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the Lolland-Falster Health Study

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Prevalence and population characteristics associated with frailty in a rural low socioeconomic area in Denmark: the Lolland-Falster Health Study

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ABSTRACT

Background Frailty is a major geriatric syndrome that predicts increased vulnerability to minor stressor events and adverse outcomes such as falls, fractures, disability and death. The prevalence of frailty among individuals above the age of 65 varies widely with an overall weighted prevalence of 10.7%.

Objectives The purpose of this study was to examine the prevalence of prefrailty and frailty in community-dwelling older adults from the regions of Lolland-Falster, which is one of the most socioeconomically disadvantaged areas of Denmark with lower income and lower life expectancy compared with the general Danish population. Moreover, the objective was to find selected individual characteristics associated with frailty.

Design An observational, cross-sectional registry-based population study with data from the regions of Lolland-Falster collected between February 2016 and February 2020.

Results The study included 19 000 individuals. There were 10 154 above the age of 50 included for analysis. Prevalence of frailty in the age group of 50–64 years was 4.7% and 8.7% in the age group of 65 years and above. The study demonstrates associations between frailty and high age, female gender, low education level, low income, smoking, living alone, frequency of seeing one's children and getting help when needed. These associations are comparable with findings from other studies.

Conclusion The syndrome of frailty consists of not only physiological and medical issues but also education, life conditions such as living alone and living in poverty and how you evaluate your own health.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study is a large population study describing socioeconomic as well as biological features associated with frailty.
⇒ The frailty measurement used is almost identical to the Survey of Health, Ageing and Retirement in Europe frailty instrument validated and used in several previous studies.
⇒ Participants were invited to take part and may therefore not be fully representative for the population.

INTRODUCTION

Frailty is a distinct, important geriatric syndrome associated with but different from disability, sarcopenia and multimorbidity.[1 2] Chronological and biological age correlate, but individuals with the same chronological age may vary widely in health and functional status, and the concept of frailty contributes to an explanation of this heterogeneity in older adults.[3] Frailty predicts increased vulnerability to stressor events and adverse outcomes, such as falls, fractures, hospitalisation, disability, mobility decline, less independence, institutionalisation, use of health services and death.[3–5] In an ageing society, frailty is of particular interest, because it is likely to be a precursor of disability and may be reversible in its early stages.[5] It is therefore important for clinical care, research and policy planning within the health sector.[6]

Although there is an intuitive understanding of frailty by clinicians, consensus on an operational definition of frailty has been difficult to reach,[5] and there are now more than 60 different validated instruments for measuring frailty.[1] The most frequently used is the frailty phenotype (FP), proposed by Fried *et al*.[3 7–9] FP is based on five criteria: unintentional weight loss, exhaustion, weakness, slowness and low physical activity.[3 6 10] An individual is considered frail if three or more criteria are fulfilled and prefrail if one or two criteria are fulfilled. Another frequently used definition is based on the cumulative deficit model proposed by Rockwood and Mitnitski.[11] In this model, a frailty index is

calculated from the accumulation of a wide spectrum of different deficits throughout life.[1 12]

The two definitions have similar predictive values regarding adverse outcomes, such as falls, hip fractures and death, but FP finds a lower prevalence of frailty. This is not surprising since the FP is defined by biological measurements only, whereas the cumulative deficit model includes social and psychological aspects.[3] The prevalence of frailty varies by classification methods[13] and among nations[7 14] making the interpretation of data by geographic region challenging. Generally, studies show a higher prevalence of frailty in low-income communities[15] and higher prevalence with increasing age, female gender and certain socioeconomic factors, particularly shorter educational level and less wealth.[1 8 16]

Based on the Survey of Health, Ageing and Retirement in Europe (SHARE), a SHARE Frailty Instrument (SHARE-FI) was developed with the primary purpose of facilitating quick frailty risk assessment in the population >50 years in a primary care setting. SHARE-FI has since been validated and used in several studies throughout the last decade.[5 17] Compared with the FP, it has shown a slightly higher prevalence of frailty and prefrailty.[18 19]

The prevalence of frailty found in studies among individuals aged 65 years and older varies widely (between 4.0% and 59.1%) with an overall prevalence of 10.7%.[3] The prevalence of frailty found in SHARE varied between 8.6% (Sweden) and 27.3% (Spain). Among 877 Danish participants aged 50–64 years, the prevalence was 3.0% and among 635 participants aged 65 years and above the prevalence was 12.4%.[5] To our knowledge, the present study is the largest prevalence study ever performed in Denmark.

Objectives

The purpose of this study was to examine the prevalence of prefrailty and frailty in community-dwelling older adults participating in the Danish population study Lolland-Falster Health Study (LOFUS).

Moreover, we aimed to identify individual characteristics associated with prefrailty and frailty. Factors such as educational level, marital status, smoking, age, sex, body mass index (BMI), alcohol intake, physical activity, self-assessed health, chronic diseases, selected biomarkers (blood samples, blood pressure and muscle mass), social network and the possibility of getting help when needed.

METHODS

Setting

Denmark is a small, high-income welfare state of approximately six million inhabitants with universal rights to education and healthcare. However, there are still substantial socioeconomical differences within the country, and Lolland-Falster is one of the most socioeconomically disadvantaged areas of Denmark; an area in which the average income is lower and life expectancy is almost 5 years shorter compared with the regions north of the capitol and 2.5 years shorter compared with the general Danish population.[20–23]

Materials

We used data from LOFUS which is described in detail elsewhere.[21 24] In summary, LOFUS is a household-based study where households of randomly selected individuals ≥18 years old were invited to participate. The data collection encompassed self-administered, age-specific questionnaires concerning mental and physical health, as well as social and lifestyle factors. Furthermore, anthropometric, physiological measurements and biological samples were collected in the study clinic. The data collection started in February 2016 and ended in February 2020. LOFUS included 18 949 individuals, and 11 057 of those were 50 years or above.

Frailty status was assessed using items almost identical to the SHARE-FI developed from the SHARE study.[5 20] SHARE-FI evaluates frailty by one objective measurement of handgrip strength and four self-report questions and was chosen based on the similarity with the FP originally described by Fried and colleagues.[12] (The items used in LOFUS and the items included in Fried's phenotype are shown in online supplemental table 1.)

Participants with missing values on one or two frailty criteria (n=639) were included in the analysis with the three to four remaining criteria.

Furthermore, we used self-reported data on marital status, smoking, self-assessed health, morbidity, alcohol intake, frequency of seeing one's children, possibility of getting help when needed, educational level, financial difficulties and physical activity. Details concerning the classification of each of these variables are shown in table 1.

Morbidity was assessed by asking participants if they suffer or had suffered from myocardial infarction, angina, migraine or headache, arthritis, cancer, diabetes, hypertension, respiratory disease (asthma, chronic bronchitis, emphysema and chronic obstructive pulmonary disease), depression, anxiety, kidney disease, dementia or Parkinson's disease.

From the clinical examinations, BMI and body composition (total and regional fat and lean mass) were obtained using tetrapolar bioelectrical impedance. Body composition was analysed using either Tanita Body Composition Analyzer BC-420MA III or Tanita Body Composition Analyzer DC-430MA, (Tokyo, Japan). Based on these assessments, Tanita estimated a metabolic age.[25] In the present study, we subtracted factual age from estimated metabolic age.

Handgrip strength was measured with a Saehan DHD-1 Digital Hand Dynamometer. The best of three attempts using the dominant hand was registered.

Plasma values of total blood cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), haemoglobin A1c (HbA1c), transferrin, sodium, High Sensitive C reactive protein (HS-CRP) and albumin were included in the analyses.

Table 1 Prevalence of non-frailty, prefrailty and frailty among 10 154 individuals aged ≥50 years according to demographic, socioeconomic and lifestyle status, comorbidities, biomarkers and Tanita body analysis in the Lolland-Falster Health Study, Denmark

	Total (%)	Non-frail (%)	Prefrail (%)	Frail (%)	Trend p value	Age-adjusted trend, p value
Total	10 154 (100)	4766 (46.9)	4707 (46.4)	681 (6.7)		
Age (years)						
50–65	5090 (100)	2279 (44.9)	2571 (50.5)	240 (4.7)		
65–74	3623 (100)	1947 (53.8)	1439 (39.7)	237 (6.5)		
75–84	1276 (100)	508 (40.0)	606 (47.4)	162 (12.7)		
85+	165 (100)	32 (19.8)	91 (55.0)	42 (25.1)	<0.0001	
Sex						
Female	5318 (100)	2364 (44.5)	2557 (48.1)	397 (7.5)		
Male	4836 (100)	2402 (49.7)	2150 (44.4)	284 (5.9)	<0.0001	<0.0001
Marital status						
Married/cohabitation	7375 (100)	3695 (50.1)	3286 (44.5)	394 (5.3)		
Divorced	915 (100)	353 (38.6)	464 (50.7)	98 (10.7)		
Unmarried	1011 (100)	392 (38.8)	530 (52.4)	89 (8.8)		
Widow/widower	804 (100)	307 (38.2)	399 (49.6)	98 (12.2)	<0.0001	<0.0001
Educational level						
Primary school	1017 (100)	335 (33.2)	541 (53.0)	141 (13.8)		
Short (1–3 years)	6030 (100)	2881 (47.8)	2781 (46.1)	368 (6.1)		
Medium (3–4 years)	2025 (100)	1026 (50.7)	905 (44.7)	94 (4.6)		
Long (>4 years)	413 (100)	225 (54.5)	170 (41.2)	18 (4.4)	<0.0001	<0.0001
Other	617 (100)	284 (46.0)	281 (45.5)	52 (8.4)		
Smoking						
Current smoker	1774 (100)	687 (38.8)	904 (50.9)	183 (10.3)		
Former smoker	4108 (100)	1885 (45.9)	1910 (46.5)	313 (7.6)		
Never smoker	4242 (100)	2186 (51.6)	1873 (44.1)	183 (4.3)	<0.0001	<0.0001
Drinking >5 units						
Daily or almost daily	177 (100)	54 (3.0)	95 (53.4)	28 (15.7)		
Weekly	621 (100)	291 (46.9)	297 (47.8)	33 (5.3)		
Monthly	1174 (100)	603 (51.4)	520 (44.3)	51 (4.3)		
Seldom	4801 (100)	2401 (50.0)	2171 (45.2)	229 (4.8)		
Never	2274 (100)	1053 (46.3)	1041 (45.7)	180 (7.9)	0.614	0.298
Physical activity						
Sedentary activity	1152 (100)	193 (16.8)	634 (55.0)	325 (28.2)		
Moderate activity	6580 (100)	3112 (47.3)	3170 (48.1)	298 (4.5)		
Heavy activity	2341 (100)	1442 (61.6)	853 (36.4)	46 (2.0)	<0.0001	<0.0001
Self-assessed health						
Very good or good	6746 (100)	4098 (60.8)	2526 (37.4)	122 (1.8)		
Fair	2883 (100)	639 (22.2)	1864 (64.6)	380 (13.2)		
Very bad or poor	499 (100)	21 (4.4)	303 (60.6)	175 (35.0)	<0.0001	<0.0001
Financial difficulties						
Never	9471 (100)	4582 (48.4)	4310 (45.5)	579 (6.1)		
A few months	478 (100)	135 (7.3)	273 (57.1)	70 (14.6)		
Approximately 6 months	69 (100)	12 (17.4)	41 (59.4)	16 (23.2)		

Continued

Table 1 Continued

	Total (%)	Non-frail (%)	Prefrail (%)	Frail (%)	Trend p value	Age-adjusted trend, p value
Every month	79 (100)	15 (19.0)	50 (63.3)	14 (17.7)	<0.0001	<0.0001
Seeing one's children						
Several days a week	1673 (100)	765 (45.7)	796 (47.6)	113 (6.8)		
Once a week	1876 (100)	914 (48.7)	861 (45.9)	102 (5.4)		
1–3 times a month	3442 (100)	1752 (50.9)	1514 (44.7)	178 (5.2)		
Less than once a month	1912 (100)	818 (42.8)	920 (48.1)	174 (9.1)		
Never	170 (100)	69 (40.6)	69 (40.6)	32 (18.8)	<0.0001	<0.0001
Have none	929 (100)	401 (43.2)	465 (50.1)	63 (6.8)		
Help from network						
Always	7395 (100)	3691 (49.9)	3300 (44.6)	404 (5.4)		
Often	1524 (100)	646 (42.3)	773 (50.7)	105 (6.9)		
Sometimes	929 (100)	342 (36.9)	479 (51.5)	108 (11.6)		
Seldom	165 (100)	47 (28.5)	80 (48.5)	38 (23.0)		
Never or have none	54 (100)	13 (24.1)	28 (51.9)	13 (24.1)	<0.0001	<0.0001
Chronic diseases						
Myocardial infarction	400 (100)	123 (31.1)	220 (54.7)	57 (14.2)	<0.0001	<0.0001
Angina	333 (100)	82 (24.6)	174 (52.3)	77 (23.1)	<0.0001	<0.0001
Migraine or headache	1149 (100)	327 (28.6)	700 (60.1)	122 (10.6)	<0.0001	<0.0001
Arthritis	3991 (100)	1444 (36.2)	2131 (53.4)	416 (10.4)	<0.0001	<0.0001
Cancer	535 (100)	197 (36.9)	270 (50.4)	68 (12.7)	<0.0001	<0.0001
Diabetes	735 (100)	219 (30.0)	388 (52.6)	128 (17.4)	<0.0001	<0.0001
Hypertension	3421 (100)	1382 (40.5)	1711 (50.0)	328 (9.6)	<0.0001	<0.0001
Respiratory disease	609 (100)	144 (23.9)	327 (53.5)	138 (22.6)	<0.0001	<0.0001
Depression	759 (100)	144 (19.1)	465 (61.2)	150 (19.7)	<0.0001	<0.0001
Anxiety	588 (100)	128 (22.0)	356 (60.3)	104 (17.6)	<0.0001	<0.0001
Kidney disease	169 (100)	44 (26.0)	88 (52.1)	37 (21.9)	<0.0001	<0.0001
Asthma	594 (100)	188 (31.9)	312 (52.3)	94 (15.8)	<0.0001	<0.0001
Dementia	26 (100)	5 (19.2)	16 (61.5)	5 (19.2)	0.001	0.002
Parkinson's disease	51 (100)	19 (37.3)	26 (51.0)	6 (11.8)	0.100	0.136
Biomarkers, mean values (SD)						
Total cholesterol (mmol/L) (n=10 080)	4.80 (1.86)	4.83 (1.91)	4.82 (1.82)	4.57 (1.80)	0.059	0.086
HDL (mmol/L) (n=10 080)	1.39 (0.63)	1.44 (0.64)	1.35 (0.61)	1.25 (0.64)	<0.0001	<0.0001
LDL (mmol/L) (n=9799)	2.68 (1.29)	2.76 (1.26)	2.62 (1.31)	2.46 (1.29)	<0.0001	<0.0001
HbA1C (mmol/L) (n=10 062)	38.2 (6.7)	37.6 (5.8)	38.4 (6.8)	41.2 (10.1)	<0.0001	<0.0001
Transferrin (g/L) (n=10 080)	2.51 (0.56)	2.51 (0.53)	2.52 (0.58)	2.57 (0.65)	0.025	0.011
Ferritin (µg/L) (10 080)	145.6 (136.7)	146.8 (128.5)	144.3 (142.7)	145.6 (149.8)	0.434	0.254
Sodium (mmol/L) (n=10 062)	138.7 (2.08)	138.8 (1.94)	138.6 (2.15)	138.4 (2.44)	<0.0001	<0.0001
HS-CRP (mg/L) (n=10 079)	1.98 (1.96)	1.74 (1.76)	2.14 (2.06)	2.50 (2.35)	<0.0001	<0.0001
Albumin (g/L) (n=10 080)	39.1 (2.6)	39.3 (2.5)	39.1 (2.6)	38.3 (3.0)	<0.0001	<0.0001
Muscle mass (Tanita), mean values (SD)						
Fat mass (kg)	26.1 (10.5)	24.0 (8.9)	27.5 (11.1)	31.7 (12.8)	<0.0001	<0.0001
Difference in metabolic and factual age	3.0 (12.1)	−5.4 (11.3)	−1.16 (12.4)	+1.0 (12.5)	<0.0001	<0.0001

Continued

Table 1 Continued

	Total (%)	Non-frail (%)	Prefrail (%)	Frail (%)	Trend p value	Age-adjusted trend, p value
Muscle mass (kg)	51.0 (11.1)	51.0 (10.9)	51.1 (11.2)	50.3 (11.6)	0.603	0.901
Hand grip strength (kg)	34.6 (11.5)	36.4 (11.0)	33.8 (11.6)	26.8 (9.9)	<0.0001	<0.0001
BMI (kg/m^2)						
<18.5	92 (100)	37 (40.2)	44 (47.8)	11 (12.0)		
18.5–24.9	3197 (100)	1790 (56.0)	1289 (40.3)	118 (3.7)		
25–29.9	4032 (100)	2024 (50.2)	1791 (44.4)	217 (5.4)		
30+	2606 (100)	850 (32.7)	1466 (56.2)	290 (11.1)	<0.0001	<0.0001

BMI, body mass index; HbA1c, haemoglobin A1c; HDL, high-density lipoprotein; HS-CRP, High sensitive C reactive protein; LDL, low-density lipoprotein.

Patient and public involvement statement

Patients and public were not involved in the development of this study.

Data analysis

The prevalence of each of the five frailty criteria and the number of participants fulfilling one, two, three, four or five frailty criteria were calculated (online supplemental table 2). For associations of non-frailty, prefrailty and frailty with demographic and health characteristics, we performed tests for trend by using the continuous variable in an ordered logistic model with age adjustment (table 1).

Additionally, for each of the independent variables we determined the odds (OR) of (1) frailty versus prefrailty and non-frailty (table 2 and figures 1–4) and (2) frailty and prefrailty versus non-frailty (table 3 and figures 1–4). All odds were age and sex adjusted using a logistic regression model.

Subsequently, we included all demographic and socioeconomic variables in a multivariable model (tables 2 and 3: Model 1), additionally adding comorbidity (tables 2 and 3: Model 2) and biomarkers and Tanita body analysis (tables 2 and 3: Model 3). Hand grip strength was excluded from the models as it is included in the frailty criteria.

Analyses were performed using STATA V.17.0 (StataCorp, College Station, Texas, USA).

RESULTS

LOFUS included 11 057 participants aged 50–96 years. Out of these, 10 163 answered the questions on frailty, but 9 individuals were excluded due to three or more missing frailty criteria, leaving 10 154 for analysis (52.4% women).

Overall, 6.7% met ≥3 frailty criteria, 46.3% met one or two criteria, and 46.9% met none. Only 0.2% met all five frailty criteria. Exhaustion was the most frequent frailty criterion with 41.7%, next were slowness and low activity (online supplemental table 2).

Demographic status

Prevalence of frailty was strongly associated with age increasing from 4.7% among the 50–64 years old to 25.0% among ≥85 years old. Prefrailty was less dependent on age with a prevalence of 50.5% among individuals below 65 years and 55.0% among those aged 85 years or above. Women had a higher prevalence of frailty compared with men (table 1).

Comorbidity

Prevalence of frailty was associated with comorbidities in a stepwise pattern (table 1). Among persons with no chronic diseases, the prevalence of frailty was 1.8%, whereas the prevalence of frailty was 34.7% among persons with ≥5 chronic diseases. Notably, among persons with 3–4 chronic diseases, 60.0% were prefrail. There was an overlap between frailty and multimorbidity (≥2 chronic diseases). The majority (493 out of 681=72.4%) of those with frailty had multimorbidity, whereas a smaller fraction (493 out of 3235=15.2%) of those with multimorbidity had frailty.

Biomarkers

Among the frail, we found significantly higher plasma values of HbA1c, transferrin and HS-CRP and significantly lower plasma values of sodium, albumin, HDLs and LDLs compared with prefrail and non-frail individuals. No significance was found regarding ferritin (table 1).

In the fully adjusted models assessing frailty and prefrailty versus non-frailty HDL, LDL and albumin remained significant (table 3 and figure 1).

Muscle mass was lower and fat mass higher in the frail individuals compared with the non-frail and prefrail individuals. In the fully adjusted models, assessing frailty and prefrailty versus non-frailty fat mass remained significant (table 2 and figure 1).

Estimated metabolic age from Tanita body composition measurement was higher than factual age (+1 year) in individuals with frailty, whereas non-frail individuals were estimated younger than their factual age (−5.4 years) (table 1). BMI showed a u-shaped association with

Table 2 Logistic regression of frailty versus non-frailty and prefrailty among 10 154 individuals aged ≥50 years according to demographic, socioeconomic and lifestyle status, comorbidities, biomarkers and Tanita body analysis in the Lolland-Falster Health Study, Denmark

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=7892	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=7483
Age (years)				
50–65	1.00	1.00	1.00	1.00
65–74	1.43 (1.19 to 1.72)	1.90 (1.45 to 2.49)	1.64 (1.24 to 2.19)	1.52 (1.11 to 2.09)*
75–84	3.00 (2.43 to 3.70)	4.72 (3.38 to 6.58)	4.24 (2.99 to 6.02)	4.36 (2.88 to 6.62)*
85+	7.00 (4.82 to 10.19	6.71 (3.55 to 12.68)	5.71 (2.96 to 11.04)	6.97 (3.31 to 14.7)*
Sex				
Female	1.00	1.00	1.00	1.00
Male	0.74 (0.63 to 0.87)	0.59 (0.46 to 0.75)	0.59 (0.45 to 0.76)	0.69 (0.40 to 1.20)
Legal marital status				
Widow/widower	1.00	1.00	1.00	1.00
Unmarried	1.50 (1.07 to 2.10)	1.37 (0.80 to 2.36)	1.44 (0.82 to 2.52)	1.57 (0.86 to 2.89)
Divorced	1.64 (1.19 to 2.27)	1.31 (0.81 to 2.12)	1.32 (0.81 to 2.15)	1.51 (0.90 to 2.53)
Married or cohabitation	0.71 (0.55 to 0.92)	1.09 (0.74 to 1.61)	1.18 (0.79 to 1.75)	1.22 (0.80 to 1.87)
Educational level				
Primary school	1.00	1.00	1.00	1.00
Short (1–3 years)	0.50 (0.40 to 0.61)	0.63 (0.46 to 0.86)	0.64 (0.47 to 0.88)	0.68 (0.49 to 0.95)*
Medium (3–4 years)	0.38 (0.29 to 0.50)	0.49 (0.33 to 0.72)	0.53 (0.35 to 0.79)	0.58 (0.38 to 0.88)*
Long (>4 years)	0.36 (0.21 to 0.60)	0.59 (0.29 to 1.23)	0.62 (0.30 to 1.29)	0.62 (0.27 to 1.43)
Other	0.64 (0.45 to 0.90)	0.76 (0.47 to 1.24)	0.76 (0.46 to 1.26)	0.87 (0.52 to 1.49)
Smoking				
Never smoker	1.00	1.00	1.00	1.00
Former smoker	1.82 (1.50 to 2.20)	1.56 (1.19 to 2.03)	1.43 (1.08 to 1.88)	1.33 (0.99 to 1.78)
Current smoker	3.06 (2.46 to 3.81)	1.57 (1.14 to 2.17)	1.47 (1.05 to 2.05)	1.59 (1.11 to 2.27)*
Drinking >5 units				
Never	1.00	1.00	1.00	1.00
Seldom	0.76 (0.61 to 0.93)	0.84 (0.64 to 1.09)	0.79 (0.61 to 1.03)	0.84 (0.64 to 1.12)
Monthly	0.82 (0.59 to 1.15)	1.03 (0.68 to 1.56)	0.98 (0.64 to 1.49)	0.93 (0.60 to 1.45)
Weekly	1.04 (0.70 to 1.55)	1.30 (0.79 to 2.12)	1.32 (0.80 to 2.20)	1.10 (0.63 to 2.92)
Daily or almost daily	3.06 (1.94 to 4.81)	1.38 (0.74 to 2.53)	1.37 (0.74 to 2.56)	1.34 (0.68 to 2.64)
Physical activity				
Sedentary activity	8.01 (6.71 to 9.56)	5.02 (3.93 to 6.39)	5.13 (3.99 to 6.58)	4.39 (3.36 to 5.74)*
Moderate activity	1.00	1.00	1.00	1.00
Heavy activity	0.46 (0.33 to 0.63)	0.63 (0.43 to 0.94)	0.64 (0.43 to 0.95)	0.62 (0.41 to 0.95)*
Self-assessed health				
Very good or good	1.00	1.00	1.00	1.00
Fair	8.52 (6.89 to 10.5)	7.11 (5.41 to 9.34)	5.45 (4.10 to 7.23)	4.69 (3.50 to 6.29)*
Very bad or poor	36.6 (28.0 to 47.8)	26.2 (18.2 to 37.6)	15.95 (10.84 to 23.49)	15.0 (9.91 to 22.6)*
Financial difficulties				
Never	1.00	1.00	1.00	1.00
A few months	3.16 (2.40 to 4.15)	1.49 (0.99 to 2.26)	1.39 (0.91 to 2.13)	1.39 (0.89 to 2.19)
Approximately 6 months	6.32 (3.56 to 11.2)	2.46 (1.01 to 5.97)	2.25 (0.89 to 5.64)	1.94 (0.69 to 5.41)

Continued

Table 2 Continued

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=7892	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=7483
Every month	4.50 (2.49 to 8.15)	1.65 (0.65 to 4.16)	1.27 (0.48 to 3.39)	1.03 (0.32 to 3.30)
Seeing one's children				
Never	1.00	1.00	1.00	1.00
Less than once a month	0.36 (0.24 to 0.56)	0.40 (0.21 to 0.77)	0.40 (0.21 to 0.78)	0.42 (0.20 to 0.85)*
1–3 times a month	0.22 (0.15 to 0.34)	0.34 (0.18 to 0.64)	0.35 (0.18 to 0.67)	0.33 (0.16 to 0.69)*
Once a week	0.22 (0.14 to 0.35)	0.26 (0.13 to 0.52)	0.26 (0.13 to 0.53)	0.26 (0.12 to 0.55)*
Several days a week	0.29 (0.18 to 0.45)	0.43 (0.22 to 0.84)	0.43 (0.22 to 0.86)	0.44 (0.21 to 0.92)*
Help from network				
Never or have none	1.00	1.00	1.00	
Seldom	1.45 (0.61 to 3.42)	4.32 (0.45 to 41.1)	5.61 (0.55 to 57.4)	4.32 (0.38 to 49.3)
Sometimes	0.63 (0.28 to 1.40)	4.18 (0.47 to 36.9)	5.73 (0.61 to 54.2)	5.66 (0.55 to 58.3)
Often	0.40 (0.18 to 0.90)	3.12 (0.35 to 27.6)	4.12 (0.44 to 38.9)	3.81 (0.37 to 39.2)
Always	0.31 (0.14 to 0.68)	2.78 (0.32 to 24.4)	3.67 (0.39 to 34.4)	3.53 (0.35 to 35.9)
Chronic diseases				
Myocardial infarction vs no myocardial infarction	2.18 (1.61 to 2.95)		1.01 (0.64 to 1.58)	0.85 (0.51 to 1.39)
Angina vs no angina	4.22 (3.20 to 5.56)		1.54 (0.99 to 2.37)	1.79 (1.11 to 2.86)*
Migraine/headache vs no migraine or headache	2.06 (1.66 to 2.55)		1.19 (0.87 to 1.63)	1.17 (0.83 to 1.64)
Arthritis vs no arthritis	2.37 (2.01 to 2.79)		1.56 (1.23 to 1.97)	1.55 (1.21 to 1.99)*
Cancer vs no cancer	1.73 (1.31 to 2.27)		2.33 (1.64 to 3.33)	2.42 (1.67 to 3.52)*
Diabetes vs no diabetes	3.45 (2.78 to 4.28)		2.17 (1.56 to 3.02)	1.77 (1.12 to 2.79)
Hypertension vs no hypertension	1.72 (1.46 to 2.02)		1.02 (0.80 to 1.29)	0.91 (0.71 to 1.17)*
Respiratory disease* vs no respiratory disease	4.57 (3.69 to 5.66)		1.53 (1.07 to 2.19)	1.91 (1.30 to 2.79)*
Depression vs no depression	4.47 (3.65 to 5.49)		1.61 (1.11 to 2.32)	1.58 (1.07 to 2.34)*
Anxiety vs no anxiety	3.59 (2.84 to 4.54)		1.27 (0.83 to 1.92)	1.30 (0.84 to 2.03)
Kidney disease vs no kidney disease	3.78 (2.57 to 5.56)		1.33 (0.71 to 2.46)	1.50 (0.76 to 2.96)
Asthma vs no asthma	2.92 (2.30 to 3.71)		1.07 (0.71 to 1.61)	0.98 (0.63 to 1.52)
Dementia vs no dementia	2.12 (0.77 to 5.87)		2.73 (0.70 to 10.6)	3.05 (0.78 to 11.87)
Parkinson's vs no Parkinson's disease	1.48 (0.62 to 3.55)		0.70 (0.17 to 2.89)	0.96 (0.22 to 4.05)
Biomarkers, mean values (SD)				
Total cholesterol (mmol/L) (n=10 080)	0.94 (0.90 to 0.98)			0.99 (0.92 to 1.06)
HDL (mmol/L) (n=10 080)	0.64 (0.57 to 0.72)			0.88 (0.72 to 1.07)
LDL (mmol/L) (n=9799)	0.89 (0.84 to 0.94)			0.95 (0.86 to 1.05)
HbA1C (mmol/L) (n=10 062)	95.7 (41.9 to 218.6)			2.39 (0.31 to 18.2)
Transferrin (g/L) (n=10 080)	1.33 (1.13 to 1.57)			1.13 (0.92 to 1.40)
Ferritin (µg/L) (10 080)	1.02 (0.97 to 1.08)			1.06 (0.99 to 1.14)
Sodium (mmol/L) (n=10 062)	0.00 (0.97 to 0.07)			0.005 (0.00 to 1.01)
HS-CRP (mg/L) (n=10 079)	1.12 (1.08 to 1.16)			1.01 (0.95 to 1.06)
Albumin (g/L) (n=10 080)	0.91 (0.88 to 0.94)			1.01 (0.96 to 1.03)
Muscle mass (Tanita), mean values (SD)				
Fat mass (kg)	1.05 (1.04 to 1.06)			1.02 (1.00 to 1.04)*
Difference in metabolic and factual age	0.96 (0.95 to 0.96)			1.01 (0.99 to 1.03)

Continued

Table 2 Continued

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=7892	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=7483
Muscle mass (kg)	1.04 (1.02 to 1.05)			0.99 (0.96 to 1.01)
BMI <18.5 (kg/m^2)	3.53 (1.81 to 6.88)			1.53 (0.47 to 5.00)
BMI 18.5–24.9 (kg/m^2)	1.00			1.00
BMI 25–29.9 (kg/m^2)	1.65 (1.30 to 2.10)			1.45 (0.98 to 2.13)
BMI 30+ (kg/m^2)	3.88 (3.09 to 4.86)			1.99 (1.12 to 3.55)*

Model 1: We included all demographic, socioeconomic and lifestyle variables. Model 2: Model 1+comorbidity. Model 3: Model 1+biomarkers and Tanita body analysis.
Light grey areas: Variables not included in the model.
*p≤0.05.
BMI, body mass index; HbA1c, haemoglobin A1c; HDL, high-density lipoprotein; HS-CRP, High sensitive C reactive protein; LDL, low-density lipoprotein.

a higher prevalence of frailty among those with the lowest and the highest BMI (table 1).

In the fully adjusted models, BMI >30 remained significant (tables 2 and 3 and figure 1).

Socioeconomic status

There was a higher prevalence of frailty among individuals with short education and financial difficulties (table 1). Living alone (unmarried, divorced, widowed) having difficulties getting help when needed and low frequency of seeing ones children were also associated with frailty (table 1). Short education and low frequency of seeing one's children remained significant in the fully adjusted models when looking at frailty versus non-frailty and prefrailty (table 2 and figures 2 and 3).

Lifestyle

Current as well as former smoking and low physical activity were associated with frailty. Among those reporting sedentary physical behaviour, the prevalence of frailty was 28.2% and the prevalence of prefrailty was 55.0% (table 1). Level of physical activity remained significant in the fully adjusted models (tables 2 and 3 and figure 2).

There was a strong association between prevalence of frailty and poor self-assessed health. This association remained significant in both of the fully adjusted models (tables 2 and 3 and figure 4). Among those reporting 'good' health, only 1.8% was frail. Among those reporting 'very bad or poor health', 35% were frail and 60.6% were prefrail (table 1).

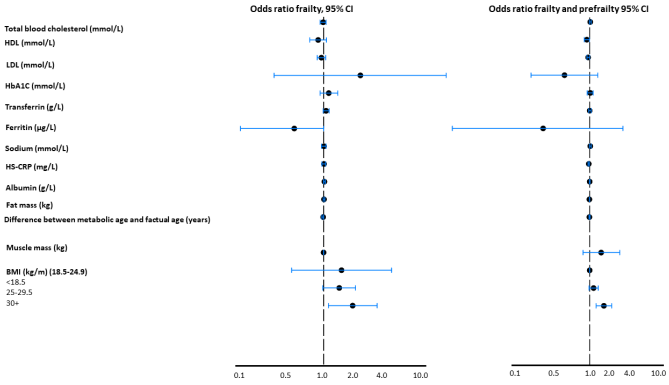

Figure 1 Multivariate ORs of frailty versus non-frailty and prefrailty (left) and frailty and prefrailty versus non-frailty (right) among 10 154 individuals aged ≥50 years according to demographic variables in the Lolland-Falster Health Study, Denmark. All ORs are adjusted for demographic, socioeconomic and lifestyle variables, comorbidity and biomarkers (Model 3, tables 2 and 3). BMI, body mass index; HS-CRP, High sensitive C reactive protein; HbA1c, haemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

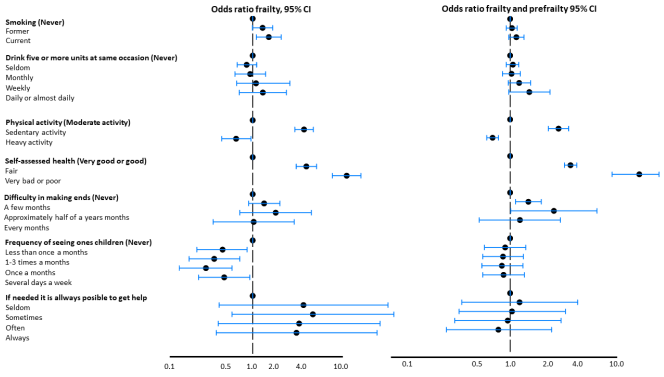

Figure 2 Multivariate ORs of frailty versus non-frailty and prefrailty (left) and frailty and prefrailty versus non-frailty (right) among 10 154 individuals aged ≥50 years according to socioeconomic variables in the Lolland-Falster Health Study, Denmark. All ORs are adjusted for demographic, socioeconomic and lifestyle variables, comorbidity and biomarkers (Model 3, tables 2 and 3).

DISCUSSION

In this study, we assessed the prevalence of frailty and associated factors including demographic status, socioeconomic factors, social network, lifestyle, medical health status and body composition in the specific area of Lolland-Falster, which is one of the most socioeconomically disadvantaged areas of Denmark.

Many of the socioeconomic variables are significantly associated with frailty also in the fully adjusted models and the adjustments through Models 1–3 only change very little.

The association of chronic diseases with frailty is underlined by the fact that most of individuals with frailty have multimorbidity (72.4%) while only a minority of individuals with multimorbidity are frail (15.2%). However, this discrepancy illustrates that other factors different from known chronic diseases must influence the development of frailty.

Frailty and cardiovascular disease go hand-in-hand, and studies have shown that cardiovascular diseases not necessarily are a consequence of ageing but are related to modifiable risk factors, that is, smoking, obesity and low physical activity.[26] For instance, a sedentary lifestyle is an established risk factor for cardiovascular disease,[27] and there is a strong association between a sedentary lifestyle and frailty confirmed in the present study.

The study demonstrates associations between frailty and high age, female gender, short educational level, economic difficulties (difficulties making ends meet) and smoking. Furthermore, we found an association between frailty and living alone, low frequency of seeing one's children and rarely getting help when needed. These associations are comparable with findings from other studies.[5 28–32]

We found higher levels of HS-CRP, transferrin and HbA1c and lower levels of sodium, albumin, HDL and LDL among the frail. This is in concordance with findings in other studies.[33–35] We found a u-shaped association between frailty and BMI in our study which is in accordance with findings in other studies.[36 37] There are ongoing studies of biomarkers as a possible mean of identifying individuals at risk of developing frailty and prefrailty, but the relevance of different standalone biomarkers is uncertain due to the complexity of the frailty syndrome.[34] For instance, increasing levels of HbA1c have been associated with a higher risk of frailty, which is in accordance with the theory of inflammageing (age-related chronic, sterile low-grade inflammation) as well as endocrine and cardiovascular disease as possible mediators in the pathogenesis of frailty.[38] On the other hand, frailty, loss of appetite and weight loss may lead to lower levels of HbA1c, and therefore HbA1c cannot stand alone as a biomarker of frailty and is unsuited for screening.[34]

Prevalence of frailty in the age group of 50–64 years was 4.7%, and it was 8.7% in the age group of 65 years and above. In comparison, the Danish participants in the European SHARE study had a frailty prevalence of 3.0% in the age group 50–64 years and 12.0% in the age group above 65 years. The population in the area covered by LOFUS is known to have a lower average life expectancy compared with the rest of Denmark.[22] It may therefore seem contradictory that frailty prevalence is lower in the 65+ group. However, compared with Danish SHARE participants, frailty prevalence was higher among our participants in the younger age group (50–64). If frailty occurs in a younger age, we expect some of the frail individuals to die earlier, which may lead to a selection bias in the older age groups (healthy survivor effect). Furthermore, a previous LOFUS study has shown that there were lower rates of participation among people with high age and lower socioeconomic status, and this would lead to the underestimation the of prevalence of frailty among the oldest.[23 39] In the SHARE study and the present study, the percentages of participants 85 years and above were 4.6% and 1.6%, respectively. This indicates that the oldest

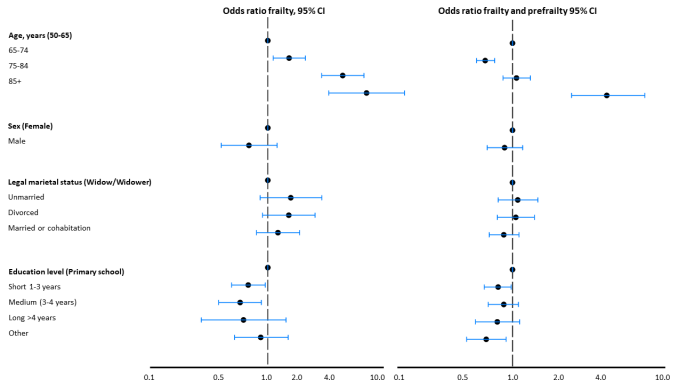

Figure 3 Multivariate ORs of frailty versus non-frailty and prefrailty (left) and frailty and prefrailty versus non-frailty (right) among 10 154 individuals aged ≥50 years according to comorbidity variables in the Lolland-Falster Health Study, Denmark. All ORs are adjusted for demographic, socioeconomic and lifestyle variables, comorbidity and biomarkers (Model 3, tables 2 and 3).

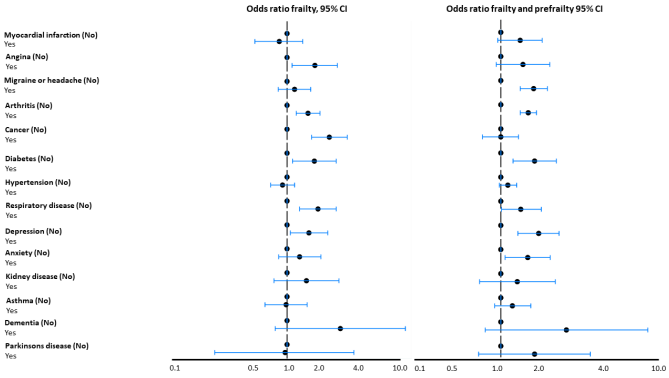

Figure 4 Multivariate ORs of frailty versus non-frailty and prefrailty (left) and frailty and prefrailty versus non-frailty (right) among 10 154 individuals aged ≥50 years according to biomarker variables in the Lolland-Falster Health Study, Denmark. All ORs are adjusted for demographic, socioeconomic and lifestyle variables, comorbidity and biomarkers (Model 3, tables 2 and 3).

Table 3 Logistic regression of frailty and prefrailty versus non-frailty among 10 154 individuals aged ≥50 years according to demographic, socioeconomic and lifestyle variables, comorbidity, biomarkers and Tanita body analysis in the Lolland-Falster Health Study, Denmark

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=8867	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=8483
Age (years)				
50–65	1.00	1.00	1.00	1.00
65–74	0.73 (0.67 to 0.79)	0.73 (0.65 to 0.81)	0.67 (0.59 to 0.75)	0.67 (0.59 to 0.77)*
75–84	1.26 (1.11 to 1.44)	1.14 (0.97 to 1.36)	1.04 (0.87 to 1.24)	1.06 (0.87 to 1.30)
85+	3.15 (2.11 to 4.69)	3.47 (2.06 to 5.82)	3.30 (1.95 to 5.59)	3.99 (2.38 to 6.97)*
Sex				
Female	1.00	1.00	1.00	1.00
Male	0.82 (0.76 to 0.89)	0.84 (0.75 to 0.93)	0.87 (0.78 to 0.97)	0.89 (0.69 to 1.16)
Legal marital status				
Widow/widower	1.00	1.00	1.00	1.00
Unmarried	1.13 (0.92 to 1.38)	1.04 (0.77 to 1.36)	1.09 (0.82 to 1.44)	1.08 (0.81 to 1.45)
Divorced	1.15 (0.93 to 1.40)	1.00 (0.77 to 1.30)	1.01 (0.78 to 1.31)	1.05 (0.80 to 1.38)
Married or cohabitation	0.73 (0.62 to 0.86)	0.86 (0.69 to 1.05)	0.87 (0.71 to 1.08)	0.88 (0.71 to 1.10)
Educational level				
Primary school	1.00	1.00	1.00	1.00
Short (1–3 years)	0.57 (0.49 to 0.66)	0.80 (0.66 to 0.97)	0.80 (0.66 to 0.97)	0.81 (0.66 to 0.98)
Medium (3–4 years)	0.50 (0.43 to 0.59)	0.85 (0.69 to 1.05)	0.86 (0.70 to 1.07)	0.88 (0.70 to 1.09)
Long (>4 years)	0.45 (0.35 to 0.57)	0.78 (0.57 to 1.05)	0.80 (0.59 to 1.09)	0.80 (0.58 to 1.11)
Other	0.60 (0.49 to 0.74)	0.70 (0.53 to 0.92)	0.70 (0.53 to 0.92)	0.68 (0.51 to 0.91)*
Smoking				
Never smoker	1.00	1.00	1.00	1.00
Former smoker	1.29 (1.18 to 1.41)	1.09 (0.98 to 1.22)	1.05 (0.94 to 1.17)	1.04 (0.92 to 1.16)
Current smoker	1.74 (1.56 to 1.96)	1.18 (1.02 to 1.37)	1.14 (0.98 to 1.33)	1.14 (0.97 to 1.34)
Drinking >5 units				
Never	1.00	1.00	1.00	1.00
Seldom	0.92 (0.83 to 1.02)	1.05 (0.92 to 1.19)	1.07 (0.95 to 1.22)	1.06 (0.92 to 1.20)
Monthly	0.91 (0.78 to 1.05)	1.05 (0.88 to 1.25)	1.08 (0.90 to 1.29)	1.03 (0.85 to 1.24)
Weekly	1.08 (0.90 to 1.30)	1.25 (1.00 to 1.57)	1.30 (1.03 to 1.62)	1.21 (0.96 to 1.54)
Daily or almost daily	2.24 (1.60 to 3.13)	1.66 (1.10 to 2.52)	1.68 (1.11 to 2.56)	1.50 (0.97 to 2.32)
Physical activity				
Sedentary activity	4.39 (3.73 to 5.17)	3.24 (2.64 to 3.98)	3.09 (2.52 to 3.80)	2.78 (2.24 to 3.44)*
Moderate activity	1.00	1.00	1.00	1.00
Heavy activity	0.57 (1.26 to 1.45)	0.65 (0.58 to 0.73)	0.66 (0.59 to 0.75)	0.69 (0.61 to 0.78)*
Self-assessed health				
Very good or good	1.00	1.00	1.00	1.00
Fair	5.50 (4.97 to 6.09)	4.76 (4.22 to 5.36)	3.82 (3.38 to 4.33)	3.58 (3.15 to 4.08)*
Very bad or poor	35.5 (22.9 to 55.2)	27.04 (15.39 to 47.50)	17.5 (9.90 to 30.9)	15.31 (8.61 to 23.24)*
Financial difficulties				
Never	1.00	1.00	1.00	1.00
A few months	2.37 (1.93 to 2.91)	1.63 (1.26 to 2.12)	1.52 (1.17 to 2.98)	1.47 (1.12 to 1.93)*

Continued

Table 3 Continued

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=8867	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=8483
Approximately 6 months	4.68 (2.50 to 8.74)	3.03 (1.32 to 6.97)	2.63 (1.13 to 6.13)	2.52 (1.01 to 6.26)*
Every month	3.98 (2.26 to 7.01)	1.55 (0.68 to 3.51)	1.34 (0.58 to 3.11)	1.23 (0.52 to 2.89)
Seeing one's children				
Never	1.00	1.00	1.00	
Less than once a month	0.86 (0.62 to 1.19)	0.94 (0.62 to 1.43)	0.96 (0.62 to 1.47)	0.90 (0.58 to 1.39)
1–3 times a month	0.63 (0.46 to 0.87)	0.85 (0.56 to 1.29)	0.89 (0.56 to 1.35)	0.86 (0.56 to 1.32)
Once a week	0.68 (0.49 to 0.94)	0.86 (0.56 to 1.31)	0.88 (0.56 to 1.34)	0.84 (0.55 to 1.31)
Several days a week	0.76 (0.55 to 1.05)	0.92 (0.60 to 1.40)	0.93 (0.60 to 1.42)	0.87 (0.56 to 1.35)
Help from network				
Never or have none	1.00	1.00	1.00	1.00
Seldom	0.84 (0.40 to 1.78)	1.14 (0.35 to 3.72)	1.20 (0.36 to 4.01)	1.22 (0.36 to 4.16)
Sometimes	0.58 (0.29 to 1.14)	1.08 (0.36 to 3.18)	1.10 (0.36 to 3.33)	1.04 (0.34 to 3.22)
Often	0.46 (0.24 to 0.91)	0.95 (0.32 to 2.79)	0.99 (0.33 to 2.99)	0.95 (0.31 to 2.93)
Always	0.35 (0.18 to 0.69)	0.79 (0.27 to 2.32)	0.82 (0.27 to 2.27)	0.78 (0.26 to 2.40)
Chronic diseases				
Myocardial infarction vs no myocardial infarction	2.15 (1.72 to 2.68)		1.34 (1.01 to 1.78)	1.30 (0.96 to 1.75)
Angina vs no angina	2.92 (2.26 to 5.56)		1.25 (0.89 to 1.76)	1.35 (0.94 to 1.94)
Migraine or headache vs no migraine or headache	2.39 (2.08 to 1.74)		1.55 (1.30 to 1.86)	1.56 (1.30 to 1.88)*
Arthritis vs no arthritis	2.11 (1.94 to 2.29)		1.45 (1.31 to 1.62)	1.45 (1.30 to 1.62)*
Cancer vs no cancer	1.59 (1.32 to 1.91)		1.02 (0.81 to 1.30)	1.00 (0.78 to 1.27)
Diabetes vs no diabetes	2.41 (2.04 to 2.85)		1.56 (1.25 to 1.96)	1.58 (1.18 to 2.12)*
Hypertension vs no hypertension	1.58 (1.45 to 1.73)		1.21 (1.08 to 1.35)	1.10 (0.98 to 1.24)
Respiratory disease* vs no respiratory disease	3.12 (2.57 to 3.78)		1.37 (1.05 to 1.78)	1.31 (1.01 to 1.73)*
Depression vs no depression	4.09 (3.40 to 4.93)		1.63 (1.25 to 2.14)	1.67 (1.26 to 2.20)*
Anxiety vs no anxiety	3.27 (2.68 to 4.00)		1.49 (1.11 to 2.00)	1.44 (1.06 to 1.95)*
Kidney disease vs no kidney disease	2.55 (1.80 to 3.61)		1.44 (0.89 to 2.33)	1.25 (0.75 to 2.09)
Asthma vs no asthma	1.97 (1.65 to 2.36)		1.19 (0.94 to 1.52)	1.17 (0.92 to 1.50)
Dementia vs no dementia	3.66 (1.36 to 9.84)		2.40 (0.79 to 7.31)	2.43 (0.81 to 7.32)
Parkinson's disease vs no Parkinson's disease	1.48 (0.83 to 2.64)		1.48 (0.70 to 3.13)	1.58 (0.74 to 3.36)
Biomarkers, mean values (SD)				
Total cholesterol (mmol/L) (n=10 080)	0.98 (0.96 to 1.00)			1.02 (0.99 to 1.05)
HDL (mmol/L) (n=10 080)	0.73 (0.68 to 0.78)			0.91 (0.83 to 0.99)*
LDL (mmol/L) (n=9799)	0.90 (0.87 to 0.93)			0.95 (0.91 to 1.00)*
HbA1C (mmol/L) (n=10 062)	25.0 (12.8 to 48.9)			0.43 (0.14 to 1.31)
Transferrin (g/L) (n=10 080)	1.06 (0.98 to 1.13)			1.02 (0.92 to 1.12)
Ferritin (µg/L) (10 080)	1.02 (0.99 to 1.05)			1.00 (0.97 to 1.05)

Continued

Table 3 Continued

	OR (95% CI) Age and sex adjusted	Model 1 OR (95% CI) Demographic and socioeconomic variables; n=7892	Model 2 OR (95% CI) +comorbidity n=8867	Model 3 OR (95% CI) +biomarkers and Tanita body analysis; n=8483
Sodium (mmol/L) (n=10 062)	0.01 (0.00 to 0.09)			0.21 (0.01 to 3.05)
HS-CRP (mg/L) (n=10 079)	1.13 (1.10 to 1.15)			1.02 (0.99 to 1.05)
Albumin (g/L) (n=10 080)	0.95 (0.93 to 0.96)			0.97 (0.95 to 0.99)*
Muscle mass (Tanita), mean values (SD)				
Fat mass (kg)	1.04 (1.04 to 1.05)			1.00 (0.99 to 1.01)
Difference between metabolic age and factual age	0.97 (0.96 to 0.97)			0.99 (0.98 to 1.00)
Muscle mass (kg)	1.03 (1.02 to 1.03)			0.99 (0.98 to 1.33)
BMI<18.5 (kg/m^2)	1.36 (1.24 to 1.50)			1.47 (0.80 to 2.74)
BMI 18.5–24.9 (kg/m^2)	1.00			1.00
BMI 25–29.9 (kg/m^2)	2.88 (2.58 to 3.21)			1.14 (0.98 to 1.33)
BMI 30+ (kg/m^2)	1.86 (1.21 to 2.85)			1.61 (1.24 to 2.09)

Model 1: We included all demographic, socioeconomic and lifestyle variables. Model 2: Model 1+comorbidities. Model 3: Model 1+biomarkers and Tanita body analysis.
Light grey areas: Variables not included in the model.
*p≤0.05.
BMI, body mass index; HbA1c, haemoglobin A1c; HDL, high-density lipoprotein; HS-CRP, High sensitive C reactive protein; LDL, low-density lipoprotein.

and probably the frailest did not participate in LOFUS thus leading to a lower prevalence of frailty among the oldest.

The present study is an observational, cross-sectional study and thus, it cannot demonstrate a causal relationship. However, there is reason to believe that some of the socioeconomic variables associated with frailty in our study could also be risk factors for developing frailty. In theory, socioeconomic variables may influence health through several factors such as social position, risk of exposure, differential vulnerability and consequences of poor health.[40] Possible deteriorating effects on health due to social position and associated risk factors for poor health throughout life may accumulate in elderly individuals, causing social vulnerability and frailty. For example, educational level of a parent influences dental health in the offspring.[41] It has further been demonstrated that an individual's socioeconomic position has an impact on the tendency to seek dental care,[42] and finally that oral health problems influence eating habits[43] and promote frailty.[44]

Earlier studies found older individuals with few social contacts to have twice the likelihood of dying compared with those with a social network.[26] One of several possible mediating factors could be the consequences of eating alone which is associated with malnutrition, depression and social isolation.[45 46] Remaining healthy, strong and not becoming frail thereby depends not only on good health status but also on socioeconomic and network-related aspects.

Strengths and limitations

The study is a large population study, with detailed information concerning individual experiences of, for example, traumatic events in childhood, economic difficulties and self-assessed health.

The instrument used for frailty assessment has been validated in several previous studies.[17 20]

Approximately 36% of invited subjects participated, which is in accordance with similar studies.[23 39 47] However, there were lower rates of participation among people with high age and lower socioeconomic status, possibly leading to underestimation of the prevalence of frailty among the oldest.

CONCLUSION

The syndrome of frailty is complex and associated with not only physiological and medical issues but also socioeconomic factors such as educational level, living alone, difficulties making ends meet, as well as lifestyle factors and self-assessed health. This makes the syndrome difficult to comprehend and underlines the necessity of further studies.

Due to an increase in frailty arising from an ageing society, industrialised countries will need to adapt their healthcare systems in order to plan for future

needs.[5 6 14] This may be especially important for people living in socioeconomically deprived areas in order to reduce further inequalities in health. To this date, comprehensive geriatric assessment, nutrition and regular, moderate exercise are the interventions shown to have the most consistent benefits in treating the frailty syndrome.[38 48 49]

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Ethics approval Informed written consent was obtained from all LOFUS participants. The LOFUS study was approved by Region Zealand's Ethical Committee on Health Research (SJ-421) and the Danish Data Protection Agency (REG-024-2015). The present study is registered under the Danish Data Protection Agency (P-2019-191). LOFUS is registered in Clinical Trials (NCT02482896). Participants gave informed consent to participate in the study before taking part.

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