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Multimorbidity Patterns and 6-Year Risk of Institutionalization in Older Persons: The Role of Social Formal and Informal Care

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A B S T R A C T

Keywords:
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Objectives: The aim was to evaluate patterns of multimorbidity that increase the risk of institutionalization in older persons, also exploring the potential buffering effect of formal and informal care.

Design: Prospective cohort study.

Setting and Participants: The population-based Swedish National study on Aging and Care in Kungsholmen, Stockholm, Sweden.

Measures: In total, 2571 community-dwelling older adults were grouped at baseline according to their underlying multimorbidity patterns, using a fuzzy c-means cluster algorithm, and followed up for 6 years to test the association between multimorbidity patterns and institutionalization.

Results: Six patterns of multimorbidity were identified: psychiatric diseases; cardiovascular diseases, anemia, and dementia; metabolic and sleep disorders; sensory impairments and cancer; musculoskeletal, respiratory, and gastrointestinal diseases; and an unspecific pattern including diseases of which none were overrepresented. In total, 110 (4.3%) participants were institutionalized during the follow-up, ranging from 1.7% in the metabolic and sleep disorders pattern to 8.4% in the cardiovascular diseases, anemia, and dementia pattern. Compared with the unspecific pattern, only the cardiovascular diseases, anemia, dementia pattern was significantly associated with institutionalization [relative risk ratio (RRR) = 2.23; 95% confidence interval (CI) 1.07–4.65], after adjusting for demographic characteristics and disability status at baseline. In stratified analyses, those not receiving formal care in the psychiatric diseases pattern (RRR 3.34; 95% CI 1.20–9.32) and those not receiving formal or informal care in the 'cardiovascular diseases, anemia, dementia' pattern (RRR 2.99; 95% CI 1.20–7.46; RRR 2.79; 95% CI 1.16–6.71, respectively) had increased risks of institutionalization.

Conclusions and Implications: Older persons suffering from specific multimorbidity patterns have a higher risk of institutionalization, especially if they lack formal or informal care. Interventions aimed at

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Data are from the SNAC-K project, a population-based study on aging and dementia (<http://www.snac-k.se/>). Access to these original data is available to the research community upon approval by the SNAC-K data management and maintenance committee. Applications for accessing these data can be submitted to Maria Wahlberg (Maria.Wahlberg@ki.se) at the Aging Research Center, Karolinska Institutet.

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preventing the clustering of diseases could reduce the associated burden on residential long-term care. Formal and informal care provision may be effective strategies in reducing the risk of institutionalization. © 2021 AMDA — The Society for Post-Acute and Long-Term Care Medicine. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Nursing homes represent a fundamental response of healthcare systems and social services to the increasing number of older adults affected by severe functional impairments and social disadvantages. At present, the global proportion of 65+ year-old persons residing in nursing homes ranges from 0.2% in Korea to 7.9% in Sweden.¹ However, with population aging and the increase in the absolute number of persons affected by progressive and disabling chronic diseases, the need for long-term care and its associated costs, is expected to increase worldwide. Thus, identifying groups of older individuals at high risk of institutionalization could be a valuable strategy to properly plan resource allocation and reduce or delay the need for residential long-term care.

The bulk of previous research on predictors of institutionalization has focused on the role played by specific diseases, such as dementia,^{2,3} depression,^{4,5} stroke,⁴ urinary incontinence,⁶ and hip fractures.² Notably, risk of institutionalization is reportedly high in persons affected by multimorbidity, which is the co-existence of multiple diseases in the same person.^{7,8} It can be argued that multimorbidity will differentially impact health outcomes, such as institutionalization depending on disease combinations and interactions. In recent years, an increasing body of evidence has shown that diseases develop in an individual, following specific patterns. In fact, the clustering of multiple conditions in an individual, following predictable patterns of diseases, is mostly driven by a nonrandom series of biological, lifestyle, and environmental risk factors. Specific multimorbidity patterns have different effects on various health outcomes, such as mortality,⁹ functional decline,¹⁰ and dementia risk.¹¹ However, the role of multimorbidity patterns in the risk of institutionalization has never been evaluated. Moreover, previous studies on the effectiveness of interventions aimed at enabling older people to remain in their home environment (ie, the provision of formal social care and informal support) have shown inconsistent results.^{12,13} Our hypothesis is that specific patterns of multimorbidity carry a different risk of institutionalization, and that receiving formal and informal care will decrease such risk.

The aim of this study is to evaluate which patterns of multimorbidity increase the risk of institutionalization during 6 years of follow-up in older Swedish persons, additionally examining the potential buffering effect of receiving formal and informal social care.

Methods

Study Design and Population

Data from the Swedish National study on Aging and Care in Kungsholmen (SNAC-K) were used to answer the research questions. SNAC-K is a cohort study that includes adults living in the Kungsholmen district of Stockholm, Sweden, who are age 60 years or older.¹⁴ There are 11 age cohorts (60, 66, 72, 78, 81, 84, 87, 90, 93, 96, and 99+ years) from which participants were randomly selected, with 73% of invited individuals enrolling in SNAC-K at baseline (2001–2004).¹⁴ Those younger than 72 years are followed every 6 years and those 78 years and older are followed at 3-year intervals.¹⁴ The study was approved by the Regional Ethics Review Board in Stockholm. Participants in the study provided written informed consent. For participants with cognitive impairment, written informed consent was obtained from the next of kin.

This study involved a longitudinal design to determine the relationship between multimorbidity patterns and institutionalization over 6 years. Participants were excluded if they (1) did not have multimorbidity at baseline (ie, 2 or more diseases; $n = 432$); (2) were

institutionalized at baseline ($n = 190$); and (3) were missing information on informal care status ($n = 87$), formal care status ($n = 73$), disability ($n = 5$), education ($n = 3$), or marital status ($n = 2$) at baseline. After applying the exclusion criteria, 2571 community-dwelling participants with multimorbidity at baseline remained for the analyses. Those excluded because of missing observations were older, less educated, affected by more chronic diseases, and more likely to be women than the participants included in the study ($P < .01$).

Data Collection

Each study visit involved the following data collection: (1) a clinical examination (neurological, geriatric, psychiatric assessments) performed by a physician; (2) a social interview and physical function assessment conducted by a nurse; and (3) a psychologist-administered cognitive assessment.¹⁵

Chronic diseases were diagnosed in SNAC-K through self-reported health status of participants, medical journal review, clinical laboratory parameters, medication utilization, and anamnestic data. Four-digit level codes from the *International Classification of Diseases, Tenth Revision* (ICD-10) were dichotomized as chronic or nonchronic. Baseline data from SNAC-K were used to generate a list of 60 categories of chronic diseases; diseases prognosis, pathophysiology, prevalence, and treatment were considered in the development of this list.¹⁶

Institutionalization was established during the social interview that was conducted by research nurses at each study visit, and it included retirement homes, group dwellings, or nursing homes.

Death was included as an outcome in the analysis. Date and cause of death were identified from the Swedish Cause of Death Register.

Loss-to-follow-up was included as an additional outcome and was obtained from the SNAC-K database. Those who dropped out over the 6 years were slightly less educated than the other participants, however, no significant differences were observed in age, sex, or number of chronic diseases between these 2 groups.

Covariates adjusted for in the analyses were collected in the nurse's interview and included sex; age; education categorized into elementary (<8 years), high school (8–13 years), and university or higher (14+ years); marital status classified as partnered, widowed, unmarried, and divorced; and disability calculated as the sum of activities of daily living (continence, feeding, transferring, toileting, bathing, dressing) and instrumental activities of daily living (telephoning, shopping, housekeeping, food preparation, laundry, transportation use, managing medications, and handling finances) deficits experienced by the participant, which could range from 0 to 14. Informal care was categorized as zero or ≤ 1 hour or > 1 hour of care per day; it refers to care assistance from relatives, friends, neighbors, or volunteer/nonprofit organizations. Formal care was classified as zero or ≤ 1 hour or > 1 hour of care per day; it includes help with household chores and personal care that is financed by the municipality and which may be delivered either by the municipality or a private company that has a contract with the municipality.

Statistical Analyses

All SNAC-K participants who were noninstitutionalized with at least 2 chronic conditions at baseline were included in the generation of the multimorbidity patterns. A dimensionality reduction (multiple correspondence analysis) was conducted, considering all diseases

which had a prevalence of at least 2%. To create clusters of individuals (based on their chronic diseases), a fuzzy *c*-means cluster algorithm was used as a soft cluster technique. The soft clustering assigned participants a membership probability to every cluster, permitting participants to exist in multiple clusters. Validation indices and various degrees of “fuzzification” were tested to identify the optimal number of clusters. To minimize the random nature of the clustering output, the soft clustering analysis was carried out 100 times, producing an average outcome. Participants were allotted to the cluster where their membership probability was highest so the most probable situation could be analyzed. Observed/expected ratios and disease exclusivity measures were used to distinguish which diseases belong to the clusters. Diseases were identified as components of specific clusters when the observed/expected ratio was 2 or greater and the exclusivity was at least 25%.¹⁷ Additional information on the cluster development can be found in a previous publication.¹⁸

The χ^2 test and 1-way analysis of variance were employed to examine baseline characteristics of the participants by multimorbidity pattern. The association between multimorbidity patterns and institutionalization over 6 years of follow-up was assessed through multinomial logistic regression. The outcome possibilities were noninstitutionalized, institutionalized, deceased, or dropped out during the 6 years of follow-up. The unspecific cluster was used as the reference group. The association between multimorbidity patterns and institutionalization was initially adjusted for sociodemographic characteristics and disability, and then 2 additional models included the presence of formal and informal care (hours per day). Analyses stratified by the presence of formal care and informal care were also carried out. The potential presence of multiplicative interactions between the multimorbidity patterns and sex, education, formal care, and informal care, in relation to institutionalization, was assessed. In all analyses, a *P* value of <.05 was considered statistically significant. Stata/IC v 15.1 (Stata Statistical Software: Release 15. College Station, TX) and R v 4.0.0 (R Foundation for Statistical Computing, Vienna, Austria) were used to conduct the analyses.

Results

There were 2571 participants included in the analyses, with a mean age of 74.5 ± 10.3 years, and female participants constituted 65% of the population. Six patterns of multimorbidity were identified at baseline: psychiatric diseases ($n = 149$; 5.8%); cardiovascular diseases, anemia, and dementia ($n = 203$; 7.9%); metabolic and sleep disorders ($n = 297$; 11.6%); sensory impairments and cancer ($n = 303$; 11.8%); musculoskeletal, respiratory, and gastrointestinal diseases ($n = 411$; 16.0%); and an unspecific ($n = 1208$; 47.0%) pattern with none of the diseases exceeding the expected prevalence, which can be considered generic multimorbidity.

Baseline characteristics of the participants by multimorbidity pattern can be found in Table 1. Those in the sensory impairments and cancer (83.8 ± 8.5 years) and cardiovascular diseases, anemia, and dementia (83.2 ± 8.4 years) patterns were the oldest, on average. Individuals in the cardiovascular diseases, anemia, and dementia pattern had highest number of chronic diseases per person, on average (7.8 ± 2.4), and were most affected by disability. The participants were younger (71.3 ± 9.2) and affected by less chronic diseases (3.1 ± 1.1) in the unspecific pattern, which was a relatively healthier pattern.

Over the 6 years of follow-up, 108 (4.2%) participants were institutionalized, 519 (20.2%) died, and 365 (14.2%) dropped out. Those institutionalized were older, more likely to be female, and affected by more chronic diseases on average (Table 2). Figure 1 displays the percentage of participants institutionalized over 6 years; this was highest in the cardiovascular diseases, anemia, and dementia pattern (8.4%) and lowest in the metabolic and sleep disorders pattern (1.7%).

The association between multimorbidity patterns and institutionalization is shown in Table 3.

The cardiovascular diseases, anemia, and dementia pattern was the only one associated with institutionalization over 6 years compared with the unspecific pattern, with similar relative risk ratios (RRR) across all 3 models [RRR_{MODEL3} 2.23; 95% confidence interval (CI) 1.07–

Table 1
Baseline Characteristics of the Study Population by Multimorbidity Pattern

Characteristics	Unspecific (n = 1208; 47.0%)	MSK, Respiratory, and GI Diseases (n = 411; 16.0%)	Sensory Impairments and Cancer (n = 303, 11.8%)	Metabolic and Sleep Disorders (n = 297, 11.6%)	Cardiovascular Diseases, Anemia, and Dementia (n = 203, 7.9%)	Psychiatric (n = 149, 5.8%)	Total (n = 2571)
Age, y	71.3 ± 9.2	75.1 ± 10.0	83.8 ± 8.5	72.9 ± 8.8	83.2 ± 8.4	71.5 ± 9.6	74.5 ± 10.3
Sex (female)	758 (62.8)	316 (76.9)	203 (67.0)	141 (47.5)	130 (64.0)	111 (74.5)	1659 (64.5)
Education							
Elementary	175 (14.5)	67 (16.3)	75 (24.8)	46 (15.5)	54 (26.6)	21 (14.1)	438 (17.0)
High school	593 (49.1)	210 (51.1)	162 (53.5)	163 (54.9)	114 (56.2)	71 (47.7)	1313 (51.1)
University	440 (36.4)	134 (32.6)	66 (21.8)	88 (29.6)	35 (17.2)	57 (38.3)	820 (31.9)
Marital status							
Partnered	638 (52.8)	170 (41.4)	88 (29.0)	150 (50.5)	67 (33.0)	60 (40.3)	1173 (45.6)
Widowed	247 (20.5)	115 (28.0)	138 (45.5)	66 (22.2)	93 (45.8)	36 (24.2)	695 (27.0)
Unmarried	167 (13.8)	60 (14.6)	42 (13.9)	41 (13.8)	31 (15.3)	21 (14.1)	362 (14.1)
Divorced	156 (12.9)	66 (16.1)	35 (11.6)	40 (13.5)	12 (5.9)	32 (21.5)	341 (13.3)
Formal care (h/mo)							
None	1160 (96.0)	357 (86.9)	213 (70.3)	282 (95.0)	120 (59.1)	124 (83.2)	2256 (87.8)
≤ 1 h/d	44 (3.6)	44 (10.7)	76 (25.1)	14 (4.7)	70 (34.5)	20 (13.4)	268 (10.4)
> 1 h/d	4 (0.3)	10 (2.4)	14 (4.6)	1 (0.3)	13 (6.4)	5 (3.4)	47 (1.8)
Informal care (h/mo)							
None	1154 (95.5)	351 (85.4)	222 (73.3)	266 (89.6)	141 (69.5)	124 (83.2)	2258 (87.8)
≤ 1 h/d	47 (3.9)	51 (12.4)	65 (21.5)	28 (9.4)	48 (23.7)	18 (12.1)	257 (10.0)
> 1 h/d	7 (0.6)	9 (2.2)	16 (5.3)	3 (1.0)	14 (6.9)	7 (4.7)	56 (2.2)
Disability*	0.2 ± 0.7	0.6 ± 1.5	1.4 ± 2.3	0.2 ± 0.7	1.9 ± 2.4	0.9 ± 2.0	0.6 ± 1.5
Number of diseases	3.1 ± 1.1	4.6 ± 1.9	5.7 ± 1.9	5.2 ± 1.9	7.8 ± 2.4	5.5 ± 2.1	4.4 ± 2.2

GI, gastrointestinal; MSK, musculoskeletal.

Values are presented as absolute number and column percentage (%) or mean ± standard deviation.

*Disability is the sum of deficits in activities of daily life and instrumental activities of daily life.

Table 2
Baseline Characteristics of the Study Population by 6-Year Institutionalization Status

Characteristics	Noninstitutionalized (n = 2463; 95.8%)	Institutionalized (n = 108; 4.2%)	Total (n = 2571)
Age	74.1 ± 10.2	84.5 ± 7.8	74.5 ± 10.3
Sex (female)	1569 (63.7)	90 (83.3)	1659 (64.5)
Education			
Elementary	408 (16.6)	30 (27.8)	438 (17.0)
High school	1250 (50.8)	63 (58.3)	1313 (51.1)
University	805 (32.7)	15 (13.9)	820 (31.9)
Marital status			
Partnered	1151 (46.7)	22 (20.4)	1173 (45.6)
Widowed	647 (26.3)	48 (44.4)	695 (27.0)
Unmarried	338 (13.7)	24 (22.2)	362 (14.1)
Divorced	327 (13.3)	14 (13.0)	341 (13.3)
Formal care			
None	2192 (89.0)	64 (59.3)	2256 (87.8)
≤1 h/d	235 (9.5)	33 (30.6)	268 (10.4)
>1 h/d	36 (1.5)	11 (10.2)	47 (1.8)
Informal care			
None	2182 (88.6)	76 (70.4)	2258 (87.8)
≤1 h/d	231 (9.4)	26 (24.1)	257 (10.0)
>1 h/d	50 (2.0)	6 (5.6)	56 (2.2)
Disability*	0.5 ± 1.4	2.0 ± 2.4	0.6 ± 1.5
Number of diseases	4.3 ± 2.2	5.3 ± 2.4	4.4 ± 2.2

Values are presented as absolute number and column percentage (%) or mean ± standard deviation.

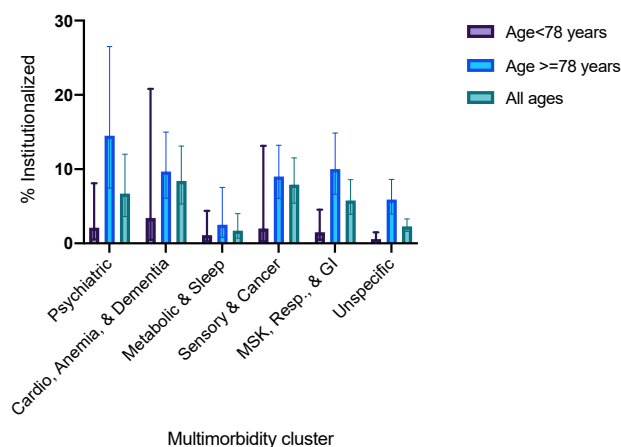
*Disability is the sum of deficits in activities of daily life and instrumental activities of daily life.

4.65] (Table 3). In the stratified analyses, those without any formal care at baseline who were part of the psychiatric diseases (RRR 3.34; 95% CI 1.20–9.32) and cardiovascular diseases, anemia, and dementia (RRR 2.99; 95% CI 1.20–7.46) patterns had increased relative risks of institutionalization over 6 years compared with the unspecific pattern (Table 4). The stratification by informal care showed those without any informal care at baseline who belonged to the cardiovascular diseases, anemia, and dementia pattern to be at increased risk of institutionalization over 6 years, relative to the unspecific pattern (RRR 2.79; 95% CI 1.16–6.71) (Table 5). There was no multiplicative interaction between the multimorbidity patterns and sex or education with institutionalization over 6 years.

The association between the multimorbidity patterns and death and dropouts over 6 years can be found as supplementary material (Supplementary Tables 1 and 2).

Discussion

Findings from this study showed that, compared with a less burdensome and more generic combination of chronic diseases

**Fig. 1.** Institutionalization over 6 years by multimorbidity pattern in the whole sample and by age group.

(ie, the unspecific pattern), older adults with multimorbidity characterized by cardiovascular diseases, anemia, and dementia were at higher risk of institutionalization over 6 years, independent of socio-demographic characteristics and baseline disability. Within this pattern, those receiving formal or informal care showed a lower risk of relocation to a nursing home. Finally, participants within the psychiatric diseases multimorbidity pattern not receiving formal care were at higher risk of institutionalization.

Previous studies have found cognitive and/or functional impairments to be major predictors of institutionalization.⁴ Such impairments usually increase in the presence of multimorbidity, arguably mediating the association between specific multimorbidity patterns and institutionalization, as shown in our analyses.^{19–21} Persons affected by specific disease combinations may show differential risk of developing functional and cognitive impairments over time. Koller et al showed that individuals within the cardiovascular and metabolic and anxiety, depression, and somatoform disorders patterns had a higher risk of becoming care-dependent, and even more so for those within the neuropsychiatric disorders pattern, who had a 79% higher risk of long-term care dependency.²² In a previous study on another Swedish population, Marengoni et al showed that the prevalence of disability varied greatly among specific pairs of diseases: from 6.7% in persons affected by hypertension and atrial fibrillation to 82.4% in persons affected by dementia and hip fracture.²³ In another study, 3 specific multimorbidity patterns (ie, cardiovascular, neuropsychiatric, and sensorial impairments/cancer) increased the risk of dementia development.¹¹ Thus, findings from our study showing that belonging to the cardiovascular diseases, anemia, and dementia pattern

Table 3
Six-Year Association between Multimorbidity Patterns and Institutionalization

Multimorbidity Patterns	Cases		Model 1		Model 2		Model 3	
	n/N	%	RRR	95% CI	RRR	95% CI	RRR	95% CI
Unspecific	28/1208	2.3	1 (ref)	-	1 (ref)	-	1 (ref)	-
MSK, respiratory, and GI diseases	24/411	5.8	1.69	0.92-3.08	1.67	0.91-3.07	1.70	0.93-3.10
Sensory impairments and cancer	24/303	7.9	0.92	0.48-1.78	0.91	0.47-1.75	0.92	0.48-1.79
Metabolic and sleep disorders	5/297	1.7	0.81	0.30-2.18	0.81	0.30-2.19	0.81	0.30-2.18
Cardiovascular diseases, anemia, and dementia	17/203	8.4	2.22	1.06-4.63	2.17	1.04-4.53	2.23	1.07-4.65
Psychiatric	10/149	6.7	2.25	0.96-5.27	2.24	0.95-5.25	2.26	0.96-5.31

GI, gastrointestinal; MSK, musculoskeletal.

Model 1: age, sex, education, marital status, disability.

Model 2: age, sex, education, marital status, disability, formal care.

Model 3: age, sex, education, marital status, disability, informal care.

Table 4
Six-year Association between Multimorbidity Patterns and Institutionalization Stratified by Formal Care

Multimorbidity Patterns	Formal Care 0 h/d				Formal Care ≥ 1 h/d			
	n/N	%	RRR	95% CI	n/N	%	RRR	95% CI
Unspecific	19/1160	1.6	1 (ref)	-	9/48	18.8	1 (ref)	-
MSK, respiratory, and GI diseases	12/357	3.4	1.55	0.72–3.33	12/54	22.2	1.84	0.47–7.20
Sensory impairments and cancer	13/213	6.1	1.25	0.56–2.81	11/90	12.2	0.27	0.08–0.96
Metabolic and sleep disorders	5/282	1.8	1.14	0.41–3.16	0/15	0.0	0.0	NA
Cardiovascular diseases, anemia, and dementia	9/120	7.5	2.99	1.20–7.46	8/83	9.6	0.70	0.17–2.83
Psychiatric	6/124	4.8	3.34	1.20–9.32	4/25	16.0	0.40	0.07–2.20

GI, gastrointestinal; MSK, musculoskeletal.

Model is adjusted for age, sex, education, marital status, disability.

Table 5
Six-Year Association between Multimorbidity Patterns and Institutionalization Stratified by Informal Care

Multimorbidity Patterns	Informal Care 0 h/d				Informal Care ≥ 1 h/d			
	n/N	%	RRR	95% CI	n/N	%	RRR	95% CI
Unspecific	22/1154	1.9	1 (ref)	-	6/54	11.1	1 (ref)	-
MSK, respiratory, and GI diseases	15/351	4.3	1.58	0.77–3.21	9/60	15.0	1.41	0.37–5.41
Sensory impairments and cancer	16/222	7.2	1.04	0.48–2.24	8/81	9.9	0.53	0.13–2.11
Metabolic and sleep disorders	5/266	1.9	1.06	0.38–2.91	0/31	0.0	0.0	NA
Cardiovascular diseases, anemia, and dementia	11/141	7.8	2.79	1.16–6.71	6/62	9.7	0.76	0.18–3.22
Psychiatric	7/124	5.7	2.43	0.88–6.69	3/25	12.0	0.94	0.16–5.55

GI, gastrointestinal; MSK, musculoskeletal.

Model is adjusted for age, sex, education, marital status, disability.

increased the risk of institutionalization could be explained by the strong association of dementia with incident disability and cardiovascular diseases with cognitive impairment. To note, co-occurring cardiovascular and neuropsychiatric diseases have previously been associated with a faster functional decline and mortality.⁹

In Nordic countries, the healthcare system provides more comprehensive formal home care services compared with other European countries. The purpose of providing extensive long-term formal care services is to enable older adults to live in their homes for as long as possible, avoiding admissions to nursing homes and related healthcare costs.²⁴ Although there has been a slight increase in the provision of formal care in recent years, it has not been able to compensate for the steep decrease in residential care, neither in terms of coverage nor intensity of eldercare.²⁵ Between 2000 and 2016, nursing home beds decreased by one-third and the coverage rate of those ≥ 65 and ≥ 80 years of age decreased from 8% to 4% and from 21% to 13%, respectively.²⁶ Consequently, informal care has become the dominant source of support in Sweden, contributing to almost two-thirds of the care provided to community-dwelling older people,²⁷ with few older people relying uniquely on public services.²⁸ In our study, we showed that, after accounting for disability status, those not receiving any formal care in the psychiatric diseases pattern, and those without either formal or informal care in the cardiovascular diseases, anemia, and dementia pattern had increased risks of institutionalization. This suggests that formal and informal care can buffer the risk of institutionalization associated with specific multimorbidity

patterns. This directly calls for a prolonged and sustainable investment, not only in municipality-driven formal home care, but also in the provision of support to those informal carers who are most vulnerable to the adverse health consequences of caregiving.²⁹ The decision to place a person in a nursing home is complex and based on several characteristics of the patient, the caregiver, and the sociocultural environment, but also on the availability of familial and social resources.³⁰ Moreover, priorities for nursing home care allocation in Sweden have become increasingly strict since the 2000s.³¹ Knowing which multimorbidity patterns are associated with a higher risk of nursing home admission, in the absence of formal or informal care, might help in the distribution and allocation of future resources and public funds.

Comparison of our findings with those of other studies is difficult, as to the best of our knowledge, this is the first study analyzing multimorbidity patterns and risk of institutionalization. In the Nordic Study, which includes participants receiving home care in Oslo, Stockholm, Copenhagen, and Reykjavik, receiving skilled nursing procedures at baseline was a predictor for nursing home admission, suggesting that when a patient requires skilled nursing over time, the threshold for receiving a nursing home bed is lower.³² In line with these findings, caregivers of patients with dementia have previously expressed that a reason for nursing home placement was that they lacked the skills required for the caregiving tasks.³⁰ In such cases, formal care could and should supply services that are more expert. This could be the reason why the cardiovascular, anemia and dementia pattern was associated with an increased risk of institutionalization, when either formal or informal care was lacking. Similarly, caring for older individuals with special needs, such as those belonging to the psychiatric diseases pattern, often requires highly specialized care, which may explain their increased risk of institutionalization when formal care is lacking.

The strengths of the study are the comprehensive evaluation of participants' health status and the high number of very old people in the cohort. The following limitations should also be taken into account. First, information on the provision of formal and informal care was self-reported, thus, the possibility of recall bias cannot be excluded. Second, the study investigated the period between 2001 and 2010, but we know that chronic disease management, as well as social care and nursing home provision, have changed over the last decade. For the reasons explained above, we need to be cautious when generalizing findings from this study.

Conclusions and Implications

The presence of specific multimorbidity patterns characterized by cardiovascular diseases, anemia, and dementia and psychiatric diseases significantly increases the risk of institutionalization in older persons. Accordingly, interventions aimed at preventing the clustering of these specific diseases could reduce the associated burden on residential long-term care. Moreover, formal and informal care provision may be effective strategies in reducing the risk of institutionalization, and thus, should be especially directed toward individuals suffering from the above-mentioned multimorbidity patterns.

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Supplementary Table 1

Six-Year Association of Multimorbidity Patterns with Death

Multimorbidity Patterns	Cases		Model 1		Model 2		Model 3	
	n/N	%	RRR	95% CI	RRR	95% CI	RRR	95% CI
Unspecific	139/1208	11.5	1 (ref)	–	1 (ref)	–	1 (ref)	–
MSK, respiratory, and GI diseases	82/411	20.0	1.45	1.02–2.04	1.43	1.01–2.03	1.45	1.03–2.05
Sensory impairments and cancer	103/303	34.0	1.10	0.76–1.61	1.08	0.74–1.58	1.11	0.76–1.61
Metabolic and sleep disorders	63/297	21.2	1.88	1.30–2.70	1.88	1.30–2.70	1.87	1.30–2.70
Cardiovascular diseases, anemia, and dementia	108/203	53.2	3.63	2.35–5.58	3.50	2.27–5.41	3.63	2.35–5.58
Psychiatric	24/149	16.1	1.30	0.74–2.27	1.28	0.73–2.25	1.30	0.74–2.28

GI, gastrointestinal; MSK, musculoskeletal.

Model 1: age, sex, education, marital status, disability.

Model 2: age sex, education, marital status, disability, formal care.

Model 3: age, sex, education, marital status, disability, informal care.

Supplementary Table 2

Six-Year Association of Multimorbidity Patterns with Dropouts

Multimorbidity Patterns	Cases		Model 1		Model 2		Model 3	
	n/N	%	RRR	95% CI	RRR	95% CI	RRR	95% CI
Unspecific	170/1208	14.1	1 (ref)	–	1 (ref)	–	1 (ref)	–
MSK, respiratory, and GI diseases	62/411	15.1	1.14	0.81–1.58	1.14	0.82–1.59	1.12	0.80–1.56
Sensory impairments and cancer	36/303	11.9	0.78	0.51–1.21	0.79	0.51–1.22	0.77	0.50–1.20
Metabolic and sleep disorders	46/297	15.5	1.23	0.85–1.78	1.23	0.85–1.78	1.20	0.83–1.74
Cardiovascular diseases, anemia, and dementia	26/203	12.8	1.56	0.92–2.63	1.57	0.93–2.65	1.53	0.91–2.59
Psychiatric	25/149	16.8	1.35	0.83–2.20	1.35	0.83–2.20	1.32	0.81–2.16

GI, gastrointestinal; MSK, musculoskeletal.

Model 1: age, sex, education, marital status, disability.

Model 2: age sex, education, marital status, disability, formal care.

Model 3: age, sex, education, marital status, disability, informal care.