G. I. (2002). Temporal and reciprocal relationship between IADL/ADL disability and depressive symptoms in late life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 57*(4), P338–P347.

Peng, S., Wang, S., & Feng, X. L. (2021). Multimorbidity, depressive symptoms and disability in activities of daily living amongst middle-aged and older Chinese: Evidence from the China health and retirement longitudinal study. *Journal of Affective Disorders, 295*, 703–710.

R Core Team. (2019). *R: A language and environment for statistical computing*. Vienna, AustriaAvailable from: https://www.R-project.org/.

Raˆche, M., Hebert, R., Dubois, M. F., Dubuc, N., et al. (2012). Yearly transitions of disability pro les in older people living at home. *Archives of Gerontology and Geriatrics, 55*(2), 399–405.

Storeng, S. H., Krokstad, S., Westin, S., & Sund, E. R. (2018). Decennial trends and inequalities in healthy life expectancy: The HUNT study, Norway. *Scandinavian Journal of Public Health, 46*(1), 124–131.

Suurmeijer, T., Doeglas, D. M., Moum, T., Briancon, S., Krol, B., Sanderman, R., et al. (1994). The Groningen activity restriction scale for measuring disability: Its utility in international comparisons. *American Journal of Public Health, 84*(8), 1270–1273.

Taylor, M. G. (2010). Capturing transitions and trajectories: The role of socioeconomic status in later life disability. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 65*(6), 733–743.

Twisk, J. W. (2013). *Applied longitudinal data analysis for epidemiology: A practical guide*. Cambridge University Press.

United Nations Department of Economic and Social A airs, P D . World population prospects 2022: Summary of results; 2022. Available from: https://www.un.org/de

velopment/desa/pd/sites/www.un.org.development.desa.pd/les/wpp2022summaryofresults.pdf.
Van Der Ploeg, T., Gobbens, R. J., & Salem, B. E. (2023). Bayesian techniques in predicting frailty among community-dwelling older adults in the Netherlands. *Archives of Gerontology and Geriatrics, 105*, Article 104836.
Van Houwelingen, A. H., ID, Cameron, Gussekloo, J., Putter, H., Kurrle, S., de Craen, A. J., et al. (2014). Disability transitions in the oldest old in the general population. The Leiden 85-plus study. *Age, 36*, 483–493.
WebPower. Statistical power analysis on line; 2021. Available from: http://psychstat.org/rmanova.
World Health Organization. International classification of functioning, disability and health (ICF); 2001. Available from: https://www.who.int/standards/classications/international-classication-of-functioning-disability-and-health.
Yong, V., & Saito, Y. (2012). Are there education differentials in disability and mortality transitions and active life expectancy among Japanese older adults? Findings from a 10-year prospective cohort study. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 67*(3), 343–353.
Zhou, J., Lyu, Y., Wei, Y., Wang, J., Ye, L., Wu, B., et al. (2022). Prediction of 6-year risk of activities of daily living disability in elderly aged 65 years and older in China. *Zhonghua yi xue za zhi, 102*(2), 94–100.