

**Appendix 1. Coding definitions (ICD-10) for 30 conditions included in Tonelli et al. (2015)**

<b>Morbidity</b>	<b>ICD-10 codes</b>	<b>Description</b>	<b>Prevalence (%)</b>
Hypertension	I10 I11 I12 I13 I15	Essential (primary) hypertension Hypertensive heart disease Hypertensive renal disease Hypertensive heart and renal disease Secondary hypertension	19.0
Diabetes	E10 E11 E12 E13 E14	Insulin-dependent diabetes mellitus Non-insulin-dependent diabetes mellitus Malnutrition-related diabetes mellitus Other specified diabetes mellitus Unspecified diabetes mellitus	8.4
Chronic kidney disease	N00-N23	Glomerular diseases (N00-N08) Renal tubulo-interstitial diseases (N10-N16) Renal failure (N17-N19) Urolithiasis (N20-N23)	8.2
Asthma	J45	Asthma	6.7
Atrial fibrillation and flutter	I48	Atrial fibrillation and flutter	6.1
Chronic pain	F45.4 M08.1 M25.5 M43.2 M43.3 M43.4 M43.5 M43.6 M45 M46.1 M46.3 M46.4 M46.9 M47 M48.0 M48.1 M48.8 M48.9 M50.8 M50.9 M51 M53.1 M53.2 M53.3 M53.8 M53.9 M54 M60.8 M60.9 M63.3 M79.0 M79.1 M79.2 M79.6 M79.7 M96.1	Persistent somatoform pain disorder Juvenile ankylosing spondylitis Pain in joint Other fusion of spine Recurrent atlantoaxial subluxation with myelopathy Other recurrent atlantoaxial subluxation Other recurrent vertebral subluxation Torticollis Ankylosing spondylitis Sacroiliitis, not elsewhere classified Infection of intervertebral disc (pyogenic) Discitis, unspecified Inflammatory spondylopathy, unspecified Spondylosis Spinal stenosis Ankylosing hyperostosis [Forestier] Other specified spondylopathies Spondylopathy, unspecified Other cervical disc disorders Cervical disc disorder, unspecified Other intervertebral disc disorders Cervicobrachial syndrome Spinal instabilities Sacrococcygeal disorders, not elsewhere classified Other specified dorsopathies Dorsopathy, unspecified Dorsalgia Other myositis Myositis, unspecified Myositis in sarcoidosis Rheumatism, unspecified Myalgia Neuralgia and neuritis, unspecified Pain in limb Fibromyalgia Postlaminectomy syndrome, not elsewhere classified	6.1

Morbidity	ICD-10 codes	Description	Prevalence (%)
Chronic pulmonary disease (excludes asthma)	I27.8 I27.9 J40 J41 J42 J43 J44 J46 J47 J60 J61 J62 J63 J64 J65 J66 J67 J68.4 J70.1 J70.3	Other specified pulmonary heart diseases Pulmonary heart disease, unspecified Bronchitis, not specified as acute or chronic Simple and mucopurulent chronic bronchitis Unspecified chronic bronchitis Emphysema Other chronic obstructive pulmonary disease Status asthmaticus Bronchiectasis Coalworker pneumoconiosis Pneumoconiosis due to asbestos and other mineral fibres Pneumoconiosis due to dust containing silica Pneumoconiosis due to other inorganic dusts Unspecified pneumoconiosis Pneumoconiosis associated with tuberculosis Airway disease due to specific organic dust Hypersensitivity pneumonitis due to organic dust Chronic respiratory conditions due to chemicals, gases, fumes and vapours Chronic and other pulmonary manifestations due to radiation Chronic drug-induced interstitial lung disorders	5.9
Hypothyroidism	E00 E01 E02 E03 E89.0	Congenital iodine-deficiency syndrome Iodine-deficiency-related thyroid disorders and allied conditions Subclinical iodine-deficiency hypothyroidism Other hypothyroidism Postprocedural hypothyroidism	4.5
Cancer, non-metastatic (breast, cervical, colorectal, lung, prostate)	C18 C19 C20 C21 C33 C34 C38.4 C45.0 C46.7 C50 C53 C61 D01.0 D01.1 D01.2 D01.3 D02.2 D05 D06 D07.5	Malignant neoplasm of colon Malignant neoplasm of rectosigmoid junction Malignant neoplasm of rectum Malignant neoplasm of anus and anal canal Malignant neoplasm of trachea Malignant neoplasm of bronchus and lung Pleura Mesothelioma of pleura Kaposi sarcoma of other sites Malignant neoplasm of breast Malignant neoplasm of cervix uteri Malignant neoplasm of prostate Carcinoma in situ of Colon Carcinoma in situ of Rectosigmoid junction Carcinoma in situ of Rectum Carcinoma in situ of Anus and anal canal Carcinoma in situ of Bronchus and lung Carcinoma in situ of breast Carcinoma in situ of cervix uteri Carcinoma in situ of Prostate	4.2
Alcohol misuse	E52 F10 G62.1 I42.6	Niacin deficiency Mental and behavioural disorders due to use of alcohol Alcoholic polyneuropathy Alcoholic cardiomyopathy	4.1

Morbidity	ICD-10 codes	Description	Prevalence (%)
	K29.2 K70.0 K70.3 K70.9 T51 Z50.2 Z71.4 Z72.1	Alcoholic gastritis Alcoholic fatty liver Alcoholic cirrhosis of liver Alcoholic liver disease, unspecified Toxic effect of alcohol Alcohol rehabilitation Alcohol abuse counselling and surveillance Alcohol use	
Chronic heart failure	I09.9 I25.5 I42.0 I42.5 I42.6 I42.7 I42.8 I42.9 I43 I50	Rheumatic heart disease, unspecified Ischaemic cardiomyopathy Dilated cardiomyopathy Other restrictive cardiomyopathy Alcoholic cardiomyopathy Cardiomyopathy due to drugs and other external agents Other cardiomyopathies Cardiomyopathy, unspecified Cardiomyopathy in diseases classified elsewhere Heart failure	3.8
Severe constipation	K55.8 K56.0 K56.4 K56.7 K59.0 K63.1 K63.4 K63.8 K92.8	Other vascular disorders of intestine Paralytic ileus Other impaction of intestine Ileus, unspecified Constipation Perforation of intestine (nontraumatic) Enteroptosis Other specified diseases of intestine Other specified diseases of digestive system	3.3
Myocardial infarction	I21 I22	Acute myocardial infarction Subsequent myocardial infarction	2.3
Depression	F20.4 F31.3 F31.4 F31.5 F32 F33 F34.1 F41.2 F43.2	Post-schizophrenic depression Bipolar affective disorder, current episode mild or moderate depression Bipolar affective disorder, current episode severe depression without psychotic symptoms Bipolar affective disorder, current episode severe depression with psychotic symptoms Depressive episode Recurrent depressive disorder Dysthymia Mixed anxiety and depressive disorder Adjustment disorders	2.3
Stroke or transient ischaemic attack	G45.0 G45.1 G45.2 G45.3 G45.8 G45.9 H34.1 I60 I61 I63 I64	Vertebro-basilar artery syndrome Carotid artery syndrome (hemispheric) Multiple and bilateral precerebral artery syndromes Amaurosis fugax Other transient cerebral ischaemic attacks and related syndromes Transient cerebral ischaemic attack, unspecified Central retinal artery occlusion Subarachnoid haemorrhage Intracerebral haemorrhage Cerebral infarction Stroke, not specified as haemorrhage or infarction	2.0

Morbidity	ICD-10 codes	Description	Prevalence (%)
Cancer, metastatic	C77 C78 C79 C80	Secondary and unspecified malignant neoplasm of lymph nodes Secondary malignant neoplasm of respiratory and digestive organs Secondary malignant neoplasm of other and unspecified sites Malignant neoplasm, without specification of site	1.8
Dementia	F00 F01 F02 F03 F05.1 G30 G31.1	Dementia in Alzheimer disease Vascular dementia Dementia in other diseases classified elsewhere Unspecified dementia Delirium superimposed on dementia Alzheimer disease Senile degeneration of brain, not elsewhere classified	1.7
Rheumatoid arthritis	M05 M06 M31.5 M32 M33 M34 M35.1 M35.3 M36.0	Seropositive rheumatoid arthritis Other rheumatoid arthritis Giant cell arteritis with polymyalgia rheumatica Systemic lupus erythematosus Dermatopolymyositis Systemic sclerosis Other overlap syndromes Polymyalgia rheumatica Dermato(poly)myositis in neoplastic disease	1.7
Epilepsy	G40 G41	Epilepsy Status epilepticus	1.4
Inflammatory bowel disease	K50 K51	Crohn disease [regional enteritis] Ulcerative colitis	1.4
Cirrhosis and hepatic decompensation	K70.3 K74.3 K74.4 K74.5 K74.6 I85.0 I85.9 I98.2  I98.3  K65.0 K65.8 K65.9 K67.0 K67.1 K67.2 K67.3 K67.8  K76.7 K93.0  R18	Alcoholic cirrhosis of liver Primary biliary cirrhosis Secondary biliary cirrhosis Biliary cirrhosis, unspecified Other and unspecified cirrhosis of liver Oesophageal varices with bleeding Oesophageal varices without bleeding Oesophageal varices without bleeding in diseases classified elsewhere Oesophageal varices with bleeding in diseases classified elsewhere Acute peritonitis Other peritonitis Peritonitis, unspecified Chlamydial peritonitis Gonococcal peritonitis Syphilitic peritonitis Tuberculous peritonitis Other disorders of peritoneum in infectious diseases classified elsewhere Hepatorenal syndrome Tuberculous disorders of intestines, peritoneum and mesenteric glands Ascites	1.1
Cancer, lymphoma	C81 C82 C83 C84	Hodgkin lymphoma Follicular lymphoma Non-follicular lymphoma Mature T/NK-cell lymphomas	0.6

Morbidity	ICD-10 codes	Description	Prevalence (%)
	C85 C88 C90.0 C90.2 C96	Other and unspecified types of non-Hodgkin lymphoma Malignant immunoproliferative diseases Multiple myeloma Extramedullary plasmacytoma Other leukaemias of specified cell type	
Peptic ulcer disease without haemorrhage	K25.7 K25.9 K26.7 K26.9 K27.7 K27.9 K28.7 K28.9	Gastric ulcer-Chronic without haemorrhage or perforation Gastric ulcer-Unspecified as acute or chronic, without haemorrhage or perforation Duodenal ulcer-Chronic without haemorrhage or perforation Duodenal ulcer-Unspecified as acute or chronic, without haemorrhage or perforation Peptic ulcer, site unspecified- Chronic without haemorrhage or perforation Peptic ulcer, site unspecified- Unspecified as acute or chronic, without haemorrhage or perforation Gastrojejunal ulcer- Chronic without haemorrhage or perforation Gastrojejunal ulcer- Unspecified as acute or chronic, without haemorrhage or perforation	0.6
Irritable bowel syndrome	K58	Irritable bowel syndrome	0.5
Multiple sclerosis	G35 G36 G37 H46	Multiple sclerosis Other acute disseminated demyelination Other demyelinating diseases of central nervous system Optic neuritis	0.5
Parkinson's disease	G20 G21 G22	Parkinson disease Secondary parkinsonism Parkinsonism in diseases classified elsewhere	0.5
Schizophrenia	F20 F21 F23.2 F25	Schizophrenia Schizotypal disorder Acute schizophrenia-like psychotic disorder Schizoaffective disorders	0.3
Psoriasis	L40.0 L40.1 L40.2 L40.3 L40.4 L40.8 L40.9	Psoriasis vulgaris Generalized pustular psoriasis Acrodermatitis continua Pustulosis palmaris et plantaris Guttate psoriasis Other psoriasis Psoriasis, unspecified	0.2
Peripheral vascular disease	I70.2	Atherosclerosis of arteries of extremities	0.1
Chronic viral hepatitis B	B16 B18.0 B18.1	Acute hepatitis B Chronic viral hepatitis B with delta-agent Chronic viral hepatitis B without delta-agent	0.0

Note: Minor changes to the Tonelli et al. (2015) published algorithms were made. The algorithms developed by Tonelli required a combination of hospitalization, claims and outpatient codes over varying time periods. We modified this to at least one hospitalisation in the five years prior to index for all morbidities. For identifying chronic kidney disease, Tonelli supplemented the algorithm using lab data, however we only used administrative data. The codes for "peptic ulcer disease" referred to "peptic ulcer disease without haemorrhage or perforation", therefore we amended the morbidity description. As specific codes for atrial fibrillation were only implemented in Scotland from April 2016 (ICD-10 version 2016), we included "atrial fibrillation and flutter" (ICD-10 code I48). No entry in ICD-10 was identified for: C46.71 (replaced with C46.7); M25.50, M25.51, M25.55, M25.57 (replaced with M25.5); K63.81 and K63.88 (replaced with K63.8), K92.80 and K92.88 (replaced with K92.8).

## Appendix 2. Characteristics of patients with missing CHI numbers, SIMD quintile or UR category

### Age-sex distribution of admissions with missing CHI numbers (adults with an inpatient stay 2014)

Age	Female	Male	Total
18-20	8	17	<b>25</b>
21-30	33	111	<b>144</b>
31-40	17	86	<b>103</b>
41-50	29	88	<b>117</b>
51-60	18	84	<b>102</b>
61-70	30	47	<b>77</b>
71-80	33	29	<b>62</b>
≥81	19	13	<b>32</b>
<b>Total</b>	<b>187</b>	<b>475</b>	<b>662</b>

### Patients with missing SIMD quintile and Urban-Rural category

Characteristic	SIMD		U-R	
	missing		missing	
	n	%	n	%
<b>Total</b>	<b>314</b>		<b>576</b>	
<b>Males, n (%)</b>	155	(49.4)	258	(44.8)
<b>Age, median (IQR)</b>	47	(31-62)	43	(29-60)
<b>Admission type, n (%)</b>				
<b>Routine</b>	82	(26.1)	156	(27.1)
<b>Emergency</b>	232	(73.9)	420	(72.9)

### Appendix 3. Prevalence of multimorbidity by age and urban-rural category

	Total	≥2 conditions				
	n	n	%	95% CI		p <sup>a</sup>
<b>18-29 yrs</b>						
1 (large urban)	2,164	115	5.31	(4.4% -6.3%)		0.06
2	673	43	6.39	(4.8% -8.5%)		
3	306	26	8.50	(5.8% -12.2%)		
4	340	24	7.06	(4.8% -10.3%)		
5	697	48	6.89	(5.2% -9.0%)		
6 (remote rural)	352	13	3.69	(2.2% -6.3%)		
<b>30-44 yrs</b>						
1 (large urban)	2,467	300	12.16	(10.9% -13.5%)		0.03
2	873	105	12.03	(10.0% -14.4%)		
3	466	45	9.66	(7.3% -12.7%)		
4	465	55	11.83	(9.2% -15.1%)		
5	968	94	9.71	(8.0% -11.7%)		
6 (remote rural)	529	41	7.75	(5.8% -10.4%)		
<b>45-59 yrs</b>						
1 (large urban)	3,168	699	22.06	(20.7% -23.5%)		<0.001
2	1,270	240	18.90	(16.8% -21.1%)		
3	707	123	17.40	(14.8% -20.4%)		
4	709	124	17.49	(14.9% -20.5%)		
5	1,670	305	18.26	(16.5% -20.2%)		
6 (remote rural)	1,029	135	13.12	(11.2% -15.3%)		
<b>60-74 yrs</b>						
1 (large urban)	3,722	1340	36.00	(34.5% -37.6%)		<0.001
2	1,738	609	35.04	(32.8% -37.3%)		
3	914	315	34.46	(31.4% -37.6%)		
4	1,014	329	32.45	(29.6% -35.4%)		
5	2,264	688	30.39	(28.5% -32.3%)		
6 (remote rural)	1,416	367	25.92	(23.7% -28.3%)		
<b>75-89 yrs</b>						
1 (large urban)	3,564	1,753	49.19	(47.5% -50.8%)		<0.001
2	1,549	731	47.19	(44.7% -49.7%)		
3	816	353	43.26	(39.9% -46.7%)		
4	1,022	450	44.03	(41.0% -47.1%)		
5	1,641	746	45.46	(43.1% -47.9%)		
6 (remote rural)	1,062	388	36.53	(33.7% -39.5%)		
<b>≥90 yrs</b>						
1 (large urban)	492	281	57.11	(52.7% -61.4%)		<0.001
2	226	113	50.00	(43.5% -56.5%)		
3	120	63	52.50	(43.5% -61.3%)		
4	169	70	41.42	(34.2% -49.0%)		
5	244	115	47.13	(40.9% -53.4%)		
6 (remote rural)	143	55	38.46	(30.8% -46.7%)		

CI, confidence intervals.

<sup>a</sup> p-value for  $\chi^2$  test for the association between multimorbidity status (<2 or ≥2 conditions) and urban-rural category.

#### Appendix 4. Prevalence of multimorbidity by age and SIMD category

	Total	≥2 conditions				
	n	n	%	95% CI		p <sup>a</sup>
<b>18-29 yrs</b>						
1 (most deprived)	466	27	(5.8)	(4.0%	-8.3%)	0.26
2	825	60	(7.3)	(5.7%	-9.3%)	
3	1,081	65	(6.0)	(4.7%	-7.6%)	
4	1,060	65	(6.1)	(4.8%	-7.7%)	
5 (least deprived)	1,178	57	(4.8)	(3.7%	-6.2%)	
<b>30-44 yrs</b>						
1 (most deprived)	690	94	(13.6)	(11.3%	-16.4%)	0.01
2	972	124	(12.8)	(10.8%	-15.0%)	
3	1,326	147	(11.1)	(9.5%	-12.9%)	
4	1,398	155	(11.1)	(9.5%	-12.8%)	
5 (least deprived)	1,463	130	(8.9)	(7.5%	-10.5%)	
<b>45-59 yrs</b>						
1 (most deprived)	779	214	(27.5)	(24.4%	-30.7%)	<0.001
2	1,334	297	(22.3)	(20.1%	-24.6%)	
3	1,981	391	(19.7)	(18.0%	-21.5%)	
4	2,287	392	(17.1)	(15.7%	-18.7%)	
5 (least deprived)	2,221	349	(15.7)	(14.3%	-17.3%)	
<b>60-74 yrs</b>						
1 (most deprived)	771	295	(38.3)	(34.9%	-41.7%)	<0.001
2	1,545	554	(35.9)	(33.5%	-38.3%)	
3	2,751	945	(34.4)	(32.6%	-36.1%)	
4	3,045	929	(30.5)	(28.9%	-32.2%)	
5 (least deprived)	2,989	933	(31.2)	(29.6%	-32.9%)	
<b>75-89 yrs</b>						
1 (most deprived)	557	284	(51.0)	(46.8%	-55.1%)	<0.001
2	1,411	711	(50.4)	(47.8%	-53.0%)	
3	2,409	1,122	(46.6)	(44.6%	-48.6%)	
4	2,584	1,135	(43.9)	(42.0%	-45.8%)	
5 (least deprived)	2,709	1,178	(43.5)	(41.6%	-45.4%)	
<b>≥90 yrs</b>						
1 (most deprived)	54	39	(72.2)	(58.8%	-82.6%)	0.01
2	192	90	(46.9)	(39.9%	-54.0%)	
3	338	169	(50.0)	(44.7%	-55.3%)	
4	418	197	(47.1)	(42.4%	-51.9%)	
5 (least deprived)	397	206	(51.9)	(47.0%	-56.8%)	

CI, confidence intervals.

<sup>a</sup> p-value for  $\chi^2$  test for the association between multimorbidity status (<2 or ≥2 conditions) and SIMD quintiles.