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Prevalence of multimorbidity with frailty and associations with socioeconomic position in an adult population: findings from the cross-sectional HUNT Study in Norway

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ABSTRACT

Objectives To explore prevalences and occupational group inequalities of two measures of multimorbidity with frailty.

Design Cross-sectional study.

Setting The Nord-Trøndelag Health Study (HUNT), Norway, a total county population health survey, 2006–2008.

Participants Participants older than 25 years, with complete questionnaires, measurements and occupation data were included.

Outcomes ≥2 of 51 multimorbid conditions with ≥1 of 4 frailty measures (poor health, mental illness, physical impairment or social impairment) and ≥3 of 51 multimorbid conditions with ≥2 of 4 frailty measures.

Analysis Logistic regression models with age and occupational group were specified for each sex separately.

Results Of 41 193 adults, 38 027 (55% female; 25–100 years old) were included. Of them, 39% had ≥2 multimorbid conditions with ≥1 frailty measure, and 17% had ≥3 multimorbid conditions with ≥2 frailty measures. Prevalence differences in percentage points (pp) with 95% confidence intervals of those in high versus low occupational group with ≥2 multimorbid conditions and ≥1 frailty measure were largest in women age 30 years, 17 (14 to 20) pp and 55 years, 15 (13 to 17) pp and in men age 55 years, 15 (13 to 17) pp and 80 years, 14 (9 to 18) pp. In those with ≥3 multimorbid conditions and ≥2 frailty measures, prevalence differences were largest in women age 30 years, 8 (6 to 10) pp and 55 years, 10 (8 to 11) ppand in men age 55 years, 9 (8 to 11) pp and 80 years, 6 (95% CI 1 to 10) pp.

Conclusion Multimorbidity with frailty is common, and social inequalities persist until age 80 years in women and throughout the lifespan in men. To manage complex multimorbidity, strategies for proportionate universalism in medical education, healthcare, public health prevention and promotion seem necessary.

Strengths and limitations of this study

- ► The HUNT Study is a large total county population general health survey with a multitude of variables, suitable to estimate prevalences of multimorbidity and frailty by self-reports and clinical measurements.
- ► Occupation is used as a marker for socioeconomic position, enabling international comparison.
- ► Sex-specific occupational group differences in multimorbidity with frailty are reported as both absolute and relative measures of inequality.
- ► As a secondary analysis, the measures in this study need to be adjusted to fit previously collected data.
- ► In particular, the original data lacked information of chronicity of conditions, which may lead to overestimation of multimorbidity.

INTRODUCTION

Multimorbidity, the co-occurrence of multiple, chronic conditions, where none is more central,[1] is increasingly prevalent and is becoming the norm.[2–4] Multimorbidity is associated with high healthcare utilisation[5] and challenges clinicians in a fragmented healthcare system, aided by single disease guidelines.[6] The treatment burden to patients is often substantial including lowered ability to self-care.[6] Ways to harmonise guidelines to fit multimorbidity[7 8] and manage patients with multimorbidity in clinical practice[6] have been explored, and specific multimorbidity care guidelines are emerging.[9 10]

Multimorbidity alone may not imply a need for complex, multidisciplinary care.[1] Sociodemographic characteristics, individual health and social experiences, and mental and somatic health characteristics[11] increase patient complexity. The British National Institute for Health and Care Excellence (NICE) guideline[10] defines multimorbidity as two or more long-term, single-count health conditions and recommends a multimorbid approach to care in various contexts,

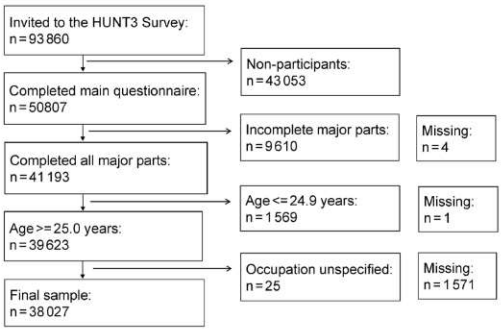

Figure 1 Flowchart for sample selection: inclusion and exclusion criteria and missing data.

including mixed mental and somatic multimorbidity and multimorbidity with frailty.

Frailty increases the vulnerability for adverse outcomes. It has been understood as characterised by loss of biophysical reserves in elderly,[12] operationalised as the frailty phenotype.[12] Another approach is the frailty index,[13] which calculates a ratio of accumulation of numerous deficits in several domains. An opinion of experts further emphasises the latter multidimensional view and defines frailty as a dynamic state of multicausality, involving loss of function in spheres such as physical, psychological and social domains.[14] This can be regarded as a biopsychosocial frailty model.[15] The NICE guideline proposes identification of frailty through observation of a low gait speed or poor self-rated health or by scoring a frailty scale combining demographic characteristics and multidimensional impairments.[10]

Social health inequalities are established; low socioeconomic position is associated with poorer health outcomes in Nordic countries[16] and globally.[17] Multimorbidity and frailty are no exception. Common determinants are socioeconomic deprivation,[18 19] female sex[18 20] and higher age.[18 20] In descriptive studies, any indicator of socioeconomic position will detect occurring differences.[21] Socioeconomic gradients in prevalence of multimorbidity and frailty have been explored by education,[18 19 22 23] income,[22 23] occupation[3] and deprivation indexes.[18 19] Occupation is associated with education and income and may have an impact on health outcomes through biopsychosocial work exposures.[21] Although proportions with multimorbidity and frailty increase with higher age, more multimorbid are young and middle aged than old,[4 24] and frailty is associated with multimorbidity and mortality from middle age.[25] The NICE guideline emphasises assessment of a multimorbid approach to care for adults of all ages but does not take into account social position.

There are numerous operational definitions of both multimorbidity and frailty and prevalence vary by setting, definitions and methods.[18 26–28] The literature suggests that multimorbidity, defined as three or more single health conditions, increases specificity especially in older age groups.[26 29] Common frailty scales require multidimensional loss of function to identify frail individuals[20] and share ability to show associations to age, sex and mortality.[20]

The overall purpose of this study is to identify how many in a general adult population is likely to need complex, multidisciplinary care as given by one of the contexts suggested by the NICE guideline; multimorbidity with frailty. Two measures will be assessed, one in line with the guideline (two conditions of multimorbidity plus one dimension of frailty) and the other with expected increased specificity (three conditions of multimorbidity plus two dimensions of frailty). The second aim is to examine associations of these measures according to age, sex and socioeconomic position.

MATERIALS AND METHODS

Reporting statement

The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) cross-sectional reporting guidelines[30] were used for reporting this observational study.

Study design and population

This cross-sectional study use data from the third wave in the Norwegian HUNT Study (the HUNT3 Survey, 2006–2008). Details on data collection and the cohort profile of this total county population health survey were published previously.[31] In brief, 93 860 residents older than 20 years were invited. Of these. 54% (n=50 807 of 93 860) completed the main questionnaire, meeting the minimum requirement for HUNT3 Survey attendance.[31] Figure 1 presents the sample selection for this analysis.

Eighty-one per cent (41 193 of 50 807) of eligible participants completed all major parts of the HUNT3 Survey; the main, age-specific and sex-specific questionnaires, interviews and measurements. Incomplete participation excluded 9610 individuals, while four missed complete information on participation. Of the responders, 1569 were younger than 25 years and were excluded on the assumption that the highest level of occupational group may not yet be obtained by those in this age category. One missed information on age. A total of 1571 individuals missed information on occupation, while 25 people had 'unspecified occupation' and was excluded. Of 41 193 (92%) participants, 38 027 were included in the final sample.

Overall, lower socioeconomic position was associated with lower participation rate in the HUNT3 Survey.[32] In this study, the distribution of occupational groups was 24% (high), 27% (middle) and 49% (low) in the sample and 17% (high), 20% (middle), 52% (low) and 11% (missing) among non-eligible. One hundred per cent of the missing were due to missing classifiable occupational data. Women constituted 55%, 51% and 81% of the sample, non-eligible and missing, respectively. The mean (SD) age was 55 (14) years in the sample, 44 (18) years among non-eligible and 66 (18) years among those missing data.

Box 1 Conditions grouped by ICD-10 chapter

ICD-10 chapter	Conditions
II Neoplasms	Cancer
III Blood/blood-forming organs/immune mechanism	Sarcoidosis
IV Endocrine/nutritional/metabolic	Obesity Hypercholesterolemia Diabetes Hypothyroidism Hyperthyroidism
V Mental/behavioural	Alcohol problem Depression Anxiety Insomnia
VI Nervous system	Epilepsy Migraine Chronic headache, other
VII Eye/adnexa	Cataract Macula degeneration Glaucoma
VIII Ear/mastoid	Hearing impairment
IX Circulatory system	Hypertension Angina pectoris Myocardial infarction Heart failure Other heart disease* Stroke or brain haemorrhage*
X Respiratory system	Chronic bronchitis, emphysema or COPD* Asthma
XI Digestive system	Dental health status Gastro-oesophageal reflux disease Irritable bowel syndrome
XII Skin/subcutaneous tissue	Hand eczema Psoriasis
XIII Musculoskeletal/connective tissue	Rheumatoid arthritis Osteoarthritis Ankylosing spondylitis Fibromyalgia Osteoporosis Local musculoskeletal pain/stiffness in: Neck or upper back or lower back or shoulder or elbow or Hand or hip or knee or foot/ankle
XIV Genitourinary system	Kidney disease Urine incontinence Prostate symptoms Menopausal hot flashes
XVIII Symptoms/signs/abnormal clinical/laboratory findings	Nocturia. Chronic widespread pain.

*Exception to single entity.
COPD, Chronic Obstructive Pulmonary Disease.

Demographic and socioeconomic characteristics

Sex and age at participation in the HUNT3 Survey was constructed by the HUNT Databank. Occupational group was used as indicator of socioeconomic position.[21] In the HUNT3 Survey interview, all participants were asked, "What is/was the title of your main occupation?" Free-text answers were manually categorised corresponding to Standard Classifications of Occupations by Statistics Norway,[33] which is based on the International Standard Classification of Occupations–88.[34] Occupational socioeconomic position was operationalised using occupation only, corresponding to a simplified version of the European Socio-economic Classification scheme.[35] The scheme aims to differentiate occupational groups on employment relationships and is not hierarchical per se. Still, the higher occupational groups are likely to have higher and more secure income.[35] Collapsed to a three-class version, the high level represents large employers, higher grade and lower grade professionals, administrative and managerial occupations, and higher grade technician and supervisory occupations. The middle group consists of small employers, self-employed individuals, and lower-grade supervisory and technician occupations. The low level contains lower-grade service positions, sales and clerical occupations, and lower-grade technical and routine occupations. Details are provided in online supplementary appendix A.

Outcomes

Multimorbidity

The construction of 51 single, chronic conditions from the HUNT3 Survey data is described in online supplementary appendix B. Box 1 lists the 51 conditions by 14 International Classification of Diseases 10th Revision (ICD-10) chapters, a disease classification system in major organised by organ systems. In this study, a simple, non-weighted summary score was generated and two multimorbidity variables created, with cut-off values of at least 2 of 51 and 3 of 51 conditions.

Frailty

Original data did not match any exact frailty scale. A qualitative judgement of available data was undertaken and general, mental, physical and social dimensions[10 14 20] of frailty were operationalised from six original variables:

1. General health status, defined as those reporting the answers 'poor' or 'not so good' (vs 'good' and 'very good') to the single question, "How is your health at the moment?"

2. Mental health status, included those reporting symptoms of anxiety and/or depression, on the Hospital Anxiety and Depression Scale. The HUNT Databank calculated a total score for subscales of anxiety and depression, if all items for anxiety and depression, respectively, were answered. In this study, cut-off was set at 8/21 points for both conditions[36] and a combined variable was created.
3. Physical impairment was identified by combining those reporting 'yes' (vs 'no') in response to the question, "Do you suffer from any long-term (at least 1 year) illness or injury of a physical or psychological nature that impairs your functioning in your daily life?" and reporting either motor ability, vision or hearing impairment to a moderate or severe degree.
4. Social impairment was derived from answers to the single question, "To what extent has your physical health or emotional problems limited you in your usual socializing with family or friends during the last 4 weeks?" Included were those reporting 'much' and 'not able to socialise' (vs 'not at all,' 'very little,' or 'somewhat').

A summary score was generated and two frailty variables created, with cut-off values of at least one of four and two of four frailty measures with impairment.

Multimorbidity with frailty

The two final outcome variables were created by combining self-reported multimorbidity and frailty as at least 2 of 51 chronic health conditions plus impairment in 1 of 4 dimensions of frailty and 3 of 51 chronic health conditions plus impairments in 2 of 4 dimensions of frailty.

Statistical analysis

We used cross-tables to identify sociodemographic characteristics by occupational group (table 1) and by multimorbidity with frailty, stratified by sex (table 2).

Associations between occupational group and the two measures of multimorbidity with frailty were analysed using logistic regression, adjusted for age and sex. All models were stratified by sex and included occupational group, continuous age, age squared and an interaction term between occupational group and age. Likelihood ratio tests were used to compare models.

Given the high prevalence of multimorbidity with frailty and the knowledge that odds ratios will deviate from relative risks,[37] we used postestimation commands to obtain prevalence differences and prevalence ratios[38] between the occupational groups with high occupational group as the reference category. The prevalence difference is the difference in mean predicted probability, and prevalence ratio is the ratio between the mean predicted probabilities while holding other covariates constant.[38] Prevalence difference and prevalence ratio between occupational groups were calculated at age 25–100 years in 5-year intervals (online supplementary appendix C). Calculations (with 95% confidence intervals) are presented at the ages 30, 55 and 80 years to reflect young adults, middle aged and elderly (table 3).

We performed complete case analysis and used Stata V.15.1 (StataCorp., College Station, Texas, USA) to analyse the data.

Patient and public involvement

During the preparation of the HUNT3 Survey, there was a wide citizen and stakeholder participation. This study is a secondary analysis of data collected in 2006–2008. Multimorbidity is a universal topic, not represented by any particular patient group, thus no patient or public representatives were involved in designing the study.

RESULTS

A total of 38 027 individuals, older than 25 years, who had completed all major parts of the HUNT3 Survey and had data on occupation, comprised the final sample for this study (figure 1). Further sociodemographic characteristics are presented in table 1.

Most participants, 49% (n=18 814 of 38 027), are categorised as low occupational group, which is comprised of

Table 1 Sex and age distribution by occupational group

	Occupational group							
	High		Middle		Low		Total	
	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)
Total	8970	(100)	10243	(100)	18814	(100)	38027	(100)
Sex								
Female	4505	(50)	5386	(53)	10922	(58)	20813	(55)
Male	4465	(50)	4857	(47)	7892	(42)	17214	(45)
Age, years								
25–44	2837	(32)	2600	(25)	4487	(24)	9924	(26)
45–64	4468	(50)	4787	(47)	8951	(48)	18206	(48)
65–74	1118	(12)	1846	(18)	3297	(18)	6261	(16)
75–100	547	(6)	1010	(10)	2079	(11)	3636	(10)

Table 2 Frequency distribution of two definitions of multimorbidity with frailty across occupational groups and age categories, stratified by sex

	Women						Men					
	Two conditions of multimorbidityand one dimension of frailty*						Two conditions of multimorbidity and one dimension of frailty*					
	No, freq.	(%)	Yes, freq.	(%)	Total, freq.	(%)	No, freq.	(%)	Yes, freq.	(%)	Total, freq.	(%)
Total	12304	(59)	8482	(41)	20813	(100)	10826	(63)	6378	(37)	17214	(100)
Occupational group												
High	3222	(72)	1282	(28)	4505	(100)	3220	(72)	1242	(28)	4465	(100)
Middle	3370	(63)	2009	(37)	5386	(100)	2995	(62)	1860	(38)	4857	(100)
Low	5712	(52)	5191	(48)	10922	(100)	4611	(58)	3276	(42)	7892	(100)
Age, years												
25–44	4298	(72)	1680	(28)	5 981	(100)	3 075	(78)	867	(22)	3 943	(100)
45–64	5712	(58)	4122	(42)	9 840	(100)	5 398	(65)	2 967	(35)	8 366	(100)
65–74	1615	(51)	1 548	(49)	3 168	(100)	1 681	(54)	1 409	(46)	3 093	(100)
75–100	679	(37)	1 132	(62)	1 824	(100)	672	(37)	1 135	(63)	1 812	(100)
Mean (SD)	52	(14)	58	(14)	54	(14)	54	(14)	61	(14)	56	(14)
	Three conditions of multimorbidity and two dimensions of frailty*						Three conditions of multimorbidity and two dimensions of frailty*					
	No, freq.	(%)	Yes, freq.	(%)	Total, freq.	(%)	No, freq.	(%)	Yes, freq.	(%)	Total, freq.	(%)
Total	16983	(82)	3803	(18)	20813	(100)	14367	(83)	2837	(16)	17214	(100)
Occupational group												
High	4029	(89)	475	(11)	4505	(100)	3977	(89)	485	(11)	4465	(100)
Middle	4491	(83)	888	(16)	5386	(100)	3995	(82)	860	(18)	4857	(100)
Low	8463	(77)	2440	(22)	10922	(100)	6395	(81)	1492	(19)	7892	(100)
Age, years												
25–44	5378	(90)	600	(10)	5981	(100)	3651	(93)	291	(7)	3943	(100)
45–64	7920	(80)	1914	(19)	9840	(100)	7024	(84)	1341	(16)	8366	(100)
65–74	2449	(77)	714	(23)	3168	(100)	2472	(80)	618	(20)	3093	(100)
75–100	1236	(68)	575	(32)	1824	(100)	1220	(67)	587	(32)	1812	(100)
Mean (SD)	53	(14)	60	(14)	54	(14)	55	(14)	63	(13)	56	(14)

*In total, 27 women and 10 men miss data on both measures of multimorbidity with frailty.
freq., frequency.

58% (n=10922 of 18 814) women, while women constitute 55% (n=20813 of 38027) of the total sample.

In total, 77% reported more than two and 62% more than three conditions of multimorbidity. Frailty with one impairment was identified in 41% and with two impairments in 18%. Table 2 shows the distribution of the combined measures across occupational groups and stratified by sex.

Overall, 39% met the criteria of having at least two conditions of multimorbidity with one dimension of frailty (41% (n=8482 of 20813) of women, 37% (n=6378 of 17214) of men) and 17% met the criteria of three-condition multimorbidity with two dimensions of frailty (18% (n=3803 of 20813) of women, 16% (n=2837 of 17 214) of men).

Proportions of multimorbidity with frailty increased with lower occupational rank and increasing age, in both sexes, regardless of definition. Most individuals with any definition of multimorbidity with frailty were younger than 64 years.

Table 3 shows prevalence differences and prevalence ratios with 95% CI for each definition of multimorbidity with frailty between occupational groups for women and men at the ages 30, 55 and 80 years.

Prevalence differences in percentage points (pp) for two-condition multimorbidity with one dimension of frailty between high and low occupational groups were largest in women at 30 years, 17 (14 to 20) pp and 55 years, 15 (13 to 17) pp, and for men at 55 years, 15 (13 to 17) pp and 80 years, 14 (9 to 18) pp. The prevalence ratio

Table 3 Prevalence ratios (PR) and prevalence differences (PD) with 95% CI between occupational groups and multimorbidity with frailty, stratified by sex

Age, years	Occupational group	Women				Men			
		Two conditions of multimorbidity and one dimension of frailty							
		PR	(95% CI)	PD	(95% CI)	PR	(95% CI)	PD	(95% CI)
30	High	1.00	(Ref.)	0.00	(Ref.)	1.00	(Ref.)	0.00	(Ref.)
	Middle	1.36	(1.11 to 1.65)	0.06	(0.02 to 0.09)	0.93	(0.70 to 1.23)	−0.01	(−0.06 to 0.03)
	Low	2.09	(1.76 to 2.47)	0.17	(0.14 to 0.20)	1.32	(1.04 to 1.67)	0.05	(0.01 to 0.09)
55	High	1.00	(Ref.)	0.00	(Ref.)	1.00	(Ref.)	0.00	(Ref.)
	Middle	1.22	(1.13 to 1.31)	0.07	(0.04 to 0.09)	1.34	(1.23 to 1.45)	0.08	(0.06 to 0.11)
	Low	1.48	(1.38 to 1.58)	0.15	(0.13 to 0.17)	1.60	(1.48 to 1.72)	0.15	(0.13 to 0.17)
80	High	1.00	(Ref.)	0.00	(Ref.)	1.00	(Ref.)	0.00	(Ref.)
	Middle	0.96	(0.86 to 1.08)	−0.02	(−0.09 to 0.05)	1.23	(1.12 to 1.35)	0.12	(0.06 to 0.17)
	Low	1.05	(0.95 to 1.16)	0.03	(−0.03 to 0.09)	1.27	(1.15 to 1.39)	0.14	(0.09 to 0.18)
Age, years	Occupational group	Three conditions of multimorbidity and two dimensions of frailty							
		PR	(95% CI)	PD	(95% CI)	PR	(95% CI)	PD	(95% CI)
30	High	1.00	(Ref.)	0.00	(Ref.)	1.00	(Ref.)	0.00	(Ref.)
	Middle	2.31	(1.56 to 3.40)	0.04	(0.02 to 0.06)	1.29	(0.77 to 2.17)	0.01	(−0.01 to 0.03)
	Low	3.59	(2.53 to 5.08)	0.08	(0.06 to 0.10)	1.60	(1.02 to 2.51)	0.02	(0.00 to 0.04)
55	High	1.00		0.00		1.00		0.00	
	Middle	1.31	(1.14 to 1.50)	0.04	(0.02 to 0.06)	1.62	(1.40 to 1.87)	0.06	(0.04 to 0.07)
	Low	1.78	(1.59 to 2.00)	0.10	(0.08 to 0.11)	2.05	(1.80 to 2.33)	0.09	(0.08 to 0.11)
80	High	1.00	(Ref.)	0.00	(Ref.)	1.00	(Ref.)	0.00	(Ref.)
	Middle	1.17	(0.94 to 1.47)	0.05	(−0.02 to 0.11)	1.26	(1.06 to 1.50)	0.07	(0.02 to 0.11)
	Low	1.16	(0.94 to 1.42)	0.04	(−0.01 to 0.10)	1.22	(1.04 to 1.44)	0.06	(0.01 to 0.10)

for the low occupational group compared with the high occupational group, for two-condition multimorbidity with one dimension of frailty, was greatest in women at 30 years, 2.09 (1.76 to 2.47) and in men at 55 years, 1.60 (1.48 to 1.72). The prevalence ratio decreased in both sexes in high age and was at 80 years 1.05 (0.95 to 1.16) for women and 1.27 (1.15 to 1.39) for men.

Correspondingly, prevalence differences between high and low occupational groups for three-condition multimorbidity with two dimensions of frailty were largest in women at 30 years, 8 (6 to 10) pp and 55 years, 10 (8 to 11) pp and in men at 55 years, 9 (8 to 11) pp and 80 years, 6 (1 to 10) pp. Prevalence ratio, comparing the low occupational group with the highest occupational group for three-conditions multimorbidity with two conditions of frailty, was greatest in women at 30 years, 3.59 (1.43 to 5.08) and in men at 55 years, 2.05 (1.80 to 2.33). The prevalence ratio decreased in both sexes in high age and was at 80 years 1.16 (0.94 to 1.42) for women and 1.22 (1.04 to 1.44) for men.

DISCUSSION

Main results

In this adult population health study, multimorbidity with frailty was common as 39% met the criteria of two-condition multimorbidity plus one dimension of frailty and 17% met the criteria of three-condition multimorbidity plus two dimensions of frailty. Proportions increased with lower occupational group, higher age and female sex from 25 to 74 years, but was common across age groups in both sexes. Occupational inequalities were consistent in both sexes until high age, diminishing in women, while still present in men at age 80 years.

Comparison with existing literature

Investigating two measures of multimorbidity with frailty in one sample offers a unique direct comparison of occurrences and socioeconomic gradients. Lower overall prevalence for the stricter measure three-condition multimorbidity with two dimensions of frailty is expected. Defining multimorbidity by three or more conditions differentiates into older age.[26 29] The joint measure multimorbidity and frailty show the same tendency, as 62% of 75–100 year olds met the criteria of at least two-condition multimorbidity with one dimension of frailty, while 32% reported three-condition multimorbidity with two dimensions of frailty. In line with individual studies on multimorbidity[4 24] and frailty,[25] most individuals with co-present multimorbidity and frailty are younger than 64 years.

A recent commentary[1] emphasised exploring multimorbidity guidelines and frailty as part of multimorbidity's

complexity, and overlap of multimorbidity and frailty has newly been reviewed.[28] A pooled prevalence of 16% (95% CI 12% to 21%) was reported for two conditions multimorbidity with the frailty phenotype among elderly,[28] while 39% in our study reported at least two conditions of multimorbidity with one dimension of frailty. The prevalence differences are likely explained by differences in methods. The articles included in the review studied age 60 years and older. Still, the prevalence of multimorbidity is low. All but one defined multimorbidity from lists of less than 12 conditions and prevalences are probably underestimated.[26 29] Frailty too was only operationalised with the biophysical model, while more people are expected to be detected using a multidimensional measure.

We have not identified studies on prevalence and social determinants of multimorbidity with frailty. Low social position,[18 19] older age[18 20] and female sex[18 20] are known common determinants of multimorbidity and frailty. We therefore argue that the direction of the sociodemographic determinants in this study is as expected. The magnitudes of these gradients, however, have not been comparable with other studies.

Mechanisms to explain findings

The aggregation of ill health, multimorbidity and frailty included in lower socioeconomic positions is explained by numerous theories. Overall, unequal distribution of power, income and resources result in fundamental different conditions of daily life yielding inequalities in health.[17] With regard to occupation, several mechanisms can explain associations to health outcomes. The higher occupational group is expected to have higher, more stable income,[35 39] more beneficial social networks[39] and more autonomy and control[35 39] at work. Adverse working conditions such as exposure to toxic work environments[21] or demanding physical requirements[39] tend to cluster in lower occupational groups.[17] Persisting health inequalities in assumed egalitarian Nordic countries is partly understood as mortality selection, where, given the well-developed healthcare and welfare systems, frail individuals survive, but likely end up in a low social position.[16] Further, smoking, overall morbidity and mortality decrease at a higher rate among higher than lower social groups.[16] In this study, the demographic age distribution explain the high number of 45 to 64 years old with co-present multimorbidity and frailty. Additionally, incidence of new conditions is associated with count of conditions at baseline,[4] as well as age,[4] thus individuals in lower occupational groups may aggregate conditions faster. The bidirectional association of health and occupation may explain higher occupational group prevalence ratios in younger individuals,[21] while lower ratios by increasing age are expected, since multimorbidity with frailty is more common[40] with advancing age. Finally, survival bias justifies diminishing occupational differences at age 80 years.

Strengths and limitations

Materials and methods meet the standards of studies on multimorbidity, frailty and social health inequalities, strengthening this study. In multimorbidity studies, population-based health surveys are the most frequent study design,[41] and prevalence estimates from self-reports are justified when studying large samples.[26] Deriving the condition count multimorbidity measures from a complete list of single-entity conditions is shown to yield proper prevalence estimates.[29] A multidimensional frailty measure agrees with a holistic, unrestricted on age, conceptual definition of frailty[14] and with common frailty scales, which share ability to show associations to age, sex and mortality.[20] In descriptive studies, any measure of socioeconomic position will reveal health inequalities, if such exists.[21] Occupation is an established marker for socioeconomic position,[21] in which this study had individual data classified to facilitate international comparison. Finally, socioeconomic differences are explored as both absolute and relative measures[16] and presented by sex.[18]

There are always limitations in secondary analysis of data collected a priori and not for the purpose of the current study. Measures of multimorbidity and frailty are also manifold, and operationalisations were adjusted to fit the available data. This challenges the external validity, and comparability between studies, however, is sought reduced through transparency of morbidities included and construction of variables. A majority of included multimorbidity conditions do not contain information regarding duration. Thus, reported prevalence of multimorbidity may be overestimated and not represent true chronicity. It is recognised that frailty scales may differ in accuracy of detecting frailty in younger age groups[10 20]; however, frailty symptoms are of great clinical value regardless of age.[10 42] The accuracy of the frailty variables were not explored and frailty was measured solely as self-report, an approach that may underestimate overall prevalence[43] and overestimate proportion among women compared with men.[43]

Lastly, in the HUNT3 Survey, participants were asked for their 'main' occupation, which is not necessarily the current or longest lasting occupation, more commonly studied.[39] Younger than middle aged may to some extent be misclassified in the lower occupational group, which will underestimate social differences in health among younger subjects. Occupational data may obscure current social context[39] and underestimate socioeconomic inequalities. Thus, the study would have benefitted from exploring socioeconomic position with several indicators,[44] such as individual education and income or a household measure.

Attendance in the HUNT3 Survey varied by age, sex and social position[32]; still, the HUNT Study is considered representative for Norway as a whole[45] and the cohort follows trends in health development in western high-income countries.[46–48] Depression hindered participation,[32] which may yield underestimation of both

multimorbidity and frailty. An overall bias towards healthy elders is probable, since eligibility depended on attendance at a screening station.

Implications for clinical practice and policy makers

This study aimed to quantify the total prevalence of adults in the general population who might need complex, multidisciplinary care assessed as the joint measure multimorbidity with frailty. In a clinical context, the definition of at least three-condition multimorbidity with two dimensions of frailty to detect individuals for whom to initiate a multimorbid approach to care seems more feasible. Despite acknowledgement of the association of multimorbidity and frailty with age, sex and socioeconomic position, guidelines and interventions have yet to take this into account in assessment and management for multimorbidity.[49] Based on literature and reproduction of social gradients in our study, we suggest that clinicians consider evaluation of multimorbidity and frailty in younger age groups with social context in mind. Further research on implementation of the multimorbid approach to care model and mortality is needed before recommending changing inclusion criteria in a guideline. Since multimorbidity is becoming the norm, the organisation of healthcare should reform to fit person-centred, coordinated, multidisciplinary care.[6 10 50] To prevent cases of multimorbidity and frailty and minimise social discrepancies, both universal and targeted life cycle approaches seem necessary.[51]

Frailty is independently associated with mortality, adjusted for multimorbidity,[25] and is reversible.[52] Thus, detection of frailty is relevant for both public health and clinical purposes.

Future research

Some forms of biases are possible for both multimorbidity, frailty and social position, and a careful interpretation of findings is warranted. However, multimorbidity with frailty is common in this general population and with occupational inequalities throughout adulthood, even with stricter definitions. This adds knowledge to the public health literature about the sociodemographic distribution of multimorbidity with frailty in younger age groups, as well as very old individuals. On this background, we recommend exploring the sociodemographic distribution of alternative measures on multimorbidity, including patterns, aiming to detect individuals suspected in high need of complex, multidisciplinary healthcare. Furthermore, such measurements can be compared as prognostic factors for healthcare utilisation and mortality.

CONCLUSION

Multimorbidity with frailty is common from young adulthood onward, with consistent socioeconomic inequalities until 80 years old. Prevention will require a proportionate universal approach on social determinants of health throughout the entire life span. The crucial need for person-centred multimorbid approach to care that acknowledges social context, demands reforms in healthcare organisational structure, medical education and treatment. Further research on competing measures of high-need multimorbidity and the association of these factors with healthcare utilisation and mortality should be explored by socioeconomic position, age and sex.

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