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The Development of Multidimensional Frailty Over Seven Years A longitudinal study among Dutch community-dwelling older people using the Tilburg Frailty Indicator

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ABSTRACT

Purpose: : To examine the development of multidimensional frailty, including physical, psychological and social components, over a period of seven years. To determine the effects of sociodemographic factors (gender, age, marital status, education, income) on the development of frailty.
Methods: : This longitudinal study was conducted in sample of 479 community-dwelling people aged ≥ 75 years living in the municipality of Roosendaal, the Netherlands. The Tilburg Frailty Indicator (TFI), a self-report questionnaire, was used to collect data about frailty. Frailty was assessed annually.
Results: : Frailty increased significantly over seven years among the people who completed the entire TFI all years (n = 121), the average score was 3.75 (SD 2.80) at baseline and 5.05 (SD 3.18) after seven years. Regarding frailty transitions, most participants remained unchanged from their baseline status. The transition from non-frail to frail was present in 8.3% to 12.6% of the participants and 5.1% to 10.7% made a transition from frail to non-frail. Gender (woman), age (≥80 years), marital status (not married/cohabiting), high level of education, and incomes from €601-€1800 were significantly associated with a higher frailty score.
Conclusion: : This study showed that multidimensional frailty, assessed with the TFI, increased among Dutch community-dwelling people aged ≥75 years using a follow-up of seven years. Gender, age, marital status, education, and income were associated with frailty transitions. These findings provide healthcare professionals clues to identify people at increased risk of frailty, and target interventions which aim to prevent or delay frailty and its adverse outcomes, such as disability and mortality.

1. Introduction

Frailty is a concept that is attracting a great deal of attention. This is not surprising, because older people who are frail are at increased risk of adverse outcomes such as limitations in performing activities of daily living (Liu et al., 2019; Vermeulen, Neyens, van Rossum, Spreeuwenberg, & de Witte, 2011), increased use of care (hospitalization, institutionalization) (Kojima, 2016; Vermeiren et al., 2016), and related costs (Kojima, 2019) and mortality.(Kojima, Iliffe, & Walters, 2018; Vermeiren et al., 2016). With regard to mortality, frail older people have a 1.8 to 2.3-fold risk (Vermeiren et al., 2016). Forecasts indicate that the number of older people will increase worldwide in the coming decades, for example, the United Nations Department of Economic and Social Affairs has estimated in 2015 that the population of European people aged 60 years or older will rise from 24% to 34% in 2050 (United Nations Department of Economic and Social Affairs 2015). Therefore, attention for frail older people is desperately needed to prevent, or at least to postpone, the above adverse outcomes and maintain a good quality of life. Policymakers and healthcare professionals will play an important role in achieving these goals.

Originally, frailty was a medical concept that focused only on the physical limitations that older people may have had (Gobbens, Luijkx, Wijnen-Sponselee, & Schols, 2010a). The conceptual and operational definition of Fried et al. is an excellent example of this approach (Fried

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et al., 2001). According to these researchers, frailty should be considered as "a biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems" and identifying frail older people can be given concrete form by using the phenotype of frailty criteria: unintentional weight loss, weakness, slowness, low physical activity, and poor endurance (Fried et al., 2001). Contrary to this approach to frailty, multidimensional frailty definitions stress the need to consider the whole functioning of older people (Gobbens, Luijkx, et al., 2010a). This is clearly reflected in the conceptual definition by Gobbens et al.: "frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social)" (Gobbens, Luijkx, et al., 2010a). The same applies to the Tilburg Frailty Indicator (TFI), which makes it possible to identify physical, psychological, and social frailty (Gobbens, van Assen, Luijkx, Wijnen-Sponselee, & Schols, 2010b).

Previous studies have shown that frailty does indeed have a dynamic nature; transitions between frailty states over time are common (Kojima, Taniguchi, Iliffe, Jivraj, & Walters, 2019). A recent systematic review and meta-analysis among 42,775 community-dwelling older people from 16 studies using a mean follow-up period of 3.9 years observed that their frailty status improved, worsened, and maintained in 13.7%, 29.1%, and 56.5%, respectively (Kojima et al., 2019). However, this study has a major limitation; it contains only studies in which frailty was established on the basis of the phenotype of frailty. So the development of multidimensional frailty, including physical, psychological, and social components, over time were not examined. The Frailty Index (FI), developed by Mitnitski, Mogilner, & Rockwood (2001, is however, characterized by a multidimensional approach of frailty. Some studies using the FI have demonstrated that there are also transitions in the case of multidimensional frailty (Liu et al., 2018; Setiati et al., 2019; Thompson, Theou, Adams, Tucker, & Visvanathan, 2018). In a sample of 696 Australian community-dwelling people aged 65 years or older improvement of frailty was present in 7.9%, 52.6% remained stable, and 39.5% transitioned to worse frailty, at a follow-up period of 4.5 years (Thompson et al., 2018). Data of 11.165 older people from the Chinese Longitudinal Healthy Longevity Survey showed that 30.4% transitioned between different frailty states, (distinguishing between non-frail, pre-frail, frail); in addition, transitions to worse frailty occurred more than transitions to improved frailty status (Liu et al., 2018). In Indonesia, 27.2% of the cohort consisting of 162 people aged ≥60 years had a worse frailty status after one year (Setiati et al., 2019), and in 1659 Dutch people aged ≥65 years the average FI score at baseline was 0.17 and this score increased to 0.39 after 17 years (Hoogendijk et al., 2018). A study using another instrument for assessing multidimensional frailty, the Vulnerable Elders Survey (VES-13) also found that frailty is a dynamic state with transitions over time; among 281 older individuals 19% remained their non-frail status, 22% became frail, 22% stayed frail, and 37% of them became more frail (Bentur, Sternberg, & Shuldiner, 2016).

Many studies have adopted the physical approach to frailty, and have demonstrated that gender and age were associated with frailty transitions (Herr et al., 2019; Kojima et al., 2019). Because far fewer studies have been carried out using the multidimensional approach, the evidence for these associations is less available. In aforementioned studies, including Australian and Indonesian older people, gender and age, and only age was associated with frailty state transitions, respectively (Setiati et al., 2019; Thompson et al., 2018). In the latter, having an age ≥70 years was a prognostic factor for a worse frailty state (Setiati et al., 2019). The Newcastle 85+ cohort study showed that socioeconomic status (SES) had no impact on the likelihood of shifting from one frailty state to another (Mendonça et al., 2020).

To date, no study has been carried out into the development of multidimensional frailty assessed with the TFI. This is recommended because the TFI has shown good psychometric properties (Sutton et al., 2016), is user-friendly (Gobbens, Schols, & van Assen, 2017), and has been used in studies in many countries around the world such as the Netherlands (Gobbens, van Assen, et al., 2010b), Portugal (Coelho, Santos, Paul, Gobbens, & Fernandes, 2015), China (Dong et al., 2017), Iran (Mazoochi, Gobbens, Lotfi, & Fadayevatan, 2020), and Brazil (Santiago, Luz, Mattos, Gobbens, & van Assen, 2013). Therefore, the main aim of the present longitudinal study was to examine the development of multidimensional frailty using the TFI in a sample of Dutch community-dwelling older people aged 75 years or older, over a period of seven years. Currently, only two comparable studies, including the phenotype of frailty and the Frailty Index, were conducted with a longer follow-up period of ten and seventeen years, respectively (Hoogendijk et al., 2018; Ottenbacher et al., 2009). We were able to follow the development of multidimensional frailty very well because we carried out an annual assessment. The second aim of our study was to determine the effects of sociodemographic factors (gender, age, marital status, education, income) on the development of frailty.

2. Methods

2.1. Study population and data collection

In June 2008, a questionnaire including the TFI and questions about sociodemographic characteristics, was sent to a sample comprising 1154 community-dwelling people aged ≥75 years. The sample was randomly drawn from the municipality in Roosendaal (the Netherlands), a municipality with 78,000 inhabitants. A total of 484 people completed the questionnaire, 479 of which were useful for analysis. Until June 2014, the people belonging to the sample were invited each year to complete the same questionnaire; we were therefore able to present the results of seven measurements. The sample was previously used for frailty studies, e.g., focusing on the psychometric properties of the TFI (Gobbens, van Assen, Luijkx, & Schols, 2012; Gobbens, van Assen, et al., 2010b), and the relationship between frailty and quality of life in older people (Gobbens & van Assen, 2014).

2.2. Ethical considerations

For the present study, medical ethics approval was not necessary because particular treatments or interventions were not offered or withheld from respondents. Moreover, the integrity of respondents was not encroached upon as a consequence of participating in this study, which is the main criterion in medical-ethical procedures in the Netherlands (Central Committee on, 2010). Informed consent related to detailing the study and maintaining confidentiality was observed.

2.3. Measures

2.3.1. Frailty

As mentioned in the introduction, we decided to use the TFI for assessing multidimensional frailty (Gobbens, van Assen, et al., 2010b). The TFI is a self-report questionnaire which is based on the results of a literature review and consultation of frailty experts (Gobbens, Luijkx, Wijnen-Sponselee, & Schols, 2010b). The TFI (part B) consists of fifteen questions referring to eight, four and three, physical, psychological and social frailty components, respectively; the components are: poor physical health, unintentional weight loss, difficulty in walking, difficulty in maintaining balance, poor hearing, poor vision, lack of strength in the hands, physical tiredness, memory problems, feeling down, feeling nervous ox anxious, unable to cope with problems, living alone, lack of social relations, and lack of social support (Gobbens, van Assen, et al., 2010b). The score ranges from 0 to 15; the higher the score, the more frail an older person is. Based on the score individuals can be divided into two groups, non-frail and frail. The cut-off point is 5 (<5 non-frail, ≥5 frail) (Gobbens, van Assen, et al., 2010b).

Table 1
Participant characteristics.

Characteristic	n	%
Gender		
Man	207	43.2
Woman	272	56.8
Marital status		
Married or cohabiting	238	49.8
Other	240	50.2
Education		
No or primary	181	38.1
Secondary	221	46.5
Higher	73	15.4
Net monthly income (€)		
600 or less	12	2.7
601 - 900	71	16.2
901 - 1200	106	24.2
1201 - 1500	57	13.0
1501 - 1800	67	15.3
1801 - 2100	48	11.0
2101 or more	77	17.6
Continuous variable		
	Mean	SD
Age	80.3	3.8

2.3.2. Sociodemographic characteristics

Sociodemographic characteristics of interest were: gender, age, marital status, education, and net monthly income. We refer to Table 1 for the answering categories of these five characteristics. For analysis purposes, the age of the participants was classified into <80 and ≥80.

2.4. Statistical analyses

We used counts and percentages to describe the categorical variables. For the description of the continuous variables, we used the characteristics mean and standard deviation (SD). Two types of deletion were used: pairwise deletion and listwise deletion. In pairwise deletion a participant is deleted because it has a missing value in at least one of the specified variables in a specific pair. In listwise deletion a participant is deleted because it has a missing value in at least one of the specified variables. The analysis is only run on participants which have a complete set of data. Paired Wilcoxon tests were used to compare the consecutive measurements. For the bivariate analysis and multivariable analysis of the measurements over time with respect to the sociodemographic variables, we used generalized estimation equations (GEE) (Hardin, 2005; Twisk, 2013). A p-value <0.05 was considered as significant. For all analyses, we used R version 3.4.4 (R Core Team, 2018).

3. Results

3.1. Participant characteristics

Table 1 shows the participant characteristics at baseline. The mean age was 80.3 (SD = 3.8). Of the participants, 24.2% was in the net monthly income category 901–1200 euro and 46.5% had an education on a secondary level.

Table 2
Characteristics and p-values pairwise comparison.

Year	Descriptive statistics*			Year*			Descriptive statistics**			Year**		
	Mean	SD	n	from	to	p-value	Mean	SD	n	from	to	p-value
1	4.71	3.04	445				3.75	2.80	121			
2	4.30	3.08	327	1	2	0.468	3.60	2.82	121	1	2	0.203
3	4.64	3.12	258	2	3	0.000	4.11	3.01	121	2	3	0.002
4	4.82	3.07	233	3	4	0.016	4.29	2.83	121	3	4	0.184
5	4.99	3.16	195	4	5	0.004	4.67	3.19	121	4	5	0.008
6	4.98	3.01	157	5	6	0.079	4.97	3.01	121	5	6	0.083
7	5.00	3.12	131	6	7	0.381	5.05	3.18	121	6	7	0.526

* =pairwise deletion,
** =listwise deletion

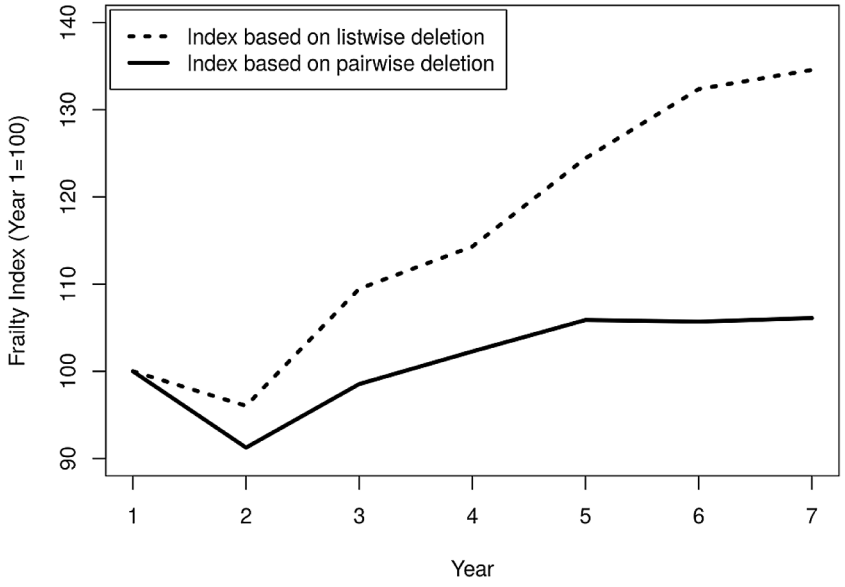

Fig. 1. Development frailty index over time.

Table 3
Transition of status from year to year based on cut-off value.

Year Frailty	Distribution			One year later (n)			One year later (%)			Valid (%)		Total (%)	
	n	%	Valid (%)	Frail	Non-frail	Unknown	Frail	Non-frail	Unknown	Frail	Non-frail	Frail	Non-frail
1													
Frail	209	43.6	47.0	102	25	82	48.8	12.0	39.2	80.3	19.7	33.6	8.2
Non-frail	236	49.3	53.0	29	148	59	12.3	62.7	25.0	16.4	83.6	9.5	48.7
Unknown	34	7.1	-	12	11	11	35.3	32.4	32.4	-	-	-	-
2													
Frail	143	29.9	43.7	83	19	41	58.0	13.3	28.7	81.4	18.6	32.7	7.5
Non-frail	184	38.4	56.3	32	120	32	17.4	65.2	17.4	21.1	78.9	12.6	47.2
Unknown	152	31.7	-	4	0	148	2.6	0.0	97.4	-	-	-	-
3													
Frail	119	24.8	46.1	88	14	17	73.9	11.8	14.3	86.3	13.7	38.4	6.1
Non-frail	139	29.0	53.9	24	103	12	17.3	74.1	8.6	18.9	81.1	10.5	45.0
Unknown	221	46.1	-	1	3	217	0.5	1.4	98.2	-	-	-	-
4													
Frail	113	23.6	48.5	77	14	22	68.1	12.4	19.5	84.6	15.4	39.9	7.3
Non-frail	120	25.1	51.5	16	86	18	13.3	71.7	15.0	15.7	84.3	8.3	44.6
Unknown	246	51.4	-	1	1	244	0.4	0.4	99.2	-	-	-	-
5													
Frail	94	19.6	48.2	60	8	26	63.8	8.5	27.7	88.2	11.8	38.2	5.1
Non-frail	101	21.1	51.8	19	70	12	18.8	69.3	11.9	21.3	78.7	12.1	44.6
Unknown	284	59.3	-	0	0	284	0.0	0.0	100.0	-	-	-	-
6													
Frail	79	16.5	50.3	48	14	17	60.8	17.7	21.5	77.4	22.6	36.6	10.7
Non-frail	78	16.3	49.7	16	53	9	20.5	67.9	11.5	23.2	76.8	12.2	40.5
Unknown	322	67.2	-	0	0	322	0.0	0.0	100.0	-	-	-	-
7													
Frail	64	13.4	48.9	-	-	-	-	-	-	-	-	-	-
Non-frail	67	14.0	51.1	-	-	-	-	-	-	-	-	-	-
Unknown	348	72.7	-	-	-	-	-	-	-	-	-	-	-

3.2. Measurements from year to year

Table 2 shows the characteristics of the measurements for each year in case of pairwise deletion and in case of listwise deletion. In both cases, the mean frailty scores at the end of the follow-up period were somewhat higher compared to the beginning of the follow-up period. Table 2 also shows the p-values for the pairwise comparison of the measurements from year to year. In case of pairwise deletion, the differences from year 2 to 3, 3 to 4 and 4 to 5 were significant ($p < 0.05$). In the case of listwise deletion, the differences from year 2 to 3 and from 4 to 5 were significant (p-values <0.05).

3.3. Visualization development of the measurements over time

In order to gain insight into the development of the measurements over time, we transformed the mean values into index values. The mean value of year 1 was set to index 100 and from there we calculated the index values for year 2 to 7 for the mean values based on pairwise deletion and for the mean values based on the listwise deletion. Figure 1 shows the development of the scores on the TFI over time for both cases.

3.4. Comparison total frailty score for known and unknown

For the known group and the unknown group in each year, we compared the mean values of total frailty one year earlier. The unknown group consisted of people with missing values with regard to frailty and people who could no longer participate in the study, e.g. through death. The mean values of total frailty one year earlier for the known group in year 2 to 7 were 4.4, 4.1, 4.5, 4.6, 4.7 and 4.9, respectively. For the unknown group in year 2 to 7, the mean values of total frailty one year earlier were 5.4, 5.1, 5.5, 5.7, 6.3, and 5.5, respectively. The values for the unknown group were somewhat higher, but only the differences in the years 2, 3, and 6 were significant ($p < 0.05$).

3.5. Development frailty over-time based on cut-off scores

Non-frail was defined as a total frailty score <5 and frail was defined as total frailty score ≥ 5. In each year, the ratio of non-frail and frail for the participants was approximately 1:1. For the distribution of non-frail, frail, and unknown within each year, see Table 3.

3.6. Transition over time

Table 3 shows the year by year transition with respect to the frailty status of the participants. The table shows for example that 58.0% of the participants who were frail in year 2 were also frail in year 3, and that 17.4% of the participants who were non-frail 136 in year 2 were frail in year 3. Table 3 also shows that in year 1 152 ($82 + 59 + 11$) participants had a transition to status unknown in year 2 of which 82 came from status frail (82 out of $152 = 53.9\%$). For the transition to status unknown in year 3, this percentage was 18.6% (41 out of 221). For year 4 to 7, the percentages for participants who changed from status frail to status unknown were <10

Figure 2 shows the transitions of frailty status (frail, non-frail, unknown) year by year expressed in percentages. For example, from year 1 to year 2, 12% of the non-frail participants shifted to frail, whereas this percentage was 17% from year 2 to year 3.

The highest percentage of this transition was achieved between year 6 and year 7 (21%). Figure 2 also shows that at least 9% of the frail participants went through an annual transition to non-frail.

3.7. Repeated measures analysis with generalized estimation equations (GEE)

Table 4 shows the coefficients and p-values of the bivariate and multivariable GEE analysis for the demographic factors with all seven scores as an outcome as well as with all seven binary outcomes (non-frail versus frail) as an outcome. For both outcomes, the demographic factors of gender (woman), age (≥ 80), marital status (other) were all significant (p-values <0.05). Higher education was significant for the score and for the binary outcome (p-values <0.05). Net monthly incomes from €601–€1800 were significant for the score, and net monthly income of €2101 or more was significant for the binary outcome (p-values <0.05).

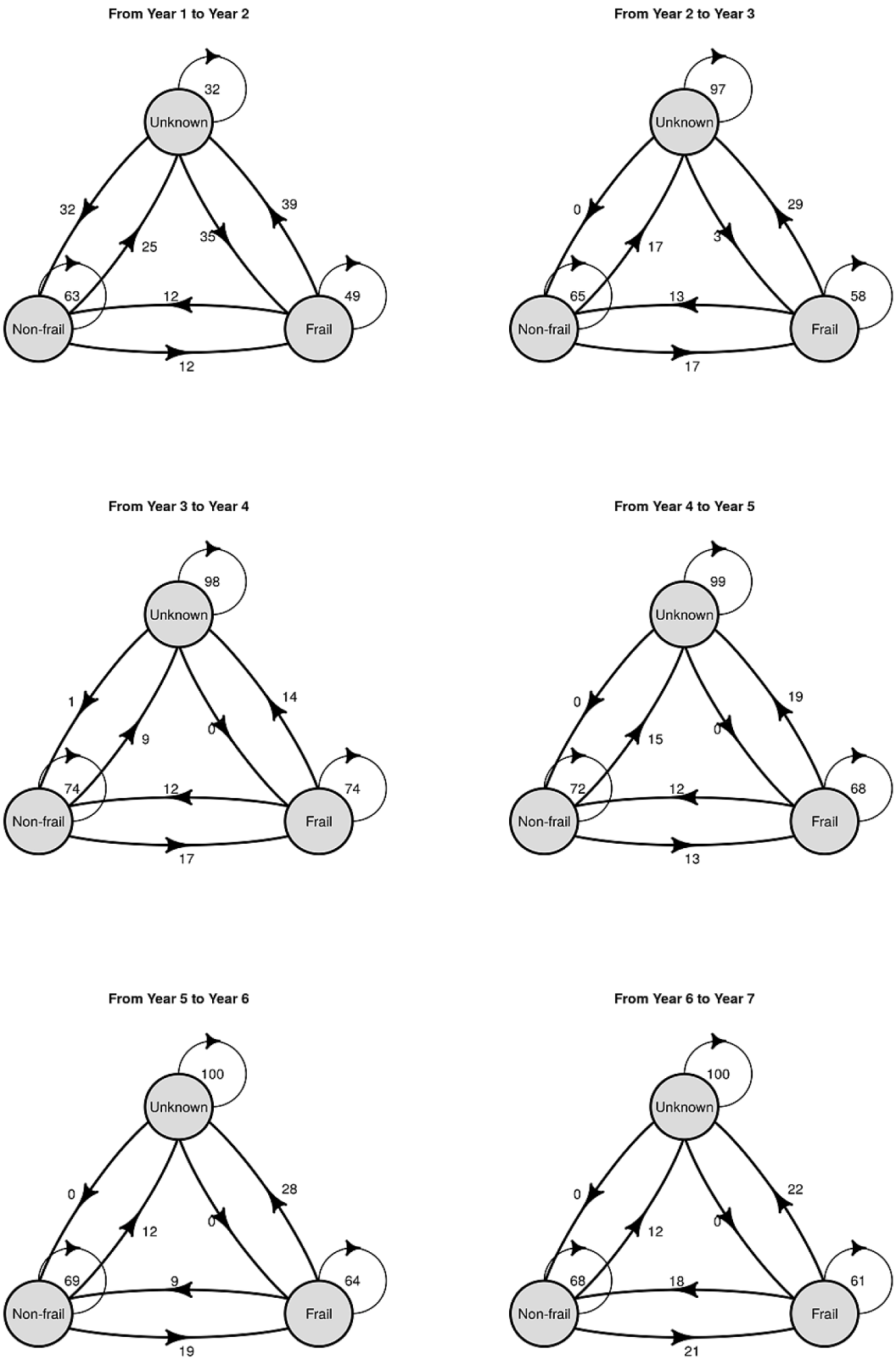

Fig. 2. Transitions of frailty status year by year expressed in percentages.

4. Discussion

A systematic review and meta-analysis showed that transitions between physical frailty states, assessed with the criteria of the phenotype of frailty,(Fried et al., 2001) are common.(Kojima et al., 2019) In addition, studies using a multidimensional assessment of frailty, mainly using the FI, demonstrated the dynamic nature of frailty (Hoogendijk et al., 2018; Z. Y. Liu et al., 2018; Setiati et al., 2019; Thompson et al., 2018). In the present longitudinal study, we examined the development of multidimensional frailty using the TFI (Gobbens, van Assen, et al.,

Table 4
Bi- and multivariable characteristics generalized estimation equations (GEE).

Characteristic	Bivariate* Coefficient	p-value	Multivariable* Coefficient	p-value	Bivariate** Coefficient	p-value	Multivariable** Coefficient	p-value
Gender								
Woman	1.06	<0.001	0.44	<0.001	0.59	<0.001	0.37	<0.001
Age								
≥80	0.49	<0.001	0.42	<0.001	0.31	<0.001	0.37	0.001
Marital status								
Other	1.80	<0.001	1.37	<0.001	0.80	<0.001	0.47	<0.001
Education								
Secondary	-0.89	<0.001	-0.16	0.124	-0.49	<0.001	-0.09	0.389
Higher	-0.81	<0.001	0.50	<0.001	-0.39	<0.001	0.45	<0.001
Net monthly income (€)								
601 - 900	0.66	0.057	1.12	<0.001	-0.05	0.865	0.21	0.478
901 - 1200	1.80	<0.001	1.47	<0.001	0.60	0.082	0.54	0.157
1201 - 1500	0.56	0.092	0.80	0.007	-0.17	0.537	0.01	0.983
1501 - 1800	1.01	0.007	1.18	<0.001	0.20	0.541	0.38	0.241
1801 - 2100	0.31	0.445	0.40	0.254	-0.01	0.972	0.03	0.934
2101 or more	-0.72	0.038	-0.42	0.190	-0.85	0.009	-0.77	0.028

* =based on score,
** =based on cut-off

2010b); this operationalization of frailty is quite different from the FI. The TFI (part B components) contains only 15 items, and no item relates to disability and comorbidity (Gobbens, van Assen, et al., 2010b), which are concepts other than frailty (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004). We aimed to establish the development of multidimensional frailty, including physical, psychological, and social components, in 479 Dutch community-dwelling older people using a follow-up period of seven years. In addition, we determined the effects of five demographic factors (gender, age, marital status, education, income) on the development of frailty.

Our study showed that frailty increases significantly over a seven-year period. Among the people who completed the entire TFI all years, the average score was 3.75 (SD 2.80) at baseline and 5.05 (SD 3.18) after seven years. In addition, during the seven years that we followed the sample the difference between the average frailty scores between two consecutive years was significant in three out of six cases ($p < 0.05$) in case of pairwise deletion. We also found that the unknown group, which in addition to people who had not fully completed the TFI, consisted mainly of people who could no longer fill in the TFI (e.g., due to death), scored in three consecutive years significantly higher than the known group. This confirms what other studies claim that people who do not participate in a study are more frail than participants and have a higher risk for mortality (Gobbens, van Assen, Augustijn, Goumans, & van der Ploeg, 2020; Romero-Ortuno, 2011).

By excluding, the unknown group, the proportion of non-frail and frail was 53.0% and 47.0% at baseline, respectively. Regarding frailty transitions, most participants remained unchanged from their baseline status; viewed from the perspective of the entire sample the range of frail and non-frail people that maintained their status was 33.6% to 39.9% and 40.5% to 48.7%, respectively. The transition from non-frail to frail was present in 8.3% to 12.6% of the participants and 5.1% to 10.7% made a transition from frail to non-frail. In all consecutive years, the percentage of people who went through a transition from non-frail to frail was higher than vice versa. Previous studies also demonstrated that the majority of the participants remained unchanged from their baseline status (non-frail, frail) (Kojima et al., 2019; Thompson et al., 2018; Ye et al., 2020). Moreover, we also observed that more participants transitioned to a frail state rather than to a non-frail state (Kojima et al., 2019; Thompson et al., 2018; Ye et al., 2020). Our findings provide further evidence that frailty is a dynamic concept and that frail older people can regress to a non-frail status. Because frailty is related to many adverse outcomes e.g., disability and mortality, healthcare professionals need to carry out interventions so that frail older individuals can make the desired transition to a non-frail status.

Sociodemographic factors such as gender (woman), age (≥80 years) and marital status (not married or cohabiting) were significantly associated with a higher score on the TFI or with a higher risk on frailty over a period of seven years, using both a continuous and dichotomous score of frailty. A high level of education increased the risk of frailty, in contrast to a high net income (≥ €2101) which reduced the risk of frailty. Three studies presented in a scoping review indicated that being a woman could be considered a protective factor of frailty transition, and being a man was considered as a risk factor (Ho, Cheung, Kwan, Wong, & Lai, 2020). This difference in findings can be explained by the physical definition that has been used in these studies (Ho et al., 2020), modified versions of the phenotype of frailty (Fried et al., 2001). The TFI contains three questions that refer to social frailty; women score higher on social frailty assessed with the TFI (Gobbens, van Assen, Luijkx, Wijnen-Sponselee, & Schols, 2010a). Our findings, with regard to age and income are supported by many studies (Ho et al., 2020). We also conducted an additional repeated measures analysis with a neural network, which showed that income and education were important factors in the development of multidimensional frailty (Maity & Pal, 2013). With regard to marital status, the findings were more ambiguous. Among American people aged ≥65 years, being married was considered as a protective factor (Pollack et al., 2017), while being without a partner was indicated as a protective factor among Dutch people belonging to the same age category (Hoogendijk et al., 2018). It should be mentioned that our findings concerning the associations of marital status and frailty transitions were biased because living alone is one of the components of the TFI (Gobbens, van Assen, et al., 2010b).

Some limitations of our study should be noted. First, only a small group of people (n = 121) completed all the assessments of frailty. However, this number was sufficient to detect small effects (Faul, Erdfelder, Buchner, & Lang, 2009). Secondly, we examined the associations of five sociodemographic factors with frailty transitions, however, more factors exist related to these transitions. For instance, it was observed that multimorbidity was associated with increased frailty, assessed by the phenotype of frailty and the FI, among non-frail older people (Thompson et al., 2018). Moreover, healthy lifestyle behaviors, such as exercise, social participation, and intellectual activity were associated with lower odds of becoming frail (Abe et al., 2020). We recommend that a longitudinal study is required, which includes more possible predictors of multidimensional frailty transitions. Thirdly, we used the entire TFI and made no distinction between physical, psychological, and social frailty transitions. In a sample of older Mexican American slow walking speed and weight loss were associated with physical frailty transitions (Li, Al Snih, Karmarkar, Markides, & Ottenbacher, 2018), thus, we recommend to determine which components are responsible for multidimensional frailty transitions. Finally, comparing our findings

with those of other studies had its limitations, because many studies are based on a physical assessment of frailty, and the present study was the first that used the TFI.

5. Conclusion

In conclusion, this study showed that multidimensional frailty, assessed with the TFI, significantly increases among Dutch community-dwelling older people aged 75 years or older using a follow-up of seven years. In addition, more people move from a non-frail state to a frail state than vice versa. Sociodemographic factors that were associated with frailty transitions are gender, age, marital status, education, and income. These findings provide healthcare professionals clues to identify the group of people at increased risk of frailty with the aim to prevent or delay frailty and its adverse outcomes (e.g., disability, mortality).

Author contributions

Robbert Gobbens: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review & Editing; **Tjeerd van der Ploeg:** Conceptualization, Methodology, Formal analysis, Writing – Original Draft, Writing – Review & Editing, Visualization

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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