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Multimorbiditätsmuster in der deutschen Allgemeinbevölkerung im Alter von 40 Jahren und älter

Dissertation

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[1] In dieser Arbeit wird aus Gründen der besseren Lesbarkeit das generische Maskulinum verwendet. Weibliche und anderweitige Geschlechteridentitäten werden dabei ausdrücklich mitgemeint, soweit es für die Aussage erforderlich ist.

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Multimorbidity patterns in the German general population aged 40 years and over

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Highlights

- Data were taken from a large nationally representative sample.
- Five multimorbidity patterns were identified.
- A relatively large group belonged to high morbidity class.
- Gender differences were only apparent in the arthrosis/inflammatory/mental illnesses class.
- Knowledge about multimorbidity patterns can assist in reducing healthcare costs.

Abstract

Aim

The aim of this study was to identify and describe multimorbidity patterns among middle-aged and older community-dwelling individuals in Germany. Moreover, we aimed to determine potential gender differences in multimorbidity patterns.

Methods

We analysed data from the most recent (sixth) wave (2017) of the large nationally representative German Ageing Survey (DEAS). Altogether n = 6,554 individuals participated, mean age was 62.0 (ranging from 43 to 92 years). Latent Class Analysis was performed to identify multimorbidity patterns, based on 13 chronic conditions and diseases. Multimorbidity was defined as the presence of at least two chronic conditions.

Results

Altogether, 53.3% of individuals were multimorbid. We identified and clinically described five multimorbidity patterns: the relatively healthy class (45.1%), the high morbidity class (10.8%), the arthrosis/inflammatory/mental illnesses class (20.6%), the hypertension-metabolic illness class (21.7%), and the cardiovascular/cancer class (1.7%). Our analysis revealed that women compared to men have higher relative risk (IRR = 1.61, 95% CI 1.25–2.06) of being in the arthrosis/inflammatory/mental illnesses class, compared to the relatively healthy class. Furthermore, we found that, depending on which multimorbidity pattern individuals belong to, they differ greatly in terms of socio-demographic factors, health behaviour, and lifestyle factors.

Conclusions

We showed that the many chronic diseases cluster in a non-random way. Five clinically meaningful multimorbidity patterns were identified. Gender differences were apparent only in one class, namely in the arthrosis/inflammatory/mental illnesses class.

Previous Next

Keywords

Multimorbidity patterns; Multimorbidity clusters; Multiple chronic conditions; Old age; Latent class analysis; LCA

1. Introduction

Multimorbidity is defined as the co-occurrence of two (Aubert et al., 2020) or more (Garin et al., 2014; Ioakeim-Skoufa et al., 2020) diseases in an individual. It is a growing phenomenon, consisting of different chronic diseases. In most developed countries, many individuals are now reaching old age and are surviving illnesses that used to be fatal, partly due to medical advances (Bayes-Marin et al., 2020; Clerencia-Sierra et al., 2015). It is projected that this will lead to an increasing number of older multimorbid individuals in the coming decades. Multimorbidity is associated with polypharmacy, poorer quality of life (Violán et al., 2019), as well as a marked increase in healthcare utilization (Buczak-Stec et al., 2022) and corresponding healthcare costs (Aubert et al., 2019).

It has been shown that among individuals with multimorbidity, the diseases tend to occur not randomly but in specific clusters or patterns. Some authors describe multimorbidity patterns "as non-randomly associated diseases" (Aubert et al., 2020; Jovic et al., 2016; Marengoni et al., 2009). Most authors do not define clusters directly, but describe them using various analyses (e.g., latent class analysis (LCA), explorative factor analysis, cluster analysis) (Aubert et al., 2019; Clerencia-Sierra et al., 2015; Garin et al., 2016; Ioakeim-Skoufa et al., 2020; Kirchberger et al., 2012; Lenzi et al., 2016; Marengoni et al., 2020; Prazeres & Santiago, 2015; van den Bussche et al., 2011; Zemedikun et al., 2018) or determine clusters by using observed-to-expected ratios (Foguet-Boreu et al., 2015; Formiga et al., 2013; Garin et al., 2014; Violán et al., 2019).

Medical guidelines as well as health care systems often mainly focus on a specific disease (Aubert et al., 2020; van den Bussche et al., 2011). In this respect, multimorbidity represents a huge challenge, both from a therapeutic (Bayes-Marin et al., 2020; Prazeres & Santiago, 2015) and an economic (Prazeres & Santiago, 2015) point of view. Therefore, it is important to investigate how diseases cluster in multimorbidity patterns and

whether common pathological mechanisms exist. This could be useful in the development of new clinical guidelines and prevention programs. This in turn may lead to an improvement in the treatment of multimorbid patients and to a reduction of costs in health care systems.

A recent systematic review revealed that there are two multimorbidity patterns that most commonly occur in general populations, namely mental health conditions (including depression, anxiety, and psychoses) and cardio-metabolic conditions (including cardiovascular disease, diabetes, hypertension, lipid metabolism disorder, obesity/overweight) (Busija et al., 2019). In another systematic review, in addition to these two patterns, it was demonstrated that musculoskeletal disorders patterns were also commonly reported in many studies (Prados-Torres et al., 2014). Further, similar patterns were identified also across low-, middle, and high-income countries (Garin et al., 2016). Namely, Garin et al. showed that cardio-respiratory pattern (angina, asthma and chronic obstructive pulmonary disease), metabolic patterns (diabetes, obesity and hypertension) and mental-articular patterns (arthritis and depression) were present in several countries (Garin et al., 2016). Additionally, the following three multimorbidity patterns were frequently found: COPD and asthma pattern, falls and fractures with sensory deficits pattern, and patterns that include Parkinson's disease with cognitive decline (Busija et al., 2019).

However, to date, little is known about multimorbidity patterns in Germany. Only three studies related to multimorbidity patterns have been conducted in Germany. The first German study was conducted in 2011 (van den Bussche et al., 2011). It was a cross-sectional study based on insurance company data. Patients older than 65 years were included. This resulted in a large sample size of 123,244 individuals. Patients were described as multimorbid if they had 3 or more illnesses. The disease spectrum of the multimorbid sample was covered by six individual diseases (hypertension, dyslipidemia, chronic low back pain, diabetes mellitus, osteoarthritis and chronic ischaemic heart disease). Interestingly, gender differences were small in this study.

The second German study from 2012 examined multimorbidity patterns in patients aged 65–94 years. The data came from the population-based project KORA AGE study (Kirchberger et al., 2012). The sample size was 4127 people living in the city of Augsburg and surrounding counties in southern Germany. Patients were defined as multimorbid if they had at least two diseases. Using factor analysis, four patterns of multimorbidity were identified: (i) cardiovascular and metabolic diseases, (ii) joint, liver, lung and eye diseases, (iii) mental and neurological diseases and (iv) gastrointestinal diseases and cancer.

The third study on multimorbidity patterns in Germany is based on data from the MultiCare Cohort study (year 2012). This is a multicentre, prospective, observational cohort study with 3189 patients aged 65+. Patients were randomly selected from 158 GP practices. Data were collected via GP interviews and patient surveys. Two patterns of multimorbidity were found: (i) patients with mainly cardiovascular and metabolic disorders, (ii) patients with ADHD (anxiety, depression, somatoform disorders) and pain-related morbidity (Schäfer et al., 2012).

Based on a large nationally representative sample, the aim of our study was to identify and describe multimorbidity patterns in Germany. Moreover, we aimed to determine potential gender differences in multimorbidity patterns. Previous studies mentioned above are limited to patients from specific institutions (e.g., hospitals, GP practices insurance company), or are restricted in regions. Therefore, previous findings are not generalizable to the whole population aged 40 years in Germany. In contrast, our current study includes community-dwelling individuals aged 40 and older from Germany as a whole (i.e., a nationally representative sample). Thus, it is generalizable to middle-aged and older adults residing in private households in Germany.

Knowledge generated by this study can act as a basis for future research in this emerging field. Future studies could focus on the antecedents and consequences of different multimorbidity patterns (in contrast to a simple

count of chronic conditions). A more detailed understanding of the different profiles of multimorbidity can support the delivery of more person-centred care, as opposed to disease-centred care, in the medium to long term.

We hypothesized that there would be gender differences in patterns related to multimorbidity, especially in the area of vascular, cardiopulmonary, cardiac and mental disease (Dong et al., 2013). It is interesting to note gender differences that show a correlation of individual classes related to chronic diseases. This is because the sexes differ both biologically and in social behaviour. For example, women give birth to children and go through menopause, each of which brings different diseases (e.g., obesity, athritis, hypertension). As a result, women require different therapeutic approaches, such as oestrogen therapy. Men, on the other hand, use medical services less frequently, thus diseases remain undetected longer (Gamper et al., 2019). Gender differences have been observed in some studies. For example, Dong et al. (2013) and Schäfer et al. (2012) showed that there are relatively large differences in multimorbidity patterns between men and women. More precisely, they found that a greater proportion of women suffered from anxiety, depression, somatoform disorder, and pain, and a large proportion of men in turn suffered from cardiovascular and metabolic disorders (Schäfer et al., 2012). Dong et al. found that only men were represented in the vascular, cardiopulmonary, cardiac, and somatic-mental clusters, and only women were represented in mental disease clusters (Dong et al., 2013).

2. Methods

2.1. Study design and participants

Our study is based on data from the German Ageing Survey (DEAS) wave 6, which was conducted in 2017. DEAS is a long-term study by the German Centre of Gerontology (DZA) on changes in people's life situations and age trajectories, funded by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ). The representative cross-sectional and longitudinal surveys are conducted nationwide, involving several thousand people aged 40 and older.

The study design is a combination of cross-sectional and longitudinal samples. The first survey was conducted in 1996 (n = 4838), followed by further surveys together with additional samples in 2002 (n = 4608), 2008 (n = 8196), 2011 (n = 4854), 2014 (n = 10,324), and 2017 (n = 6226), The Institute for Applied Social Science GmbH in Bonn (infas) is responsible for conducting the survey. Further details about the survey are provided elsewhere (Klaus et al., 2017).

In survey wave six (2017), participants who have already taken part in the DEAS at least once were interviewed. The sample size was n = 6626 (age: 43 – 97 years). The study participants were asked about different life domains. For example: health and health behaviour, basic sociodemographic data, subjective well-being, work and retirement, partnership, family and intergenerational relationships, social networks and social support, leisure activities and civic engagement, housing and mobility and, economic situation.

The survey was divided into two parts, a face-to-face interview and a questionnaire to be self-completed by the respondent (drop-off). The first part (interview) took place in the household of the target person with a personal interview. It lasted about 90 min and was conducted orally. The questions were used analogously to the previous wave. Some survey modules could be omitted, such as level of education attained or childhood history, because they were stable survey characteristics. The survey used the information from the previous wave to obtain a more efficient survey of personal changes in private relationships. In 2017, the proxy survey option was newly introduced. Individuals who were no longer able to answer the questions due to health reasons were able to select a person to answer the questions in their place. A pulmonary function test was performed during the interview, and a cognitive ability test (number and drawing test) was performed after the interview. The proxy

interviews were excluded from this test. Subsequently, the respondents were asked to complete a questionnaire (drop-off) including more sensitive questions. Questions were asked about attitudes, values, images of old age, well-being, information about the material situation and health, and items to measure psychological concepts. In 2017, the option of completing the drop-off questionnaire as an online questionnaire was introduced.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committees, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Since the criteria for an ethics vote were not fulfilled (e.g., use of invasive methods, examination of patients or risk for the individuals), an ethics committee approval was not required. Written informed consent was obtained from all individual participants included in the study.

2.2. Multimorbidity patterns

The assessment of multimorbidity and multimorbidity patterns was based on questions concerning chronic conditions and diseases diagnosed by a physician. The participants were given a list of nineteen different diseases and were asked to indicate whether a physician had ever diagnosed them with one of the diseases listed. The selection of diseases was informed by the Federal Health Survey (Bundesgesundheitssurvey-98), Charlson Comorbidity Index and additional consultation of three specialists from a geriatric context. In our study, we included the diseases with a prevalence higher than 5% (elevated blood lipid levels (high cholesterol); diabetes, high blood sugar levels; high blood pressure; heart attack, angina pectoris; circulatory disorders in the legs; joint degeneration (arthrosis) of the hip or knee joints or the spine; osteoporosis; inflammatory joint or spinal disease (arthritis or rheumatism); chronic lung disease (e.g. chronic bronchitis, emphysema); cancer, malignant tumour (including leukaemia); mental illness (e.g. anxiety, depression, psychosis); glaucoma (glaucoma or macular degeneration) and others). In accordance with previous research (Aubert et al., 2020, 2019; Bayes-Marin et al., 2020; Dong et al., 2013; Foguet-Boreu et al., 2015; Formiga et al., 2013; Garin et al., 2014; Jovic et al., 2016; Kirchberger et al., 2012; Lenzi et al., 2016; Marengoni et al., 2009, 2020; Nguyen et al., 2020; Prazeres & Santiago, 2015; Violán et al., 2019; Zemedikun et al., 2018), multimorbidity was defined as the presence of two or more chronic diseases or conditions in an individual.

2.3. Statistical analysis

Latent class analysis (LCA). To identify the multimorbidity patterns, we performed Latent Class Analysis (LCA) (Bayes-Marin et al., 2020; Nguyen et al., 2020; Weller et al., 2020). The first step in the LCA is the identification of the optimal number of latent classes. We conducted this class enumeration based only on presence of chronic diseases (in the models, we used only variables indicating chronic diseases; additional covariates such as sex, age, educational level were not used at this stage). Using LCA Stata plug-in Lanza et al. (2015), eight LCA models were fitted (with one to eight classes) in order to decide on number of optimum latent classes. In each step, we increased the number of classes by one. We then investigated whether the addition of each class leads to statistically and conceptually better solutions (Nylund-Gibson, 2018). The number of latent classes were chosen based on a set of indices such as the lowest consistent Akaike Information Criterion (cAIC), Akaike Information Criterion (AIC), the Bayesian Schwarz Information Criterion (BIC), adjusted Bayesian Schwarz Information Criterion (aBIC) and relative entropy (from 0 to 1, higher values indicating better classification quality) (Nylund et al., 2007; Nylund-Gibson, 2018). Lower values of cAIC, AIC, BIC and aBIC indicate better fit. After the number of latent classes was determined, each individual in the sample was then assigned to one class (i.e. the class to which they were most likely to belong) based on the highest posterior probability. Further, we extended the LCA in order to account for sociodemographic variables and in order to identify the gender differences in class membership. For this purpose, we conducted multinomial logistic regression analysis with the relatively healthy class as the reference one.

We have chosen this method because it is superior to classical cluster analytic methods, where only a few observed properties or property characteristics are available (Nylund-Gibson, 2018). This analytical approach is established in research on multimorbidity patterns (Bayes-Marin et al., 2020; Bendayan et al., 2021; Nguyen et al., 2020).

In all analyses, we included cross-sectional and cross-sectional drop-off weights to obtain a nationally representative sample. Multinomial logistic regression analysis was conducted to identify gender differences in class membership. For the statistical analysis, we used StataMP 16.0 (Stata-Corp, College Station, Texas, USA) and we used a LCA Stata plugin (Version 1.2.1) (Lanza et al., 2015). The criterion for statistical significance was set at $p < 0.05$.

3. Results

3.1. Sample characteristics

Table 1 shows the sample characteristics. Altogether, 6554 individuals were included in the analytical sample, average age was 62.0 years (SD: 12.0 years, range 43–92 years), and 49.3% were female. The prevalence of multimorbidity (two or more chronic conditions) in the total sample was 53.3% (54.9% in women and 51.5% in men; $p = 0.78$). Average number of chronic conditions was 2.0 (SD: 1.8, ranging from 0 to 14). Most prevalent chronic conditions were high blood pressure (47.5%), joint degeneration (arthrosis) of the hips, knees, or spine (41.7%), high cholesterol (28.2%), inflammatory joint or spinal disease (arthritis or rheumatoid arthritis) (16.3%), and diabetes, high blood sugar levels (13.5%).

Table 1. Descriptive statistics.

	Male (***n*** **= 3301**)	**Female** (***n*** **= 3253**)	**Total sample** (***n*** **= 6554**)	
Age				<0.001
Mean (SD), range	61.5 (11.7); 43–92	62.6 (12.2); 43–90	62.0 (12.0); 43–92	
Education				<0.001
- **low (ISCED 0–2)**	108 (3.4%)	453 (13.3%)	560 (8.5%)	
- **medium (ISCED 3–4)**	1570 (49.7%)	1898 (55.9%)	3468 (52.9%)	
- **high (ISCED 5–6)**	1481 (46.9%)	1047 (30.8%)	2528 (38.6%)	
Marital status				<0.001
- **married, living together**	2342 (74.2%)	2057 (60.6%)	4399 (67.1%)	
- **married living separated**	60 (1.9%)	56 (1.6%)	115 (1.8%)	
- **divorced**	268 (8.5%)	417 (12.3%)	684 (10.4%)	
- **widowed**	162 (5.1%)	562 (16.6%)	724 (11.0%)	

- **single**	328 (10.4%)	303 (8.9%)	631 (9.6%)	
Labour force status				<0.001
- **working**	1694 (53.7%)	1530 (45.1%)	3224 (49.2%)	
- **retired**	1321 (41.9%)	1526 (44.9%)	2847 (43.5%)	
- **other: not employed**	141 (4.5%)	341 (10.0%)	481 (7.3%)	
Place of residence				0.398
- **west (former Federal Republic of Germany)**	2590 (82.0%)	2782 (81.9%)	5371 (81.9%)	
- **east (former German Democratic Republic)**	568 (18.0%)	616 (18.1%)	1184 (18.1%)	
Body mass index (BMI)				<0.001
- **non-overweight**	954 (30.2%)	1467 (43.2%)	2421 (36.9%)	
- **overweight**	1453 (46.0%)	1084 (31.9%)	2536 (38.7%)	
- **obesity**	752 (23.8%)	847 (24.9%)	1598 (24.4%)	
Smoking behaviour				<0.001
- **never smoked**	971 (37.1%)	1586 (54.7%)	2557 (46.3%)	
- **daily, occasionally**	550 (21.0%)	514 (17.7%)	1064 (19.3%)	
- **used to smoke**	1099 (42.0%)	800 (27.6%)	1898 (34.4%)	
Physical activity level				0.168
- **less often or never**	237 (9.2%)	369 (13.0%)	606 (11.2%)	
- **daily to 1–3 times a month**	2348 (90.8%)	2473 (87.0%)	4820 (88.8%)	
Income				<0.001
Mean (SD)	2238.15 (1347.1)	1985.64 (1228.3)	2108.88 (1293.7)	
Median (Q1, Q3)	2000.0 (1416.7, 2666.7)	1750.0 (1300.0, 2381.0)	1866.7 (1333.3, 2500.0)	

Range	200–20,000	1–30,000	1–30,000	
Number of chronic diseases				<0.001
Mean (SD)	1.93 (1.74)	2.14 (1.91)	2.04 (1.83)	
Median (Q1, Q3)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	
Range	0–13	0–13	0–13	
Multimorbidity				0.783
- **no**	1532 (48.5%)	1532 (45.1%)	3063 (46.7%)	
- **yes**	1626 (51.5%)	1866 (54.9%)	3491 (53.3%)	

Notes: Weighted counts, means and percentages are presented for all variables; p-values: chi-square (categorical variables) or ANOVA (continuous variables); Standard deviation (SD) or percentage in parentheses; Income - Monthly equivalence income (new OECD equivalence scale); body mass index - BMI (non-overweight (BMI <25 kg/m2); overweight (BMI 25–29.9 kg/m2) and obesity (BMI ≥ 30 kg/m2)).

3.2. Multimorbidity patterns

The multimorbidity patterns are summarized by classes consisting of different chronic diseases. The number of classes was based on AIC, cAIC BIC, adjusted BIC, relative entropy and the size of each class (Table 2). Moreover, we took into account the clinical interpretability of each class. In order to name the classes, we investigated highest predicted membership probabilities in each latent class (Fig. 1; Supplementary data Tab. A1.). Additionally, we compared the prevalence of chronic diseases in each multimorbidity class with cohort average to identify diseases with a significantly higher prevalence than in the population. We chose the five-class model as it had the lowest BIC, aBIC, and cBIC, moderate entropy and the size of each class was not too small ($n > 50$).

Table 2. Comparison between potential models with one to eight classes.

Modell	**1-class**	**2-class**	**3-class**	**4-class**	**5-class**	**6-class**	**7-class**	**8-class**
aBIC	5833.76	3768.83	3595.26	3492.44	3422.13	3428.92	3444.91	3452.43
cAIC	5888.07	3881.62	3766.55	3722.22	3710.40	3775.67	3850.15	3916.16
BIC	5875.07	3854.62	3725.55	3667.22	3641.40	3692.67	3753.15	3805.16
AIC	5786.83	3671.35	3447.25	3293.89	3173.04	3129.28	3094.73	**3051.71**
Entropy	1.0	0.531	0.544	0.447	0.521	0.545	0.587	0.607
Predicted membership probabilities (size of the classes)		C1 69.0% C2 31.0%	C1 65.8% C2 31.0% C3 15.7%	C1 45.6% C2 11.6% C3 21.6% C4 21.2%	C1 45.1% C2 10.8% C3 20.6% C4 21.7% C5 1.7%	C1 41.3% C2 9.4% C3 3.7% C4 20.8% C5 1.7% C6 23.0%	C1 44.1% C2 8.2% C3 2.9% C4 15.6% C5 2.0% C6 19.1% C7 8.0%	C1 45.5% C2 0.3% C3 3.7% C4 15.5% C5 1.8% C6 19.3% C7 7.6% C8 6.3%

Notes: aBIC = adjusted Bayesian information criterion; cAIC- consistent Akaike Information Criterion; BIC = Bayesian information criterion; AIC = Akaike information criterion; C- class.

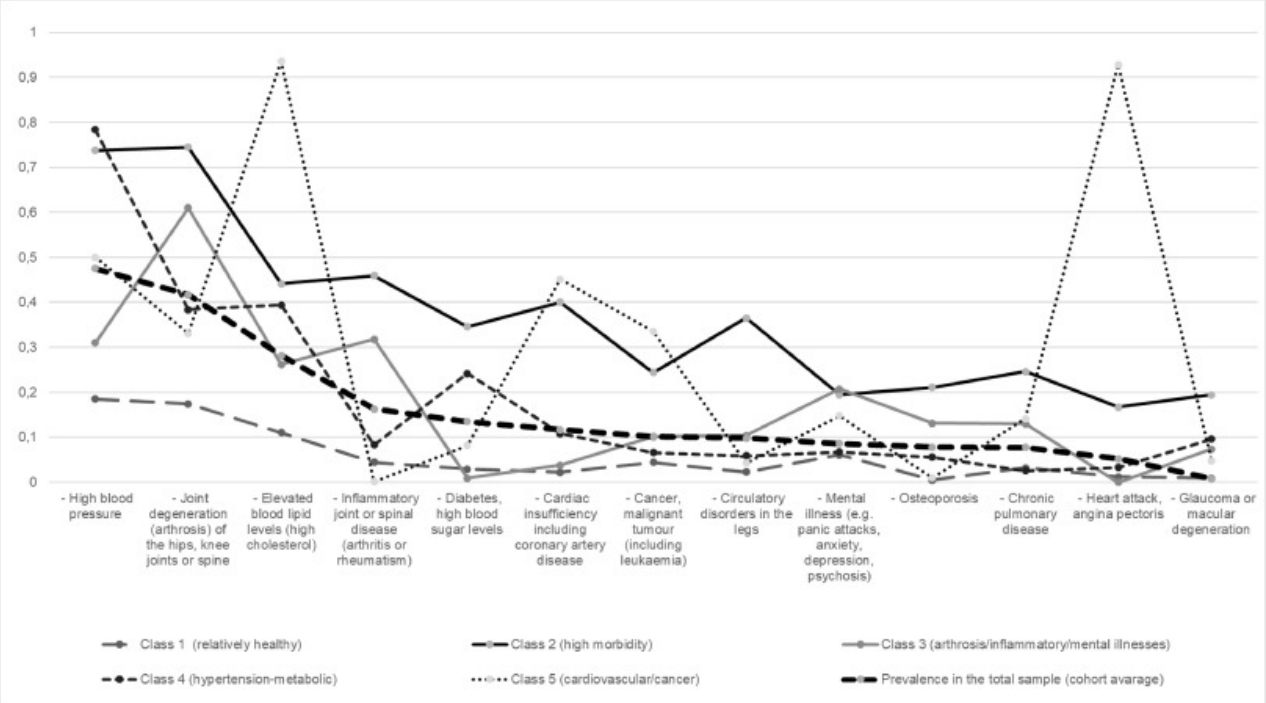

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Fig. 1. Item response probabilities.

Using latent class analysis, we identified five multimorbidity patterns: class 1 – "relatively healthy" (45.1% of the sample); class 2 – "high morbidity class" (10.8% of the sample); class 3 – "arthrosis/inflammatory/mental illnesses" (20.6% of the sample), class 4 – "hypertension-metabolic" (21.7% of the sample); and class 5 – "cardiovascular/cancer" (1.7% of the sample). The names of each group were, among other things, informed by the highest prevalence of the disease and also based on previous research (Bayes-Marin et al., 2020; Ioakeim-Skoufa et al., 2020).

The *relatively healthy class* (class 1) was characterized by a substantial lower prevalence of each chronic condition/disease compared to the total sample, except for glaucoma or macular degeneration (0.8% vs 0.9%) (Table A.1). In this class, individuals had on average 0.7 (SD: 0.7; ranging from 0 to 4) chronic conditions. The relatively healthy class also include individuals with some chronic conditions. However, on average, the number of chronic conditions is mostly markedly lower than in the other classes. For instance, in the relatively healthy class, the average number of chronic diseases is about 0.7, whereas it is 4.2 in the cardiovascular/cancer class. This class mainly included individuals who were younger than cohort average, had a high level of education, and were physically active. The average age was 58.3 years (SD: 11.1 years). The *relatively healthy class* included a total of 2883 individuals. The class was equally distributed in terms of gender, comprising 50.8% men and 49.2% women (Table 3).

Table 3. Descriptive statistics of analytical sample stratified by multimorbidity classes.

	Class 1	Class 2	Class 3	Class 4	Class 5	Total

	(relatively healthy)	(high morbidity)	arthrosis/inflammatory/mental illnesses	(hypertension-metabolic)	(cardiovascular/cancer)	sample
	(*N* = 2883)	(*N* = 772)	(*N* = 1154)	(*N* = 1635)	(*N* = 110)	(*N* = 65
Age						
Mean (SD), range	58.3 (11.1); 43–90	70.6 (11.6); 44–92	62.7 (11.1); 43–90	66.5 (11.2); 43–90	68.6 (10.7); 49–90	62.0 (12.0); 43–92
Sex						
- **male**	1709 (50.8%)	258 (42.2%)	402 (35.0%)	708 (53.9%)	83 (65.5%)	3158 (48.2%)
- **female**	1652 (49.2%)	353 (57.8%)	745 (65.0%)	605 (46.1%)	44 (34.5%)	3397 (51.8%)
Level of education						
- **low**	222 (6.6%)	106 (17.2%)	135 (11.7%)	94 (7.1%)	5 (3.5%)	560 (8.
- **medium**	1680 (50.0%)	359 (58.7%)	622 (54.3%)	738 (56.2%)	71 (55.9%)	3468 (52.9%)
- **high**	1459 (43.4%)	148 (24.1%)	390 (34.0%)	481 (36.6%)	52 (40.6%)	2528 (38.6%)
Marital status						
- **married living together with spouse**	2384 (70.9%)	329 (53.9%)	707 (61.9%)	900 (68.6%)	80 (63.2%)	4399 (67.1%)
- **married living separated from spouse**	57 (1.7%)	9 (1.3%)	34 (2.9%)	17 (1.2%)	1 (0.4%)	115 (1.8
- **divorced**	322 (9.6%)	92 (15.0%)	138 (12.0%)	117 (8.9%)	16 (12.6%)	684 (10.4%)
- **widowed**	234 (7.0%)	129 (21.1%)	175 (15.3%)	180 (13.7%)	7 (5.2%)	724 (11.0%)
- **single**	365 (10.8%)	53 (8.6%)	91 (7.9%)	100 (7.6%)	24 (18.5%)	631 (9.6
Labour force status						

- **working**	2178 (64.8%)	80 (13.0%)	492 (42.9%)	438 (33.4%)	38 (29.9%)	3224 (49.2%)
- **retired**	967 (28.8%)	457 (75.0%)	558 (48.7%)	783 (59.7%)	84 (66.5%)	2847 (43.5%)
- **other: not employed**	216 (6.4%)	74 (12.0%)	97 (8.4%)	91 (6.9%)	5 (3.5%)	481 (7.3
Place of residence						
- **West**	2819 (83.9%)	490 (80.1%)	935 (81.5%)	1.035 (78.9%)	94 (74.7%)	5371 (81.9%)
- **East**	542 (16.1%)	122 (19.9%)	212 (18.5%)	278 (21.1%)	32 (25.3%)	1184 (18.1%)
Body mass index (BMI)						
- **non-overweight**	1476 (43.9%)	169 (27.6%)	429 (37.4%)	313 (23.9%)	36 (28.0%)	2421 (36.9%)
- **overweight**	1344 (40.0%)	189 (30.8%)	426 (37.1%)	509 (38.7%)	71 (55.9%)	2536 (38.7%)
- **obesity**	541 (16.1%)	255 (41.6%)	292 (25.5%)	491 (37.4%)	21 (16.1%)	1598 (24.4%)
Smoking behaviour						
- **never smoked**	1307 (46.8%)	190 (38.7%)	460 (46.4%)	542 (48.1%)	60 (50.3%)	2557 (46.3%)
- **daily, occasionally**	581 (20.8%)	81 (16.5%)	208 (21.0%)	174 (15.4%)	21 (17.1%)	1064 (19.3%)
- **used to smoke**	907 (32.4%)	220 (44.9%)	324 (32.6%)	410 (36.4%)	39 (32.6%)	1898 (34.4%)
Physical activity level						
- **less often or never**	209 (7.6%)	115 (23.9%)	108 (11.0%)	144 (12.9%)	33 (27.5%)	606 (11.2%)
- **daily to 1–3 times a week**	2.543 (92.4%)	365 (76.1%)	865 (89.0%)	963 (87.1%)	86 (72.5%)	4820 (88.8%)

Income						
Median (Q1. Q3)	2000.0 (1416.7. 2666.7)	1400.0 (1083.3. 2000.0)	1800.0 (1333.3. 2400.0)	1800.0 (1333.3. 2400.0)	2083.3 (1600.0. 2400.0)	1866.7 (1333.3 2500.0
Number of chronic diseases						
Mean (SD)	0.69 (0.66)	5.69 (1.53)	2.89 (1.01)	2.84 (0.93)	4.20 (1.40)	2.04 (1.83)
Min. Max	0–4	3–14	1–8	2–8	2–8	0–14
Multimorbidity						
- **no**	3045 (90.6%)	0 (0.0%)	19 (1.6%)	0 (0.0%)	0 (0.0%)	3063 (46.7%)
- **yes**	316 (9.4%)	611 (100.0%)	1128 (98.4%)	1312 (100.0%)	126 (100.0%)	3491 (53.3%)

Notes: Weighted counts, means and percentages are presented for all variables; Standard deviation or percentage in parentheses; class 1 “relatively healthy”; class 2 – “high morbidity class”; class 3 – “arthrosis/inflammatory/mental illnesses; class 4 – “hypertension-metabolic”; and class 5 – “cardiovascular/cancer”.

Table 3 shows the five classes and reports the number of individuals included in these classes. The average and the proportion of both women and men in each class are displayed. Furthermore, social aspects concerning family and educational status, employment, income and place of residence can be seen for each pattern. For each pattern, three most frequent risk factors (body mass index (BMI), smoking behaviour, physical activity level) are shown. For example, the physical activity level differs between class 1 and class 2. Table 3 also shows the average number as well as the minimum and maximum number of chronic diseases in each of the 5 classes. In addition, the number of multimorbid individuals in each group is displayed.

In the *high morbidity class* (class 2) the prevalence of all diseases and chronic conditions was higher compared to the cohort average. The high morbidity class represented excess prevalence of e.g., joint degeneration (arthrosis) of the hips, knee joints or spine; 74.5% vs. 41.7%), high blood pressure (73.8% vs. 47.5%), inflammatory disease - arthritis or rheumatism (45.9% vs.16.3%), elevated blood lipid levels, cardiac insufficiency including coronary artery disease, circulatory disorder in the legs, and diabetes. In this pattern, the individuals had the highest average number of chronic diseases (5.7, SD: 1.5, ranging from 3 to 14). The sample included 772 individuals (10.8%) and the average age was 70.6 years (SD: 11.6 years). There was a slight unequal distribution of gender (men: 42.2%, women 57.8%). In comparison to other classes, individuals were less educated, most of them were retired or not employed, and a high proportion were obese.

The *arthrosis/inflammatory/mental illnesses class* (class 3) showed greater prevalence of arthrosis, inflammatory, high blood pressure, high cholesterol and mental illness compared to the cohort average. For example, the prevalence of mental illnesses such as panic attacks, anxiety, psychosis or depression in this class was almost three times higher compared to the total sample (20.7% vs. 8.6%). In this class, individuals had on average 2.9 chronic conditions (SD: 1.0; ranging from 1 to 8). The mean age was 62.7 years (SD: 11.4 years) and 1154 individuals were included. The class was predominately female (65.0%).

The *hypertension-metabolic class* (class 4) represented a higher prevalence of high blood pressure (78.4%), high cholesterol (39.4%) and diabetes (24.2%) than in cohort average. This pattern is composed of conditions whose coexistence could potentially lead to the diagnosis of metabolic syndrome. The individuals had on average 2.8 (SD: 0.9; ranging from 2 to 8) chronic diseases. The *hypertension-metabolic class* comprised a total of 1635 individuals. The mean age in this pattern was 66.5 years (SD: 11.2 years). Slightly more men (53.9%) than women (46.1%) belonged to this class.

Finally, the *cardiovascular/cancer class* (class 5) was characterized by a high prevalence of cardiovascular diseases. Almost all members of this class (92.8%) reported having suffered a heart attack or angina pectoris, 45.1% had cardiac insufficiency. The prevalence of elevated blood lipid levels was also very high (93.6%). Further, the prevalence of cancer was much higher than the cohort average, with one in three (33.5%) diagnosed with cancer or malignant tumour, including leukaemia. The individuals had on average 4.2 (SD: 1.4; ranging from 2 to 8) chronic diseases. This class represented the smallest sample with 110 individuals (1.7%). The average age was 68.6 years (SD: 10.7 years). Compared to other multimorbidity classes, the proportion of men in this class was the highest (65.5%).

Further, with regard to gender differences, our analysis revealed that women compared to men have higher relative risk (IRR = 1.61, 95%CI 1.25–2.06) of being in the arthrosis/inflammatory/mental illnesses class compared to the relatively healthy class. In other multimorbidity classes, gender differences were not statistically significant (Supplementary material Tab. A2.)

4. Discussion

4.1. Key results

Based on large nationally representative study, in our LCA analysis, we aimed to identify and to describe multimorbidity patterns among community-dwelling middle-aged and older individuals in Germany. Moreover, we aimed to determine potential gender differences in the multimorbidity class membership.

The prevalence of multimorbidity was relatively high in our sample. Approximately half of our sample had two or more chronic diseases. Regarding our key findings: first, we identified five clinically meaningful multimorbidity patterns, namely the relatively healthy class (45.1%), the high morbidity class (10.8%), the arthrosis/inflammatory/mental illnesses class (20.6%), the hypertension-metabolic class (21.7%), and the cardiovascular/cancer class (1.7%). Furthermore, our analysis revealed that gender differences in class membership were only apparent in one class, namely in arthrosis/inflammatory/mental illnesses class. Compared to men, women had a higher risk of belonging to this class.

4.2. Multimorbidity patterns

In our analysis, the *relatively healthy class* represented the largest class. In this class, the prevalence of all chronic diseases was much lower than in a cohort average, and more than 90% of individuals had less than two chronic conditions. Our findings support previous research, namely, a large number of studies similarly identified a relatively healthy class (Bayes-Marin et al., 2020; Larsen et al., 2017; Nguyen et al., 2020; Olaya et al., 2017; Park et al., 2019; Zheng et al., 2021; Zhou, 2022). Commonly, this class represents the largest cluster, with approximately 30%–67% of individuals belonging to it (Olaya et al., 2017; Whitson et al., 2016; Zheng et al., 2021; Zhou, 2022). In common with other studies, participants in the relatively healthy class tended to be younger, have a higher education, they tended to have a high level of physical activity, and the proportion of obese individuals was low (Whitson et al., 2016; Zheng et al., 2021). On the other hand, there was a number of individuals in our analysis who were much older (e.g., 75+ years) and still belonged to the *relatively healthy class*.

A similar result was also demonstrated in a study conducted among centenarians (Gellert et al., 2019). It was shown that a certain subgroup of older individuals have low morbidity rates.

Further, in our study, we showed that a relatively large group (approximately 10% of the cohort) belonged to the *high morbidity class* – the class in which individuals had at least three and up to fourteen chronic conditions and diseases. Our results demonstrated several similarities with other studies that also identified a class with an excess prevalence for nearly all diseases and chronic conditions (Gellert et al., 2019; Zhou, 2022). Consistent with previous research, the average age of participants classified in the *high morbidity* class was the highest compared to the other classes identified. Further, our class was also characterized by a high proportion of obese individuals, individuals with low levels of physical activity, and lower level of education. In line with other studies, many diseases belonged to the age-associated chronic conditions such as hypertension and arthritis (Zheng et al., 2021). Furthermore, this class was characterized by co-occurring of various chronic diseases with different aetiology, which was also been observed in other studies (Zhou, 2022). This findings suggest that proper treatment of individuals in the high morbidity class can be a challenge for the health care system (Jovic et al., 2016). Due to different aetiology of the chronic diseases, the patients may be required to consult several specialists. Owing to the multitude of chronic conditions, the management of polypharmacy can also be a challenge for the GPs and specialists (Garin et al., 2014,2016; Ioakeim-Skoufa et al., 2020; Marengoni et al., 2020). Other studies also highlighted the long-term consequences of being in the high morbidity class such, as incidence of disability (Zhou, 2022; Ronaldson et al., 2021).

In our study, we also identified the multimorbidity pattern that included *arthrosis/inflammatory/mental* conditions. Although it is still not entirely clear why these diseases co-occur and what the exact causes are, similar patterns were reported by several other studies (e.g., (Bayes-Marin et al., 2020; Bendayan et al., 2021; Garin et al., 2014,2016)). It has been suggested that severe pain, movement restriction, and psychological stress due to inflammatory diseases like arthrosis, may trigger the development of psychiatric disorders (Garin et al., 2016; He et al., 2008).

Further, *arthrosis/inflammatory/mental* class has been found to be characterized by a high proportion of women (Garin et al., 2014; Bendayan et al., 2021). Women are more likely than men to develop such diseases which might be due to female hormones promoting autoimmune responses, as a large body of evidence suggests (Medizinarium, n.d.; Weik, n.d.). Similar to other studies, the proportion of women was the highest in our analysis. This could be attributable to the higher prevalence of arthrosis and depression in women (Bendayan et al., 2021; Garin et al., 2014; Schäfer et al., 2012). Interestingly, similar to the study based on representative sample of UK older adults, we also found that the individuals in this class tend to be obese (Bendayan et al., 2021). It may be worth noting that previous research dealing with multimorbidity patterns also found such a class. More precisely, such a pattern was classified as 'mental-arthritis' in prior research (Bayes-Marin et al., 2020; Garin et al., 2014; Jovic et al., 2016). Similar findings were also reported by Olaya et al. (2017). A link between inflammatory diseases (Nerurkar et al., 2019) or arthrosis (Blümel et al., 2020) and mental health has also been shown in former research.

In our analysis, we also identified the well-established *hypertension-metabolic class*. Other studies, including a systematic review, showed that this pattern is most likely to be replicable across various populations and was identified in most studies of multimorbidity patterns (Busija et al., 2019; Lu et al., 2021; Ng et al., 2018). Due to shared aetiology, cardiovascular and metabolic disorders often occur together (Ronaldson et al., 2021). In line with other studies, in our study, the prevalence of hypertension and diabetes were much higher than the cohort average (Prados-Torres et al., 2014). Similarly, our class was also characterized by the high proportion of obese individuals. Particular attention should be paid to individuals in this cluster, as research showed, among other things, that individuals in this cluster are at highest risk of mortality (Zheng et al., 2021), and functional disability (Wang et al., 2021), compared to other clusters.

In contrast to earlier findings, in our analysis, we identified a *cardiovascular/cancer class*. To our knowledge, none of the studies addressing multimorbidity patterns identified this class. Nonetheless, some studies described certain related patterns, which included cancer e.g., the cardiovascular, malignant neoplasm, prostate class (Clerencia-Sierra et al., 2015), the complex cardio-metabolic disorders class with high prevalence of cancer (Larsen et al., 2017), the gastrointestinal diseases and cancer class (Kirchberger et al., 2012), or the sensory impairment/cancer class (Tazzeo et al., 2021). The differences in class membership may be due to the non-specific designation of cancer in those studies. In addition, these classes may include patients with the co-occurrence of heart diseases among cancer patients, or cardiovascular diseases that may result from cancer treatments. This inconsistency may also be due to the fact that cancer has not been included in many studies on multimorbidity patterns (Lu et al., 2021). We should acknowledge that a cardiovascular/cancer class was the smallest class in our study, representing approximately 1.7% of the cohort population. A cardiovascular/cancer class should be further explored in later studies.

With regard to gender differences, more women belonged to the arthrosis/inflammation/mental illness class compared to men. In contrast, more men than women belonged to the cardiovascular/cancer class. In regression analysis, gender differences were only apparent in one multimorbidity pattern. Namely, women, in comparison to men, had a higher risk of being in the arthrosis/inflammatory/mental illnesses class than in the relatively healthy class. These results might be explained in part by the higher prevalence of inflammatory arthritis among women in Germany (Schneider et al., 2006). Park et al. showed similar results, namely that women had an increased likelihood of membership in similar class to ours (the arthritis, asthma, allergy, depression, and thyroid disease class) (Park et al., 2019).

In summary, some patterns identified in our study share great similarities with other studies e.g., *a hypertension-metabolic class, an arthrosis/inflammatory/mental class* or *a high morbidity class.* This may indicate that the replicable multimorbidity patterns exists and some diseases tend to cluster together regardless of specific characteristics of the population studied. In addition, we also showed that some diseases, such as those included in the *cardiovascular/cancer class, high morbidity class* or *arthrosis/inflammation/mental illness class*, which did not seem to have a common aetiology, were grouped together in a multimorbidity pattern. This may suggest that discordant multimorbidity patterns exist. This is in line with other studies suggesting that chronic diseases that form specific multimorbidity pattern could be divided into concordant (same aetiology) and discordant patterns (no common aetiology) (Nguyen et al., 2020). It is important to investigate other risk factors and other exposures that may influence these disease patterns, and in particular in multimorbidity patterns without common aetiology.

4.3. Strengths and limitations

One of the main strengths of this analysis is the use of a large nationally representative sample of community-dwelling individuals. We captured a larger number of patients who do not adhere to certain prerequisites, such as belonging to a specific health insurance company, or specific facility e.g., only hospitalized patients. In addition, the use of LCA allowed further investigation of multimorbidity within the population, rather than relying solely on the number of chronic conditions. The study also has some limitations. The bias of self-reports and panel attrition should be mentioned. The chronic conditions and diseases which we used to identify multimorbidity patterns were restricted to the ones listed in the questionnaire. However, the individuals were asked to select the conditions that had been diagnosed by a physician. Individuals who died due to their illness were eliminated. Similar to other large nationally representative studies, a small sample selection bias has been detected in the DEAS study (Klaus et al., 2017).

5. Conclusions and future research

Using large, nationally representative data, we showed that the many chronic diseases cluster in non-random way. We identified five clinically significant multimorbidity patterns, namely the *relatively healthy class*, the *high morbidity class*, the *arthrosis/inflammatory/mental illnesses* class, the *hypertension-metabolic*, and the *cardiovascular/cancer* class. Furthermore, we have shown that depending on which multimorbidity pattern individuals belong to, they differ greatly in terms of socio-demographic factors, health behaviour, and lifestyle factors. Our study contributes to the better understanding of the patterns and epidemiology of multimorbidity in Germany. Multimorbidity is an important topic (also in Germany). Among other things, two key factors of preventing multimorbidity are (i) healthy lifestyle (e.g., frequent physical activity, not smoking, eating well) and (ii) using preventive healthcare services (e.g., cancer screening) (BMG, 2023). The German College of General Practitioners and Family Physicians (DEGAM) also stresses the importance of the "big picture" (rather than focusing on single diseases) in their guidelines referring to multimorbidity (DEGAM, 2017). According to their guidelines, patients should be encouraged to state their personal priorities (including in the areas of: maintaining social role and social activities; prevention of specific events; minimizing medication side effects; reducing the burden of treatments; prolonging life) (DEGAM, 2017).

Future research is recommended to determine how health care services should be tailored to the specific multimorbidity pattern of patients. For example, what specific interventions, such as preventive programmes, could be adopted to ensure that individuals do not develop many other chronic conditions and remain as long as possible in the relatively healthy group.

Person-centred care plans could be established and their continuity ensured. By doing so, marked increases in healthcare utilization and increases in healthcare costs as well as polypharmacy can be potentially reduced. Given the complex needs of patients suffering from multimorbidity, integrated care programs have been suggested (Lin et al., 2022). In this context, the coverage or reimbursement for patients with multimorbidity is a topic (Lin et al., 2022). A previous systematic guideline review and expert consensus (Muth et al., 2019) also dealt with the clinical management of patients with multimorbidity – and clearly highlighted major research deficits in this research area. This work highlighted the need of an integrated approach in fuigture guidelines (Muth et al., 2019).

As mentioned, women and men are very different biologically and in social behaviour (Gamper et al., 2019). For this reason, the differences between the sexes should be researched to ensure better prevention and treatment. Finally, future research should investigate how the health care system might be adapted to the needs of multimorbid patients.

In order to arrive at more uniform multimorbidity patterns in the future, a clear definition of multimorbidity or multimorbidity patterns should be considered. Uniform statistical methods, internationally accepted coding systems, and a broad range of diseases should be used. Similarly, uniform recruitment should be sought. The more uniform the specifications, the more overlap there will be between patterns. In the future, attention should be paid to the same methodological approach.

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CRediT authorship contribution statement

Massuma Amirzada: Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Visualization. **Elżbieta Buczak-Stec:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Visualization, Supervision. **Hans-Helmut König:** Writing –

review & editing. **André Hajek:** Writing – original draft, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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Appendix. Supplementary materials

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Recommended articles

References

Aubert et al., 2019 C.E. Aubert, *et al.*

Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: A multicentre cohort study

Swiss Medical Weekly, 149 (2019), p. w20094

View in Scopus Google Scholar

Aubert et al., 2020 C.E. Aubert, *et al.*

Patterns of multimorbidity in medical inpatients: A multinational retrospective cohort study

Internal and Emergency Medicine, 15 (7) (2020), pp. 1207-1217

CrossRef View in Scopus Google Scholar

Bayes-Marin et al., 2020 I. Bayes-Marin, *et al.*

Multimorbidity patterns in low-middle and high income regions: A multiregion latent class analysis using ATHLOS harmonised cohorts

BMJ open, 10 (7) (2020), Article e034441

CrossRef View in Scopus Google Scholar

Bendayan et al., 2021 R. Bendayan, *et al.*

Multimorbidity patterns and memory trajectories in older adults: Evidence from the English longitudinal study of aging

The Journals of Gerontology Series A Biological Sciences and Medical Sciences, 76 (5) (2021), pp. 867-875

CrossRef View in Scopus Google Scholar

Blümel et al., 2020 J.E. Blümel, *et al.*

Multimorbidity in a cohort of middle-aged women: Risk factors and disease clustering

Maturitas, 137 (2020), pp. 45-49

View PDF View article View in Scopus Google Scholar

BMG, 2023 BMG (2023). Gesundheitsförderung und Prävention für ältere Menschen. Available from: https://www.bundesgesundheitsministerium.de/praevention-aeltere-menschen.html.

Google Scholar

Buczak-Stec et al., 2022 E.W. Buczak-Stec, *et al.*

Factors contributing to persistent frequent attendance in primary care among the oldest old: Longitudinal evidence from the AgeCoDe-AgeQualiDe study

Frontiers in medicine, 9 (2022), Article 815419

View in Scopus Google Scholar

Busija et al., 2019 L. Busija, *et al.*

Do replicable profiles of multimorbidity exist? Systematic review and synthesis

European Journal of Epidemiology, 34 (11) (2019), pp. 1025-1053

CrossRef View in Scopus Google Scholar

Clerencia-Sierra et al., 2015 M. Clerencia-Sierra, *et al.*

Multimorbidity patterns in hospitalized older patients: Associations among chronic diseases and geriatric syndromes

PloS one, 10 (7) (2015), Article e0132909

CrossRef View in Scopus Google Scholar

DEGAM, 2017 DEGAM

Multimorbidität. S3-Leitlinie, DEGAM, Berlin (2017)

Google Scholar

Dong, Wressle and Marcusson, 2013 H.J. Dong, E. Wressle, J. Marcusson

Multimorbidity patterns of and use of health services by Swedish 85-year-olds: An exploratory study

BMC geriatrics, 13 (2013), p. 120

View in Scopus Google Scholar

Foguet-Boreu et al., 2015 Q. Foguet-Boreu, *et al.*

Multimorbidity patterns in elderly primary health care patients in a south Mediterranean European region: A cluster analysis

PloS one, 10 (11) (2015), Article e0141155

CrossRef View in Scopus Google Scholar

Formiga et al., 2013 F. Formiga, *et al.*

Patterns of comorbidity and multimorbidity in the oldest old: The octabaix study

European Journal of Internal Medicine, 24 (1) (2013), pp. 40-44

View PDF View article View in Scopus Google Scholar

Weik Weik, K. (n.d.). Rheuma verursacht stärkere Beschwerden bei Frauen. Available from:https://www.barmer.de/gesundheit-verstehen/mensch/ungleichbehandlung/rheuma-1071308.

Google Scholar

Gamper et al., 2019 Gampe, Markurs J.S., Kupfer, Annett, Keim-Klärner, Sylvia, & Klärner, Andreas (2019)Geschlecht und gesundheitliche ungleichheiten – Soziale netzwerke im kontext von gesundheit und gesundheitsverhalten.

Google Scholar

Garin et al., 2014 N. Garin, *et al.*

Multimorbidity patterns in a national representative sample of the Spanish adult population

PloS one, 9 (1) (2014), p. e84794

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Garin et al., 2016 N. Garin, *et al.*

Global multimorbidity patterns: A cross-sectional, population-based, multi-country study

The Journals of Gerontology Series A Biological Sciences and Medical Sciences, 71 (2) (2016), pp. 205-214

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Gellert et al., 2019 P. Gellert, *et al.*

Multimorbidity profiles in German Centenarians: A latent class analysis of health insurance data

Journal of Aging and Health, 31 (4) (2019), pp. 580-594

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

He et al., 2008 Y. He, *et al.*

Mental disorders among persons with arthritis: Results from the world mental health surveys

Psychological Medicine, 38 (11) (2008), pp. 1639-1650

View in Scopus ↗ Google Scholar ↗

Ioakeim-Skoufa et al., 2020 I. Ioakeim-Skoufa, *et al.*

Multimorbidity patterns in the general population: Results from the EpiChron cohort study

International Journal of Environmental Research and Public Health, 17 (12) (2020)

Google Scholar ↗

Jovic, Vukovic and Marinkovic, 2016 D. Jovic, D. Vukovic, J. Marinkovic

Prevalence and patterns of multi-morbidity in Serbian adults: A cross-sectional study

PloS one, 11 (2) (2016), Article e0148646

CrossRef ↗ Google Scholar ↗

Kirchberger et al., 2012 I. Kirchberger, *et al.*

Patterns of multimorbidity in the aged population. Results from the KORA-age study

PloS one, 7 (1) (2012), p. e30556

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Klaus et al., 2017 D. Klaus, *et al.*

Cohort profile: The German ageing survey (DEAS)

International journal of epidemiology, 46 (4) (2017), p. 1105

-1105g

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Lanza et al., 2015 S.T. Lanza, *et al.*

LCA stata plugin users' guide (Version 1.2). University Park: The methodology center

Penn State (2015)

Google Scholar ↗

Larsen et al., 2017 F.B. Larsen, *et al.*

A latent class analysis of multimorbidity and the relationship to socio-demographic factors and health-related quality of life. A national population-based study of 162,283 Danish Adults
PloS one, 12 (1) (2017), Article e0169426
CrossRef Google Scholar

Lenzi et al., 2016 J. Lenzi, *et al.*
Burden of multimorbidity in relation to age, gender and immigrant status: A cross-sectional study based on administrative data
BMJ open, 6 (12) (2016), Article e012812
CrossRef View in Scopus Google Scholar

Lin et al., 2022 J. Lin, *et al.*
Integrated care for multimorbidity population in Asian countries: A scoping review
International journal of integrated care, 22 (1) (2022), p. 22
Google Scholar

Lu et al., 2021 J. Lu, *et al.*
Multimorbidity patterns in old adults and their associated multi-layered factors: A cross-sectional study
BMC Geriatrics, 21 (1) (2021), p. 372
CrossRef Google Scholar

Marengoni et al., 2009 A. Marengoni, *et al.*
Patterns of chronic multimorbidity in the elderly population
Journal of the American Geriatrics Society, 57 (2) (2009), pp. 225-230
CrossRef View in Scopus Google Scholar

Marengoni et al., 2020 A. Marengoni, *et al.*
Patterns of multimorbidity in a population-based cohort of older people: Sociodemographic, lifestyle, clinical, and functional differences
Journals of Gerontology Series A, Biological sciences and medical sciences, 75 (4) (2020), pp. 798-805
View in Scopus Google Scholar

Medizinarium Medizinarium (n.d.). Rheuma: Frauen häufiger betroffen, aber schlechter versorgt. Available from: https://medizinarium.de/artikel/diagnose/Frauengesundheit/20_10_frauen_rheuma.php.
Google Scholar

Muth et al., 2019 C. Muth, *et al.*
Evidence supporting the best clinical management of patients with multimorbidity and polypharmacy: A systematic guideline review and expert consensus
Journal of Internal Medicine, 285 (3) (2019), pp. 272-288
View in Scopus Google Scholar

Nerurkar et al., 2019 L. Nerurkar, *et al.*
Rheumatoid arthritis and depression: An inflammatory perspective
The Lancet Psychiatry, 6 (2) (2019), pp. 164-173
View PDF View article View in Scopus Google Scholar

Ng et al., 2018 S.K. Ng, *et al.*

Patterns of multimorbid health conditions: A systematic review of analytical methods and comparison analysis

International Journal of Epidemiology, 47 (5) (2018), pp. 1687-1704

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Nguyen et al., 2020 H. Nguyen, *et al.*

Factors associated with multimorbidity patterns in older adults in England: Findings from the English longitudinal study of aging (ELSA)

Journal of Aging and Health, 32 (9) (2020), pp. 1120-1132

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Nylund, Asparouhov and Muthén, 2007 K.L. Nylund, T. Asparouhov, B.O. Muthén

Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study

Structural Equation Modeling: A Multidisciplinary Journal, 14 (4) (2007), pp. 535-569

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Nylund-Gibson, 2018 Karen Nylund-Gibso

Ten frequently asked questions about latent class analysis

D.o.E., University of California, Santa Barbara; Andrew Young Choi, Department of Counseling, Clinical, and School Psychology, University of California, Santa Barbara (2018)

Google Scholar ↗

Olaya et al., 2017 B. Olaya, *et al.*

Latent class analysis of multimorbidity patterns and associated outcomes in Spanish older adults: A prospective cohort study

BMC Geriatrics, 17 (1) (2017), p. 186

View in Scopus ↗ Google Scholar ↗

Park, Lee and Park, 2019 B. Park, H.A. Lee, H. Park

Use of latent class analysis to identify multimorbidity patterns and associated factors in Korean adults aged 50 years and older

PloS one, 14 (11) (2019), Article e0216259

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Prados-Torres et al., 2014 A. Prados-Torres, *et al.*

Multimorbidity patterns: A systematic review

Journal of Clinical Epidemiology, 67 (3) (2014), pp. 254-266

View PDF View article View in Scopus ↗ Google Scholar ↗

Prazeres and Santiago, 2015 F. Prazeres, L. Santiago

Prevalence of multimorbidity in the adult population attending primary care in Portugal: A cross-sectional study

BMJ open, 5 (9) (2015), Article e009287

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Ronaldson et al., 2021 A. Ronaldson, *et al.*

Associations between physical multimorbidity patterns and common mental health disorders in middle-aged adults: A prospective analysis using data from the UK Biobank
The Lancet Regional Health - Europe, 8 (2021), Article 100149
View PDF View article View in Scopus Google Scholar

Schäfer et al., 2012 I. Schäfer, *et al.*
The influence of age, gender and socio-economic status on multimorbidity patterns in primary care. First results from the multicare cohort study
BMC Health Services Research, 12 (1) (2012), p. 89
View in Scopus Google Scholar

Schneider, Schmitt and Richter, 2006 S. Schneider, G. Schmitt, W. Richter
Prevalence and correlates of inflammatory arthritis in Germany: Data from the first national health survey
Rheumatology International, 27 (1) (2006), pp. 29-38
CrossRef View in Scopus Google Scholar

Tazzeo et al., 2021 C. Tazzeo, *et al.*
Multimorbidity patterns and risk of frailty in older community-dwelling adults: A population-based cohort study
Age and Ageing, 50 (6) (2021), pp. 2183-2191
CrossRef View in Scopus Google Scholar

van den Bussche et al., 2011 H. van den Bussche, *et al.*
Which chronic diseases and disease combinations are specific to multimorbidity in the elderly? Results of a claims data based cross-sectional study in Germany, 11, BMC Public Health (2011), p. 101
View in Scopus

Violán et al., 2019 C. Violán, *et al.*
Soft clustering using real-world data for the identification of multimorbidity patterns in an elderly population: Cross-sectional study in a Mediterranean population
BMJ open, 9 (8) (2019), Article e029594
CrossRef View in Scopus Google Scholar

Wang et al., 2021 Z. Wang, *et al.*
Association between multimorbidity patterns and disability among older people covered by long-term care insurance in Shanghai, China, 21, BMC Public Health (2021), p. 418

Weller, Bowen and Faubert, 2020 B.E. Weller, N.K. Bowen, S.J. Faubert
Latent class analysis: A guide to best practice
Journal of Black Psychology, 46 (4) (2020), pp. 287-311
CrossRef View in Scopus Google Scholar

Whitson et al., 2016 H.E. Whitson, *et al.*
Identifying patterns of multimorbidity in older Americans: Application of latent class analysis
Journal of the American Geriatrics Society, 64 (8) (2016), pp. 1668-1673
CrossRef View in Scopus Google Scholar

Zemedikun et al., 2018 D.T. Zemedikun, *et al.*

Patterns of multimorbidity in middle-aged and older adults: An analysis of the UK biobank data

Mayo Clinic Proceedings, 93 (7) (2018), pp. 857-866

View PDF View article View in Scopus Google Scholar

Zheng et al., 2021 D.D. Zheng, *et al.*

Multimorbidity patterns and their relationship to mortality in the US older adult population

PloS one, 16 (1) (2021), Article e0245053

CrossRef Google Scholar

Zhou, 2022 J. Zhou, *et al.*

Association of multimorbidity patterns with incident disability and recovery of independence among middle-aged and older adults

Age and Ageing, 51 (8) (2022), p. afac177

View in Scopus Google Scholar

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View Abstract

1. Zusammenfassung

Ziel: Das Ziel dieser Studie ist es, Muster der Multimorbidität in Deutschland zu identifizieren und zu beschreiben. Darüber hinaus sollen mögliche geschlechtsspezifische Unterschiede in den Multimortalitätsmustern herausgearbeitet werden.

Methoden: Hierfür wurden Daten der sechsten Welle (2017) des bundesweit repräsentativen Deutschen Alterssurveys (DEAS) analysiert, insgesamt n = 6.554 Teilnehmer. Das Durchschnittsalter beträgt 62,0 Jahre. Das Multimorbiditätsmuster wurde anhand von 13 chronischen Erkrankungen mittels der latenten Klassenanalyse ermittelt. Wir definierten Multimorbidität als das gleichzeitige Auftreten von mindestens zwei chronischen Erkrankungen.

Ergebnisse: Es wurden fünf Formen der Multimorbidität identifiziert und klinisch beschrieben:
Die „relativ gesunde Klasse“ (45,1 %), „die Klasse mit hoher Morbidität“ (10,8 %), „die Klasse der Arthrose-/Entzündungs-/psychischen Krankheiten“ (20,6%),“die Klasse der Bluthochdruck-Stoffwechselkrankheiten“ (21,7 %), und „die Klasse der Herz-Kreislauf-/Krebserkrankungen“ (1,7 %). Im Vergleich zu einer relativ gesunden Gruppe hat die Analyse gezeigt, dass Frauen im Vergleich zu Männern ein höheres relatives Risiko (IRR = 1,61, 95 % KI 1,25–2,06) haben, zur Klasse der „Arthrose/Entzündungen/psychischen Krankheiten“ zu gehören.
Darüber hinaus wurde festgestellt, dass sich die einzelnen Personen aufgrund des Multimorbiditätsclusters maßgeblich in Bezug auf soziodemografische Faktoren, Gesundheitsverhalten und Lebensstil unterschieden.

Fazit: Die Multimorbidität ist ein wichtiges Thema, das in Zukunft weiterer Forschung bedarf. Darüber hinaus sollten künftige Forschungen nicht nur chronische Krankheiten, sondern auch Lebensstil, soziodemografische Faktoren, Gesundheitsverhalten und das Geschlecht stärker berücksichtigen.

Abstract

Aim: The aim of our study is to identify and describe patterns of multimorbidity in Germany. In addition, we aim to identify possible gender differences in multimorbidity patterns.

Methods: We analyzed data from the sixth wave (2017) of the nationally representative German Ageing Survey (DEAS). Total n = 6,554 participants. The mean age was 62.0 years. The multimorbidity pattern was determined by 13 chronic diseases using latent class analysis. We defined multimorbidity as the presence of at least two chronic conditions.

Results: We identified and clinically described five forms of multimorbidity: the relatively healthy class (45.1%), the high morbidity class (10.8%), the arthrosis/inflammatory/mental illnesses class (20.6%), the hypertension-metabolic illness class (21.7%), and the cardiovascular/cancer class (1.7%). Our analysis shows that women have a higher relative risk (IRR = 1.61, 95% CI 1.25-2.06) of belonging to the arthrosis/inflammatory/mental illnesses class disease compared with men, compared with a relatively healthy group.

In addition, we found that individuals differed significantly in terms of sociodemographic factors, health behaviors, and lifestyle because of the multimorbidity cluster.

Conclusion: Multimorbidity is an important topic that needs further research in the future. In addition, future research should consider not only chronic diseases but also lifestyle, sociodemographic factors, health behaviors, and gender.

2. Einleitung

Die Multimorbidität ist ein wachsendes Phänomen, das verschiedene chronische Krankheiten umfasst. Die Lebenserwartung hat sich seit dem 19. Jahrhundert mehr als verdoppelt [1]. Es wird prognostiziert, dass dies in den kommenden Jahrzehnten dazu führen wird, dass immer mehr Menschen an Multimorbidität leiden werden. Der Hauptgrund des Älterwerdens liegt in der Forschung [2] und Entwicklung zur Behandlung und Prävention klassischer Alterserkrankungen wie zum Beispiel Herz-Kreislauf-Erkrankungen [3]. Die Folge ist eine hohe Einnahme von Medikamenten, die dazu führt, dass sich die Nebenwirkungen und unerwünschten

Wechselwirkungen erhöhen [4]. Dies resultiert nicht nur in einem starken Anstieg der Inanspruchnahme der Gesundheitsversorgung [5] und der damit verbundenen Gesundheitskosten [6], sondern hat zugleich große Auswirkungen auf die tägliche klinische Praxis aufgrund nicht konformer Leitlinien. Die Behandlungsmethoden unterscheiden sich je nach Krankheitsbild, was die Behandlung erschwert [4,7].

Wie aus früheren Studien bekannt ist, treten Krankheiten nicht zufällig auf, sondern folgen bestimmten Mustern. Daher ist es wichtig, zu untersuchen, wie sich Krankheiten in Multimorbiditätsmustern zusammenschließen und ob es gemeinsame Krankheitsmechanismen gibt.

In Deutschland wurden bisher nur drei vergleichbare Studien durchgeführt, was die Dringlichkeit weiterer Studien noch einmal unterstreicht. Die erste Studie [8], die 2011 von van de Bussche et al. durchgeführt wurde, basiert auf Daten von Versicherten, die älter als 65 Jahren waren. Die Querschnittsstudie umfasste n = 123.244 Patienten. Diese wurden als multimorbid eingestuft, wenn sie an drei oder mehr Krankheiten litten. Das Krankheitsspektrum der Multimorbiditätsstichprobe umfasste sechs Einzelerkrankungen.

Die Daten der zweiten Studie stammen aus dem bevölkerungsbasierten Projekt KOR-Age-Studie [9] aus dem Jahr 2012. Die Stichprobe umfasste n = 4.127 Personen im Alter von 65 bis 94 Jahren. Eingeschlossen wurden Personen aus der Stadt Augsburg und angrenzender Landkreise in Süddeutschland. Die Multimorbidität wurde als das gleichzeitige Auftreten von zwei oder mehr Erkrankungen definiert. Die Studie ergab vier Multimorbiditätscluster.

Die dritte deutsche Studie basierte auf Daten der MultiCare-Kohortenstudie aus dem Jahr 2012. An der Studie nahmen n = 3.189 Patienten im Alter von 65 Jahren teil. Die an der Studie teilnehmenden Patienten wurden zufällig aus 158 Hausarztpraxen ausgewählt. Es wurden zwei Cluster evaluiert.

Die bisher erzielten Ergebnisse lassen sich nicht auf die gesamte deutsche Bevölkerung übertragen.

Im Gegensatz dazu basiert die vorliegende Studie auf einer großen, bundesweit repräsentativen Stichprobe von 40-Jährigen und Älteren aus ganz Deutschland, sodass sie auf Erwachsene mittleren und höheren Alters, die in deutschen Haushalten leben, verallgemeinert werden kann.

Außerdem wurde die Hypothese aufgestellt, dass es auf der Grundlage einiger früheren Studien Unterschiede in den Mustern der Multimorbidität geben würde. Dong et al. (2013) und Schäfer et. (2012) konnten jeweils in ihrer Studie relative Unterschiede in den Multimorbiditätsmustern zwischen Frauen und Männern aufzeigen. Dies liegt daran, dass sich die Geschlechter sowohl biologisch als auch im sozialen Verhalten unterscheiden. Erklärt werden soll dies an einem klinischen Beispiel. Nicht jeder Herzinfarkt ist gleich – es gibt deutliche Unterschiede zwischen den Geschlechtern. Diese betreffen nicht nur die Ätiologie, klinische Symptomatik, sondern auch die Diagnostik. Bei Männern tritt die Erkrankung im Schnitt 10 Jahre früher auf als bei Frauen [10, 11]. Ebenso kommt es bei Männern häufiger zu schweren Veränderungen der großen Blutgefäße (Atherosklerose), die bei den Frauen meist mit milderen Veränderungen einhergehen. Diese unterschiedlichen Mechanismen entsprechen unterschiedlichen Symptomen. Die Männer zeigten typische Herzinfarktsymptome, Brustschmerzen, die in den linken Arm ausstrahlen. Im Gegensatz dazu neigen Frauen zu unspezifischen Symptomen wie Schmerzen im Oberbauch oder Schmerzen im Unterkiefer. Aufgrund dieser unterschiedlichen Symptome werden die Diagnoseergebnisse unterschiedlich interpretiert und behandelt. Daher ist es wichtig, in zukünftigen Studien geschlechtsspezifische Unterschiede im Zusammenhang mit Multimorbidität zu untersuchen.

Ziel der Studie ist es, Muster von Multimorbidität in Deutschland zu identifizieren und zu beschreiben. Darüber hinaus sollen mögliche geschlechtsspezifische Unterschiede in den Multimortalitätsmustern herausgearbeitet werden. Die bisherigen Ergebnisse können nicht auf die gesamte deutsche 40-jährige Bevölkerung übertragen werden, die sie sich auf bestimmte Regionen oder Patienten aus bestimmten Institutionen beschränkten. Stattdessen umfasst die aktuelle Studie 6.226 Personen ab 40 Jahren aus verschiedenen Teilen Deutschlands (also eine bundesweit repräsentative Stichprobe). Somit kann sie auf Erwachsene mittleren und höheren Lebensalters übertragen werden, die in

Haushalten in Deutschland leben. Die aus dieser Studie gewonnenen Erkenntnisse können als Grundlage für zukünftige Forschungen in diesem bedeutsamen Bereich dienen.

Multimorbidität

In einer alternden Gesellschaft gewinnt die Multimorbidität zunehmend an Bedeutung. Die Definition von Multimorbidität ist nicht einheitlich festgelegt. Multimorbidität wird als das gleichzeitige Auftreten von einer [12] oder mehreren [13, 14] Krankheiten in einer Person definiert. Ein Multimorbiditätsmuster beschreibt das gleichzeitige Auftreten mehrerer Krankheiten bei ein und derselben Person. Die meisten Autoren definieren sie nicht direkt, sondern spezifizieren sie mithilfe verschiedener Analysemethoden [8, 14-16]. Im Gegensatz dazu beschreiben andere Autoren die Multimorbiditätsmuster „als nicht zufällig assoziierte Krankheiten" [12, 17].

Auch die Prävalenz ist schwer zu ermitteln, da die zuvor angeführte Definition von Multimorbidität vage ist, insbesondere im Hinblick auf die Krankheitsauswahl. Das macht einen großen Unterschied in der Prävalenz. Basierend auf bisher veröffentlichten Daten kann von einer Prävalenzrate zwischen 55 % und 98 % ausgegangen werden [18, 19].

Multimorbidität stellt ein großes Hindernis für Patienten, behandelnde Ärzte, Pflegepersonal und das Gesundheitssysteme dar. Für Patienten bedeutet Multimorbidität eine Einschränkung und eine Verringerung der Lebensqualität [6]. Die Behandlung von multimorbiden Patienten ist für behandelnde Ärzte schwierig, da es keine leitlinienkonformen Behandlungsmöglichkeiten gibt. Eine leitlinienbasierte Behandlung ist nicht immer möglich, da diese auf eine Erkrankung konzepiert ist. Multimorbide Patienten müssen aufgrund ihrer multiplen Erkrankungen unterschiedliche Fachärzte konsultieren. Dies führt zu einer starken Steigerung der Inanspruchnahme der Gesundheitsversorgung und höheren Gesundheitskosten. [6].

3. Methoden

3.1 Studiendesign und Teilnehmer

Diese Forschung basiert auf Daten aus Welle 6 des Deutschen Alterssurveys (DEAS) aus dem Jahr 2017. Die repräsentativen Querschnitts- und Längsschnittstudien des DEAS werden bundesweit durchgeführt und umfassen mehrere tausend Menschen über 40 Jahre.
Verwendet wurden die Daten der sechsten Welle. Die Stichprobengröße betrug n = 6.626 im Alter von 43–97 Jahren. Die Teilnehmer der Studie wurden zu verschiedenen Bereichen ihres Lebens befragt.
Die Befragung bestand aus einem persönlichen Interview und einem Fragebogen (*drop-off*). Anschließend wurde ein Lungenfunktionstest durchgeführt und die kognitiven Fähigkeiten überprüft.

Eine schriftliche Zustimmung seitens der Teilnehmer erfolgte vor Durchführung der Interviews. Ein Ethik-Votum für die DEAS-Studie war gemäß den DFG-Richtlinien nicht notwendig (die fehlende Notwendigkeit wurde auch vom ständigen Beirat des DEAS bestätigt).

3.2 Multimorbiditätsmuster

Den Teilnehmern wurde eine Liste mit neunzehn verschiedenen Krankheiten ausgehändigt, und sie wurden gefragt, ob bei ihnen jemals eine der auf der Liste aufgeführten Krankheiten von einem Arzt diagnostiziert worden ist. Die Auswahl der Krankheiten erfolgte auf der Grundlage des Federal Health Survey, des Charlson-Komorbiditätsindex und zusätzlicher Konsultationen mit drei Geriatern. Auf dieser Befragung basiert die Bewertung von Multimorbidität und Multimorbiditätsmustern.
In der Studie wurden Erkrankungen mit einer Prävalenz von mehr als 5 % eingeschlossen. Personen, die über zwei oder mehr chronische Erkrankungen berichteten, wurden basierend auf der Definition früherer Studien als multimorbid eingestuft.

3.3 Statistische Analyse

Es wurde sich für die latente Klassenanalyse (LCA) [7, 16, 17] entschieden. Dies ist eine Methode, die häufig gegenüber klassischen Methoden der Clusteranalyse favorisiert wird, bei denen nur wenige Attribute bzw. Attributausprägungen zur Verfügung stehen [20]. Zunächst wurden 5 latente Klassen anhand chronischer Erkrankungen ermittelt.
Nachdem die Anzahl der latenten Klassen bestimmt worden war, wurde jedes Individuum in der Stichprobe auf der Grundlage der höchsten A-posteriori-Wahrscheinlichkeit seiner Klasse zugeordnet.

Darüber hinaus wurde die LCA erweitert, um soziodemografische Variablen zu berücksichtigen und geschlechtsspezifische Unterschiede in der Klassenzugehörigkeit zu identifizieren.

4. Ergebnisse

4.1 Merkmale der Stichprobe

Insgesamt wurden 6.554 Personen in die analytische Stichprobe einbezogen. Frauen waren mit 49,3 % und Männer mit 50,7 % vertreten. Das Durchschnittsalter betrug 62,0 Jahre (SD: 12,0 Jahren, 43–92 Jahren). In der Gesamtstichprobe waren 54,9 % Frauen und 51,1 % Männer multimorbid. Somit betrug die Prävalenz der Multimorbidität in der gesamten Stichprobe 53,3 %. Die durchschnittliche Zahl chronischer Erkrankungen lag bei 2,0 (SD: 1.8).

4.2 Multimorbiditätsmuster

Insgesamt wurden 5 Multimorbiditätsklassen identifiziert. Die Klassen werden nach der höchsten Inzidenz benannt und basieren auf bisherigen Studien.

Klasse 1 („relativ gesund”) umfasste 45,1 % (n = 2883) der gesamten Stichprobe. Diese Klasse bestand größtenteils aus gesunden Personen, die jünger als der

Gruppendurchschnitt waren und nur 0,7 chronische Krankheiten hatten. Es bestand eine vergleichbare Geschlechterverteilung.

Die Klasse 2 wurde als die „Klasse mit hoher Morbidität" bezeichnet, da die Prävalenz aller Erkrankungen und die Multimorbidität am höchsten war. In diesem Muster bestand eine leichte geschlechtsspezifische Tendenz. Es waren 15,6 % (n = 772) mehr Frauen vertreten.

Die „Arthrose/Entzündung/ Psychische Störungen" umfassen die **dritte Klasse** (n = 1154). In dieser Gruppe hatten die Personen im Durchschnitt 2,9 chronische Erkrankungen. Die Inzidenz von Arthrose, Entzündungen, Bluthochdruck, hohem Cholesterinspiegel und psychischen Erkrankungen war höher als im Kohortendurchschnitt. Die Klasse bestand überwiegend aus Frauen (65 %).

In der **Klasse 4** („metabolische Hypertonie") traten Bluthochdruck (78,4 %), Hypercholesterinämie (39,4 %) und Diabetes (24,2 %) häufiger auf. Es waren 7,8 % (n = 1.154) mehr Männer vertreten.

In der Klasse 5 („Herz-Kreislauf/Krebs") gaben die meisten Patienten an, einen Herzinfarkt oder eine Angina pectoris gehabt zu haben, und 45,1 % berichteten, an Herzinsuffizienz zu leiden. Im Vergleich zu den anderen Klassen weist diese Klasse den höchsten Männeranteil auf.

Hinsichtlich der geschlechtsspezifischen Unterschiede zeigte die Analyse, dass Frauen im Vergleich zu Männern ein höheres relatives Risiko (IRR = 1,61, 95 %-KI 1,25–2,06) haben, an Arthrose/Entzündung/ Psychische Störungen zu erkranken. In den übrigen Klassen war der Unterschied zwischen den Geschlechtern statistisch nicht signifikant.

5. Diskussion

Es wurden fünf klinisch signifikante Multimorbiditätsklassen identifiziert (relativ gesund, Klasse mit hoher Morbidität, Arthrose/Entzündung/ Psychische Störungen, Bluthochdruck-Stoffwechselstörungen, Kardiovaskulär/Krebs). Darüber hinaus konnten Geschlechterunterschiede innerhalb einer Klasse (Arthrose/Entzündung/ Psychische Störungen) nachgewiesen werden, in der Frauen einem höheren Risiko ausgesetzt waren. Im Gegensatz zu früheren Studien umfasste die aktuelle Studie in ganz Deutschland lebende Personen im Alter von 40 Jahren und älter. Die Studie

ist daher auf Menschen mittleren und höheren Lebensalters übertragbar, die in Privathaushalten in Deutschland leben. Darüber hinaus konnte eine Gruppe „Kardiovaskulär/Krebs“ identifiziert werden, die in keiner früheren Studie auftrat.

5.2 Multimorbiditätsmuster

Es konnte auch, wie andere Studien [16, 17], eine „relativ gesunde“ Klasse aufgezeigt werden, die überwiegend aus jungen Menschen mit hohem Bildungsniveau und sportlichen Fähigkeiten bestand. Dies ließ erkennen, dass Multimorbidität nicht nur mit dem Alter zusammenhängt, sondern ebenso mit dem sozioökonomischen Status [18].

Darüber hinaus lässt sich die hohe Multimorbidität der Klasse 2 („Klasse mit hoher Morbidität“) erklären. Die Mehrheit hatte einen niedrigen Bildungsstand, war entweder im Ruhestand oder nicht erwerbstätig und wies eine hohe Adipositasrate auf. Aufgrund des geringen Bildungsstandes und der Nicht-Erwerbstätigkeit führt dies zu einer Fehlernährung und einem Bewegungsmangel. Daraus resultiert wiederum eine Mangelernährung und eine erhöhte Fettleibigkeitsrate. Dies bedeutet, dass diese Menschen einem hohen Risiko für andere Krankheiten ausgesetzt sind [21]. Ferner verursachen die Nebenwirkungen einiger Medikamente andere unerwünschte Krankheiten [4] – so zum Beispiel die Koronare-Herzkrankheit. Den Leitlinien [22] zufolge wird diese mit Antikoagulanzien, Statinen, Betablockern und ACE-Hemmern behandelt. Jedes dieser Medikamente hat eine lange Liste von Nebenwirkungen. Aus diesen resultieren unterschiedliche weitere Erkrankungen, was auch die nicht kausale Clusterbildung erklärt.

Die geschlechtsspezifischen Unterschiede wurden in der Gruppe „Arthrose/Entzündung/psychische Erkrankung“ (Klasse 3) hervorgehoben. In dieser Gruppe gibt es einen hohen Frauenanteil. Dies ist durchaus auf die Ätiologie der einzelnen Krankheiten zurückzuführen. Wie in der Fachliteratur oft erwähnt [23, 24], leiden immer mehr Frauen an Arthrose. Dies ist wahrscheinlich auf die biologischen Eigenschaften von Frauen zurückzuführen. Frauen erleben in ihrem Leben häufig hormonelle Veränderungen und sind daher immer dem Risiko ausgesetzt, Krankheiten zu entwickeln, die einen hormonellen Ursprung aufweisen.

Außerdem konnte ein Zusammenhang zwischen Bluthochdruck und Stoffwechselstörungen nachwiesen werden, der sowohl in der Literatur als auch in früheren Studien [20, 25, 26] festgestellt wurde. Diese Klasse ist in der Tat durch die Ätiologie der beiden Erkrankungen erklärbar.

Es konnte die Klasse 5 („Kardiovaskulär/Krebs“) identifiziert werden, die in keiner anderen Studie nachgewiesen wurde. Auffällig ist, dass in dieser Klasse nicht nur aus der Literatur und anderen Studien [17, 27] bekannte Krankheiten mit gleicher Ätiologie, wie Herzkreislauferkrankungen, in einer Gruppe zusammengefasst, sondern auch Krebserkrankungen aufgeführt werden. Dieser Zusammenhang lässt sich möglicherweise dadurch erklären, dass Herz-Kreislauf-Erkrankungen eher ältere Menschen betreffen und Krebs auch das Ergebnis einer kontinuierlichen Zellteilung ist. Mit zunehmendem Alter kommt es sodann häufiger zu Zellteilungen, und das Risiko einer Degeneration steigt. Diese Gruppe sollte in Zukunft Gegenstand weiterer Forschung sein.

Zusammenfassend lässt sich sagen, dass das Multimorbiditätscluster nicht nur Erkrankungen mit gleicher Ursache und ein hohes Alter einbezieht, sondern zugleich Erkrankungen mit unterschiedlichen Ursachen, soziodemografischen Faktoren, Gesundheitsverhalten und Lebensstilen kombiniert.

5.3 Stärken und Einschränkungen

Eine große Stärke dieser Analyse ist die Verwendung einer großen, landesweit repräsentativen Stichprobe von zu Hause lebenden Personen. Die Studie umfasste n = 6.554 Personen aus ganz Deutschland. Darüber hinaus wurden nicht nur Menschen ab 60 Jahren in der Studie einbezogen, sondern ebenso Menschen ab 40 Jahren. Eine weitere Stärke der Studie besteht darin, dass sie nicht auf bestimmte Organisationen beschränkt ist, sondern das gesamte Land umfasst. Die durchgeführte Forschung hat jedoch auch gewisse Schwächen oder Einschränkungen aufgedeckt. Erwähnenswert ist die Verzerrung, die durch die Beteiligung von Menschen entsteht, die noch aktiv am Leben teilnehmen. Sie leben zu Hause, und die meisten können für sich selbst sorgen. Darüber hinaus wurden

Daten aus dem Jahr 2017 verwendet, es ist jedoch unwahrscheinlich, dass es in den letzten Jahren zu wesentlichen Veränderungen gekommen ist. Eine wichtige Gruppe oder Institution konnte aus Gründen der Datenverfügbarkeit nicht untersucht werden: Menschen, die in Pflegeheimen oder Seniorenheimen leben. Ebenso Patienten, die aufgrund chronischer Erkrankungen länger im Krankenhaus bleiben müssen. Die Pflegeheime beherbergen viele multimorbide Patienten. Darüber hinaus wurden 13 Krankheiten berücksichtigt, die jeweils von einem Arzt diagnostiziert worden sind. Es sind insbesondere neurologische Erkrankungen wie Demenz, die häufig bei älteren Menschen auftreten, vernachlässigt worden. Ebenso bestehen in der DEAS-Studie gewisse Selektionseffekte. Ferner ist eine moderate Attrition in der DEAS-Studie zu beobachten. Insofern sind die gewonnenen Ergebnisse vermutlich nicht auf z. B. schwerkranke zu Hause lebende Individuen generalisierbar.

6. Schlussfolgerung und zukünftige Forschung

Es wurden fünf klinisch bedeutsame Muster der Multimorbidität identifiziert und gezeigt, dass viele chronische Krankheiten nicht zufällig gehäuft auftraten. Darüber hinaus konnte festgestellt werden, dass soziodemografische Faktoren, Gesundheitsverhalten und Lebensstile offenbar darüber entscheiden, welcher Gruppe die Personen angehören. Die Studie trägt somit zu einem besseren Verständnis der Muster und Epidemiologie der Multimorbidität in Deutschland bei.

Im klinischen Alltag stellt die Multimorbidität weiterhin eine große Herausforderung dar: In akuten Situationen muss stets darüber nachgedacht werden, welche Krankheit behandelt werden muss, was dazu führt, dass weitere Erkrankungen oder die Verschlechterung eines anderen Organs (z. B. Niere) akzeptiert werden. Es ist wichtig, weitere Forschungsarbeiten durchzuführen, um Präventionsmethoden und Leitlinien zu entwickeln, die auf Multimorbidität zugeschnitten sind und diesen Herausforderungen genau begegnen. Es gibt bereits einige vorbeugende Maßnahmen wie das Disease-Management-Programm. Dabei handelt es sich um strukturierte Behandlungsprogramme für Menschen mit chronischen Erkrankungen, die auf evidenzbasierter Medizin basieren. Jedoch sind diese auf 6 Krankheiten beschränkt (Asthma, Chronisch Obstruktive Lungenerkrankung, Brustkrebs,

Diabetes mellitus Typ 1, Diabetes mellitus Typ 2, Koronare Herzkrankheit). Darüber hinaus ist eine hohe Patientencompliance erforderlich, die bei manchen älteren Patienten nicht erreicht wird. Deshalb sind individuell anwendbare Leitlinien und Präventionsmaßnahmen erforderlich.

Bekanntermaßen ist Multimorbidität ein wichtiges Thema, das in Zukunft weiterer Forschung bedarf. Die untersuchten Muster sollten künftig weiter erforscht werden, um mehr Erkenntnisse über die Bedürfnisse von multimorbiden Patienten zu erlangen und somit die notwenigen Leitlinien zu gestalten. Es sollten zusätzliche Studien durchgeführt werden, um die Multimorbidität als auch die Multimorbiditätscluster einheitlicher definieren zu können. Einheitliche statistische Methoden, international akzeptierte Kodierungssysteme und eine große Auswahl an Krankheiten sollten verwendet werden. Ebenfalls sollte eine einheitliche Rekrutierung angestrebt werden – je mehr einheitliche Vorgaben, desto mehr Überschneidungen der einzelnen Muster. Darüber hinaus sollten künftige Forschungen nicht nur chronische Krankheiten, sondern auch Lebensstil, soziodemografische Faktoren, Gesundheitsverhalten und das Geschlecht stärker berücksichtigen, die mit Multimorbiditätsmustern assoziiert sind.

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9. Literaturverzeichnis

1. (Destatis), S.B. *Lebenserwartung und Sterblichkeit.https://www.destatis.de/DE/Themen/Querschnitt/Demografischer-Wandel/Aspekte/demografie-lebenserwartung.html.2023*. 2023.
2. Wissen, F.u., *Steigende Lebenserwartung. Warum die Menschen immer älter werden.2020. https://www.forschung-und-wissen.de/nachrichten/medizin/warum-die-menschen-immer-aelter-werden-13373969*. 2020.
3. Reiff, S. *Steigende Lebenserwartung: Die Menschen werden immer älter*. 2017; Available from: https://www.alumniportal-deutschland.org/de/magazin/the-global-goals-powered-by-alumni/ziel-3-gesundheit-und-wohlergehen/die-lebenserwartung-der-menschen-steigt-weltweit.
4. Zeeh, D.M.J., *Des Guten zu viel ? . MMW - Fortschritte der Medizin 154 , 46–50 (2012). https://doi.org/10.1007/s15006-012-1599-5*. Springer, 2012.
5. Buczak-Stec EW, H.A., van den Bussche H, Eisele M, Oey A, Wiese B, Weyerer S, Werle J, Fuchs A, Pentzek M, Luppa M, Löbner M, Weeg D, Mösch E, Heser K, Wagner M, Riedel-Heller SG, Maier W, Scherer M, König HH., *Factors Contributing to Persistent Frequent Attendance in Primary Care Among the Oldest Old: Longitudinal Evidence From the AgeCoDe-AgeQualiDe Study. Front Med (Lausanne). 2022 Mar 21;9:815419. doi: 10.3389/fmed.2022.815419. PMID: 35386909; PMCID: PMC8977578.*
6. Aubert, C.E., Fankhauser, N., Marques-Vidal, P., Stirnemann, J., Aujesky, D., Limacher, A., & Donzé, J. (2019). *Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: a multicentre cohort study. Swiss Med Wkly, 149 , w20094. doi:10.4414/smw.2019.20094*.
7. Olaya, B., Moneta, M.V., Caballero, F. *et al.*, *Latent class analysis of multimorbidity patterns and associated outcomes in Spanish older adults: a prospective cohort study. BMC Geriatr 17 , 186 (2017). https://doi.org/10.1186/s12877-017-0586-1*. 2017.
8. van den Bussche, H., Koller, D., Kolonko, T., Hansen, H., Wegscheider, K., Glaeske, G., . . . Schön, G. (2011). *Which chronic diseases and disease combinations are specific to multimorbidity in the elderly? Results of a claims data based cross-sectional study in Germany. BMC Public Health, 11, 101. doi:10.1186/1471-2458-11-101*. 2011.
9. Kirchberger I, M.C., Heier M, Zimmermann AK, Thorand B, Autenrieth CS, Peters A, Ladwig KH, Döring A., *Patterns of multimorbidity in the aged population. Results from the KORA-Age study. PLoS One. 2012;7(1):e30556. doi: 10.1371/journal.pone.0030556. Epub 2012 Jan 23. PMID: 22291986; PMCID: PMC3264590.*
10. *Notfall Herzinfarkt*. 2023; Available from: https://www.helios-gesundheit.de/magazin/kardiologie/news/notfall-herzinfarkt/.
11. Herzstiftung, D. *Herzinfarkt bei Frauen: Diese Symptome sollten Sie kennen!* ; Available from: https://herzstiftung.de/infos-zu-herzerkrankungen/herzinfarkt/anzeichen/herzinfarkt-frauen-symptome.
12. Aubert, C.E., Schnipper, J. L., Fankhauser, N., Marques-Vidal, P., Stirnemann, J. M., Auerbach, A. D., . . . Donze, J. (2020). *Patterns of multimorbidity in medical inpatients: a multinational retrospective cohort study. Internal and Emergency Medicine, 15(7), 1207-1217. doi:10.1007/s11739-020-02306-2*. 2020.
13. Garin, N., Olaya, B., Perales, J., Moneta, M. V., Miret, M., Ayuso-Mateos, J. L., & Haro, J. M. (2014). *Multimorbidity patterns in a national representative sample of*

the Spanish adult population. PLoS One, 9(1), e84794. doi:10.1371/journal.pone.0084794. 2014.
14. Ioakeim-Skoufa, I., Poblador-Plou, B., Carmona-Pírez, J., Díez-Manglano, J., Navickas, R., Gimeno-Feliu, L. A., . . . Gimeno-Miguel, A. (2020). *Multimorbidity Patterns in the General Population: Results from the EpiChron Cohort Study. Int J Environ Res Public Health, 17(12). doi:10.3390/ijerph17124242*. 2020.
15. Kirchberger, I., Meisinger, C., Heier, M., Zimmermann, A. K., Thorand, B., Autenrieth, C. S., . . . Döring, A. (2012). *Patterns of multimorbidity in the aged population. Results from the KORA-Age study. PLoS One, 7(1), e30556. doi:10.1371/journal.pone.0030556*. 2012.
16. Nguyen, H., Chua, K. C., Dregan, A., Vitoratou, S., Bayes-Marin, I., Olaya, B., & Prina, A. M. (2020). *Factors Associated With Multimorbidity Patterns in Older Adults in England: Findings From the English Longitudinal Study of Aging (ELSA). J Aging Health, 32(9), 1120-1132. doi:10.1177/0898264319891026*. 2020.
17. Bayes-Marin, I., Sanchez-Niubo, A., Egea-Cortés, L., Nguyen, H., Prina, M., Fernández, D., . . . Olaya, B. (2020), *Multimorbidity patterns in low-middle and high income regions: a multiregion latent class analysis using ATHLOS harmonised cohorts. BMJ Open, 10(7), e034441. doi:10.1136/bmjopen-2019-034441*.
18. Violan C, F.-B.Q., Flores-Mateo G, Salisbury C, Blom J, Freitag M, Glynn L, Muth C, Valderas JM.2014., *Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies. PLoS One. 2014 Jul 21;9(7):e102149. doi: 10.1371/journal.pone.0102149. PMID: 25048354; PMCID: PMC4105594.* 2014.
19. Marengoni A, A.S., Melis R, Mangialasche F, Karp A, Garmen A, Meinow B, Fratiglioni L. 2011., *Aging with multimorbidity: a systematic review of the literature. Ageing Res Rev. 2011 Sep;10(4):430-9. doi: 10.1016/j.arr.2011.03.003. Epub 2011 Mar 23. PMID: 21402176.* 2011.
20. Busija L, L.K., Szoeke C, Sanders KM, McCabe MP., *Do replicable profiles of multimorbidity exist? Systematic review and synthesis. Eur J Epidemiol. 2019 Nov;34(11):1025-1053. doi: 10.1007/s10654-019-00568-5. Epub 2019 Oct 17. PMID: 31624969.* 2019.
21. *Armut und Ernährung.Eine qualitative Studie über das Ernährungsverhalten von ausgewählten Familien mit niedrigem Einkommen. https://jlupub.ub.uni-giessen.de/bitstream/handle/jlupub/5120/SdF-1998_2-74-82.pdf?sequence=1*.
22. Versorgungsleitlinien, N., *NVL Chronische KHK, Version 6.https://www.leitlinien.de/themen/khk/version-6/kapitel-7*.
23. Antwerpes, D.F. *Arthrose*. Available from: https://flexikon.doccheck.com/de/Arthrose.
24. Institut, R.K. *12-Monats-Prävalenz von Arthrose in Deutschland. https://www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsJ/FactSheets/JoHM_03_2017_Praevalenz_Arthrose.pdf?__blob=publicationFile#:~:text=Der%20Anteil%20von%20Personen%20mit,(31%2C2%20%25)%20betroffen.*; Available from: https://www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsJ/FactSheets/JoHM_03_2017_Praevalenz_Arthrose.pdf?__blob=publicationFile#:~:text=Der%20Anteil%20von%20Personen%20mit,(31%2C2%20%25)%20betroffen.
25. Christ, M., Klima, T. & Maisch, B., *Arterielle Hypertonie und metabolisches Syndrom. Herz 28 , 674–685 (2003). https://doi.org/10.1007/s00059-003-2518-4*.

26. Lu, J., Wang, Y., Hou, L. *et al.*, *Multimorbidity patterns in old adults and their associated multi-layered factors: a cross-sectional study. BMC Geriatr 21 , 372 (2021). https://doi.org/10.1186/s12877-021-02292-w*. 2021.
27. Dong, H.J., Wressle, E., & Marcusson, J. (2013). *Multimorbidity patterns of and use of health services by Swedish 85-year-olds: an exploratory study. BMC Geriatr, 13, 120. doi:10.1186/1471-2318-13-120*. 2013.

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13. Eidesstattliche Versicherung

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.
Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.
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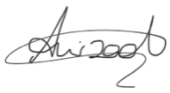

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