

# BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email [info.bmjopen@bmj.com](mailto:info.bmjopen@bmj.com)

# BMJ Open

## Prevalence of chronic conditions and multimorbidity in Estonia: a population-based cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-049045
Article Type:	Original research
Date Submitted by the Author:	02-Feb-2021
Complete List of Authors:	Jurisson, M; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health Pisarev, Heti; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health Uusküla, Anneli; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health Lang, Katrin; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health Oona, M; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health Kalda, Ruth; Tartu Ulikool Arstiteaduskond, Institute of Family Medicine and Public Health
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), PUBLIC HEALTH

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1  
2  
3 **Title page**  
4  
5  
6  
7  
8

9 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
10 **cross-sectional study**  
11  
12  
13  
14  
15  
16

17 Mikk Jürisson, Heti Pisarev, Anneli Uusküla, Katrin Lang, Marje Oona, Ruth Kalda  
18  
19  
20  
21  
22

23  
24 Corresponding author: Mikk Jürisson, Institute of Family Medicine and Public Health,  
25 University of Tartu, Ravila 19, 50411 Tartu, Estonia, [mikkjurisson@gmail.com](mailto:mikkjurisson@gmail.com)  
26  
27

28  
29 Heti Pisarev, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
30  
31 Estonia  
32

33  
34 Anneli Uusküla, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
35  
36 Estonia  
37

38  
39 Katrin Lang, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
40  
41 Estonia  
42

43  
44 Marje Oona, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
45  
46

47  
48 Ruth Kalda, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
49

50  
51 Word count: 2975  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
4 **cross-sectional study**  
5  
6  
7

8 **Objectives:** Prevalence estimates for specific chronic conditions and multimorbidity (MM) in  
9 Eastern Europe are scarce. This national study estimates the prevalence of MM by age group  
10 and gender in Estonia.  
11  
12  
13

14  
15  
16 **Design:** Population-based cross-sectional study utilizing administrative data.  
17

18  
19 **Setting:** Data were collected on 55 chronic conditions from the Estonian Health Insurance Fund  
20 during 2015-2017. MM was defined as the coexistence of two or more conditions.  
21  
22

23  
24 **Participants:** The Estonian Health Insurance Fund includes data for approximately 95% of the  
25 Estonian population receiving public health insurance.  
26  
27

28  
29 **Primary and secondary outcome measures:** Prevalence and 95% confidence intervals (CI)  
30 for MM stratified by age group and gender.  
31  
32

33  
34 **Results:** Nearly half (49.1%) of the individuals (95% CI 49.0–49.3) had at least one chronic  
35 condition, and 30.1% (95% CI 30.0–30.2) had MM (2 or more chronic conditions). The number  
36 of conditions and the prevalence of MM increased with age, ranging from a MM prevalence of  
37 3.5% (3.5–3.6) in the youngest (0–24 years) to as high as 80.4% (79.4–81.3) in the oldest ( $\geq 85$ )  
38 age group. Half of all individuals had MM by 60 years, and 75% of the population had MM by  
39 75 years of age. Women had a higher prevalence of MM (34.9%, 95% CI 34.7–35.0) than men  
40 (24.4%, 95% CI 24.3–24.5). Hypertension was by far the most frequent chronic condition  
41 (24.5%), followed by chronic pain (12.4%) and arthritis (7.7%).  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51

52  
53  
54 **Conclusions:** Hypertension is an important chronic condition amenable to treatment with  
55 lifestyle and therapeutic interventions. Given the established correlation between uncontrolled  
56  
57  
58  
59  
60

1  
2  
3 hypertension and exacerbation of other cardiovascular conditions as well as acute illnesses, this  
4  
5 leading MM may be suitable for targeted public health interventions.  
6  
7

### 8 **Strengths and limitations of this study**

9

- 10  
11 • One of the strengths of our study is the methodological comparability with previous  
12 research.  
13
- 14  
15 • The second strength is the nearly 95% nationwide coverage of our dataset, the validity  
16 of which has been tested and proven.  
17
- 18  
19 • A limitation of our study is the definition of a chronic condition and multimorbidity  
20 used in our study which is contestable in all studies of MM.  
21  
22  
23  
24  
25

### 26 **Funding statement**

27

28  
29 This work was supported by the Estonian Ministry of Education and Research Grant IUT34-  
30  
31 17.  
32

### 33 **Competing Interests Statement**

34

35  
36  
37 The authors declare no conflict of interests.  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## Background

The management of patients with multimorbidity (MM) has become a challenge for healthcare systems as most of those with long-term disorders are multimorbid. [1] The prevalence of MM is increasing along with population aging, [2] but aging is not the only factor predisposing the population increase in MM [3] and healthcare utilization has experienced a concomitant increase in response to managing these complex patients. [4–6] In addition to aging, MM is associated with other sociodemographic factors, such as female gender, lower education, lower household income, and living alone [7–9] as well as health conditions, such as obesity, hypertension, having one chronic condition at baseline, social deprivation, and ethnicity. Behavioral factors like smoking and physical inactivity are also influential. [10] Having multiple chronic conditions is associated with poor outcomes: patients have a decreased quality of life, psychological distress, longer hospital stays, more postoperative complications, a higher cost of care, and higher mortality. [11]

The management of patients with multimorbidity (MM) is a formidable challenge for healthcare systems as most individuals presenting with long-term chronic conditions are MM. Research in this area is perhaps most urgently needed in low- and middle-income countries (LMIC) where the burden of multimorbidity is high, the specific distributions and determinants of disease may differ, and access to care may be impeded by a fragmented healthcare system which is continuing to modernize and restructure [12]. Although research is beginning to elucidate the distribution of comorbid conditions in these countries, the comparability of findings is limited by methodological differences. This study presents an important contribution to this developing literature with a comprehensive set of prevalence estimates for MM in Eastern Europe.

1  
2  
3 MM is a growing global health problem affecting all nations regardless of wealth [13]. A better  
4 understanding of the national or regional epidemiology of MM is necessary to allocate health  
5 care resources and develop treatment strategies that allow clinicians to deliver patient-centered  
6 care that appreciates the potential for competing priorities. [1,13] Furthermore, in the context  
7 of the coronavirus pandemic, the clinician is faced with the challenge of reconciling competing  
8 priorities: maintain stable health among those with MM via telemedicine and other access  
9 interventions while preventing the exacerbation of acute SARS-CoV-2 if the patient becomes  
10 infected. Certainly, the time has come for all nations to better support individuals in preventing  
11 or modifying MM in the interest of improved overall health as well as optimizing patient  
12 outcomes following infection. The prevalence of MM has been extensively studied in Western  
13 European countries. For example, in a recent MM prevalence study utilizing a medical practice  
14 database in Scotland, 23.2% of patients were multimorbid. [1] A recent systematic review and  
15 meta-analysis of observational studies [14] found an overall pooled 33.1% prevalence of MM.  
16 There was a considerable difference in the pooled estimates between high and low-income  
17 countries, with a prevalence of 37.9% and 29.7%, respectively. Still, data are scarce regarding  
18 the prevalence of MM in Eastern Europe, where life expectancy is shorter than in Western  
19 Europe, particularly among men. The recent Survey of Health, Ageing, and Retirement in  
20 Europe study found that among all European countries, Eastern and Central Europe (SHARE)  
21 had the highest MM prevalence, revealing a remarkable health inequality across European  
22 regions. [7] To illustrate the gap, 70-79-year-old Central and Eastern Europeans suffer from  
23 about the same level of MM as  $\geq 80$ -year old Northern Europeans. [7] However, the SHARE  
24 study is limited to self-reported data among individuals aged 50 years or more. Given the  
25 limited population-based research in Eastern Europe, administrative health data is necessary to  
26 develop more accurate regional MM prevalence estimates.  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3 Estonia belongs to the group of Eastern European high-middle income countries with relatively  
4  
5 low life expectancy and a large gender health gap. The life expectancy among Estonian men is  
6  
7 73.8 years (compared to that of 82.1 in Estonian women) and is comparable to male life  
8  
9 expectancy in China (74.5 years), Argentina (73.6 years), and Mexico (72.6 years). Estonian  
10  
11 male life expectancy is markedly shorter than that of regional neighboring countries, such as  
12  
13 Finland (78.6 years), Sweden (80.8 years), or France (79.8 years). [15] Disability-free life  
14  
15 expectancy in Estonia is also low, being 52.8 years for men and 55.6 years for women in 2018.  
16  
17 [16] The burden of multimorbid chronic disease, leading to disability and premature death, be  
18  
19 an important contributor to this reduced life expectancy in Estonia.  
20  
21  
22  
23

24 In Estonia, national public health insurance covers approximately 95% of the population.  
25  
26 Family physicians are responsible for providing a core package of health services to the  
27  
28 individuals registering with the practice for care. [17] Following Estonian independence in  
29  
30 1992, important steps were implemented to modernize the health system and improve  
31  
32 coordination and access to primary care. In particular, access to family physicians was  
33  
34 expanded prior to streamlining the hospital network, centralizing specialty care, and  
35  
36 establishing a pharmaceutical formulary and treatment guidelines. [18] One of the stated goals  
37  
38 of restructuring was to provide better chronic disease management, coordinated by the general  
39  
40 practitioner, for whom a bonus system was implemented in 2005 to take on these duties.  
41  
42 Although management guidelines and quality standards have been implemented for specific  
43  
44 chronic conditions, this process has been slow to consider multimorbidity. [18] Family  
45  
46 physicians in Estonia lack clear evidence-based standards for the management of patients with  
47  
48 multiple chronic diseases, and the applicability of a single evidence-based guideline to MM is  
49  
50 limited and can be problematic. [19]  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 A definitive, population-based assessment of MM prevalence by age and gender is needed to  
4 inform the continued restructuring of the health care system to accommodate the growing  
5 proportion of these patients.  
6  
7  
8

## 9 10 **Methods**

11  
12  
13 For this population-based cross-sectional study, we obtained data from the Estonian Health  
14 Insurance Fund (EHIF) which is essentially the sole health insurance provider in Estonia  
15 covering approximately 95% of the population. [20] We included all subjects from the EHIF  
16 database from January 1, 2015, through December 31, 2017. The data abstraction from the  
17 EHIF database included year and month of birth, sex assigned at birth, dates for health claims,  
18 type of care (in- and outpatient care, rehabilitation, nursing care, etc.), provided services, all  
19 diagnosis codes on claims, and the date and diagnosis code on prescriptions. Study subjects  
20 were assigned a unique identifier decoupled from personal identification information to enable  
21 longitudinal tracking of care while maintaining patient privacy.  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34

35 To identify all patients with chronic physical and mental conditions, the ICD-10 diagnosis codes  
36 for main and other (accompanying) diagnoses were used. For the chronic physical and mental  
37 conditions analysis, we selected 55 conditions (Supplementary appendix, Table 1). The list of  
38 conditions was based on previous MM research to enable comparability [1,21,22] and adjusted  
39 by the authors (MJ, RK, AU, MO, HP) for use in Estonia. According to Barnett, et al., we  
40 included morbidities that were likely to be chronic, defined as having a significant impact on  
41 patients over at least the most recent year, defined in terms of the need for chronic treatment,  
42 reduced function, reduced quality of life, and risk of future morbidity and mortality. [1]  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53

54 We constructed the case definition for a chronic condition as follows: the presence of at least  
55 two diagnosis codes at least 6 weeks apart for the same condition (i.e., matching ICD-10  
56 category) during the study period January 1, 2015, through December 31, 2017 (Supplementary  
57  
58  
59  
60

1  
2  
3 Appendix, Table 1). This definition enabled us to include chronic conditions while excluding  
4 patients with previously diagnosed but improved conditions (e.g., conditions where remission  
5 is possible, such as epilepsy, asthma, pain, or depression). The 6-week interval between the  
6 diagnoses reduced double-counting and over-ascertainment of cases. The inclusion of  
7 prescriptions in the data query allowed us to identify patients whose claims profile included  
8 diagnosis codes for only one condition, whereas their prescription history identified treatment  
9 for multiple conditions.  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19

20 The ascertainment period was extended to 3 years because some patients visit their physician  
21 infrequently. For instance, 17% of publicly insured individuals had no evidence of a visit to a  
22 family physician and 37% had no evidence of a visit to a specialist in 2017. [20] If we had  
23 elected a shorter study period, we might have inadvertently excluded the MM profile of nearly  
24 20% of the population. Any correlation between lower health care utilization and  
25 sociodemographic characteristics that impede access (such as lack of paid time off from work  
26 for illness, lack of transportation in rural areas, etc.) would bias our claims-driven prevalence  
27 estimates to undercount MM among individuals facing these access challenges. The prevalence  
28 of chronic conditions among all publicly insured individuals was estimated at 31 December  
29 2017 among all persons who were publicly insured at that time.  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43

44 The study procedures were conducted according to local data protection regulations. The study  
45 was approved by the Tartu University Research Ethics Committee.  
46  
47

### 48 **Patient and public involvement**

49  
50  
51 This was an administrative claims study, and as such there were no patients enrolled in this  
52 study.  
53  
54  
55

### 56 **Statistical analysis**

1  
2  
3 The outcomes were the prevalence of chronic disorders, MM, and the mean number of disorders  
4 by age and sex, estimated as a proportion of individuals with the current characteristics and  
5 among the total number of people insured. All results are presented with 95% confidence  
6 intervals. Adjustment by age and sex were done using uni- and multivariate Poisson regression.  
7  
8 Prevalence ratios and 95% confidence intervals are presented. The analysis was performed  
9 using STATA version 14.  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19

## 20 **Results**

21  
22 We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total  
23 population as of December 31, 2017). [20,23] Half of the individuals (49.1%, 95% CI 49.0–  
24 49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean  
25 number of conditions was 1.33 (95% CI 1.21–1.33) (Table 1).  
26  
27  
28  
29

30  
31 The prevalence of chronic conditions increased with age, from 18.2% (95% CI 18.0–18.3) in  
32 the youngest age group (0–24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of  
33 45–64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years) (Table 1). In the  
34 youngest age group, 0–24 years, the mean number of conditions was 0.23 (0.22–0.23), and it  
35 increased with age, reaching 3.22 (3.21–3.22) in age 65–84 and 3.92 (3.9–3.94) among those  
36  $\geq 85$  years. The prevalence and number of chronic conditions in 5-year age groups are presented  
37 in Figure 1.  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48

49 The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) in the age of 0–24  
50 to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq 85$  years. MM prevalence was higher  
51 among women than men, with about every third woman and every fourth man having MM. At  
52 a younger age, the prevalence of MM among women was comparable to that in men: the  
53 prevalence ratio (PR<sub>women/men</sub>) was 1.00 (95% CI 0.99–1.02) in the age group of 0–24 years. It  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 increased gradually from 1.10 (95% CI 1.09-1.10 among those of 25-29 years to 1.27 (95% CI  
4 1.24-1.29) in 65-69 years, and declined again to be more similar between women and men  
5  
6 among those aged 85+ (1.09, 95% CI 1.05-1.13).  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For peer review only

**Table 1.** Study population, the prevalence of chronic conditions, mean number of chronic conditions, and MM by age group and sex.

		Population (%)	Prevalence of chronic conditions (95% CI)	Mean number of conditions (95% CI)	Prevalence of MM (95% CI)
Total		1 240 927 (100.0)	49.1 (49.0–49.3)	1.33 (1.32–1.33)	30.1 (30.0–30.2)
Age group (years)	0–24	331 450 (26.7)	18.2 (18.0–18.3)	0.23 (0.22–0.23)	3.5 (3.5–3.6)
	25–44	326 460 (26.3)	34.8 (34.6–35.0)	0.56 (0.55–0.56)	12.6 (12.5–12.7)
	45–64	323 256 (26.0)	65.6 (65.3–65.8)	1.64 (1.63–1.64)	41.0 (40.7–41.2)
	65–84	225 705 (18.2)	85.6 (85.2–85.9)	3.22 (3.21–3.22)	71.1 (70.8–71.5)
	≥85	34 056 (2.7)	90.4 (89.4–91.4)	3.92 (3.9–3.94)	80.4 (79.4–81.3)
Sex	Men	569 087 (45.9)	43.6 (43.4–43.7)	1.06 (1.06–1.07)	24.4 (24.3–24.5)
	Women	671 840 (54.1)	53.8 (53.7–54.0)	1.55 (1.54–1.55)	34.9 (34.7–35.0)
Number of conditions	0	631 299 (50.9)	...	...	...
	1	236 547 (19.1)	...	...	...
	2	128 263 (10.3)	...	...	...
	3	83 751 (6.7)	...	...	...
	4	57 501 (4.6)	...	...	...
	5	39 159 (3.2)	...	...	...
	6	25 567 (2.1)	...	...	...
	7	16 259 (1.3)	...	...	...
	≥8	22 581 (1.8)	...	...	...

1  
2  
3 /Figure 1 here/  
4  
5

6 **Figure 1.** Prevalence of chronic conditions and multimorbidity (in numbers) by 5-year age  
7 groups.  
8  
9

10  
11  
12  
13  
14 The prevalence of the 10 most common chronic conditions in men and women by age group is  
15 shown in Figure 2, and the prevalence of all chronic conditions in the study (in the total  
16 population and among MM patients) in the Supplementary Appendix, Table 1. Hypertension  
17 was by far the most frequent chronic condition in the three oldest age groups for both men and  
18 women. Hypertension affects one in four individuals (24.5 %) in the total population and about  
19 two-thirds (67.4%) among MM patients.  
20  
21  
22  
23  
24  
25  
26  
27

28  
29 Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3%  
30 among MM patients. Chronic pain was defined according to Barnett, et al. [1] as chronic pain  
31 associated with selected physical conditions such as osteoarthritis and low back pain  
32 (Supplementary appendix, Table 1). The prevalence of painful conditions increases in older age  
33 as does the prevalence of cardiovascular diseases and conditions (e.g., atrial fibrillation,  
34 ischaemic heart disease, and heart failure).  
35  
36  
37  
38  
39  
40  
41  
42

43 Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population  
44 and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was  
45 closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients.  
46  
47

48 The conditions with prevalence over 10% among MM patients included diabetes, sleep  
49 disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic  
50 heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were  
51 frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%).  
52  
53  
54  
55  
56  
57  
58

59 Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In  
60

1  
2  
3 younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions  
4  
5 were most frequent.  
6  
7  
8  
9

10  
11 */Figure 2 here/*  
12  
13

14 **Figure 2.** The prevalence of the 10 most common chronic conditions in men and women by  
15  
16 age group.  
17  
18  
19  
20  
21

## 22 **Discussion**

23  
24  
25 The disease burden from chronic conditions is high in Estonia. Half of the individuals had at  
26  
27 least one chronic disorder, and one-third had MM. The burden is increasing with age, being  
28  
29 high already among middle-aged population groups (aged 45-64 years), where 82/3 of  
30  
31 individuals have a prevalent condition. Among those with MM, hypertension is the most  
32  
33 prominent chronic condition, followed by chronic pain and arthritis.  
34  
35  
36

37  
38 Our results were overall very similar to the results of global and regional studies. A recent  
39  
40 systematic review and meta-analysis of observational studies [14] resulted in an overall 33.1%  
41  
42 pooled prevalence of MM. Still, their estimate of MM for the high-income countries in that  
43  
44 review was 37.9%, whereas our estimate of 30.1% is a bit lower, apparently due to the  
45  
46 methodological differences discussed above. As described earlier in the background, disability-  
47  
48 free life expectancy is low for Estonia, perhaps owing to the relatively high burden of MM.  
49  
50 Comparing our results to the Scottish primary care research, MM was higher in our study  
51  
52 (30.1% compared to 23.2% in Scotland). [1]  
53  
54  
55

56  
57 As for the types of prevalent chronic conditions, our findings converge with several other  
58  
59 studies that identified hypertension, diabetes, asthma, and arthritis as the most prevalent  
60



1  
2  
3 conditions. In a recent Canadian study, the top five chronic conditions of the 17 examined  
4  
5 among those with MM were mood disorders, hypertensive disorders, asthma, arthritis, and  
6  
7 diabetes. [24] Lenzi, et al., found that hypertension, diabetes, and depression were highly  
8  
9 prevalent among Italians. [25] Our national data also concur that morbidity increases with age,  
10  
11 an association that has been demonstrated in other studies as well [1,3,24–26]. In a Canadian  
12  
13 study of self-reported chronic conditions, the prevalence of 3+ conditions increased with age  
14  
15 from 30% in the 45-49-year-old age group to 52% in individuals aged 60-64 years [26]. In  
16  
17 Lithuania, the risk of acquiring an additional chronic condition was found to increase  
18  
19 exponentially from the age of 29 years and stabilize between the age of 51 and 57 years [27,28].  
20  
21  
22

23  
24 Acknowledging the gender gap in health that is characteristic of Eastern Europe, we aimed to  
25  
26 assess the sex-specific differences in MM. We found that in women age 25+, the prevalence of  
27  
28 MM is higher than men, with the largest difference among those aged 65-69 years. This elevated  
29  
30 prevalence of MM among women has been confirmed in some studies [3,26], but not in the  
31  
32 others [24].  
33  
34

35  
36 Some limitations of our study may affect generalizability. First, the definition of a chronic  
37  
38 condition used in our study is contestable. However, we sought to ensure conformance with the  
39  
40 methodologies used in prior research and establish the chronicity of the disease. Thus, the health  
41  
42 care claim or prescription with a specific condition had to be identified at least 2 times during  
43  
44 the period of observation. The second limitation is the heterogenous MM prevalence estimates  
45  
46 due to methodological differences, including the MM definition, the list and grouping of  
47  
48 conditions accounted for, the age range, data source, and collection of data. [29,30] A universal  
49  
50 definition and list of conditions used for MM research do not exist. [30] We attempted to  
51  
52 optimize generalizability by adopting the list from previous research. To allow accurate  
53  
54 estimations of disease burden, and effective disease management and resource distribution, a  
55  
56 standardized operationalization of MM are needed. [1,14] Third, it is possible that some people  
57  
58  
59  
60

1  
2  
3 with chronic conditions did not visit a physician or made only one visit over the study period,  
4 thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database  
5 covers approximately 95% of the population but lacks the data for approximately 5% of  
6 uninsured individuals. [23] However, given that all individuals aged 64 years and older are  
7 covered by health insurance, we acknowledge that a minor ascertainment bias may exist in  
8 younger age groups, as the health data for the uninsured individuals were not available. Fifth,  
9 not all individuals who were insured at the date of observation (December 31, 2017) were  
10 insured during the entire three-year study period, which might result in minor under-  
11 ascertainment among those newly enrolled.  
12  
13

14  
15 One of the strengths of our study is the effort expended to enable comparability with the results  
16 of other studies. We used the list of conditions from previous research [1,21,22,28] with only  
17 minor adjustments to reflect the diagnostic practices. Another strength of our analysis lies in  
18 the use of a data source with 95% nationwide coverage and complete follow-up, free of recall  
19 and social desirability biases. Furthermore, the validity of EHIF data, although established for  
20 financial and not health research purposes, has been tested recently [31] and the study  
21 concluded that these data can be used for monitoring changes in chronic condition prevalence  
22 with a precision sufficient for informing health care policy. Our study thus provides high  
23 validity and generalizability of results allowing inferences to other Eastern European  
24 populations.  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

## 48 **Conclusions**

49  
50  
51 The prevalence of multimorbidity in Estonia is relatively high compared to other European  
52 countries, and higher among women than men. The prevalence of MM increases with age, with  
53 hypertension by far the most frequent chronic condition, followed by chronic pain, and arthritis.  
54  
55  
56  
57  
58 As the public health infrastructure continues to modernize, efforts must be placed on primary  
59  
60

1  
2  
3 prevention of the conditions which lead to hypertension, such as obesity. The development of  
4  
5 patient-centered, evidence-based treatment recommendations will help align patient and  
6  
7 physician with respect to health goals and the means to achieve these outcomes.  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19

## 20 References

- 21  
22  
23 1 Barnett K, Mercer SSW, Norbury M, *et al.* Epidemiology of multimorbidity and  
24 implications for health care, research, and medical education: a cross-sectional study.  
25 *Lancet* 2012;**6736**:37–43. doi:10.1016/S0140-6736(12)60240-2.THELANCET-D-11-  
26 08270R1  
27  
28  
29  
30  
31  
32 2 Kingston A, Robinson L, Booth H, *et al.* Projections of multi-morbidity in the older  
33 population in England to 2035: estimates from the Population Ageing and Care  
34 Simulation (PACSim) model. *Age Ageing* 2018;**47**:374–80. doi:10.1093/ageing/afx201  
35  
36  
37  
38  
39  
40 3 Van Oostrom SH, Gijzen R, Stirbu I, *et al.* Time trends in prevalence of chronic  
41 diseases and multimorbidity not only due to aging: Data from general practices and  
42 health surveys. *PLoS One* 2016;**11**:e0160264. doi:10.1371/journal.pone.0160264  
43  
44  
45  
46  
47  
48 4 Bahler C, Huber CA, Brungger B, *et al.* Multimorbidity, health care utilization and  
49 costs in an elderly community-dwelling population: A claims data based observational  
50 study. *BMC Health Serv Res* 2015;**15**:23. doi:10.1186/s12913-015-0698-2  
51  
52  
53  
54  
55 5 van Oostrom SH, Picavet HSJ, de Bruin SR, *et al.* Multimorbidity of chronic diseases  
56 and health care utilization in general practice. *BMC Fam Pr* 2014;**15**:1–9.  
57  
58  
59  
60  
doi:10.1186/1471-2296-15-61

- 1  
2  
3 6 Quinaz Romana G, Kislaya I, Cunha Gonçalves S, *et al.* Healthcare use in patients with  
4 multimorbidity. *Eur J Public Health* Published Online First: 25 June 2019.  
5  
6 doi:10.1093/eurpub/ckz118  
7  
8  
9  
10 7 Nielsen CR, Halling A, Andersen-Ranberg K. Disparities in multimorbidity across  
11 Europe – Findings from the SHARE Survey. *Eur Geriatr Med* 2017;**8**:16–21.  
12  
13 doi:10.1016/J.EURGER.2016.11.010  
14  
15  
16  
17 8 Aminisani N, Stephens C, Allen J, *et al.* Socio-demographic and lifestyle factors  
18 associated with multimorbidity in New Zealand. *Epidemiol Health* 2020;**42**:e2020001.  
19  
20 doi:10.4178/epih.e2020001  
21  
22  
23  
24 9 Ashworth M, Durbaba S, Whitney D, *et al.* Journey to multimorbidity: Longitudinal  
25 analysis exploring cardiovascular risk factors and sociodemographic determinants in an  
26 urban setting. *BMJ Open* 2019;**9**. doi:10.1136/bmjopen-2019-031649  
27  
28  
29  
30  
31  
32  
33 10 Wikström K, Lindström J, Harald K, *et al.* Clinical and lifestyle-related risk factors for  
34 incident multimorbidity: 10-year follow-up of Finnish population-based cohorts 1982-  
35 2012. *Eur J Intern Med* 2015;**26**:211–6. doi:10.1016/j.ejim.2015.02.012  
36  
37  
38  
39  
40  
41 11 Fortin M, Soubhi H, Hudon C, *et al.* Multimorbidity's many challenges. *BMJ*  
42 2007;**334**:1016–7. doi:10.1136/bmj.39201.463819.2C  
43  
44  
45  
46 12 Hurst JR, Agarwal G, Van Boven JFM, *et al.* Critical review of multimorbidity  
47 outcome measures suitable for low-income and middle-income country settings:  
48 Perspectives from the Global Alliance for Chronic Diseases (GACD) researchers. *BMJ*  
49 *Open* 2020;**10**:e037079. doi:10.1136/bmjopen-2020-037079  
50  
51  
52  
53  
54  
55  
56 13 Sathanapally H, Sidhu M, Fahami R, *et al.* Priorities of patients with multimorbidity  
57 and of clinicians regarding treatment and health outcomes: A systematic mixed studies  
58  
59  
60

- 1  
2  
3 review. *BMJ Open*. 2020;**10**:e033445. doi:10.1136/bmjopen-2019-033445  
4  
5  
6 14 Nguyen H, Manolova G, Daskalopoulou C, *et al*. Prevalence of multimorbidity in  
7  
8 community settings: A systematic review and meta-analysis of observational studies. *J*  
9  
10 *Comorbidity* 2019;**9**:2235042X1987093. doi:10.1177/2235042x19870934  
11  
12  
13 15 Dicker D, Nguyen G, Abate D, *et al*. Global, regional, and national age-sex-specific  
14  
15 mortality and life expectancy, 1950–2017: a systematic analysis for the Global Burden  
16  
17 of Disease Study 2017. *Lancet* 2018;**392**:1684–735. doi:10.1016/S0140-  
18  
19 6736(18)31891-9  
20  
21  
22  
23 16 Life expectancy. TE75 Disabil. Free life Expect. by sex age Gr. 2020.  
24  
25  
26 17 Estonian Health Insurance Fund.  
27  
28  
29 18 Lai, T; Knai C. Chapter 5: Estonia. In: *Assessing Chronic Disease Management in*  
30  
31 *European Health Systems: Country reports*.  
32  
33  
34 19 Silina V, Kalda R. Challenges for clinical practice and research in family medicine in  
35  
36 reducing the risk of chronic diseases. Notes on the EGPRN Spring Conference 2017 in  
37  
38 Riga. *Eur J Gen Pract* 2018;**24**:112–7. doi:10.1080/13814788.2018.1429594  
39  
40  
41  
42 20 Estonian Health Insurance Fund - Eesti Haigekassa. Annu. Rep.  
43  
44 2017. <https://www.haigekassa.ee/>  
45  
46  
47 21 Van Den Bussche H, Koller D, Kolonko T, *et al*. Which chronic diseases and disease  
48  
49 combinations are specific to multimorbidity in the elderly? Results of a claims data  
50  
51 based cross-sectional study in Germany. *BMC Public Health* 2011;**11**:101.  
52  
53 doi:10.1186/1471-2458-11-101  
54  
55  
56  
57 22 Schäfer I, von Leitner E-C, Schön G, *et al*. Multimorbidity Patterns in the Elderly: A  
58  
59 New Approach of Disease Clustering Identifies Complex Interrelations between  
60

- 1  
2  
3 Chronic Conditions. *PLoS One* 2010;**5**:e15941. doi:10.1371/journal.pone.0015941  
4  
5  
6 23 Statistics Estonia. PO021: Population, 1 January by sex, year and age group.  
7  
8 2017. <https://www.stat.ee/database> (accessed 26 Jul 2019).  
9  
10  
11 24 Ryan BL, Bray Jenkyn K, Shariff SZ, *et al.* Beyond the grey tsunami: a cross-sectional  
12  
13 population-based study of multimorbidity in Ontario. *Can J Public Heal*  
14  
15 2018;**109**:845–54. doi:10.17269/s41997-018-0103-0  
16  
17  
18 25 Lenzi J, Avaldi VM, Rucci P, *et al.* Burden of multimorbidity in relation to age, gender  
19  
20 and immigrant status: A cross-sectional study based on administrative data. *BMJ Open*  
21  
22 2016;**6**:e012812. doi:10.1136/bmjopen-2016-012812  
23  
24  
25  
26 26 Sakib MN, Shooshtari S, St John P, *et al.* The prevalence of multimorbidity and  
27  
28 associations with lifestyle factors among middle-aged Canadians: An analysis of  
29  
30 Canadian Longitudinal Study on Aging data. *BMC Public Health* 2019;**19**:1–13.  
31  
32  
33 doi:10.1186/s12889-019-6567-x  
34  
35  
36 27 Jurevičienė E, Onder G, Visockienė, *et al.* Does multimorbidity still remain a matter of  
37  
38 the elderly: Lithuanian national data analysis. *Health Policy (New York)*  
39  
40 2018;**122**:681–6. doi:10.1016/j.healthpol.2018.03.003  
41  
42  
43  
44 28 Navickas R, Visockiene, Puronaite R, *et al.* Prevalence and structure of multiple  
45  
46 chronic conditions in Lithuanian population and the distribution of the associated  
47  
48 healthcare resources. *Eur J Intern Med* 2015;**26**:160–8. doi:10.1016/j.ejim.2015.02.015  
49  
50  
51 29 Diederichs C, Berger K, Bartels DB. The measurement of multiple chronic diseases - A  
52  
53 systematic review on existing multimorbidity indices. *Journals Gerontol - Ser A Biol*  
54  
55 *Sci Med Sci* 2011;**66 A**:301–11. doi:10.1093/gerona/glq208  
56  
57  
58  
59 30 Fortin M, Stewart M, Poitras M-E, *et al.* A systematic review of prevalence studies on  
60

1  
2  
3 multimorbidity: toward a more uniform methodology. *Ann Fam Med* 2012;**10**:142–51.

4  
5 doi:10.1370/afm.1337  
6  
7

- 8  
9 31 Otsa K, Talli S, Harding P, *et al.* Administrative database as a source for assessment of  
10 systemic lupus erythematosus prevalence: Estonian experience. *BMC Rheumatol*  
11 2019;**3**:1–6. doi:10.1186/s41927-019-0074-7  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

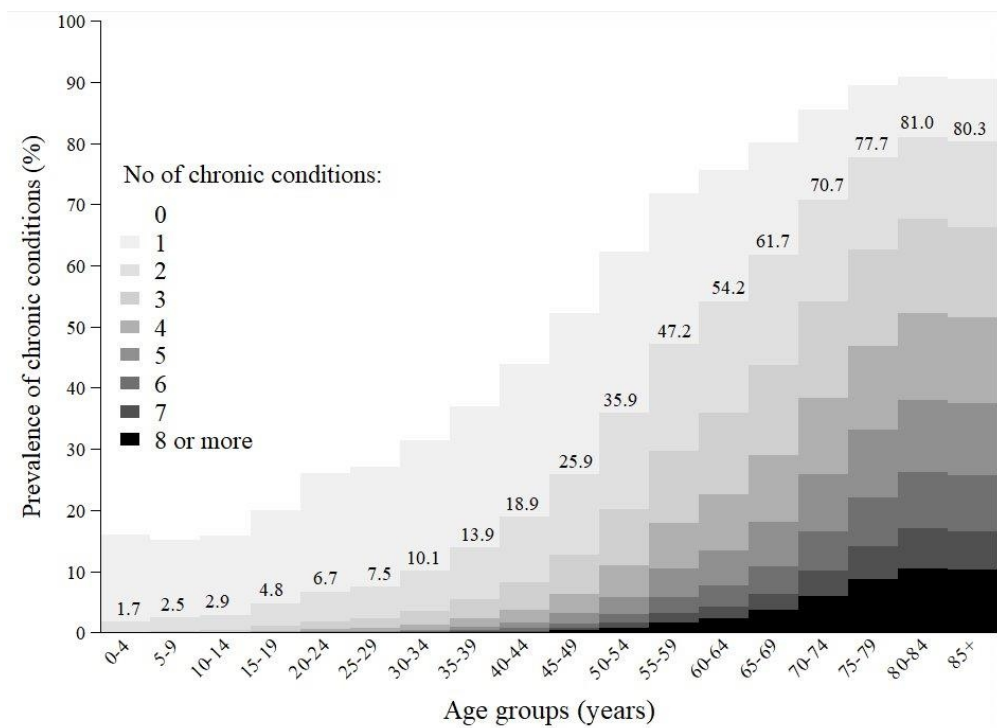


Figure 1. Prevalence of chronic conditions and multimorbidity (in numbers) by 5-year age groups.

249x181mm (96 x 96 DPI)



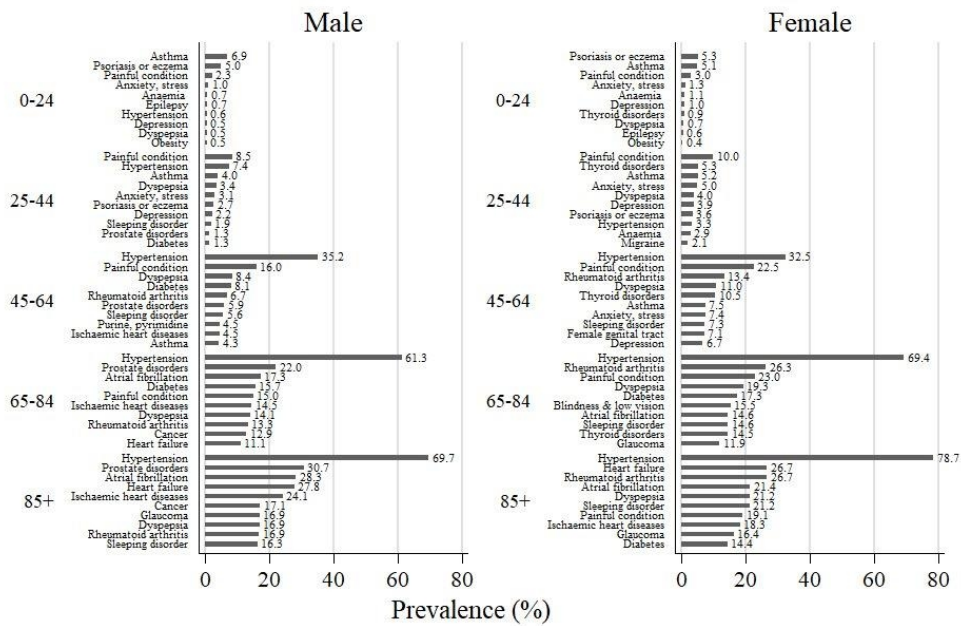


Figure 2. The prevalence of the 10 most common chronic conditions in men and women by age group.

251x167mm (96 x 96 DPI)

1  
2  
3 **Supplementary appendix.**  
4  
5

6 **Table 1.** List and prevalence of chronic conditions (in the total population and among MM  
7 patients) in the study.  
8  
9

10  
11  
12

Disorder	ICD-10 codes	Prevalence (%)	
		Total	among MM patients
Hypertension	[I10–I15]	24.49	67.40
Painful condition	[G44, R51] [M25.5] [M42–M54] [M77] [M79.1–79.9] [R10.1– 10.4] [R07.0–07.4] [R30] [R52.0] [R52.1] [R52.2] [R52.9] [S22.0] [S22.1] [S12] [S32] [S72]	12.37	32.30
Rheumatoid arthritis, other inflammatory arthropathies and systemic connective tissue disorders	[M30–M36] [M05–M09, M79.0] [M91] [M15– M19]	7.65	23.56
Dyspepsia	[K21, K25–K30]	7.41	22.12
Asthma	[J45–J46] [J30]	5.91	12.94
Diabetes	[E10–14]	5.62	17.69
Sleeping disorders	[F51, G47]	5.11	15.80
Thyroid disorders	[E01–05, E06.1–.9, E07]	4.72	12.93

13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Atrial fibrillation	[I44–I45, I47–I49]	4.7	14.99
Psoriasis or eczema	[L20] [L23] [L28] [L29] [L40] [L50] [L56]	4.17	8.25
Anxiety and other neurotic, stress- related, and somatoform disorders	[F40–F43, F45, F48]	4.09	11.20
Blindness and low vision	[H17–18, H25–28, H31, H33, H34.1–.9, H35– H36, H43, H47, H54]	3.62	11.39
Ischaemic heart diseases	[I20–I25]	3.44	11.27
Depression	[F32–F33]	3.32	9.21
Heart failure	[I50]	3.24	10.65
Glaucoma	[H40–H42]	3.17	9.86
Cancer **	C00–97, D00–09, D37– 48	3.05	8.84
Prostate disorders	[N40] [N41]	2.52	7.33
Disorders of purine and pyrimidine metabolism	[E79, M10]	2.07	6.56
Anemia	[D50–59, D60–D61, D63–64]	1.88	4.75
Obesity	[E66]	1.64	5.11

1				
2				
3	Noninflammatory	[N81] [N93] [N95]	1.57	4.45
4				
5	disorders of the			
6				
7	female genital tract			
8				
9				
10	Neuropathies	[G50–G64]	1.56	4.78
11				
12	Disorders of	[H81, H82, R42]	1.52	4.75
13				
14	vestibular function			
15				
16				
17	Stroke and transient	[I60–66, I69, G45, I67.2]	1.45	4.71
18				
19	ischaemic attack			
20				
21	Chronic obstructive	[J40–J44]	1.4	4.42
22				
23	pulmonary			
24				
25	disease/bronchitis			
26				
27				
28	Peripheral vascular	[I73.0] [I70]	0.93	2.98
29				
30	disease			
31				
32				
33	Osteoporosis	[M80, M81, M82]	0.89	2.83
34				
35	Schizophrenia or	[F20–F29] [F31]	0.85	1.75
36				
37	bipolar disorder			
38				
39				
40	Epilepsy	[G40–G41]	0.84	1.84
41				
42	Hearing loss	[H90–H91]	0.74	2.17
43				
44	Migraine	[G43]	0.72	1.57
45				
46				
47	Cholelithiasis /	[K80, K81.1]	0.5	1.47
48				
49	Cholecystitis			
50				
51	Dementia	[F00, F01, F02, F03,	0.48	1.48
52		F05.1, G30, G31, R54]		
53				
54				
55				
56	Chronic kidney	[N18–N19]	0.47	1.57
57				
58	disease			
59				
60				

1				
2				
3	Mental and behavioral	[F10]	0.43	1.16
4				
5	disorders due to use of			
6				
7	alcohol			
8				
9				
10	Chronic liver disease	[K70–74, K76]	0.42	1.31
11				
12	Valve disorders	[I34–I37]	0.37	1.20
13				
14	Viral Hepatitis	[B18]	0.36	1.02
15				
16				
17	Irritable bowel	[K58]	0.33	0.97
18				
19	syndrome			
20				
21	Parkinson's disease	[G20, G21, G22]	0.31	0.97
22				
23	HIV	[Z21, B20–B24]	0.30	0.70
24				
25				
26	disorders of the	[N39.3, N39.4, R32]	0.27	0.84
27				
28	urinary system			
29				
30	Calculus of kidney	[N20]	0.26	0.76
31				
32	and ureter			
33				
34				
35	Inflammatory bowel	[K50–K52]	0.24	0.52
36				
37	Chronic sinusitis	[J32]	0.21	0.57
38				
39				
40	Diverticular disease of	[K57]	0.2	0.63
41				
42	the intestine			
43				
44	Other psychoactive	[F11–19]	0.16	0.45
45				
46	substance misuses			
47				
48				
49	Treated constipation	[K59.0]	0.16	0.42
50				
51	Multiple sclerosis	[G35]	0.12	0.26
52				
53				
54	Coagulation defects	[D65–D69]	0.08	0.22
55				
56	Learning disability	[F81]	0.06	0.08
57				
58	Anorexia or bulimia	[F50]	0.05	0.13
59				
60				

Bronchiectasis	[J47]	0.05	0.16
Celiac disease	[K90.0]	0.03	0.07

\* [ ] repetition of diagnostic codes within the boundaries of brackets

\*\* Each cancer diagnosis code counted separately

For peer review only

STROBE Statement—checklist of items that should be included in reports of observational studies

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1	Title: population-based cross-sectional study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	Abstract provides a short summary
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6	MM is a growing global health problem, the data are scarce regarding the prevalence of MM in Eastern Europe.
Objectives	3	State specific objectives, including any prespecified hypotheses	7	A definitive, population-based assessment of MM prevalence by age and gender is needed to inform the continued restructuring of the health care system to accommodate the growing proportion of these patients.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	7-8	Key elements of the cross-sectional study were described in the Methods section.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8	We obtained data (year and month of birth, sex, dates for health claims, type of care, provided services, all diagnosis codes on claims, and the date and diagnosis code on prescriptions) from the Estonian Health Insurance Fund (EHIF) which is the sole health insurance provider in Estonia covering approximately 95% of the population. We included all subjects from the EHIF database from January 1, 2015, through December 31, 2017. To identify all patients with chronic physical and mental conditions, the ICD-10

1				
2				diagnosis codes for main and other
3				(accompanying) diagnoses were used. For the
4				prevalence analysis, we selected 55 conditions,
5				whereas the list was based on previous MM
6				research to enable comparability. We
7				constructed the case definition for a chronic
8				condition as the presence of at least two
9				diagnosis codes at least 6 weeks apart for the
10				same condition during the study period
11				January 1, 2015, through December 31, 2017.
12				
13				
14				
15	Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8, Supplementary appendix
16			Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	
17			Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
18				We included all subjects from the EHIF
19				database from January 1, 2015, through
20				December 31, 2017. We constructed the case
21				definition for a chronic condition as follows:
22				the presence of at least two diagnosis codes at
23				least 6 weeks apart for the same condition (i.e.,
24				matching ICD-10 category) during the study
25				period January 1, 2015, through December 31,
26				2017. This definition enabled us to include
27				chronic conditions while excluding patients
28				with previously diagnosed but improved
29				conditions (e.g., conditions where remission is
30				possible, such as epilepsy, asthma, pain, or
31				depression). The 6-week interval between the
32				diagnoses reduced double-counting and over-
33				ascertainment of cases. The inclusion of
34				prescriptions in the data query allowed us to
35				identify patients whose claims profile included
36				diagnosis codes for only one condition,
37				whereas their prescription history identified
38				treatment for multiple conditions. The
39				ascertainment period was extended to 3 years
40				
41				
42				

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46



					because some patients visit their physician infrequently.
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed			
		Case-control study—For matched studies, give matching criteria and the number of controls per case			
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9		The outcomes were the prevalence of chronic disorders, multimorbidity (MM), and the mean number of disorders by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8		The prevalence of conditions and MM were assessed using the population-based health data (health claims, prescriptions) from EHIF
Bias	9	Describe any efforts to address potential sources of bias	14-15		Selection and measurement bias were possible. First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist.

We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

Study size	10	Explain how the study size was arrived at	7	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017)
------------	----	---	---	--

Continued on next page

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	13 (Table 1)	We assessed the prevalence of chronic conditions, mean number of chronic conditions, and MM by age group and sex
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9	The outcomes were the prevalence of chronic disorders, MM, and the mean number of disorders by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured. All results are presented with 95% confidence intervals. Adjustment by age and sex were done using uni- and multivariate Poisson regression. Prevalence ratios and 95% confidence intervals are presented.
		(b) Describe any methods used to examine subgroups and interactions	13 (Table 1)	Prevalence ratios (by age group and sex) and 95% confidence intervals are presented.
		(c) Explain how missing data were addressed		It was not possible to identify any missing health claims or prescriptions from the EHIF data, but we assume that the impact of missing data on results is small as the health care institutions are interested in submitting the claims for reimbursement
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses		No sensitivity analyses were performed
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		This was a cross-sectional study where all claims and prescriptions of all insured individuals were collected at a single time point.

		(b) Give reasons for non-participation at each stage		This was a cross-sectional study where all claims and prescriptions of all insured individuals were collected at a single time point.
		(c) Consider use of a flow diagram		No flow diagram was used as all data were collected and analysed at a single time point.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM.
		(b) Indicate number of participants with missing data for each variable of interest		It was not possible to identify any missing health claims or prescriptions from the EHIF data, but we assume that the impact of missing data on results is small as the health care institutions are interested in submitting the claims for reimbursement
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)		This was a cross-sectional study.
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time		This was a cross-sectional study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		This was a cross-sectional study.
		Cross-sectional study—Report numbers of outcome events or summary measures	9	Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21–1.33)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10, 13 (Table 1, Figure 1)	We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one

or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21-1.33). The prevalence of chronic conditions increased with age, from 18.2% (95% CI 18.0-18.3) in the youngest age group (0-24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of 45-64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years). In the youngest age group, 0-24 years, the mean number of conditions was 0.23 (0.22–0.23), and it increased with age, reaching 3.22 (3.21–3.22) in age 65-84 and 3.92 (3.9–3.94) among those  $\geq$ 85 years. The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) in the age of 0-24 to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq$ 85 years. MM prevalence was higher among women than men, with about every third woman and every fourth man having MM. At a younger age, the prevalence of MM among women was comparable to that in men: the prevalence ratio (PR women/men) was 1.00 (95% CI 0.99-1.02) in the age group of 0-24 years. It increased gradually from 1.10 (95% CI 1.09-1.10) among those of 25-29 years to 1.27 (95% CI 1.24-1.29) in 65-69 years, and declined again to be more similar between women and men among those aged 85+ (1.09, 95% CI 1.05-1.13).

---

(b) Report category boundaries when continuous variables were categorized

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

This was a prevalence study.

---

Continued on next page

---

1				
2	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13, Figure 2, Supplementary appendix
3				Hypertension was the most frequent chronic condition in the three oldest age groups for both men and women. Hypertension affects one in four individuals (24.5 %) in the total population and about two-thirds (67.4%) among MM patients. Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3% among MM patients. Chronic pain was defined according to Barnett, et al. as chronic pain associated with selected physical conditions such as osteoarthritis and low back pain. The prevalence of painful conditions increases in older age as does the prevalence of cardiovascular diseases and conditions. Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients. The conditions with prevalence over 10% among MM patients included diabetes, sleep disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%). Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions were most frequent.
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				

---

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

---

Discussion

---

Key results	18	Summarise key results with reference to study objectives	13	The disease burden from chronic conditions is high in Estonia. Half of the individuals had at least one chronic disorder, and one-third had MM. The burden is increasing with age, being high already among middle-aged population groups (aged 45-64 years), where 82/3 of individuals have a prevalent condition. Among those with MM, hypertension is the most prominent chronic condition, followed by chronic pain and arthritis.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15	First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist. [30] We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some

people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15	The prevalence of multimorbidity in Estonia is relatively high compared to other European countries, and higher among women than men. The prevalence of MM increases with age, with hypertension by far the most frequent chronic condition, followed by chronic pain, and arthritis. As the public health infrastructure continues to modernize, efforts must be placed on primary prevention of the conditions which lead to hypertension, such as obesity. The development of patient-centered, evidence-based treatment recommendations will help align patient and physician with respect to health goals and the means to achieve these outcomes.
----------------	----	--	----	---



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15	One of the strengths of our study is the effort expended to enable comparability with the results of other studies. We used the list of conditions from previous research with only minor adjustments to reflect the diagnostic practices. Another strength of our analysis lies in the use of a data source with 95% nationwide coverage and complete follow-up, free of recall and social desirability biases. Furthermore, the validity of EHIF data, although established for financial and not health research purposes, has been tested recently and the study concluded that these data can be used for monitoring changes in chronic condition prevalence with a precision sufficient for informing health care policy. Our study thus provides high validity and generalizability of results allowing inferences to other Eastern European populations.
<b>Other information</b>				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3	This work was supported by the Estonian Ministry of Education and Research Grant IUT34-17. Funders had no role in the study.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Prevalence of chronic conditions and multimorbidity in Estonia: a population-based cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-049045.R1
Article Type:	Original research
Date Submitted by the Author:	24-Jul-2021
Complete List of Authors:	Jürisson, Mikk; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Pisarev, Heti; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Uusküla, Anneli; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Lang, Katrin; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Oona, M; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Kalda, Ruth; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Epidemiology, General practice / Family practice
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), PUBLIC HEALTH, INTERNAL MEDICINE

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1  
2  
3 **Title page**  
4  
5  
6  
7  
8

9 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
10 **cross-sectional study**  
11  
12  
13  
14  
15  
16

17 Mikk Jürisson, Heti Pisarev, Anneli Uusküla, Katrin Lang, Marje Oona, Ruth Kalda  
18  
19  
20  
21  
22

23  
24 Corresponding author: Mikk Jürisson, Institute of Family Medicine and Public Health,  
25 University of Tartu, Ravila 19, 50411 Tartu, Estonia, [mikkjurisson@gmail.com](mailto:mikkjurisson@gmail.com)  
26  
27

28  
29 Heti Pisarev, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
30  
31 Estonia  
32

33  
34 Anneli Uusküla, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
35  
36 Estonia  
37

38  
39 Katrin Lang, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
40  
41 Estonia  
42

43  
44 Marje Oona, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
45  
46

47  
48 Ruth Kalda, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
49

50  
51 Word count: 2975  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
4 **cross-sectional study**  
5  
6  
7

8 **Objectives:** Prevalence estimates for specific chronic conditions and multimorbidity (MM) in  
9 Eastern Europe are scarce. This national study estimates the prevalence of MM by age group  
10 and sex in Estonia.  
11  
12  
13

14  
15  
16 **Design:** Population-based cross-sectional study utilizing administrative data.  
17

18  
19 **Setting:** Data were collected on 55 chronic conditions from the Estonian Health Insurance Fund  
20 from 2015-2017. MM was defined as the coexistence of two or more conditions.  
21  
22

23  
24 **Participants:** The Estonian Health Insurance Fund includes data for approximately 95% of the  
25 Estonian population receiving public health insurance.  
26  
27

28  
29 **Primary and secondary outcome measures:** Prevalence and 95% confidence intervals (CI)  
30 for MM stratified by age group and sex.  
31  
32

33  
34 **Results:** Nearly half (49.1%) of the individuals (95% CI 49.0–49.3) had at least one chronic  
35 condition, and 30.1% (95% CI 30.0–30.2) had MM (2 or more chronic conditions). The number  
36 of conditions and the prevalence of MM increased with age, ranging from a MM prevalence of  
37 3.5% (3.5–3.6) in the youngest (0–24 years) to as high as 80.4% (79.4–81.3) in the oldest ( $\geq$ 85  
38 years) age group. Half of all individuals had MM by 60 years, and 75% of the population had  
39 MM by 75 years of age. Women had a higher prevalence of MM (34.9%, 95% CI 34.7–35.0)  
40 than men (24.4%, 95% CI 24.3–24.5). Hypertension was the most frequent chronic condition  
41 (24.5%), followed by chronic pain (12.4%) and arthritis (7.7%).  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52

53  
54 **Conclusions:** Hypertension is an important chronic condition amenable to treatment with  
55 lifestyle and therapeutic interventions. Given the established correlation between uncontrolled  
56 hypertension and exacerbation of other cardiovascular conditions as well as acute illnesses, this  
57  
58  
59  
60

1  
2  
3 most common condition within the context of MM may be suitable for targeted public health  
4 interventions.  
5  
6  
7

### 8 **Strengths and limitations of this study**

- 10 • One of the strengths of our study is the methodological comparability with previous  
11 research.  
12
- 13 • The second strength is the nearly 95% nationwide coverage of our dataset, the validity  
14 of which has been tested and proven.  
15
- 16 • A limitation of our study is the definition of a chronic condition and multimorbidity  
17 used in our study which is contestable in all studies of MM.  
18  
19  
20  
21  
22  
23  
24  
25

### 26 **Data availability**

27  
28 The authors confirm that all data associated with the study are fully available without restriction  
29 from the Estonian Health Insurance Fund at <https://www.haigekassa.ee/en>. The data can be  
30 requested by completing the application at the following address:  
31 <https://ankeet.haigekassa.ee/surveys/?s=4KXEPPFDEKF> or sending a written request to  
32 [info@haigekassa.ee](mailto:info@haigekassa.ee)  
33  
34  
35  
36  
37  
38  
39  
40

### 41 **Ethics approval**

42  
43 The study was conducted in accordance with local data protection regulations. The study was  
44 approved by the Tartu University Research Ethics Committee (280/T-7, 19.2018). The ethics  
45 committee waived the requirement for informed consent for the analysis presented in the  
46 manuscript.  
47  
48  
49  
50  
51  
52  
53

### 54 **Contributors**

55  
56 MJ, RK, HP, AU, and MO conceptualized and designed the study. MJ and HP collected,  
57 managed, and analyzed the data. All co-authors contributed to the interpretation of the findings  
58  
59  
60

1  
2  
3 and drafting of the manuscript. MJ wrote the original draft, and MJ and KL wrote the final  
4  
5 version. HP provided visualizations. All co-authors approved the final version for submission.  
6  
7

### 8 **Funding statement**

9  
10  
11 This work was supported by the Estonian Ministry of Education and Research Grant IUT34-  
12  
13 17.  
14  
15

### 16 **Competing Interests Statement**

17  
18  
19 The authors declare no conflict of interest.  
20  
21

### 22 **Background**

23  
24  
25 The management of patients with MM has become a challenge for healthcare systems as most  
26  
27 individuals with long-term conditions are living with multiple long-term conditions. [1] The  
28  
29 prevalence of MM is increasing along with population aging, [2] but aging is not the only factor  
30  
31 predisposing the population increase in MM [3] and healthcare utilization has experienced a  
32  
33 concomitant increase in response to managing these complex patients. [4–6] In addition to  
34  
35 aging, MM is associated with other sociodemographic factors, such as female sex, lower  
36  
37 education, lower household income, and living alone [7–10] as well as health conditions, such  
38  
39 as obesity [11], hypertension, having one chronic condition at baseline, social deprivation, and  
40  
41 ethnicity. Behavioral factors like smoking and physical inactivity are also influential. [12]  
42  
43 Having multiple chronic conditions is associated with poor outcomes: patients have a decreased  
44  
45 quality of life, psychological distress, longer hospital stays, more postoperative complications,  
46  
47 a higher cost of care, and higher mortality. [13]  
48  
49  
50  
51  
52

53  
54 The management of patients with MM is a formidable challenge for healthcare systems.  
55  
56 Research in this area is perhaps most urgently needed in low- and middle-income countries  
57  
58 (LMIC) where the burden of multimorbidity is high, the specific distributions and determinants  
59  
60

1  
2  
3 of the disease may differ, and access to care may be impeded by a fragmented healthcare system  
4 which is continuing to modernize and restructure [14]. Although research is beginning to  
5 elucidate the distribution of co-occurring conditions in these countries, the comparability of  
6 findings is limited by methodological differences. This work demonstrates the utility of  
7 administrative data for constructing prevalence estimates, an approach that is particularly helpful for  
8 middle and high-to-middle-income-countries where resource limitations make administrative data not  
9 only immediately useful but also scalable, allowing for rate comparisons with other countries. In  
10 addition, the transition from a hospital-centric system in Estonia following independence from the Soviet  
11 Union was motivated by a desire to strengthen primary health care and thereby improve population  
12 health [15]. Having a set of prevalence estimates for MM is essential for measuring the ongoing success  
13 of this transition, adjusted by the prevalence of various conditions amenable to outpatient treatment.  
14 Finally, and perhaps most importantly, the SARS-CoV-2 pandemic drew attention to the important  
15 contribution of MM to the need for sound public health measures and rapid identification of effective  
16 medical interventions based on risk stratification. Frailty has been linked to infection [16], severity  
17 [16,17], geographic differences in severity and mortality by MM [18], prompting a renewed focus on  
18 improving global health and access to care, probabilistic modelling [19], the triage of care and shielding  
19 of the most vulnerable [20]. This study presents an important contribution to this developing  
20 literature with a comprehensive set of prevalence estimates for MM in Eastern Europe.

21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43 MM is a growing global health problem affecting all nations regardless of wealth [21]. A better  
44 understanding of the national or regional epidemiology of MM is necessary to allocate health  
45 care resources and develop treatment strategies that allow clinicians to deliver patient-centered  
46 care that appreciates the potential for competing priorities. [1,21] Furthermore, in the context  
47 of the coronavirus pandemic, the clinician is faced with the challenge of reconciling competing  
48 priorities: maintain stable health among those with MM via telemedicine and other access  
49 interventions while preventing the exacerbation of acute SARS-CoV-2 if the patient becomes  
50 infected. Certainly, the time has come for all nations to better support individuals in preventing  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3 or modifying MM in the interest of improved overall health as well as optimizing patient  
4 outcomes following infection. The prevalence of MM has been extensively studied in Western  
5 European countries. For example, in a recent MM prevalence study utilizing a medical practice  
6 database in Scotland, 23.2% of patients were living with multimorbidity. [1] A recent  
7 systematic review and meta-analysis of observational studies [22] found an overall pooled  
8 33.1% prevalence of MM. There was a considerable difference in the pooled estimates of MM  
9 between high and low-income countries, with a prevalence of 37.9% and 29.7%, respectively.  
10 Still, data are scarce regarding the prevalence of MM in Eastern Europe, where life expectancy  
11 is shorter than in Western Europe, particularly among men. The recent Survey of Health,  
12 Ageing, and Retirement in Europe (SHARE) study found that among all European countries,  
13 Eastern and Central Europe had the highest MM prevalence, revealing a remarkable health  
14 inequality across European regions. [7] To illustrate the gap, 70-79-year-old Central and  
15 Eastern Europeans suffer from about the same level of MM as  $\geq 80$ -year old Northern  
16 Europeans. [7] However, the SHARE study is limited to self-reported data among individuals  
17 aged 50 years or more. Given the limited population-based research in Eastern Europe, the use  
18 of administrative health data is necessary to develop more accurate regional MM prevalence  
19 estimates.

20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43 Estonia belongs to the group of Eastern European high-middle income countries with relatively  
44 low life expectancy and a large sex health gap. The life expectancy among Estonian men is 73.8  
45 years (compared to that of 82.1 in Estonian women) and is comparable to male life expectancy  
46 in China (74.5 years), Argentina (73.6 years), and Mexico (72.6 years). Estonian male life  
47 expectancy is markedly shorter than that of regional neighboring countries, such as Finland  
48 (78.6 years), Sweden (80.8 years), or France (79.8 years). [23] Disability-free life expectancy  
49 in Estonia is also low, being 52.8 years for men and 55.6 years for women in 2018. [24] The  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 burden of co-occurring chronic disease, leading to disability and premature death, is an  
4 important contributor to this reduced life expectancy in Estonia.  
5  
6

7  
8 In Estonia, national public health insurance covers approximately 95% of the population.  
9  
10 Family physicians are responsible for providing a core package of health services to the  
11 individuals registering with the practice for care. [25] Following Estonian independence in  
12 1992, important steps were implemented to modernize the health system and improve  
13 coordination and access to primary care. In particular, access to family physicians was  
14 expanded before streamlining the hospital network, centralizing specialty care, and establishing  
15 a pharmaceutical formulary and treatment guidelines. [26] One of the stated goals of  
16 restructuring was to provide better chronic disease management, coordinated by the general  
17 practitioner, for whom a bonus system was implemented in 2005 to take on these duties.  
18 Although management guidelines and quality standards have been implemented for specific  
19 chronic conditions, this process has been slow to consider multimorbidity. [26] Family  
20 physicians in Estonia lack clear evidence-based standards for the management of patients with  
21 multiple chronic diseases, and the applicability of a single evidence-based guideline to MM is  
22 limited and can be problematic. [27]  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40

41 A definitive, population-based assessment of MM prevalence by age and between males and  
42 females is needed to inform the continued restructuring of the health care system to  
43 accommodate the growing proportion of these patients.  
44  
45  
46  
47

## 48 **Methods**

49  
50  
51 For this population-based cross-sectional study, we obtained data from the Estonian Health  
52 Insurance Fund (EHIF) which is essentially the sole health insurance provider in Estonia  
53 covering approximately 95% of the population. [28] We included all subjects from the EHIF  
54 database from January 1, 2015, through December 31, 2017. The data abstraction from the  
55  
56  
57  
58  
59  
60

1  
2  
3 EHIF database included year and month of birth, sex assigned at birth, dates for health claims,  
4 type of care (in- and outpatient care, rehabilitation, nursing care, etc.), services provided, all  
5 diagnosis codes on claims, and the date and diagnosis code on prescriptions. Study subjects  
6  
7  
8  
9  
10 were assigned a unique identifier decoupled from personal identification information to enable  
11  
12 longitudinal tracking of care while maintaining patient privacy.  
13  
14

15 To identify all patients with chronic physical and mental conditions, the ICD-10 diagnosis codes  
16 for main and other (accompanying) diagnoses were used. For the chronic physical and mental  
17 conditions analysis, we selected 55 conditions (Supplementary appendix, Table 1). The list of  
18 conditions was based on previous MM research to enable comparability [1,29,30] and adjusted  
19 by the authors (MJ, RK, AU, MO, HP) for use in Estonia. According to Barnett, et al., we  
20 included morbidities that were likely to be chronic, defined as having a significant impact on  
21 patients over at least the most recent year, defined in terms of the need for chronic treatment,  
22 reduced function, reduced quality of life, and risk of future morbidity and mortality. [1]  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33

34 We constructed the case definition for a chronic condition as follows: the presence of at least  
35 two diagnosis codes at least 6 weeks apart for the same condition (i.e., matching ICD-10  
36 category) during the study period January 1, 2015, through December 31, 2017 (Supplementary  
37 Appendix, Table 1). This definition enabled us to include chronic conditions while excluding  
38 patients with previously diagnosed but improved conditions (e.g., conditions where remission  
39 is possible, such as epilepsy, asthma, pain, or depression). The 6-week interval between the  
40 diagnoses reduced double-counting and over-ascertainment of cases. The inclusion of  
41 prescriptions in the data query allowed us to identify patients whose claims profile included  
42 diagnosis codes for only one condition, whereas their prescription history identified treatment  
43 for multiple conditions.  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56

57 The ascertainment period was extended to 3 years because some patients visit their physician  
58 infrequently. For instance, 17% of publicly insured individuals had no evidence of a visit to a  
59  
60

1  
2  
3 family physician and 37% had no evidence of a visit to a specialist in 2017. [28] If we had  
4  
5 elected a shorter study period, we might have inadvertently excluded the MM profile of nearly  
6  
7 20% of the population. Any correlation between lower health care utilization and  
8  
9 sociodemographic characteristics that impede access (such as lack of paid time off from work  
10  
11 for illness, lack of transportation in rural areas, etc.) would bias our claims-driven prevalence  
12  
13 estimates to undercount MM among individuals facing these access challenges. The prevalence  
14  
15 of chronic conditions among all publicly insured individuals was estimated on 31 December  
16  
17 2017 among all persons who were publicly insured at that time.

18  
19  
20  
21  
22 The study procedures were conducted according to local data protection regulations. The study  
23  
24 was approved by the Tartu University Research Ethics Committee.

### 25 26 27 **Patient and public involvement**

28  
29  
30 This was an administrative claims study, and as such there were no patients enrolled in this  
31  
32 study.

### 33 34 35 **Statistical analysis**

36  
37  
38 The outcomes were the prevalence of chronic conditions, MM, and the mean number of  
39  
40 conditions by age and sex, estimated as a proportion of individuals with the current  
41  
42 characteristics and among the total number of people insured. All results are presented with  
43  
44 95% confidence intervals. Adjustment by age and sex were done using uni- and multivariate  
45  
46 Poisson regression. Prevalence ratios and 95% confidence intervals are presented. The analysis  
47  
48 was performed using STATA version 14.

### 49 50 51 52 53 54 55 **Results**

1  
2  
3 We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total  
4 population as of December 31, 2017). [28,31] Half of the individuals (49.1%, 95% CI 49.0–  
5 49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean  
6  
7  
8 number of conditions was 1.33 (95% CI 1.21-1.33) (Table 1).  
9

10  
11  
12 The prevalence of any chronic condition increased with age, from 18.2% (95% CI 18.0-18.3)  
13 in the youngest age group (0-24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of  
14  
15 45-64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years) (Table 1). In the  
16  
17 youngest age group, 0-24 years, the mean number of conditions was 0.23 (0.22–0.23), and it  
18  
19 increased with age, reaching 3.22 (3.21–3.22) in age 65-84 and 3.92 (3.9–3.94) among those  
20  
21  $\geq 85$  years. The prevalence and number of chronic conditions in 5-year age groups are presented  
22  
23 in Figure 1.  
24  
25  
26  
27  
28

29  
30 The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) among those  
31  
32 younger than 25 years to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq 85$  years. MM  
33  
34 prevalence was higher among women than men, with about every third woman and every fourth  
35  
36 man having MM. At a younger age, the prevalence of MM among women was comparable to  
37  
38 that in men: the prevalence ratio (PR<sub>women/men</sub>) was 1.00 (95% CI 0.99-1.02) in the age group of  
39  
40 0-24 years. It increased gradually from 1.10 (95% CI 1.09-1.10) among those of 25-29 years to  
41  
42 1.27 (95% CI 1.24-1.29) in 65-69 years, and declined again to be more similar between women  
43  
44 and men among those aged 85 years and older (1.09, 95% CI 1.05-1.13).  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**Table 1.** Study population, the prevalence of chronic conditions, mean number of chronic conditions, and MM by age group and sex.

		Population (%)	Prevalence of chronic conditions (95% CI)	Mean number of conditions (95% CI)	Prevalence of MM (95% CI)
Total		1 240 927 (100.0)	49.1 (49.0–49.3)	1.33 (1.32–1.33)	30.1 (30.0–30.2)
Age group (years)	0–24	331 450 (26.7)	18.2 (18.0–18.3)	0.23 (0.22–0.23)	3.5 (3.5–3.6)
	25–44	326 460 (26.3)	34.8 (34.6–35.0)	0.56 (0.55–0.56)	12.6 (12.5–12.7)
	45–64	323 256 (26.0)	65.6 (65.3–65.8)	1.64 (1.63–1.64)	41.0 (40.7–41.2)
	65–84	225 705 (18.2)	85.6 (85.2–85.9)	3.22 (3.21–3.22)	71.1 (70.8–71.5)
	≥85	34 056 (2.7)	90.4 (89.4–91.4)	3.92 (3.9–3.94)	80.4 (79.4–81.3)
Sex	Men	569 087 (45.9)	43.6 (43.4–43.7)	1.06 (1.06–1.07)	24.4 (24.3–24.5)
	Women	671 840 (54.1)	53.8 (53.7–54.0)	1.55 (1.54–1.55)	34.9 (34.7–35.0)
Number of conditions	0	631 299 (50.9)	...	...	...
	1	236 547 (19.1)	...	...	...
	2	128 263 (10.3)	...	...	...
	3	83 751 (6.7)	...	...	...
	4	57 501 (4.6)	...	...	...
	5	39 159 (3.2)	...	...	...
	6	25 567 (2.1)	...	...	...
	7	16 259 (1.3)	...	...	...
	≥8	22 581 (1.8)	...	...	...

1  
2  
3 /Figure 1 here/  
4  
5

6 **Figure 1.** Prevalence of chronic conditions and multimorbidity (in numbers) by 5-year age  
7 groups.  
8  
9

10  
11  
12  
13  
14 The prevalence of the 10 most common chronic conditions in men and women by age group is  
15 shown in Figure 2, and the prevalence of all chronic conditions in the study (in the total  
16 population and among MM patients) in the Supplementary Appendix, Table 1. Hypertension  
17 was the most frequent chronic condition in the three oldest age groups for both men and women.  
18 Hypertension affects one in four individuals (24.5 %) in the total population and about two-  
19 thirds (67.4%) among MM patients.  
20  
21  
22

23  
24  
25  
26  
27  
28  
29 Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3%  
30 among MM patients. Chronic pain was defined according to Barnett, et al. [1] as chronic pain  
31 associated with selected physical conditions such as osteoarthritis and low back pain  
32 (Supplementary appendix, Table 1). The prevalence of painful conditions increases in older age  
33 as does the prevalence of cardiovascular diseases and conditions (e.g., atrial fibrillation,  
34 ischaemic heart disease, and heart failure).  
35  
36  
37

38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients.

The conditions with prevalence over 10% among MM patients included diabetes, sleep disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%). Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In

1  
2  
3 younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions  
4  
5 were most frequent.  
6  
7  
8  
9

10  
11 */Figure 2 here/*  
12  
13

14 **Figure 2.** The prevalence of the 10 most common chronic conditions in men and women by  
15  
16 age group.  
17

## 18 19 20 21 22 **Discussion**

23  
24  
25 The disease burden from chronic conditions is high in Estonia. Half of the individuals had at  
26  
27 least one chronic disorder, and one-third had MM. The burden is increasing with age, being  
28  
29 high already among middle-aged population groups (aged 45-64 years), where 66% of  
30  
31 individuals have a prevalent condition. Among those with MM, hypertension was the most  
32  
33 prominent chronic condition, followed by chronic pain and arthritis.  
34  
35

36  
37 Our results were overall very similar to the results of global and regional studies. A recent  
38  
39 systematic review and meta-analysis of observational studies [22] calculated an overall 33.1%  
40  
41 pooled prevalence of MM. Still, their estimate of MM for the high-income countries in that  
42  
43 review was 37.9%, whereas our estimate of 30.1% is a bit lower, apparently due to the  
44  
45 methodological differences discussed above. As described earlier in the background, disability-  
46  
47 free life expectancy is low for Estonia, perhaps owing to the relatively high burden of MM.  
48  
49 Comparing our results to the Scottish primary care research, MM was higher in our study  
50  
51 (30.1% compared to 23.2% in Scotland). [1]  
52  
53  
54

55  
56 As for the types of prevalent chronic conditions, our findings converge with several other  
57  
58 studies that identified hypertension, diabetes, asthma, and arthritis as the most prevalent  
59  
60



1  
2  
3 conditions. In a recent Canadian study, the top five chronic conditions of the 17 examined  
4  
5 among those with MM were mood disorders, hypertensive disorders, asthma, arthritis, and  
6  
7 diabetes. [32] Lenzi, et al., found that hypertension, diabetes, and depression were highly  
8  
9 prevalent among Italians. [33] Our national data also concur that morbidity increases with age,  
10  
11 an association that has been demonstrated in other studies as well [1,3,32–34]. In a Canadian  
12  
13 study of self-reported chronic conditions, the prevalence of 3+ conditions increased with age  
14  
15 from 30% in the 45-49-year-old age group to 52% in individuals aged 60-64 years [34]. In  
16  
17 Lithuania, the risk of acquiring an additional chronic condition was found to increase  
18  
19 exponentially from the age of 29 years and stabilize between the age of 51 and 57 years [35,36].  
20  
21  
22

23  
24 Acknowledging the sex gap in health that is characteristic of Eastern Europe, we aimed to assess  
25  
26 the sex-specific differences in MM. We found that in women age 25+, the prevalence of MM  
27  
28 is higher than men, with the largest difference among those aged 65-69 years. This elevated  
29  
30 prevalence of MM among women has been confirmed in some studies [3,34], but not in the  
31  
32 others [32].  
33  
34

35  
36 Some limitations of our study may affect generalizability. First, the definition of a chronic  
37  
38 condition used in our study is contestable. However, we sought to ensure conformance with the  
39  
40 methodologies used in prior research and establish the chronicity of the disease. Thus, the health  
41  
42 care claim or prescription with a specific condition had to be identified at least 2 times during  
43  
44 the period of observation. The second limitation is the heterogenous MM prevalence estimates  
45  
46 due to methodological differences, including the MM definition, the list and grouping of  
47  
48 conditions accounted for, the age range, data source, and collection of data. [37,38] A universal  
49  
50 definition and list of conditions used for MM research do not exist. [38] We attempted to  
51  
52 optimize generalizability by adopting the list from previous research. To allow accurate  
53  
54 estimations of disease burden, and effective disease management and resource distribution, a  
55  
56 standardized operationalization of MM are needed. [1,22] Third, it is possible that some people  
57  
58  
59  
60

1  
2  
3 with chronic conditions did not visit a physician or made only one visit over the study period,  
4 thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database  
5 covers approximately 95% of the population but lacks the data for approximately 5% of  
6 uninsured individuals. [31] However, given that all individuals aged 64 years and older are  
7 covered by health insurance, we acknowledge that a minor ascertainment bias may exist in  
8 younger age groups, as the health data for the uninsured individuals were not available. Fifth,  
9 not all individuals who were insured at the date of observation (December 31, 2017) were  
10 insured during the entire three-year study period, which might result in minor under-  
11 ascertainment among those newly enrolled.  
12  
13

14  
15 One of the strengths of our study is the effort expended to enable comparability with the results  
16 of other studies. We used the list of conditions from previous research [1,29,30,36] with only  
17 minor adjustments to reflect the diagnostic practices. Another strength of our analysis lies in  
18 the use of a data source with 95% nationwide coverage and complete follow-up, free of recall  
19 and social desirability biases. Furthermore, the validity of EHIF data, although established for  
20 financial and not health research purposes, has been tested recently [39] and the study  
21 concluded that these data can be used for monitoring changes in chronic condition prevalence  
22 with a precision sufficient for informing health care policy. Our study thus provides high  
23 validity and generalizability of results allowing inferences to other Eastern European  
24 populations.  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

## 48 **Conclusions**

49  
50  
51 The prevalence of multimorbidity in Estonia is relatively high compared to other European  
52 countries, and higher among women than men. The prevalence of MM increases with age, with  
53 hypertension the most frequent chronic condition, followed by chronic pain, and arthritis. As  
54 the public health infrastructure continues to modernize, efforts must be placed on primary  
55  
56  
57  
58  
59  
60

1  
2  
3 prevention of the conditions which lead to hypertension, such as obesity. The development of  
4 patient-centered, evidence-based treatment recommendations will help align patient and  
5 physician with respect to health goals and the means to achieve these outcomes.  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19

## 20 References

- 21  
22  
23 1 Barnett K, Mercer SSW, Norbury M, *et al.* Epidemiology of multimorbidity and  
24 implications for health care, research, and medical education: a cross-sectional study.  
25 *Lancet* 2012;**6736**:37–43. doi:10.1016/S0140-6736(12)60240-2.THELANCET-D-11-  
26 08270R1  
27  
28  
29  
30  
31  
32 2 Kingston A, Robinson L, Booth H, *et al.* Projections of multi-morbidity in the older  
33 population in England to 2035: estimates from the Population Ageing and Care  
34 Simulation (PACSim) model. *Age Ageing* 2018;**47**:374–80. doi:10.1093/ageing/afx201  
35  
36  
37  
38  
39  
40 3 Van Oostrom SH, Gijzen R, Stirbu I, *et al.* Time trends in prevalence of chronic  
41 diseases and multimorbidity not only due to aging: Data from general practices and  
42 health surveys. *PLoS One* 2016;**11**:e0160264. doi:10.1371/journal.pone.0160264  
43  
44  
45  
46  
47  
48 4 Bahler C, Huber CA, Brungger B, *et al.* Multimorbidity, health care utilization and  
49 costs in an elderly community-dwelling population: A claims data based observational  
50 study. *BMC Health Serv Res* 2015;**15**:23. doi:10.1186/s12913-015-0698-2  
51  
52  
53  
54  
55 5 van Oostrom SH, Picavet HSJ, de Bruin SR, *et al.* Multimorbidity of chronic diseases  
56 and health care utilization in general practice. *BMC Fam Pr* 2014;**15**:1–9.  
57  
58  
59  
60  
doi:10.1186/1471-2296-15-61

- 1  
2  
3 6 Quinaz Romana G, Kislaya I, Cunha Gonçalves S, *et al.* Healthcare use in patients with  
4 multimorbidity. *Eur J Public Health* Published Online First: 25 June 2019.  
5  
6 doi:10.1093/eurpub/ckz118  
7  
8  
9  
10 7 Nielsen CR, Halling A, Andersen-Ranberg K. Disparities in multimorbidity across  
11 Europe – Findings from the SHARE Survey. *Eur Geriatr Med* 2017;**8**:16–21.  
12  
13 doi:10.1016/J.EURGER.2016.11.010  
14  
15  
16  
17 8 Aminisani N, Stephens C, Allen J, *et al.* Socio-demographic and lifestyle factors  
18 associated with multimorbidity in New Zealand. *Epidemiol Health* 2020;**42**:e2020001.  
19  
20 doi:10.4178/epih.e2020001  
21  
22  
23  
24 9 Ashworth M, Durbaba S, Whitney D, *et al.* Journey to multimorbidity: Longitudinal  
25 analysis exploring cardiovascular risk factors and sociodemographic determinants in an  
26 urban setting. *BMJ Open* 2019;**9**. doi:10.1136/bmjopen-2019-031649  
27  
28  
29  
30  
31  
32  
33 10 Nunes BP, Batista SRR, Andrade FB de, *et al.* Multimorbidity: The Brazilian  
34 Longitudinal Study of Aging (ELSI-Brazil). *Rev Saude Publica* 2018;**52Suppl 2**:10s.  
35  
36 doi:10.11606/S1518-8787.2018052000637  
37  
38  
39  
40 11 Flores T, Rodrigues AP, Neves R, *et al.* The Risk of Multimorbidity Associated with  
41 Overweight and Obesity: Data from the Brazilian National Health Survey 2013. *J Obes*  
42  
43  
44  
45  
46  
47  
48  
49 12 Wikström K, Lindström J, Harald K, *et al.* Clinical and lifestyle-related risk factors for  
50 incident multimorbidity: 10-year follow-up of Finnish population-based cohorts 1982-  
51  
52  
53  
54  
55  
56 13 Fortin M, Soubhi H, Hudon C, *et al.* Multimorbidity's many challenges. *BMJ*  
57  
58  
59  
60  
2007;**334**:1016–7. doi:10.1136/bmj.39201.463819.2C

- 1  
2  
3 14 Hurst JR, Agarwal G, Van Boven JFM, *et al.* Critical review of multimorbidity  
4  
5 outcome measures suitable for low-income and middle-income country settings:  
6  
7 Perspectives from the Global Alliance for Chronic Diseases (GACD) researchers. *BMJ*  
8  
9 *Open* 2020;**10**:e037079. doi:10.1136/bmjopen-2020-037079  
10  
11  
12  
13 15 Atun R, Gurol-Urganci I, Hone T, *et al.* Shifting chronic disease management from  
14  
15 hospitals to primary care in Estonian health system: analysis of national panel data. *J*  
16  
17 *Glob Health* 2016;**6**. doi:10.7189/JOGH.06.020701  
18  
19  
20  
21 16 Chudasama Y V., Gillies CL, Appiah K, *et al.* Multimorbidity and SARS-CoV-2  
22  
23 infection in UK Biobank. *Diabetes Metab Syndr* 2020;**14**:775.  
24  
25 doi:10.1016/J.DSX.2020.06.003  
26  
27  
28 17 M H, L J, R A, *et al.* The Association between Presence of Comorbidities and COVID-  
29  
30 19 Severity: A Systematic Review and Meta-Analysis. *Cerebrovasc Dis* 2021;**50**:132–  
31  
32 40. doi:10.1159/000513288  
33  
34  
35  
36 18 Thakur B, Dubey P, Benitez J, *et al.* A systematic review and meta-analysis of  
37  
38 geographic differences in comorbidities and associated severity and mortality among  
39  
40 individuals with COVID-19. *Sci Reports* 2021 111 2021;**11**:1–13. doi:10.1038/s41598-  
41  
42 021-88130-w  
43  
44  
45  
46 19 Clark A, Jit M, Warren-Gash C, *et al.* Global, regional, and national estimates of the  
47  
48 population at increased risk of severe COVID-19 due to underlying health conditions in  
49  
50 2020: a modelling study. *Lancet Glob Heal* 2020;**8**:e1003–17. doi:10.1016/S2214-  
51  
52 109X(20)30264-3  
53  
54  
55  
56 20 Fernández-Niño JA, Guerra-Gómez JA, Idrovo AJ. Multimorbidity patterns among  
57  
58 COVID-19 deaths: proposal for the construction of etiological models. *Rev Panam*  
59  
60 *Salud Pública* 2020;**44**. doi:10.26633/RPSP.2020.166

- 1  
2  
3 21 Sathanapally H, Sidhu M, Fahami R, *et al.* Priorities of patients with multimorbidity  
4 and of clinicians regarding treatment and health outcomes: A systematic mixed studies  
5 review. *BMJ Open*. 2020;**10**:e033445. doi:10.1136/bmjopen-2019-033445  
6  
7  
8  
9  
10  
11 22 Nguyen H, Manolova G, Daskalopoulou C, *et al.* Prevalence of multimorbidity in  
12 community settings: A systematic review and meta-analysis of observational studies. *J*  
13 *Comorbidity* 2019;**9**:2235042X1987093. doi:10.1177/2235042x19870934  
14  
15  
16  
17  
18 23 Dicker D, Nguyen G, Abate D, *et al.* Global, regional, and national age-sex-specific  
19 mortality and life expectancy, 1950–2017: a systematic analysis for the Global Burden  
20 of Disease Study 2017. *Lancet* 2018;**392**:1684–735. doi:10.1016/S0140-  
21  
22  
23  
24  
25 6736(18)31891-9  
26  
27  
28 24 Life expectancy. TE75 Disabil. Free life Expect. by sex age Gr. 2020.  
29  
30  
31 25 Estonian health care system | Estonian Health Insurance Fund.  
32  
33 2021. <https://www.haigekassa.ee/en/people/health-care-services/estonian-health-care->  
34  
35 system (accessed 12 Jul 2021).  
36  
37  
38  
39 26 Lai, T; Knai C. Chapter 5: Estonia. In: *Assessing Chronic Disease Management in*  
40 *European Health Systems: Country reports*.  
41  
42  
43  
44 27 Silina V, Kalda R. Challenges for clinical practice and research in family medicine in  
45 reducing the risk of chronic diseases. Notes on the EGPRN Spring Conference 2017 in  
46 Riga. *Eur J Gen Pract* 2018;**24**:112–7. doi:10.1080/13814788.2018.1429594  
47  
48  
49  
50  
51 28 Estonian Health Insurance Fund - Eesti Haigekassa. Annu. Rep.  
52  
53 2017. <https://www.haigekassa.ee/>  
54  
55  
56  
57 29 Van Den Bussche H, Koller D, Kolonko T, *et al.* Which chronic diseases and disease  
58 combinations are specific to multimorbidity in the elderly? Results of a claims data  
59  
60

- 1  
2  
3 based cross-sectional study in Germany. *BMC Public Health* 2011;**11**:101.  
4  
5 doi:10.1186/1471-2458-11-101  
6  
7  
8  
9 30 Schäfer I, von Leitner E-C, Schön G, *et al.* Multimorbidity Patterns in the Elderly: A  
10 New Approach of Disease Clustering Identifies Complex Interrelations between  
11 Chronic Conditions. *PLoS One* 2010;**5**:e15941. doi:10.1371/journal.pone.0015941  
12  
13  
14  
15  
16 31 Statistics Estonia. PO021: Population, 1 January by sex, year and age group.  
17 2017. <https://www.stat.ee/database> (accessed 26 Jul 2019).  
18  
19  
20  
21 32 Ryan BL, Bray Jenkyn K, Shariff SZ, *et al.* Beyond the grey tsunami: a cross-sectional  
22 population-based study of multimorbidity in Ontario. *Can J Public Heal*  
23 2018;**109**:845–54. doi:10.17269/s41997-018-0103-0  
24  
25  
26  
27  
28 33 Lenzi J, Avaldi VM, Rucci P, *et al.* Burden of multimorbidity in relation to age, gender  
29 and immigrant status: A cross-sectional study based on administrative data. *BMJ Open*  
30 2016;**6**:e012812. doi:10.1136/bmjopen-2016-012812  
31  
32  
33  
34  
35  
36 34 Sakib MN, Shooshtari S, St John P, *et al.* The prevalence of multimorbidity and  
37 associations with lifestyle factors among middle-aged Canadians: An analysis of  
38 Canadian Longitudinal Study on Aging data. *BMC Public Health* 2019;**19**:1–13.  
39  
40  
41  
42  
43  
44  
45  
46 35 Jurevičienė E, Onder G, Visockienė, *et al.* Does multimorbidity still remain a matter of  
47 the elderly: Lithuanian national data analysis. *Health Policy (New York)*  
48 2018;**122**:681–6. doi:10.1016/j.healthpol.2018.03.003  
49  
50  
51  
52  
53  
54 36 Navickas R, Visockiene, Puronaite R, *et al.* Prevalence and structure of multiple  
55 chronic conditions in Lithuanian population and the distribution of the associated  
56 healthcare resources. *Eur J Intern Med* 2015;**26**:160–8. doi:10.1016/j.ejim.2015.02.015  
57  
58  
59  
60

- 1  
2  
3 37 Diederichs C, Berger K, Bartels DB. The measurement of multiple chronic diseases - A  
4 systematic review on existing multimorbidity indices. *Journals Gerontol - Ser A Biol*  
5 *Sci Med Sci* 2011;**66 A**:301–11. doi:10.1093/gerona/glq208  
6  
7  
8  
9  
10 38 Fortin M, Stewart M, Poitras M-E, *et al.* A systematic review of prevalence studies on  
11 multimorbidity: toward a more uniform methodology. *Ann Fam Med* 2012;**10**:142–51.  
12 doi:10.1370/afm.1337  
13  
14  
15  
16  
17 39 Otsa K, Talli S, Harding P, *et al.* Administrative database as a source for assessment of  
18 systemic lupus erythematosus prevalence: Estonian experience. *BMC Rheumatol*  
19 2019;**3**:1–6. doi:10.1186/s41927-019-0074-7  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



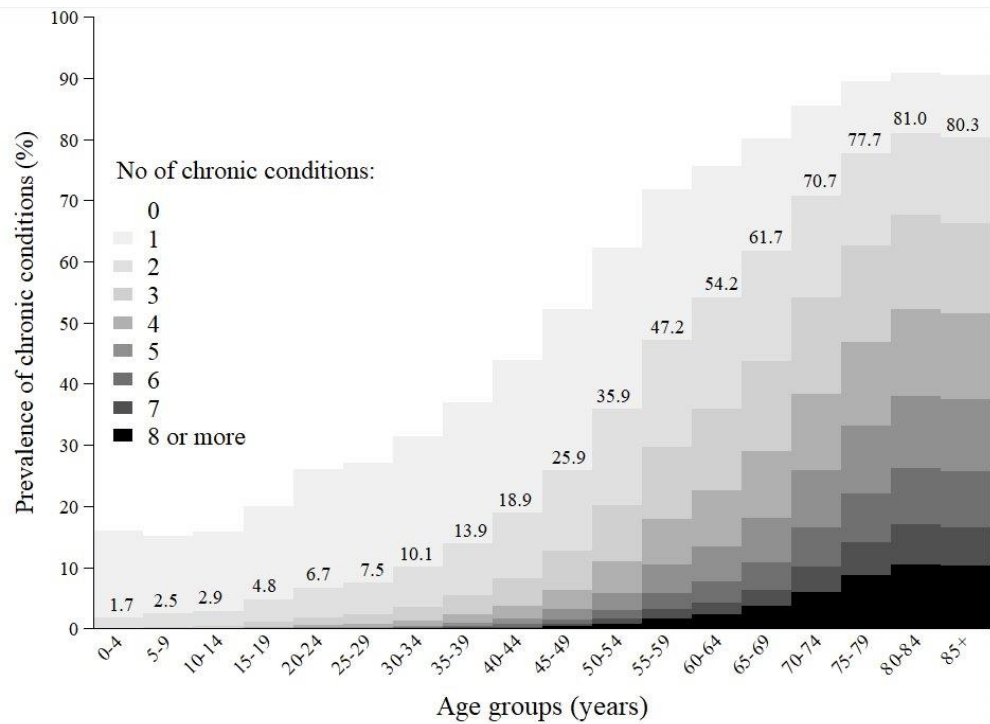


Figure 1. Prevalence of chronic conditions and multimorbidity (in numbers) by 5-year age groups.

249x181mm (96 x 96 DPI)

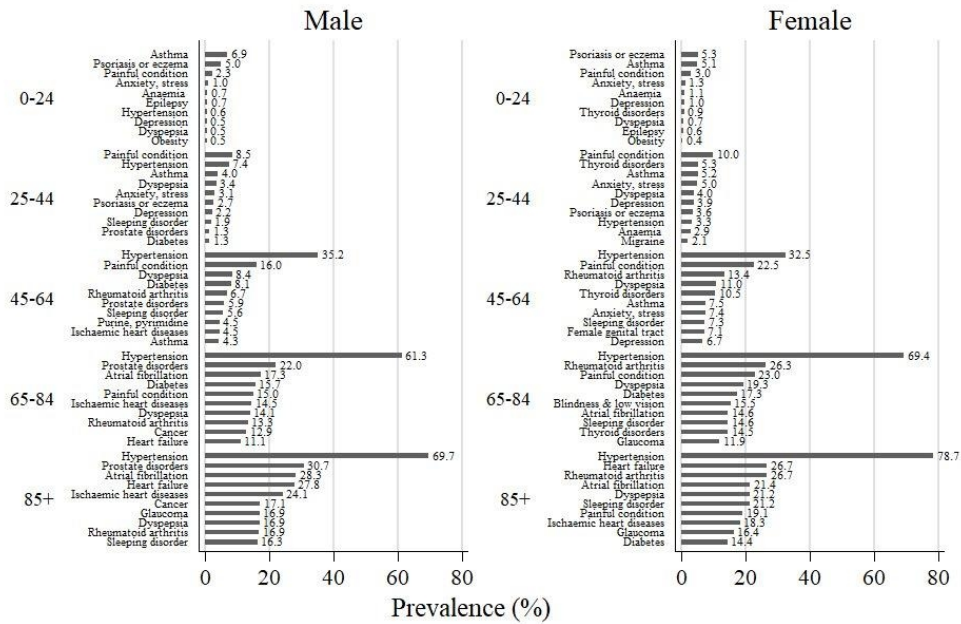


Figure 2. The prevalence of the 10 most common chronic conditions in men and women by age group.

251x167mm (96 x 96 DPI)

1  
2  
3 **Supplementary appendix.**  
4  
5

6 **Table 1.** List and prevalence of chronic conditions (in the total population and among MM  
7 patients) in the study.  
8  
9

10  
11  
12

Disorder	ICD-10 codes	Prevalence (%)	
		Total	among MM patients
Hypertension	[I10–I15]	24.49	67.40
Painful condition	[G44, R51] [M25.5] [M42–M54] [M77] [M79.1–79.9] [R10.1– 10.4] [R07.0–07.4] [R30] [R52.0] [R52.1] [R52.2] [R52.9] [S22.0] [S22.1] [S12] [S32] [S72]	12.37	32.30
Rheumatoid arthritis, other inflammatory arthropathies and systemic connective tissue disorders	[M30–M36] [M05–M09, M79.0] [M91] [M15– M19]	7.65	23.56
Dyspepsia	[K21, K25–K30]	7.41	22.12
Asthma	[J45–J46] [J30]	5.91	12.94
Diabetes	[E10–14]	5.62	17.69
Sleeping disorders	[F51, G47]	5.11	15.80
Thyroid disorders	[E01–05, E06.1–.9, E07]	4.72	12.93

13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Atrial fibrillation	[I44–I45, I47–I49]	4.7	14.99
Psoriasis or eczema	[L20] [L23] [L28] [L29] [L40] [L50] [L56]	4.17	8.25
Anxiety and other neurotic, stress- related, and somatoform disorders	[F40–F43, F45, F48]	4.09	11.20
Blindness and low vision	[H17–18, H25–28, H31, H33, H34.1–.9, H35– H36, H43, H47, H54]	3.62	11.39
Ischaemic heart diseases	[I20–I25]	3.44	11.27
Depression	[F32–F33]	3.32	9.21
Heart failure	[I50]	3.24	10.65
Glaucoma	[H40–H42]	3.17	9.86
Cancer **	C00–97, D00–09, D37– 48	3.05	8.84
Prostate disorders	[N40] [N41]	2.52	7.33
Disorders of purine and pyrimidine metabolism	[E79, M10]	2.07	6.56
Anemia	[D50–59, D60–D61, D63–64]	1.88	4.75
Obesity	[E66]	1.64	5.11

1				
2				
3	Noninflammatory	[N81] [N93] [N95]	1.57	4.45
4				
5	disorders of the			
6				
7	female genital tract			
8				
9				
10	Neuropathies	[G50–G64]	1.56	4.78
11				
12	Disorders of	[H81, H82, R42]	1.52	4.75
13				
14	vestibular function			
15				
16				
17	Stroke and transient	[I60–66, I69, G45, I67.2]	1.45	4.71
18				
19	ischaemic attack			
20				
21	Chronic obstructive	[J40–J44]	1.4	4.42
22				
23	pulmonary			
24				
25	disease/bronchitis			
26				
27				
28	Peripheral vascular	[I73.0] [I70]	0.93	2.98
29				
30	disease			
31				
32				
33	Osteoporosis	[M80, M81, M82]	0.89	2.83
34				
35	Schizophrenia or	[F20–F29] [F31]	0.85	1.75
36				
37	bipolar disorder			
38				
39				
40	Epilepsy	[G40–G41]	0.84	1.84
41				
42	Hearing loss	[H90–H91]	0.74	2.17
43				
44	Migraine	[G43]	0.72	1.57
45				
46				
47	Cholelithiasis /	[K80, K81.1]	0.5	1.47
48				
49	Cholecystitis			
50				
51	Dementia	[F00, F01, F02, F03,	0.48	1.48
52		F05.1, G30, G31, R54]		
53				
54				
55				
56	Chronic kidney	[N18–N19]	0.47	1.57
57				
58	disease			
59				
60				

Mental and behavioral disorders due to use of alcohol	[F10]	0.43	1.16
Chronic liver disease	[K70–74, K76]	0.42	1.31
Valve disorders	[I34–I37]	0.37	1.20
Viral Hepatitis	[B18]	0.36	1.02
Irritable bowel syndrome	[K58]	0.33	0.97
Parkinson's disease	[G20, G21, G22]	0.31	0.97
HIV	[Z21, B20–B24]	0.30	0.70
disorders of the urinary system	[N39.3, N39.4, R32]	0.27	0.84
Calculus of kidney and ureter	[N20]	0.26	0.76
Inflammatory bowel	[K50–K52]	0.24	0.52
Chronic sinusitis	[J32]	0.21	0.57
Diverticular disease of the intestine	[K57]	0.2	0.63
Other psychoactive substance misuses	[F11–19]	0.16	0.45
Treated constipation	[K59.0]	0.16	0.42
Multiple sclerosis	[G35]	0.12	0.26
Coagulation defects	[D65-D69]	0.08	0.22
Learning disability	[F81]	0.06	0.08
Anorexia or bulimia	[F50]	0.05	0.13

1				
2				
3	Bronchiectasis	[J47]	0.05	0.16
4				
5	Celiac disease	[K90.0]	0.03	0.07
6				
7				

8 \* [ ] repetition of diagnostic codes within the boundaries of brackets

9  
10 \*\* Each cancer diagnosis code counted separately

11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For peer review only

## STROBE Statement—checklist of items that should be included in reports of observational studies

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Title: population-based cross-sectional study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	Abstract provides a short summary
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6	MM is a growing global health problem, the data are scarce regarding the prevalence of MM in Eastern Europe.
Objectives	3	State specific objectives, including any prespecified hypotheses	7	A definitive, population-based assessment of MM prevalence by age and gender is needed to inform the continued restructuring of the health care system to accommodate the growing proportion of these patients.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	7-8	Key elements of the cross-sectional study were described in the Methods section.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8	We obtained data (year and month of birth, sex, dates for health claims, type of care, provided services, all diagnosis codes on claims, and the date and diagnosis code on prescriptions) from the Estonian Health Insurance Fund (EHIF) which is the sole health insurance provider in Estonia covering approximately 95% of the population. We included all subjects from the EHIF database from January 1, 2015, through December 31, 2017. To identify all patients with chronic physical and mental conditions, the ICD-10



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

				diagnosis codes for main and other (accompanying) diagnoses were used. For the prevalence analysis, we selected 55 conditions, whereas the list was based on previous MM research to enable comparability. We constructed the case definition for a chronic condition as the presence of at least two diagnosis codes at least 6 weeks apart for the same condition during the study period January 1, 2015, through December 31, 2017.
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	7-8, Supplementary appendix	We included all subjects from the EHIF database from January 1, 2015, through December 31, 2017. We constructed the case definition for a chronic condition as follows: the presence of at least two diagnosis codes at least 6 weeks apart for the same condition (i.e., matching ICD-10 category) during the study period January 1, 2015, through December 31, 2017. This definition enabled us to include chronic conditions while excluding patients with previously diagnosed but improved conditions (e.g., conditions where remission is possible, such as epilepsy, asthma, pain, or depression). The 6-week interval between the diagnoses reduced double-counting and over-ascertainment of cases. The inclusion of prescriptions in the data query allowed us to identify patients whose claims profile included diagnosis codes for only one condition, whereas their prescription history identified treatment for multiple conditions. The ascertainment period was extended to 3 years

				because some patients visit their physician infrequently.
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed		
		Case-control study—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9	The outcomes were the prevalence of chronic disorders, multimorbidity (MM), and the mean number of disorders by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8	The prevalence of conditions and MM were assessed using the population-based health data (health claims, prescriptions) from EHIF
Bias	9	Describe any efforts to address potential sources of bias	14-15	Selection and measurement bias were possible. First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

For peer review only

We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

---

Study size	10	Explain how the study size was arrived at	7	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017)
------------	----	---	---	--

---

Continued on next page

1				
2	Quantitative	11	Explain how quantitative variables were handled in the analyses. If applicable, describe	13 (Table 1)
3	variables		which groupings were chosen and why	
4				We assessed the prevalence of chronic
5				conditions, mean number of chronic conditions,
6	Statistical	12	(a) Describe all statistical methods, including those used to control for confounding	9
7	methods			
8				The outcomes were the prevalence of chronic
9				disorders, MM, and the mean number of
10				disorders by age and sex, estimated as a
11				proportion of individuals with the current
12				characteristics and among the total number of
13				people insured. All results are presented with
14				95% confidence intervals. Adjustment by age and
15				sex were done using uni- and multivariate
16				Poisson regression. Prevalence ratios and 95%
17				confidence intervals are presented.
18			(b) Describe any methods used to examine subgroups and interactions	13 (Table 1)
19				
20				Prevalence ratios (by age group and sex) and
21				95% confidence intervals are presented.
22			(c) Explain how missing data were addressed	
23				It was not possible to identify any missing health
24				claims or prescriptions from the EHIF data, but
25				we assume that the impact of missing data on
26				results is small as the health care institutions are
27				interested in submitting the claims for
28				reimbursement
29			(d) Cohort study—If applicable, explain how loss to follow-up was addressed	
30			Case-control study—If applicable, explain how matching of cases and controls was	
31			addressed	
32			Cross-sectional study—If applicable, describe analytical methods taking account of	
33			sampling strategy	
34			(e) Describe any sensitivity analyses	
35				No sensitivity analyses were performed
36	Results			
37	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially	
38			eligible, examined for eligibility, confirmed eligible, included in the study, completing	
39			follow-up, and analysed	
40				This was a cross-sectional study where all claims
41				and prescriptions of all insured individuals were
42				collected at a single time point.

		(b) Give reasons for non-participation at each stage		This was a cross-sectional study where all claims and prescriptions of all insured individuals were collected at a single time point.
		(c) Consider use of a flow diagram		No flow diagram was used as all data were collected and analysed at a single time point.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM.
		(b) Indicate number of participants with missing data for each variable of interest		It was not possible to identify any missing health claims or prescriptions from the EHIF data, but we assume that the impact of missing data on results is small as the health care institutions are interested in submitting the claims for reimbursement
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)		This was a cross-sectional study.
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time		This was a cross-sectional study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		This was a cross-sectional study.
		Cross-sectional study—Report numbers of outcome events or summary measures	9	Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21-1.33)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10, 13 (Table 1, Figure 1)	We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one

For peer review only

or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21–1.33). The prevalence of chronic conditions increased with age, from 18.2% (95% CI 18.0–18.3) in the youngest age group (0–24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of 45–64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years). In the youngest age group, 0–24 years, the mean number of conditions was 0.23 (0.22–0.23), and it increased with age, reaching 3.22 (3.21–3.22) in age 65–84 and 3.92 (3.9–3.94) among those  $\geq 85$  years. The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) in the age of 0–24 to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq 85$  years. MM prevalence was higher among women than men, with about every third woman and every fourth man having MM. At a younger age, the prevalence of MM among women was comparable to that in men: the prevalence ratio (PR women/men) was 1.00 (95% CI 0.99–1.02) in the age group of 0–24 years. It increased gradually from 1.10 (95% CI 1.09–1.10) among those of 25–29 years to 1.27 (95% CI 1.24–1.29) in 65–69 years, and declined again to be more similar between women and men among those aged 85+ (1.09, 95% CI 1.05–1.13).

---

(b) Report category boundaries when continuous variables were categorized

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

This was a prevalence study.

---

Continued on next page

---

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13, Figure 2, Supplementary appendix	<p>Hypertension was the most frequent chronic condition in the three oldest age groups for both men and women. Hypertension affects one in four individuals (24.5 %) in the total population and about two-thirds (67.4%) among MM patients. Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3% among MM patients. Chronic pain was defined according to Barnett, et al. as chronic pain associated with selected physical conditions such as osteoarthritis and low back pain. The prevalence of painful conditions increases in older age as does the prevalence of cardiovascular diseases and conditions.</p> <p>Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients. The conditions with prevalence over 10% among MM patients included diabetes, sleep disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%). Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions were most frequent.</p>
----------------	----	--	---	---

---

---

 Discussion
 

---

Key results	18	Summarise key results with reference to study objectives	13	The disease burden from chronic conditions is high in Estonia. Half of the individuals had at least one chronic disorder, and one-third had MM. The burden is increasing with age, being high already among middle-aged population groups (aged 45-64 years), where 82/3 of individuals have a prevalent condition. Among those with MM, hypertension is the most prominent chronic condition, followed by chronic pain and arthritis.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15	First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist. [30] We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

For peer review only

people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

Interpretation 20 Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence 15

The prevalence of multimorbidity in Estonia is relatively high compared to other European countries, and higher among women than men. The prevalence of MM increases with age, with hypertension by far the most frequent chronic condition, followed by chronic pain, and arthritis. As the public health infrastructure continues to modernize, efforts must be placed on primary prevention of the conditions which lead to hypertension, such as obesity. The development of patient-centered, evidence-based treatment recommendations will help align patient and physician with respect to health goals and the means to achieve these outcomes.

1				
2	Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25	Other information			
26	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Prevalence of chronic conditions and multimorbidity in Estonia: a population-based cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-049045.R2
Article Type:	Original research
Date Submitted by the Author:	26-Aug-2021
Complete List of Authors:	Jürisson, Mikk; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health; University of Tartu Pisarev, Heti; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Uusküla, Anneli; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Lang, Katrin; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Oona, M; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health Kalda, Ruth; Tartu Ülikool Arstiteaduskond, Institute of Family Medicine and Public Health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Epidemiology, General practice / Family practice
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), PUBLIC HEALTH, INTERNAL MEDICINE

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1  
2  
3 **Title page**  
4  
5  
6  
7  
8

9 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
10 **cross-sectional study**  
11  
12  
13  
14  
15  
16

17 Mikk Jürisson, Heti Pisarev, Anneli Uusküla, Katrin Lang, Marje Oona, Ruth Kalda  
18  
19  
20  
21  
22

23  
24 Corresponding author: Mikk Jürisson, Institute of Family Medicine and Public Health,  
25 University of Tartu, Ravila 19, 50411 Tartu, Estonia, [mikkjurisson@gmail.com](mailto:mikkjurisson@gmail.com)  
26  
27

28  
29 Heti Pisarev, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
30  
31 Estonia  
32

33  
34 Anneli Uusküla, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
35  
36 Estonia  
37

38  
39 Katrin Lang, Institute of Family Medicine and Public Health, University of Tartu, Tartu,  
40  
41 Estonia  
42

43  
44 Marje Oona, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
45  
46

47  
48 Ruth Kalda, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia  
49

50  
51 Word count: 2975  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 **Prevalence of chronic conditions and multimorbidity in Estonia: a population-based**  
4 **cross-sectional study**  
5  
6  
7

8 **Objectives:** Prevalence estimates for specific chronic conditions and multimorbidity (MM) in  
9 Eastern Europe are scarce. This national study estimates the prevalence of MM by age group  
10 and sex in Estonia.  
11  
12  
13

14  
15  
16 **Design:** Population-based cross-sectional study utilizing administrative data.  
17

18  
19 **Setting:** Data were collected on 55 chronic conditions from the Estonian Health Insurance Fund  
20 from 2015-2017. MM was defined as the coexistence of two or more conditions.  
21  
22

23  
24 **Participants:** The Estonian Health Insurance Fund includes data for approximately 95% of the  
25 Estonian population receiving public health insurance.  
26  
27

28  
29 **Primary and secondary outcome measures:** Prevalence and 95% confidence intervals (CI)  
30 for MM stratified by age group and sex.  
31  
32

33  
34 **Results:** Nearly half (49.1%) of the individuals (95% CI 49.0–49.3) had at least one chronic  
35 condition, and 30.1% (95% CI 30.0–30.2) had MM (2 or more chronic conditions). The number  
36 of conditions and the prevalence of MM increased with age, ranging from a MM prevalence of  
37 3.5% (3.5–3.6) in the youngest (0–24 years) to as high as 80.4% (79.4–81.3) in the oldest ( $\geq$ 85  
38 years) age group. Half of all individuals had MM by 60 years, and 75% of the population had  
39 MM by 75 years of age. Women had a higher prevalence of MM (34.9%, 95% CI 34.7–35.0)  
40 than men (24.4%, 95% CI 24.3–24.5). Hypertension was the most frequent chronic condition  
41 (24.5%), followed by chronic pain (12.4%) and arthritis (7.7%).  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52

53  
54 **Conclusions:** Hypertension is an important chronic condition amenable to treatment with  
55 lifestyle and therapeutic interventions. Given the established correlation between uncontrolled  
56 hypertension and exacerbation of other cardiovascular conditions as well as acute illnesses, this  
57  
58  
59  
60

1  
2  
3 most common condition within the context of MM may be suitable for targeted public health  
4 interventions.  
5  
6  
7

### 8 **Strengths and limitations of this study**

- 10 • One of the strengths of our study is the methodological comparability with previous  
11 research.  
12
- 13 • The second strength is the nearly 95% nationwide coverage of our dataset, the validity  
14 of which has been tested and proven.  
15
- 16 • A limitation of our study is the definition of a chronic condition and multimorbidity  
17 used in our study which is contestable in all studies of MM.  
18  
19  
20  
21  
22  
23  
24  
25

### 26 **Data availability**

27  
28 The authors confirm that all data associated with the study are fully available without restriction  
29 from the Estonian Health Insurance Fund at <https://www.haigekassa.ee/en>. The data can be  
30 requested by completing the application at the following address:  
31 <https://ankeet.haigekassa.ee/surveys/?s=4KXEPPFDEKF> or sending a written request to  
32 [info@haigekassa.ee](mailto:info@haigekassa.ee)  
33  
34  
35  
36  
37  
38  
39  
40

### 41 **Ethics approval**

42  
43 The study was conducted in accordance with local data protection regulations. The study was  
44 approved by the Tartu University Research Ethics Committee (280/T-7, 19.2018). The ethics  
45 committee waived the requirement for informed consent for the analysis presented in the  
46 manuscript.  
47  
48  
49  
50  
51  
52  
53

### 54 **Contributors**

55  
56 MJ, RK, HP, AU, and MO conceptualized and designed the study. MJ and HP collected,  
57 managed, and analyzed the data. All co-authors contributed to the interpretation of the findings  
58  
59  
60

1  
2  
3 and drafting of the manuscript. MJ wrote the original draft, and MJ and KL wrote the final  
4  
5 version. HP provided visualizations. All co-authors approved the final version for submission.  
6  
7

### 8 **Funding statement**

9  
10  
11 This work was supported by the Estonian Ministry of Education and Research Grant IUT34-  
12  
13 17.  
14  
15

### 16 **Competing Interests Statement**

17  
18  
19 The authors declare no conflict of interest.  
20  
21

### 22 **Background**

23  
24  
25 The management of patients with MM has become a challenge for healthcare systems as most  
26  
27 individuals with long-term conditions are living with multiple long-term conditions. [1] The  
28  
29 prevalence of MM is increasing along with population aging, [2] but aging is not the only factor  
30  
31 predisposing the population increase in MM [3] and healthcare utilization has experienced a  
32  
33 concomitant increase in response to managing these complex patients. [4–6] In addition to  
34  
35 aging, MM is associated with other sociodemographic factors, such as female sex, lower  
36  
37 education, lower household income, living alone, social deprivation and ethnicity [7–10], as  
38  
39 well as health conditions, such as obesity [11], hypertension, having one chronic condition at  
40  
41 baseline. Behavioral factors like smoking and physical inactivity are also influential. [12]  
42  
43 Having multiple chronic conditions is associated with poor outcomes: patients have a decreased  
44  
45 quality of life, psychological distress, longer hospital stays, more postoperative complications,  
46  
47 a higher cost of care, and higher mortality. [13]  
48  
49  
50  
51  
52

53  
54 The management of patients with MM is a formidable challenge for healthcare systems.  
55  
56 Research in this area is perhaps most urgently needed in low- and middle-income countries  
57  
58 (LMIC) where the burden of multimorbidity is high, the specific distributions and determinants  
59  
60



1  
2  
3 of the disease may differ, and access to care may be impeded by a fragmented healthcare system  
4 which is continuing to modernize and restructure [14]. Although research is beginning to  
5 elucidate the distribution of co-occurring conditions in these countries, the comparability of  
6 findings is limited by methodological differences. This work demonstrates the utility of  
7 administrative data for constructing prevalence estimates, an approach that is particularly  
8 helpful for middle and high-to-middle-income-countries where resource limitations make  
9 administrative data not only immediately useful but also scalable, allowing for rate comparisons  
10 with other countries. In addition, the transition from a hospital-centric system in Estonia  
11 following independence from the Soviet Union was motivated by a desire to strengthen primary  
12 health care and thereby improve population health [15]. Having a set of prevalence estimates  
13 for MM is essential for measuring the ongoing success of this transition, adjusted by the  
14 prevalence of various conditions amenable to outpatient treatment. Finally, and perhaps most  
15 importantly, the SARS-CoV-2 pandemic drew attention to the important contribution of MM  
16 to the need for sound public health measures and rapid identification of effective medical  
17 interventions based on risk stratification. Frailty has been linked to infection [16], severity  
18 [16,17], geographic differences in severity and mortality by MM [18], prompting a renewed  
19 focus on improving global health and access to care, probabilistic modelling [19], the triage of  
20 care and shielding of the most vulnerable [20]. This study presents an important contribution to  
21 this developing literature with a comprehensive set of prevalence estimates for MM in Eastern  
22 Europe.

23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50 MM is a growing global health problem affecting all nations regardless of wealth [21]. A better  
51 understanding of the national or regional epidemiology of MM is necessary to allocate health  
52 care resources and develop treatment strategies that allow clinicians to deliver patient-centered  
53 care that appreciates the potential for competing priorities. [1,21] Furthermore, in the context  
54 of the coronavirus pandemic, the clinician is faced with the challenge of reconciling competing  
55  
56  
57  
58  
59  
60

1  
2  
3 priorities: maintain stable health among those with MM via telemedicine and other access  
4 interventions while preventing the exacerbation of acute SARS-CoV-2 if the patient becomes  
5 infected. Certainly, the time has come for all nations to better support individuals in preventing  
6 or modifying MM in the interest of improved overall health as well as optimizing patient  
7 outcomes following infection. The prevalence of MM has been extensively studied in Western  
8 European countries. For example, in a recent MM prevalence study utilizing a medical practice  
9 database in Scotland, 23.2% of patients were living with multimorbidity. [1] A recent  
10 systematic review and meta-analysis of observational studies [22] found an overall pooled  
11 33.1% prevalence of MM. There was a considerable difference in the pooled estimates of MM  
12 between high and low-income countries, with a prevalence of 37.9% and 29.7%, respectively.  
13 Still, data are scarce regarding the prevalence of MM in Eastern Europe, where life expectancy  
14 is shorter than in Western Europe, particularly among men. The recent Survey of Health,  
15 Ageing, and Retirement in Europe (SHARE) study found that among all European countries,  
16 Eastern and Central Europe had the highest MM prevalence, revealing a remarkable health  
17 inequality across European regions. [7] To illustrate the gap, 70-79-year-old Central and  
18 Eastern Europeans suffer from about the same level of MM as  $\geq 80$ -year old Northern  
19 Europeans. [7] However, the SHARE study is limited to self-reported data among individuals  
20 aged 50 years or more. Given the limited population-based research in Eastern Europe, the use  
21 of administrative health data is necessary to develop more accurate regional MM prevalence  
22 estimates.

23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50 Estonia belongs to the group of Eastern European high-middle income countries with relatively  
51 low life expectancy and a large sex health gap. The life expectancy among Estonian men is 73.8  
52 years (compared to that of 82.1 in Estonian women) and is comparable to male life expectancy  
53 in China (74.5 years), Argentina (73.6 years), and Mexico (72.6 years). Estonian male life  
54 expectancy is markedly shorter than that of regional neighboring countries, such as Finland  
55  
56  
57  
58  
59  
60

1  
2  
3 (78.6 years), Sweden (80.8 years), or France (79.8 years). [23] Disability-free life expectancy  
4 in Estonia is also low, being 52.8 years for men and 55.6 years for women in 2018. [24] The  
5 burden of co-occurring chronic disease, leading to disability and premature death, is an  
6 important contributor to this reduced life expectancy in Estonia.  
7  
8  
9

10  
11  
12 In Estonia, national public health insurance covers approximately 95% of the population.  
13 Family physicians are responsible for providing a core package of health services to the  
14 individuals registering with the practice for care. [25] Following Estonian independence in  
15 1992, important steps were implemented to modernize the health system and improve  
16 coordination and access to primary care. In particular, access to family physicians was  
17 expanded before streamlining the hospital network, centralizing specialty care, and establishing  
18 a pharmaceutical formulary and treatment guidelines. [26] One of the stated goals of  
19 restructuring was to provide better chronic disease management, coordinated by the general  
20 practitioner, for whom a bonus system was implemented in 2005 to take on these duties.  
21 Although management guidelines and quality standards have been implemented for specific  
22 chronic conditions, this process has been slow to consider multimorbidity. [26] Family  
23 physicians in Estonia lack clear evidence-based standards for the management of patients with  
24 multiple chronic diseases, and the applicability of a single evidence-based guideline to MM is  
25 limited and can be problematic. [27]  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45

46 A definitive, population-based assessment of MM prevalence by age and between males and  
47 females is needed to inform the continued restructuring of the health care system to  
48 accommodate the growing proportion of these patients.  
49  
50  
51

## 52 53 **Methods**

54  
55  
56 For this population-based cross-sectional study, we obtained data from the Estonian Health  
57 Insurance Fund (EHIF) which is essentially the sole health insurance provider in Estonia  
58  
59  
60

1  
2  
3 covering approximately 95% of the population. [28] We included all subjects from the EHIF  
4 database from January 1, 2015, through December 31, 2017. The data abstraction from the  
5 EHIF database included year and month of birth, sex assigned at birth, dates for health claims,  
6 type of care (in- and outpatient care, rehabilitation, nursing care, etc.), services provided, all  
7 diagnosis codes on claims, and the date and diagnosis code on prescriptions. Study subjects  
8 were assigned a unique identifier decoupled from personal identification information to enable  
9 longitudinal tracking of care while maintaining patient privacy.

10  
11 To identify all patients with chronic physical and mental conditions, the ICD-10 diagnosis codes  
12 for main and other (accompanying) diagnoses were used. For the chronic physical and mental  
13 conditions analysis, we selected 55 conditions (Supplementary appendix, Table 1). The list of  
14 conditions was based on previous MM research to enable comparability [1,29,30] and adjusted  
15 by the authors (MJ, RK, AU, MO, HP) for use in Estonia. According to Barnett, et al., we  
16 included morbidities that were likely to be chronic, defined as having a significant impact on  
17 patients over at least the most recent year, defined in terms of the need for chronic treatment,  
18 reduced function, reduced quality of life, and risk of future morbidity and mortality. [1]

19  
20 We constructed the case definition for a chronic condition as follows: the presence of at least  
21 two diagnosis codes at least 6 weeks apart for the same condition (i.e., matching ICD-10  
22 category) during the study period January 1, 2015, through December 31, 2017 (Supplementary  
23 Appendix, Table 1). This definition enabled us to include chronic conditions while excluding  
24 patients with previously diagnosed but improved conditions (e.g., conditions where remission  
25 is possible, such as epilepsy, asthma, pain, or depression). The 6-week interval between the  
26 diagnoses reduced over-ascertainment of cases. The inclusion of prescriptions in the data query  
27 allowed us to identify patients whose claims profile included diagnosis codes for only one  
28 condition, whereas their prescription history identified treatment for multiple conditions.

1  
2  
3 The ascertainment period was extended to 3 years because some patients visit their physician  
4 infrequently. For instance, 17% of publicly insured individuals had no evidence of a visit to a  
5 family physician and 37% had no evidence of a visit to a specialist in 2017. [28] If we had  
6  
7  
8  
9  
10 elected a shorter study period, we might have inadvertently excluded the MM profile of nearly  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

The ascertainment period was extended to 3 years because some patients visit their physician infrequently. For instance, 17% of publicly insured individuals had no evidence of a visit to a family physician and 37% had no evidence of a visit to a specialist in 2017. [28] If we had elected a shorter study period, we might have inadvertently excluded the MM profile of nearly 20% of the population. Any correlation between lower health care utilization and sociodemographic characteristics that impede access (such as lack of paid time off from work for illness, lack of transportation in rural areas, etc.) would bias our claims-driven prevalence estimates to undercount MM among individuals facing these access challenges. The prevalence of chronic conditions among all publicly insured individuals was estimated on 31 December 2017 among all persons who were publicly insured at that time.

The study procedures were conducted according to local data protection regulations. The study was approved by the Tartu University Research Ethics Committee.

### **Patient and public involvement**

This was an administrative claims study, and as such there were no patients enrolled in this study.

### **Statistical analysis**

The outcomes were the prevalence of chronic conditions, MM, and the mean number of conditions by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured. All results are presented with 95% confidence intervals. Adjustment by age and sex were done using uni- and multivariate Poisson regression. Prevalence ratios and 95% confidence intervals are presented. The analysis was performed using STATA version 14.

### **Results**

1  
2  
3 We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total  
4 population as of December 31, 2017). [28,31] Half of the individuals (49.1%, 95% CI 49.0–  
5 49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean  
6  
7  
8 number of conditions was 1.33 (95% CI 1.21-1.33) (Table 1).  
9

10  
11  
12 The prevalence of any chronic condition increased with age, from 18.2% (95% CI 18.0-18.3)  
13 in the youngest age group (0-24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of  
14  
15 45-64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years) (Table 1). In the  
16  
17 youngest age group, 0-24 years, the mean number of conditions was 0.23 (0.22–0.23), and it  
18  
19 increased with age, reaching 3.22 (3.21–3.22) in age 65-84 and 3.92 (3.90–3.94) among those  
20  
21  $\geq 85$  years. The prevalence and number of chronic conditions in 5-year age groups are presented  
22  
23 in Figure 1.  
24  
25  
26  
27  
28

29  
30 The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) among those  
31  
32 younger than 25 years to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq 85$  years. MM  
33  
34 prevalence was higher among women than men, with about every third woman and every fourth  
35  
36 man having MM. At a younger age, the prevalence of MM among women was comparable to  
37  
38 that in men: the prevalence ratio (PR<sub>women/men</sub>) was 1.00 (95% CI 0.99-1.02) in the age group of  
39  
40 0-24 years. It increased gradually from 1.10 (95% CI 1.09-1.10) among those of 25-29 years to  
41  
42 1.27 (95% CI 1.24-1.29) in 65-69 years, and declined again to be more similar between women  
43  
44 and men among those aged 85 years and older (1.09, 95% CI 1.05-1.13).  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**Table 1.** Study population, the prevalence of chronic conditions, mean number of chronic conditions, and MM by age group and sex.

		Population (%)	Prevalence of chronic conditions (95% CI)	Mean number of conditions (95% CI)	Prevalence of MM (95% CI)
Total		1 240 927 (100.0)	49.1 (49.0–49.3)	1.33 (1.32–1.33)	30.1 (30.0–30.2)
Age group (years)	0–24	331 450 (26.7)	18.2 (18.0–18.3)	0.23 (0.22–0.23)	3.5 (3.5–3.6)
	25–44	326 460 (26.3)	34.8 (34.6–35.0)	0.56 (0.55–0.56)	12.6 (12.5–12.7)
	45–64	323 256 (26.0)	65.6 (65.3–65.8)	1.64 (1.63–1.64)	41.0 (40.7–41.2)
	65–84	225 705 (18.2)	85.6 (85.2–85.9)	3.22 (3.21–3.22)	71.1 (70.8–71.5)
	≥85	34 056 (2.7)	90.4 (89.4–91.4)	3.92 (3.90–3.94)	80.4 (79.4–81.3)
Sex	Men	569 087 (45.9)	43.6 (43.4–43.7)	1.06 (1.06–1.07)	24.4 (24.3–24.5)
	Women	671 840 (54.1)	53.8 (53.7–54.0)	1.55 (1.54–1.55)	34.9 (34.7–35.0)
Number of conditions	0	631 299 (50.9)	...	...	...
	1	236 547 (19.1)	...	...	...
	2	128 263 (10.3)	...	...	...
	3	83 751 (6.7)	...	...	...
	4	57 501 (4.6)	...	...	...
	5	39 159 (3.2)	...	...	...
	6	25 567 (2.1)	...	...	...
	7	16 259 (1.3)	...	...	...
	≥8	22 581 (1.8)	...	...	...

1  
2  
3 /Figure 1 here/  
4  
5

6 **Figure 1.** Prevalence of chronic conditions and multimorbidity (in numbers) by 5-year age  
7 groups.  
8  
9

10  
11  
12  
13  
14 The prevalence of the 10 most common chronic conditions in men and women by age group is  
15 shown in Figure 2, and the prevalence of all chronic conditions in the study (in the total  
16 population and among MM patients) in the Supplementary Appendix, Table 1. Hypertension  
17 was the most frequent chronic condition in the three oldest age groups for both men and women.  
18 Hypertension affects one in four individuals (24.5 %) in the total population and about two-  
19 thirds (67.4%) among MM patients.  
20  
21  
22

23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3% among MM patients. Chronic pain was defined according to Barnett, et al. [1] as chronic pain associated with selected physical conditions such as osteoarthritis and low back pain (Supplementary appendix, Table 1). The prevalence of painful conditions increases in older age as does the prevalence of cardiovascular diseases and conditions (e.g., atrial fibrillation, ischaemic heart disease, and heart failure).

Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients. The conditions with prevalence over 10% among MM patients included diabetes, sleep disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%). Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In



1  
2  
3 younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions  
4  
5 were most frequent.  
6  
7  
8  
9

10  
11 */Figure 2 here/*  
12  
13

14 **Figure 2.** The prevalence of the 10 most common chronic conditions in men and women by  
15  
16 age group.  
17  
18  
19  
20  
21

## 22 **Discussion**

23  
24  
25 The disease burden from chronic conditions is high in Estonia. Half of the individuals had at  
26  
27 least one chronic disorder, and one-third had MM. The burden is increasing with age, being  
28  
29 high already among middle-aged population groups (aged 45-64 years), where 66% of  
30  
31 individuals have a prevalent condition. Among those with MM, hypertension was the most  
32  
33 prominent chronic condition, followed by chronic pain and arthritis.  
34  
35  
36

37  
38 Our results were overall very similar to the results of global and regional studies. A recent  
39  
40 systematic review and meta-analysis of observational studies [22] calculated an overall 33.1%  
41  
42 pooled prevalence of MM. Still, their estimate of MM for the high-income countries in that  
43  
44 review was 37.9%, whereas our estimate of 30.1% is a bit lower, apparently due to the  
45  
46 methodological differences discussed above. As described earlier in the background, disability-  
47  
48 free life expectancy is low for Estonia, perhaps owing to the relatively high burden of MM.  
49  
50 Comparing our results to the Scottish primary care research, MM was higher in our study  
51  
52 (30.1% compared to 23.2% in Scotland). [1] Age group comparisons reveal that MM is more  
53  
54 prevalent in Estonia in all age groups, especially in 45-64 years (41.0% in Estonia vs 30.4% in  
55  
56  
57  
58  
59  
60

1  
2  
3 Scotland) and 65-84 years (71.1% vs 64.9%), except for the  $\geq 85$  years age group, where it is  
4 very similar (80.4% vs 81.5%).  
5  
6  
7

8 As for the types of prevalent chronic conditions, our findings converge with several other  
9 studies that identified hypertension, diabetes, asthma, and arthritis as the most prevalent  
10 conditions. In a recent Canadian study, the top five chronic conditions of the 17 examined  
11 among those with MM were mood disorders, hypertensive disorders, asthma, arthritis, and  
12 diabetes. [32] Lenzi, et al., found that hypertension, diabetes, and depression were highly  
13 prevalent among Italians. [33] Our national data also concur that morbidity increases with age,  
14 an association that has been demonstrated in other studies as well [1,3,32–34]. In a Canadian  
15 study of self-reported chronic conditions, the prevalence of 3+ conditions increased with age  
16 from 30% in the 45-49-year-old age group to 52% in individuals aged 60-64 years [34]. In  
17 Lithuania, the risk of acquiring an additional chronic condition was found to increase  
18 exponentially from the age of 29 years and stabilize between the age of 51 and 57 years [35,36].  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33

34 Acknowledging the sex gap in health that is characteristic of Eastern Europe, we aimed to assess  
35 the sex-specific differences in MM. We found that in women aged 25+ years, the prevalence of  
36 MM is higher than men, with the largest difference among those aged 65-69 years. This elevated  
37 prevalence of MM among women has been confirmed in some studies [3,34], but not in others  
38 [32].  
39  
40  
41  
42  
43  
44  
45

46 Some limitations of our study may affect generalizability. First, the definition of a chronic  
47 condition used in our study is contestable. However, we sought to ensure conformance with the  
48 methodologies used in prior research and establish the chronicity of the disease. Thus, the health  
49 care claim or prescription with a specific condition had to be identified at least 2 times during  
50 the period of observation. The second limitation is the heterogenous MM prevalence estimates  
51 due to methodological differences, including the MM definition, the list and grouping of  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 conditions accounted for, the age range, data source, and collection of data. [37,38] A universal  
4 definition and list of conditions used for MM research do not exist. [38] We attempted to  
5 optimize generalizability by adopting the list from previous research. To allow accurate  
6 estimations of disease burden, and effective disease management and resource distribution, a  
7 standardized operationalization of MM are needed. [1,22] Third, it is possible that some people  
8 with chronic conditions did not visit a physician or made only one visit over the study period,  
9 thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database  
10 covers approximately 95% of the population but lacks the data for approximately 5% of  
11 uninsured individuals. [31] However, given that all individuals aged 64 years and older are  
12 covered by health insurance, we acknowledge that a minor ascertainment bias may exist in  
13 younger age groups, as the health data for the uninsured individuals were not available. Fifth,  
14 not all individuals who were insured at the date of observation (December 31, 2017) were  
15 insured during the entire three-year study period, which might result in minor under-  
16 ascertainment among those newly enrolled.

17  
18  
19 One of the strengths of our study is the effort expended to enable comparability with the results  
20 of other studies. We used the list of conditions from previous research [1,29,30,36] with only  
21 minor adjustments to reflect the regional diagnostic practices. Another strength of our analysis  
22 lies in the use of a data source with 95% nationwide coverage and complete follow-up, free of  
23 recall and social desirability biases. Furthermore, the validity of EHIF data, although  
24 established for financial and not health research purposes, has been tested recently [39] and the  
25 study concluded that these data can be used for monitoring changes in chronic condition  
26 prevalence with a precision sufficient for informing health care policy. Our study thus provides  
27 high validity and generalizability of results allowing inferences to other Eastern European  
28 populations.

## 29 **Conclusions**

1  
2  
3 The prevalence of multimorbidity in Estonia is relatively high compared to other European  
4 countries, and higher among women than men. The prevalence of MM increases with age, with  
5 hypertension the most frequent chronic condition, followed by chronic pain, and arthritis. As  
6  
7  
8 the public health infrastructure continues to modernize, efforts must be placed on primary  
9  
10 prevention of the conditions which lead to hypertension, such as obesity. The development of  
11  
12 patient-centered, evidence-based treatment recommendations will help align patient and  
13  
14  
15 physician with respect to health goals and the means to achieve these outcomes.  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28

## 29 **References**

- 30  
31  
32 1 Barnett K, Mercer SSW, Norbury M, *et al.* Epidemiology of multimorbidity and  
33 implications for health care, research, and medical education: a cross-sectional study.  
34  
35 *Lancet* 2012;**6736**:37–43. doi:10.1016/S0140-6736(12)60240-2.THELANCET-D-11-  
36  
37 08270R1  
38  
39  
40  
41 2 Kingston A, Robinson L, Booth H, *et al.* Projections of multi-morbidity in the older  
42 population in England to 2035: estimates from the Population Ageing and Care  
43  
44 Simulation (PACSim) model. *Age Ageing* 2018;**47**:374–80. doi:10.1093/ageing/afx201  
45  
46  
47  
48 3 Van Oostrom SH, Gijsen R, Stirbu I, *et al.* Time trends in prevalence of chronic  
49 diseases and multimorbidity not only due to aging: Data from general practices and  
50  
51 health surveys. *PLoS One* 2016;**11**:e0160264. doi:10.1371/journal.pone.0160264  
52  
53  
54  
55 4 Bahler C, Huber CA, Brungger B, *et al.* Multimorbidity, health care utilization and  
56  
57 costs in an elderly community-dwelling population: A claims data based observational  
58  
59  
60

- 1  
2  
3 study. *BMC Health Serv Res* 2015;**15**:23. doi:10.1186/s12913-015-0698-2  
4  
5  
6 5 van Oostrom SH, Picavet HSJ, de Bruin SR, *et al.* Multimorbidity of chronic diseases  
7  
8 and health care utilization in general practice. *BMC Fam Pr* 2014;**15**:1–9.  
9  
10 doi:10.1186/1471-2296-15-61  
11  
12  
13 6 Quinaz Romana G, Kislaya I, Cunha Gonçalves S, *et al.* Healthcare use in patients with  
14  
15 multimorbidity. *Eur J Public Health* Published Online First: 25 June 2019.  
16  
17 doi:10.1093/eurpub/ckz118  
18  
19  
20  
21 7 Nielsen CR, Halling A, Andersen-Ranberg K. Disparities in multimorbidity across  
22  
23 Europe – Findings from the SHARE Survey. *Eur Geriatr Med* 2017;**8**:16–21.  
24  
25 doi:10.1016/J.EURGER.2016.11.010  
26  
27  
28 8 Aminisani N, Stephens C, Allen J, *et al.* Socio-demographic and lifestyle factors  
29  
30 associated with multimorbidity in New Zealand. *Epidemiol Health* 2020;**42**:e2020001.  
31  
32 doi:10.4178/epih.e2020001  
33  
34  
35  
36 9 Ashworth M, Durbaba S, Whitney D, *et al.* Journey to multimorbidity: Longitudinal  
37  
38 analysis exploring cardiovascular risk factors and sociodemographic determinants in an  
39  
40 urban setting. *BMJ Open* 2019;**9**. doi:10.1136/bmjopen-2019-031649  
41  
42  
43  
44 10 Nunes BP, Batista SRR, Andrade FB de, *et al.* Multimorbidity: The Brazilian  
45  
46 Longitudinal Study of Aging (ELSI-Brazil). *Rev Saude Publica* 2018;**52**Suppl 2:10s.  
47  
48 doi:10.11606/S1518-8787.2018052000637  
49  
50  
51  
52 11 Flores T, Rodrigues AP, Neves R, *et al.* The Risk of Multimorbidity Associated with  
53  
54 Overweight and Obesity: Data from the Brazilian National Health Survey 2013. *J Obes*  
55  
56 *Metab Syndr* 2021;**30**. doi:10.7570/jomes20110  
57  
58  
59 12 Wikström K, Lindström J, Harald K, *et al.* Clinical and lifestyle-related risk factors for  
60

- 1  
2  
3 incident multimorbidity: 10-year follow-up of Finnish population-based cohorts 1982-  
4 2012. *Eur J Intern Med* 2015;**26**:211–6. doi:10.1016/j.ejim.2015.02.012  
5  
6  
7  
8  
9 13 Fortin M, Soubhi H, Hudon C, *et al.* Multimorbidity's many challenges. *BMJ*  
10 2007;**334**:1016–7. doi:10.1136/bmj.39201.463819.2C  
11  
12  
13 14 Hurst JR, Agarwal G, Van Boven JFM, *et al.* Critical review of multimorbidity  
15 outcome measures suitable for low-income and middle-income country settings:  
16 Perspectives from the Global Alliance for Chronic Diseases (GACD) researchers. *BMJ*  
17 *Open* 2020;**10**:e037079. doi:10.1136/bmjopen-2020-037079  
18  
19  
20  
21  
22  
23 15 Atun R, Gurol-Urganci I, Hone T, *et al.* Shifting chronic disease management from  
24 hospitals to primary care in Estonian health system: analysis of national panel data. *J*  
25 *Glob Health* 2016;**6**. doi:10.7189/JOGH.06.020701  
26  
27  
28  
29  
30  
31 16 Chudasama Y V., Gillies CL, Appiah K, *et al.* Multimorbidity and SARS-CoV-2  
32 infection in UK Biobank. *Diabetes Metab Syndr* 2020;**14**:775.  
33 doi:10.1016/J.DSX.2020.06.003  
34  
35  
36  
37  
38  
39 17 M H, L J, R A, *et al.* The Association between Presence of Comorbidities and COVID-  
40 19 Severity: A Systematic Review and Meta-Analysis. *Cerebrovasc Dis* 2021;**50**:132–  
41 40. doi:10.1159/000513288  
42  
43  
44  
45  
46 18 Thakur B, Dubey P, Benitez J, *et al.* A systematic review and meta-analysis of  
47 geographic differences in comorbidities and associated severity and mortality among  
48 individuals with COVID-19. *Sci Reports* 2021 *111* 2021;**11**:1–13. doi:10.1038/s41598-  
49 021-88130-w  
50  
51  
52  
53  
54  
55  
56 19 Clark A, Jit M, Warren-Gash C, *et al.* Global, regional, and national estimates of the  
57 population at increased risk of severe COVID-19 due to underlying health conditions in  
58  
59  
60

- 2020: a modelling study. *Lancet Glob Heal* 2020;**8**:e1003–17. doi:10.1016/S2214-109X(20)30264-3
- 20 Fernández-Niño JA, Guerra-Gómez JA, Idrovo AJ. Multimorbidity patterns among COVID-19 deaths: proposal for the construction of etiological models. *Rev Panam Salud Pública* 2020;**44**. doi:10.26633/RPSP.2020.166
- 21 Sathanapally H, Sidhu M, Fahami R, *et al*. Priorities of patients with multimorbidity and of clinicians regarding treatment and health outcomes: A systematic mixed studies review. *BMJ Open*. 2020;**10**:e033445. doi:10.1136/bmjopen-2019-033445
- 22 Nguyen H, Manolova G, Daskalopoulou C, *et al*. Prevalence of multimorbidity in community settings: A systematic review and meta-analysis of observational studies. *J Comorbidity* 2019;**9**:2235042X1987093. doi:10.1177/2235042x19870934
- 23 Dicker D, Nguyen G, Abate D, *et al*. Global, regional, and national age-sex-specific mortality and life expectancy, 1950–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018;**392**:1684–735. doi:10.1016/S0140-6736(18)31891-9
- 24 Life expectancy. TE75 Disabil. Free life Expect. by sex age Gr. 2020.
- 25 Estonian health care system | Estonian Health Insurance Fund. 2021. <https://www.haigekassa.ee/en/people/health-care-services/estonian-health-care-system> (accessed 12 Jul 2021).
- 26 Lai, T; Knai C. Chapter 5: Estonia. In: *Assessing Chronic Disease Management in European Health Systems: Country reports*.
- 27 Silina V, Kalda R. Challenges for clinical practice and research in family medicine in reducing the risk of chronic diseases. Notes on the EGPRN Spring Conference 2017 in

- 1  
2  
3 Riga. *Eur J Gen Pract* 2018;**24**:112–7. doi:10.1080/13814788.2018.1429594  
4  
5  
6 28 Estonian Health Insurance Fund - Eesti Haigekassa. Annu. Rep.  
7  
8 2017.<https://www.haigekassa.ee/>  
9  
10  
11 29 Van Den Bussche H, Koller D, Kolonko T, *et al.* Which chronic diseases and disease  
12 combinations are specific to multimorbidity in the elderly? Results of a claims data  
13 based cross-sectional study in Germany. *BMC Public Health* 2011;**11**:101.  
14  
15 doi:10.1186/1471-2458-11-101  
16  
17  
18  
19  
20  
21 30 Schäfer I, von Leitner E-C, Schön G, *et al.* Multimorbidity Patterns in the Elderly: A  
22 New Approach of Disease Clustering Identifies Complex Interrelations between  
23  
24 Chronic Conditions. *PLoS One* 2010;**5**:e15941. doi:10.1371/journal.pone.0015941  
25  
26  
27  
28  
29 31 Statistics Estonia. PO021: Population, 1 January by sex, year and age group.  
30  
31 2017.<https://www.stat.ee/database> (accessed 26 Jul 2019).  
32  
33  
34 32 Ryan BL, Bray Jenkyn K, Shariff SZ, *et al.* Beyond the grey tsunami: a cross-sectional  
35 population-based study of multimorbidity in Ontario. *Can J Public Heal*  
36  
37 2018;**109**:845–54. doi:10.17269/s41997-018-0103-0  
38  
39  
40  
41 33 Lenzi J, Avaldi VM, Rucci P, *et al.* Burden of multimorbidity in relation to age, gender  
42 and immigrant status: A cross-sectional study based on administrative data. *BMJ Open*  
43  
44 2016;**6**:e012812. doi:10.1136/bmjopen-2016-012812  
45  
46  
47  
48  
49 34 Sakib MN, Shooshtari S, St John P, *et al.* The prevalence of multimorbidity and  
50 associations with lifestyle factors among middle-aged Canadians: An analysis of  
51  
52 Canadian Longitudinal Study on Aging data. *BMC Public Health* 2019;**19**:1–13.  
53  
54  
55  
56  
57  
58  
59 35 Jurevičienė E, Onder G, Visockienė, *et al.* Does multimorbidity still remain a matter of  
60



- 1  
2  
3 the elderly: Lithuanian national data analysis. *Health Policy (New York)*  
4  
5 2018;**122**:681–6. doi:10.1016/j.healthpol.2018.03.003  
6  
7  
8  
9 36 Navickas R, Visockiene, Puronaite R, *et al.* Prevalence and structure of multiple  
10 chronic conditions in Lithuanian population and the distribution of the associated  
11 healthcare resources. *Eur J Intern Med* 2015;**26**:160–8. doi:10.1016/j.ejim.2015.02.015  
12  
13  
14  
15  
16 37 Diederichs C, Berger K, Bartels DB. The measurement of multiple chronic diseases - A  
17 systematic review on existing multimorbidity indices. *Journals Gerontol - Ser A Biol*  
18 *Sci Med Sci* 2011;**66 A**:301–11. doi:10.1093/gerona/glq208  
19  
20  
21  
22  
23  
24 38 Fortin M, Stewart M, Poitras M-E, *et al.* A systematic review of prevalence studies on  
25 multimorbidity: toward a more uniform methodology. *Ann Fam Med* 2012;**10**:142–51.  
26 doi:10.1370/afm.1337  
27  
28  
29  
30  
31 39 Otsa K, Talli S, Harding P, *et al.* Administrative database as a source for assessment of  
32 systemic lupus erythematosus prevalence: Estonian experience. *BMC Rheumatol*  
33 2019;**3**:1–6. doi:10.1186/s41927-019-0074-7  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

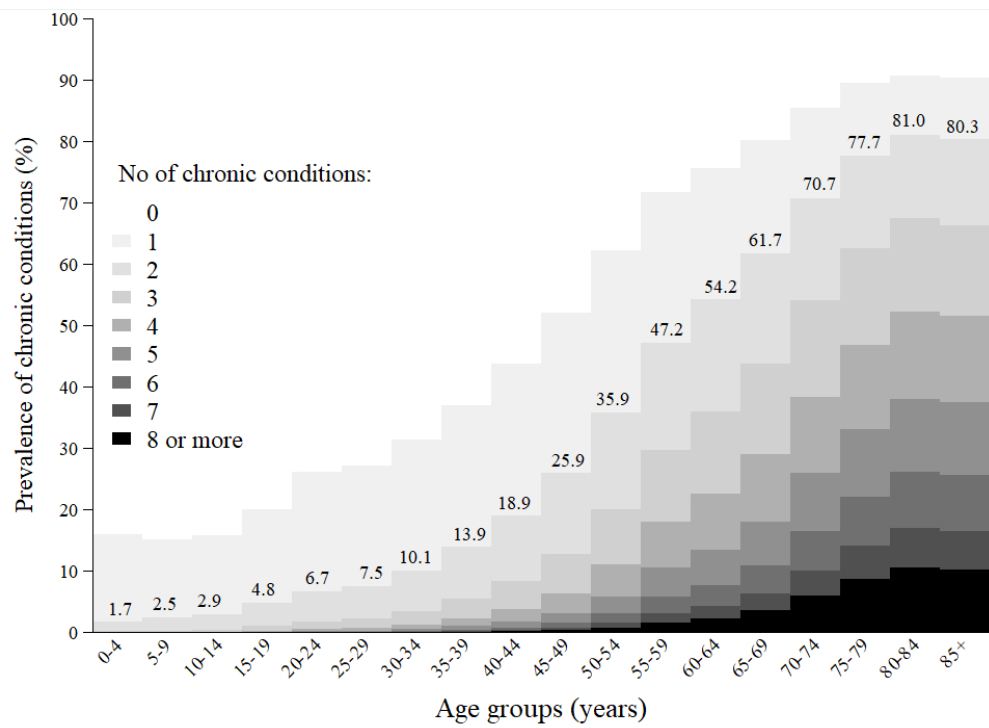


Figure 1

339x247mm (72 x 72 DPI)

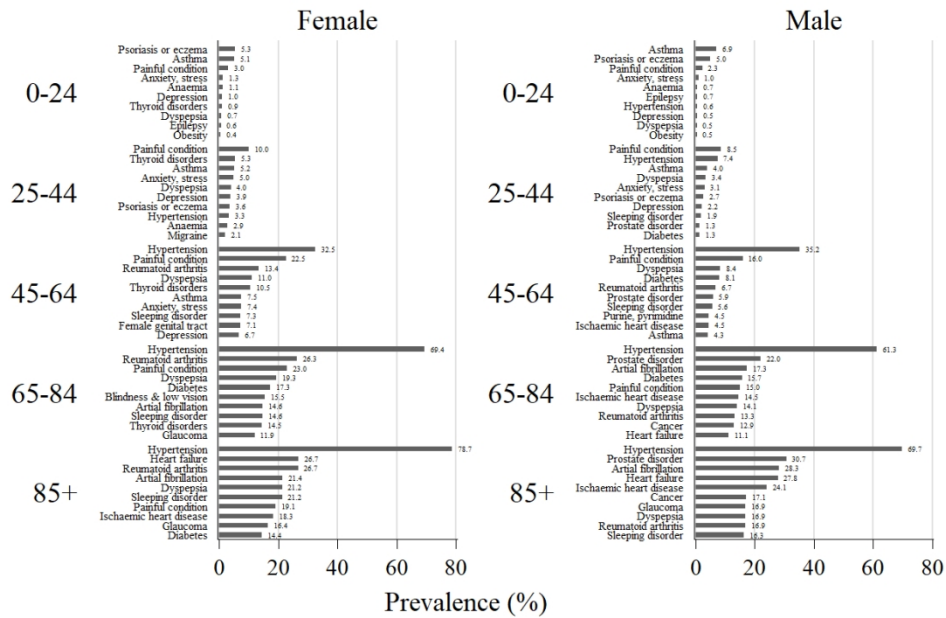


Figure 2

461x307mm (72 x 72 DPI)

1  
2  
3 **Supplementary appendix.**  
4  
5

6 **Table 1.** List and prevalence of chronic conditions (in the total population and among MM  
7 patients) in the study.  
8  
9

10  
11  
12

Disorder	ICD-10 codes	Prevalence (%)	
		Total	among MM patients
Hypertension	[I10–I15]	24.49	67.40
Painful condition	[G44, R51] [M25.5] [M42–M54] [M77] [M79.1–79.9] [R10.1– 10.4] [R07.0–07.4] [R30] [R52.0] [R52.1] [R52.2] [R52.9] [S22.0] [S22.1] [S12] [S32] [S72]	12.37	32.30
Rheumatoid arthritis, other inflammatory arthropathies and systemic connective tissue disorders	[M30–M36] [M05–M09, M79.0] [M91] [M15– M19]	7.65	23.56
Dyspepsia	[K21, K25–K30]	7.41	22.12
Asthma	[J45–J46] [J30]	5.91	12.94
Diabetes	[E10–14]	5.62	17.69
Sleeping disorders	[F51, G47]	5.11	15.80
Thyroid disorders	[E01–05, E06.1–.9, E07]	4.72	12.93

13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Atrial fibrillation	[I44–I45, I47–I49]	4.7	14.99
Psoriasis or eczema	[L20] [L23] [L28] [L29] [L40] [L50] [L56]	4.17	8.25
Anxiety and other neurotic, stress- related, and somatoform disorders	[F40–F43, F45, F48]	4.09	11.20
Blindness and low vision	[H17–18, H25–28, H31, H33, H34.1–.9, H35– H36, H43, H47, H54]	3.62	11.39
Ischaemic heart diseases	[I20–I25]	3.44	11.27
Depression	[F32–F33]	3.32	9.21
Heart failure	[I50]	3.24	10.65
Glaucoma	[H40–H42]	3.17	9.86
Cancer **	C00–97, D00–09, D37– 48	3.05	8.84
Prostate disorders	[N40] [N41]	2.52	7.33
Disorders of purine and pyrimidine metabolism	[E79, M10]	2.07	6.56
Anemia	[D50–59, D60–D61, D63–64]	1.88	4.75
Obesity	[E66]	1.64	5.11

1				
2				
3	Noninflammatory	[N81] [N93] [N95]	1.57	4.45
4				
5	disorders of the			
6				
7	female genital tract			
8				
9				
10	Neuropathies	[G50–G64]	1.56	4.78
11				
12	Disorders of	[H81, H82, R42]	1.52	4.75
13				
14	vestibular function			
15				
16				
17	Stroke and transient	[I60–66, I69, G45, I67.2]	1.45	4.71
18				
19	ischaemic attack			
20				
21	Chronic obstructive	[J40–J44]	1.4	4.42
22				
23	pulmonary			
24				
25	disease/bronchitis			
26				
27				
28	Peripheral vascular	[I73.0] [I70]	0.93	2.98
29				
30	disease			
31				
32				
33	Osteoporosis	[M80, M81, M82]	0.89	2.83
34				
35	Schizophrenia or	[F20–F29] [F31]	0.85	1.75
36				
37	bipolar disorder			
38				
39				
40	Epilepsy	[G40–G41]	0.84	1.84
41				
42	Hearing loss	[H90–H91]	0.74	2.17
43				
44	Migraine	[G43]	0.72	1.57
45				
46				
47	Cholelithiasis /	[K80, K81.1]	0.5	1.47
48				
49	Cholecystitis			
50				
51	Dementia	[F00, F01, F02, F03,	0.48	1.48
52		F05.1, G30, G31, R54]		
53				
54				
55				
56	Chronic kidney	[N18–N19]	0.47	1.57
57				
58	disease			
59				
60				

1				
2				
3	Mental and behavioral	[F10]	0.43	1.16
4				
5	disorders due to use of			
6				
7	alcohol			
8				
9				
10	Chronic liver disease	[K70–74, K76]	0.42	1.31
11				
12	Valve disorders	[I34–I37]	0.37	1.20
13				
14	Viral Hepatitis	[B18]	0.36	1.02
15				
16				
17	Irritable bowel	[K58]	0.33	0.97
18				
19	syndrome			
20				
21	Parkinson's disease	[G20, G21, G22]	0.31	0.97
22				
23	HIV	[Z21, B20–B24]	0.30	0.70
24				
25				
26	disorders of the	[N39.3, N39.4, R32]	0.27	0.84
27				
28	urinary system			
29				
30	Calculus of kidney	[N20]	0.26	0.76
31				
32	and ureter			
33				
34				
35	Inflammatory bowel	[K50–K52]	0.24	0.52
36				
37	Chronic sinusitis	[J32]	0.21	0.57
38				
39				
40	Diverticular disease of	[K57]	0.2	0.63
41				
42	the intestine			
43				
44	Other psychoactive	[F11–19]	0.16	0.45
45				
46	substance misuses			
47				
48				
49	Treated constipation	[K59.0]	0.16	0.42
50				
51	Multiple sclerosis	[G35]	0.12	0.26
52				
53				
54	Coagulation defects	[D65–D69]	0.08	0.22
55				
56	Learning disability	[F81]	0.06	0.08
57				
58	Anorexia or bulimia	[F50]	0.05	0.13
59				
60				

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

---

Bronchiectasis	[J47]	0.05	0.16
Celiac disease	[K90.0]	0.03	0.07

---

\* [ ] repetition of diagnostic codes within the boundaries of brackets

\*\* Each cancer diagnosis code counted separately

For peer review only



## STROBE Statement—checklist of items that should be included in reports of observational studies

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Title: population-based cross-sectional study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	Abstract provides a short summary
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6	MM is a growing global health problem, the data are scarce regarding the prevalence of MM in Eastern Europe.
Objectives	3	State specific objectives, including any prespecified hypotheses	7	A definitive, population-based assessment of MM prevalence by age and gender is needed to inform the continued restructuring of the health care system to accommodate the growing proportion of these patients.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	7-8	Key elements of the cross-sectional study were described in the Methods section.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8	We obtained data (year and month of birth, sex, dates for health claims, type of care, provided services, all diagnosis codes on claims, and the date and diagnosis code on prescriptions) from the Estonian Health Insurance Fund (EHIF) which is the sole health insurance provider in Estonia covering approximately 95% of the population. We included all subjects from the EHIF database from January 1, 2015, through December 31, 2017. To identify all patients with chronic physical and mental conditions, the ICD-10

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

				diagnosis codes for main and other (accompanying) diagnoses were used. For the prevalence analysis, we selected 55 conditions, whereas the list was based on previous MM research to enable comparability. We constructed the case definition for a chronic condition as the presence of at least two diagnosis codes at least 6 weeks apart for the same condition during the study period January 1, 2015, through December 31, 2017.
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	7-8, Supplementary appendix	We included all subjects from the EHIF database from January 1, 2015, through December 31, 2017. We constructed the case definition for a chronic condition as follows: the presence of at least two diagnosis codes at least 6 weeks apart for the same condition (i.e., matching ICD-10 category) during the study period January 1, 2015, through December 31, 2017. This definition enabled us to include chronic conditions while excluding patients with previously diagnosed but improved conditions (e.g., conditions where remission is possible, such as epilepsy, asthma, pain, or depression). The 6-week interval between the diagnoses reduced double-counting and over-ascertainment of cases. The inclusion of prescriptions in the data query allowed us to identify patients whose claims profile included diagnosis codes for only one condition, whereas their prescription history identified treatment for multiple conditions. The ascertainment period was extended to 3 years

				because some patients visit their physician infrequently.
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed		
		Case-control study—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9	The outcomes were the prevalence of chronic disorders, multimorbidity (MM), and the mean number of disorders by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8	The prevalence of conditions and MM were assessed using the population-based health data (health claims, prescriptions) from EHIF
Bias	9	Describe any efforts to address potential sources of bias	14-15	Selection and measurement bias were possible. First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

For peer review only

We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

---

Study size	10	Explain how the study size was arrived at	7	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017)
------------	----	---	---	--

---

Continued on next page

1				
2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	13 (Table 1) We assessed the prevalence of chronic conditions, mean number of chronic conditions, and MM by age group and sex
3				
4				
5				
6	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9 The outcomes were the prevalence of chronic disorders, MM, and the mean number of disorders by age and sex, estimated as a proportion of individuals with the current characteristics and among the total number of people insured. All results are presented with 95% confidence intervals. Adjustment by age and sex were done using uni- and multivariate Poisson regression. Prevalence ratios and 95% confidence intervals are presented.
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19			(b) Describe any methods used to examine subgroups and interactions	13 (Table 1) Prevalence ratios (by age group and sex) and 95% confidence intervals are presented.
20				
21			(c) Explain how missing data were addressed	It was not possible to identify any missing health claims or prescriptions from the EHIF data, but we assume that the impact of missing data on results is small as the health care institutions are interested in submitting the claims for reimbursement
22				
23				
24				
25				
26				
27				
28				
29			(d) Cohort study—If applicable, explain how loss to follow-up was addressed	
30			Case-control study—If applicable, explain how matching of cases and controls was addressed	
31			Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
32				
33				
34				
35			(e) Describe any sensitivity analyses	No sensitivity analyses were performed
36	Results			
37	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	This was a cross-sectional study where all claims and prescriptions of all insured individuals were collected at a single time point.
38				
39				
40				
41				
42				
43				
44				
45				
46				

		(b) Give reasons for non-participation at each stage		This was a cross-sectional study where all claims and prescriptions of all insured individuals were collected at a single time point.
		(c) Consider use of a flow diagram		No flow diagram was used as all data were collected and analysed at a single time point.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	This was a population-based study. We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM.
		(b) Indicate number of participants with missing data for each variable of interest		It was not possible to identify any missing health claims or prescriptions from the EHIF data, but we assume that the impact of missing data on results is small as the health care institutions are interested in submitting the claims for reimbursement
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)		This was a cross-sectional study.
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time		This was a cross-sectional study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		This was a cross-sectional study.
		Cross-sectional study—Report numbers of outcome events or summary measures	9	Half of the individuals (49.1%, 95% CI 49.0–49.3) had one or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21-1.33)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10, 13 (Table 1, Figure 1)	We analyzed the data of all publicly insured individuals (n = 1 240 927, 94.1% of the total population as of December 31, 2017). Half of the individuals (49.1%, 95% CI 49.0–49.3) had one

For peer review only

or more chronic conditions, and 30.1% (95% CI 30.0–30.2) had MM. The mean number of conditions was 1.33 (95% CI 1.21-1.33). The prevalence of chronic conditions increased with age, from 18.2% (95% CI 18.0-18.3) in the youngest age group (0-24 years) to as high as 65.6% (95% CI 65.3–65.8) in the group of 45-64 years, and 90.4% (95% CI 89.4–91.4) among the oldest (85+ years). In the youngest age group, 0-24 years, the mean number of conditions was 0.23 (0.22–0.23), and it increased with age, reaching 3.22 (3.21–3.22) in age 65-84 and 3.92 (3.9–3.94) among those  $\geq 85$  years. The prevalence of MM also increased with age, from 3.5% (95% CI 3.5–3.6) in the age of 0-24 to as high as 80.4% (95% CI 79.4–81.3) among those  $\geq 85$  years. MM prevalence was higher among women than men, with about every third woman and every fourth man having MM. At a younger age, the prevalence of MM among women was comparable to that in men: the prevalence ratio (PR women/men) was 1.00 (95% CI 0.99-1.02) in the age group of 0-24 years. It increased gradually from 1.10 (95% CI 1.09-1.10) among those of 25-29 years to 1.27 (95% CI 1.24-1.29) in 65-69 years, and declined again to be more similar between women and men among those aged 85+ (1.09, 95% CI 1.05-1.13).

---

(b) Report category boundaries when continuous variables were categorized

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

This was a prevalence study.

---

Continued on next page

---

1				
2	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13, Figure 2, Supplementary appendix
3				Hypertension was the most frequent chronic condition in the three oldest age groups for both men and women. Hypertension affects one in four individuals (24.5 %) in the total population and about two-thirds (67.4%) among MM patients. Chronic pain ranked second with a prevalence of 12.4% in the total population and 32.3% among MM patients. Chronic pain was defined according to Barnett, et al. as chronic pain associated with selected physical conditions such as osteoarthritis and low back pain. The prevalence of painful conditions increases in older age as does the prevalence of cardiovascular diseases and conditions.
4				Rheumatoid arthritis and other inflammatory arthropathies ranked third in the total population and MM patients, with the respective prevalences of 7.6% and 23.6%. This condition was closely followed by dyspepsia, with 7.4% of the total population and 22.12% of MM patients. The conditions with prevalence over 10% among MM patients included diabetes, sleep disorders, atrial fibrillation, asthma, thyroid disorders, blindness and low vision, ischaemic heart diseases, anxiety, and heart failure. In older men (65+ years), prostate disorders were frequent (22.8%) while in older women (65+ years) arthritis was quite prevalent (26.4%). Diseases such as asthma, diabetes, and dyspepsia were common across all age groups. In younger age groups, asthma, chronic pain, psoriasis or eczema, and mental health conditions were most frequent.
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				

---



---

 Discussion
 

---

Key results	18	Summarise key results with reference to study objectives	13	The disease burden from chronic conditions is high in Estonia. Half of the individuals had at least one chronic disorder, and one-third had MM. The burden is increasing with age, being high already among middle-aged population groups (aged 45-64 years), where 82/3 of individuals have a prevalent condition. Among those with MM, hypertension is the most prominent chronic condition, followed by chronic pain and arthritis.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15	First, the definition of a chronic condition used in our study is contestable. However, we sought to ensure conformance with the methodologies used in prior research and establish the chronicity of the disease. Thus, the health care claim or prescription with a specific condition had to be identified at least 2 times during the period of observation. The second limitation is the heterogenous MM prevalence estimates due to methodological differences, including the MM definition, the list and grouping of conditions accounted for, the age range, data source, and collection of data. A universal definition and list of conditions used for MM research do not exist. [30] We attempted to optimize generalizability by adopting the list from previous research. To allow accurate estimations of disease burden, and effective disease management and resource distribution, a standardized operationalization of MM are needed. Third, it is possible that some

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

For peer review only

people with chronic conditions did not visit a physician or made only one visit over the study period, thus the under-ascertainment of conditions cannot be ruled out. Fourth, the EHIF database covers approximately 95% of the population but lacks the data for approximately 5% of uninsured individuals. However, given that all individuals aged 64 years and older are covered by health insurance, we acknowledge that a minor ascertainment bias may exist in younger age groups, as the health data for the uninsured individuals were not available. Fifth, not all individuals who were insured at the date of observation (December 31, 2017) were insured during the entire three-year study period, which might result in minor under-ascertainment among those newly enrolled.

Interpretation 20 Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence 15

The prevalence of multimorbidity in Estonia is relatively high compared to other European countries, and higher among women than men. The prevalence of MM increases with age, with hypertension by far the most frequent chronic condition, followed by chronic pain, and arthritis. As the public health infrastructure continues to modernize, efforts must be placed on primary prevention of the conditions which lead to hypertension, such as obesity. The development of patient-centered, evidence-based treatment recommendations will help align patient and physician with respect to health goals and the means to achieve these outcomes.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15	One of the strengths of our study is the effort expended to enable comparability with the results of other studies. We used the list of conditions from previous research with only minor adjustments to reflect the diagnostic practices. Another strength of our analysis lies in the use of a data source with 95% nationwide coverage and complete follow-up, free of recall and social desirability biases. Furthermore, the validity of EHIF data, although established for financial and not health research purposes, has been tested recently and the study concluded that these data can be used for monitoring changes in chronic condition prevalence with a precision sufficient for informing health care policy. Our study thus provides high validity and generalizability of results allowing inferences to other Eastern European populations.
<b>Other information</b>				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3	This work was supported by the Estonian Ministry of Education and Research Grant IUT34-17. Funders had no role in the study.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).