

APPENDICES

Appendix 1-1: List of Chronic Conditions (Fortin et al. 2017)

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Hyperlipidaemia	1	E78.5 (Hyperlipidaemia, unspecified)	257,114	32.65	24.79 (24.86, 25.07)
2	Hypertension (high blood pressure)	2	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
3	Diabetes	3	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		4	E11.9 (Type 2 diabetes mellitus without complication)			
		5	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		6	E14.3 (Diabetes mellitus with retinopathy)			
		7	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		8	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		9	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
4	Arthritis &/or rheumatoid arthritis	10	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	100,838	12.81	10.43 (10.36, 10.50)
		11	M15.9 (Osteoarthritis (OA) - Generalised)			
		12	M19.99 (Arthritis, unspecified, site unspecified)			
5	Obesity	13	E66.9 (Obesity, unspecified)	48,893	6.21	5.29 (5.24, 5.34)
6	Cardiovascular disease (angina, MI, AF, poor circulation of lower limbs)	14	I25.9 (Chronic ischaemic heart disease, unspecified)	43,559	5.53	3.74 (3.71, 3.78)
		15	I48 (Atrial fibrillation and flutter)			
		16	I70.20 (Atherosclerosis of arteries of extremities, unspecified)			
		17	I73.9 (Peripheral vascular disease, unspecified)			
7	Asthma, COPD, or chronic bronchitis	18	J44.9 (Chronic Obstructive Pulmonary Disease, Unspecified)	32,611	4.14	3.68 (3.63, 3.72)
		19	J45.9 (Asthma, unspecified)			
8	Chronic hepatitis	20	K76.9 (Liver disease, unspecified)	25,918	3.29	3.02 (2.98, 3.06)
		21	Z22.51 (Carrier of viral hepatitis B)			
9	Stomach problem (reflux, heartburn, or gastric ulcer)	22	K21.9 (Gastro-oesophageal reflux disease without oesophagitis)	22,233	2.82	2.52 (2.48, 2.56)
		23	K27.9 (Peptic ulcer, unspecified as acute or chronic, without haemorrhage or perforation)			
10	Thyroid disorder	24	E03.9 (Hypothyroidism, unspecified)	20,781	2.64	2.36 (2.32, 2.39)
		25	E05.9 (Thyrotoxicosis, unspecified)			
11	Stroke and TIA	26	G45.9 (Transient cerebral ischaemic attack, unspecified)	23,628	3.00	2.07 (2.04, 2.10)
		27	I64 (Stroke, not specified as haemorrhage or infarction)			
12	Heart failure (including valve problems or replacement)	28	I50.0 (Congestive heart failure)	20,538	2.61	1.97 (1.94, 2.00)
		29	I51.9 (Heart disease, unspecified)			
13	Kidney disease or failure	30	N03.9 (Unspecified nephritic syndrome, unspecified)	22,221	2.82	1.82 (1.79, 1.84)
		31	N18.9 (Chronic kidney disease, unspecified)			
14	Depression or anxiety	32	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)	14,910	1.89	1.81 (1.78, 1.84)
		33	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
		34	F41.1 (Anxiety disorder, unspecified)			
15	Chronic urinary problem	35	N40 (Hyperplasia of prostate)	13,031	1.65	1.07 (1.05, 1.09)
16	Any cancer in the last 5 years	36	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)

17	Osteoporosis	37	M81.99 (Other osteoporosis, site unspecified)	7,283	0.92	0.57 (0.56, 0.59)
18	Dementia or Alzheimer's disease	38	F03 (Unspecified dementia)	3,571	0.45	0.27 (0.26, 0.28)
19	Colon problem (irritable bowel)	39	K58.9 (Irritable bowel syndrome without diarrhoea)	1,517	0.19	0.20 (0.19, 0.21)
20	Chronic musculoskeletal condition causing pain or limitation	No matching ICD-10 code		-	-	-

Appendix 1-2: List of Chronic Conditions (Ge et al. 2018 and 2019)

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Dyslipidaemia	1	E78.5 (Hyperlipidaemia, unspecified)	257,114	32.65	24.97 (24.86, 25.07)
2	Hypertension	2	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
3	Diabetes	3	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		4	E11.9 (Type 2 diabetes mellitus without complication)			
		5	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		6	E14.3 (Diabetes mellitus with retinopathy)			
		7	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		8	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		9	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
4	Osteoarthritis/Gout/RA	10	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	38,755	4.92	3.89 (3.85, 3.93)
		11	M10.99 (Gout, unspecified, site unspecified)			
		12	M15.9 (Osteoarthritis (OA) - generalized)			
5	Asthma	13	J45.9 (Asthma, unspecified)	28,778	3.65	3.37 (3.33, 3.42)
6	Heart attack/IHD	14	I25.9 (Chronic ischemic heart disease, unspecified)	36,401	4.62	3.15 (3.12, 3.19)
7	Stroke/TIA	15	G45.9 (Transient cerebral ischemic attack, unspecified)	23,628	3.00	2.07 (2.04, 2.10)
		16	I64 (Stroke, not specified as haemorrhage or infarction)			
8	CKD	17	N18.9 (Chronic kidney disease, unspecified)	21,638	2.75	1.76 (1.73, 1.78)
9	Depression	18	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)	9,941	1.26	1.20 (1.17, 1.23)
		19	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
10	Anxiety disorder	20	F41.1 (Anxiety disorder, unspecified)	6,085	0.77	0.75 (0.73, 0.77)
11	Cancer	21	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
12	Osteoporosis	22	M81.99 (Other osteoporosis, site unspecified)	7,283	0.92	0.57 (0.56, 0.59)
13	Chronic bronchitis/emphysema/COPD	23	J44.9 (Chronic obstructive pulmonary disease, unspecified)	5,080	0.65	0.41 (0.40, 0.42)
14	Schizophrenia	24	F20.9 (Schizophrenia, unspecified)	2,889	0.37	0.33 (0.31, 0.34)
15	Heart failure	25	I50.0 (Congestive heart failure)	3,469	0.44	0.29 (0.28, 0.30)
16	Dementia/Alzheimer's	26	F03 (Unspecified dementia)	3,571	0.45	0.27 (0.26, 0.28)
17	Parkinson's disease	27	G20 (Parkinson's disease)	1,900	0.24	0.15 (0.14, 0.15)

Appendix 1-3: List of Chronic Conditions (Low et al. 2019)

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Lipid disorders	1	E78.5 (Hyperlipidaemia, unspecified)	257,114	32.65	24.97 (24.86, 25.07)
2	Hypertension	2	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
3	Diabetes	3	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		4	E11.9 (Type 2 diabetes mellitus without complication)			
		5	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		6	E14.3 (Diabetes mellitus with retinopathy)			
		7	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		8	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		9	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
4	Angina Coronary heart disease Myocardial infarction	10	I25.9 (Chronic ischaemic heart disease, unspecified)	51,264	6.51	4.65 (4.61, 4.70)
		11	I51.9 (Heart disease, unspecified)			
5	Asthma	12	J45.9 (Asthma, unspecified)	28,778	3.65	3.37 (3.33, 3.42)
6	Moderate liver disease Severe liver disease	13	K76.9 (Liver disease, unspecified)	18,658	2.37	2.13 (2.09, 2.16)
7	Renal disease	14	N28.9 (Disorder of kidney and ureter, unspecified)	21,112	2.68	1.94 (1.91, 1.97)
8	CKD on dialysis or pre-dialysis Chronic kidney disease	15	N18.9 (Chronic kidney disease, unspecified)	21,638	2.75	1.76 (1.73, 1.78)
9	Osteoarthritis	16	M15.9 (Osteoarthritis (OA) - generalized)	18,378	2.33	1.72 (1.70, 1.75)
10	Haemorrhagic stroke Ischemic stroke Stroke	17	I64 (Stroke, not specified as haemorrhage or infarction)	19,808	2.52	1.72 (1.69, 1.74)
11	Hypothyroidism	18	E03.9 (Hypothyroidism)	14,133	1.79	1.51 (1.48, 1.53)
12	Major depression	19	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)	9,941	1.26	1.20 (1.17, 1.23)
		20	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
13	Benign prostatic hyperplasia (BPH)	21	N40 (Hyperplasia of prostate)	13,031	1.65	1.07 (1.05, 1.09)
14	Hyperthyroidism	22	E05.9 (Thyrotoxicosis)	7,873	1.00	1.00* (0.97, 1.02)
15	Anxiety General anxiety disease	23	F41.1 (Anxiety disorder, unspecified)	6,085	0.77	0.75 (0.73, 0.77)
16	Cancer (w/o metastasis) Metastatic carcinoma	24	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
17	Arrhythmia Atrial fibrillation	25	I48 (Atrial fibrillation and flutter)	7,241	0.92	0.58 (0.57, 0.60)
18	Osteoporosis	26	M81.99 (Other osteoporosis, site unspecified)	7,283	0.92	0.57 (0.56, 0.59)
19	Chronic obstructive pulmonary disease	27	J44.9 (Chronic obstructive pulmonary disease, unspecified)	5,080	0.65	0.41 (0.40, 0.42)
20	Epilepsy	28	G40.90 (Epilepsy, unspecified, without mention of intractable epilepsy)	2,734	0.35	0.33 (0.32, 0.35)
21	Schizophrenia	29	F20.9 (Schizophrenia, unspecified)	2,889	0.37	0.33 (0.31, 0.34)
22	Heart failure	30	I50.0 (Congestive heart failure)	3,469	0.44	0.29 (0.28, 0.30)
23	Dementia	31	F03 (Unspecified dementia)	3,571	0.45	0.27

						(0.26, 0.28)
24	Peripheral vascular disease	32	I73.9 (Peripheral vascular disease, unspecified)	2,598	0.33	0.21 (0.21, 0.22)
25	Rheumatoid arthritis	33	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	2,010	0.26	0.19 (0.18, 0.20)
26	Parkinson's disease	34	G20 (Parkinson's disease)	1,900	0.24	0.15 (0.14, 0.15)
27	Nephritis	35	N03.9 (Unspecified nephritic syndrome, unspecified)	770	0.10	0.08 (0.07, 0.08)
28	Psoriasis	36	L40.8 (Other psoriasis)	651	0.08	0.08 (0.07, 0.08)
29	Major lower extremity amputation	37	Z89.5 (Acquired absence of leg at or below knee)	236	0.03	0.02 (0.02, 0.02)
		38	Z89.6 (Acquired absence of leg above knee)			
30	Minor lower extremity amputation	39	Z89.4 (Acquired absence of foot and ankle)	122	0.02	0.01 (0.01, 0.01)
31	Bipolar disorder	40	F31.9 (Bipolar affective disorder, unspecified)	51	0.01	0.01 (0.01, 0.01)
32	Hip fracture	No matching ICD-10 code				-
33	Nephrosis	No matching ICD-10 code				-
34	Respiratory failure	No matching ICD-10 code				-
35	Secondary hypertension	No matching ICD-10 code				-
36	Spine fracture	No matching ICD-10 code				-
37	Coronary artery bypass graft	No matching ICD-10 code				-
38	Percutaneous coronary intervention	No matching ICD-10 code				-
39	Kidney transplant	No matching ICD-10 code				-

*The standardized prevalence rate of 'hyperthyroidism' is 0.9980% (0.9737, 1.0222).

Appendix 1-4: List of Chronic Conditions (Picco et al. 2016)

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	High blood pressure	1	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
2	Diabetes	2	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		3	E11.9 (Type 2 diabetes mellitus without complication)			
		4	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		5	E14.3 (Diabetes mellitus with retinopathy)			
		6	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		7	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		8	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
3	Arthritis or Rheumatism	9	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	100,838	12.81	10.43 (10.36, 10.50)
		10	M15.9 (Osteoarthritis (OA) - generalized)			
		11	M19.99 (Arthritis, unspecified, site unspecified)			
4	Heart trouble (including heart attack, angina, heart failure and valve disease)	12	I51.9 (Heart disease, unspecified)	56,797	7.21	5.11 (5.06, 5.15)
		13	I50.0 (Congestive heart failure)			
		14	I25.9 (Chronic ischaemic heart disease, unspecified)			
		15	I48 (Atrial fibrillation and flutter)			
5	Breathlessness or Asthma	16	J45.9 (Asthma, unspecified)	28,778	3.65	3.37 (3.33, 3.42)
6	Stroke	17	I64 (Stroke, not specified as haemorrhage or infarction)	19,808	2.52	1.72 (1.69, 1.74)
7	Depression	18	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)	9,941	1.26	1.20 (1.17, 1.23)
		19	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
8	Cancer	20	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
9	TIA	21	G45.9 (Transient cerebral ischaemic attack, unspecified)	5,158	0.66	0.46 (0.45, 0.48)
10	COPD	22	J44.9 (Chronic obstructive pulmonary disease, unspecified)	5,080	0.65	0.41 (0.40, 0.42)

Appendix 1-5: List of Chronic Conditions (Quah et al. 2016)

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Hyperlipidaemia	1	E78.5 (Hyperlipidaemia, unspecified)	257,114	32.65	24.97 (24.86, 25.07)
2	Hypertension	2	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
3	Diabetes	3	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		4	E11.9 (Type 2 diabetes mellitus without complication)			
		5	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		6	E14.3 (Diabetes mellitus with retinopathy)			
		7	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		8	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		9	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
4	Arthritis	10	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	100,838	12.81	10.43 (10.36, 10.50)
		11	M19.99 (Arthritis, unspecified, site unspecified)			
		12	M15.9 (Osteoarthritis (OA) - generalized)			
5	Respiratory diseases	13	J30.4 (Allergic rhinitis, unspecified)	68,048	8.64	8.73 (8.65, 8.80)
		14	J44.9 (Chronic obstructive pulmonary disease, unspecified)			
		15	J45.9 (Asthma, unspecified)			
6	Gastrointestinal diseases	16	K21.9 (Gastro-oesophageal reflux disease without oesophagitis)	49,847	6.33	5.76 (5.70, 5.81)
		17	K27.9 (Peptic ulcer, unspecified as acute or chronic, without haemorrhage or perforation)			
		18	K58.9 (Irritable bowel syndrome without diarrhoea)			
		19	K76.9 (Liver disease, unspecified)			
		20	K82.9 (Disease of gallbladder, unspecified)			
		21	Z22.51 (Carrier of viral hepatitis B)			
7	Heart diseases	22	I25.9 (Chronic ischaemic heart disease, unspecified)	56,797	7.21	5.11 (5.06, 5.15)
		23	I48 (Atrial fibrillation and flutter)			
		24	I50.0 (Congestive heart failure)			
		25	I51.9 (Heart disease, unspecified)			
8	Chronic kidney disease	26	N03.9 (Unspecified nephritic syndrome, unspecified)	38,350	4.87	3.36 (3.32, 3.39)
		27	N18.9 (Chronic kidney disease, unspecified)			
		28	N28.9 (Disorder of kidney and ureter, unspecified)			
9	Neurological conditions	29	F03 (Unspecified dementia)	31,093	3.95	2.79 (2.75, 2.82)
		30	G20 (Parkinson's disease)			
		31	G40.90 (Epilepsy, unspecified, without mention of intractable epilepsy)			
		32	G45.9 (Transient cerebral ischemic attack, unspecified)			
		33	G60.9 (Hereditary and idiopathic neuropathy, unspecified)			
		34	I64 (Stroke, not specified as haemorrhage or infarction)			
10	Thyroid diseases	35	E03.9 (Hypothyroidism, unspecified)	20,781	2.64	2.36 (2.32, 2.39)
		36	E05.9 (Thyrotoxicosis, unspecified)			
11	Psychiatric conditions	37	F20.9 (Schizophrenia, unspecified)	18,182	2.31	2.18 (2.15, 2.22)
		38	F29 (Unspecified nonorganic psychosis)			
		39	F31.9 (Bipolar affective disorder, unspecified)			
		40	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)			

		41	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
		42	F41.1 (Anxiety disorder, unspecified)			
12	Physical disability	43	H91.9 (Hearing loss, unspecified)	10,514	1.34	1.05 (1.03, 1.08)
		44	Q79.9 (Congenital malformation of musculoskeletal system, unspecified)			
13	Cancer	45	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
14	Back problems	No matching ICD-10 code		-	-	

Appendix 1-6: List of Chronic Conditions (Subramaniam et al. 2014)

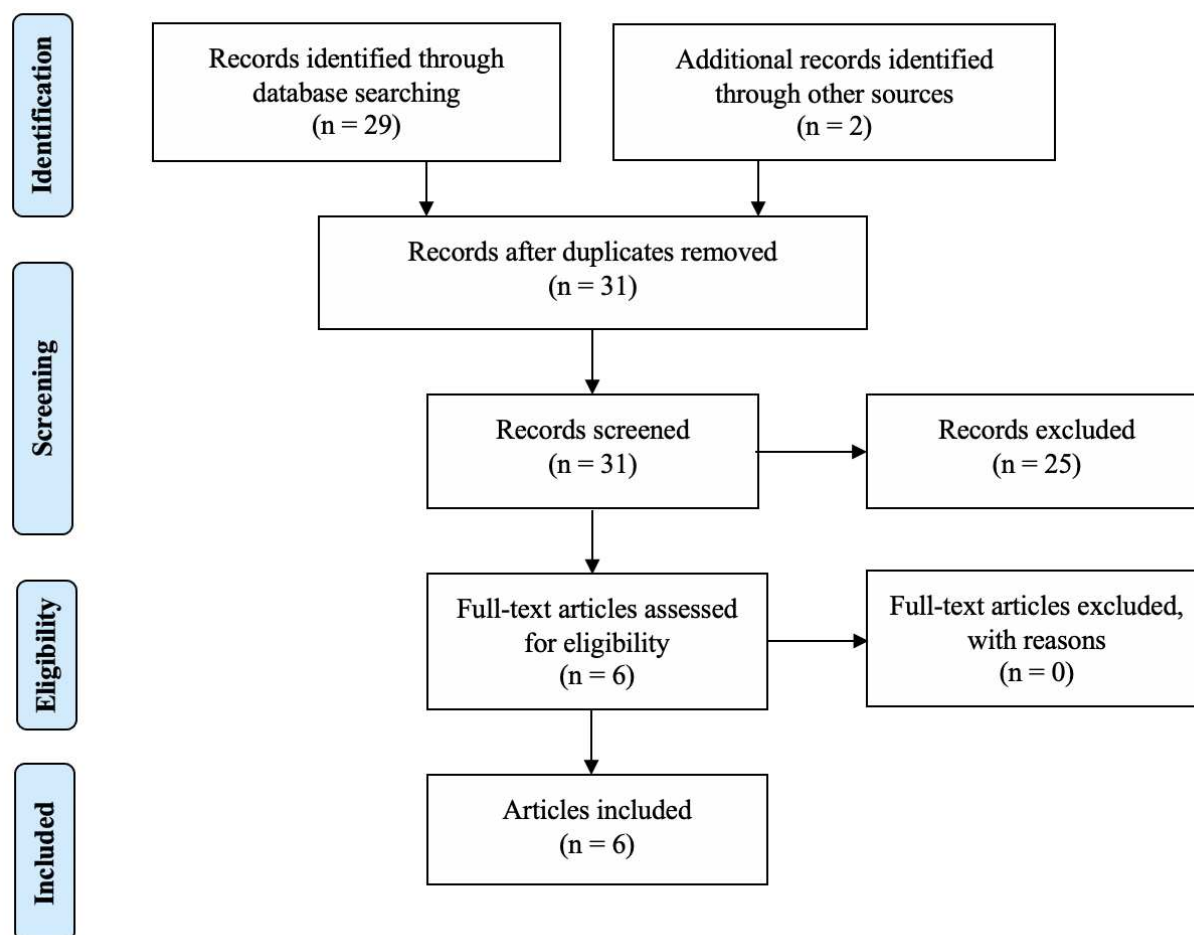
S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Hypertension and high blood pressure	1	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
2	Diabetes	2	E10.9 (Type 1 diabetes mellitus without complication)	125,058	15.88	11.86 (11.79, 11.93)
		3	E11.9 (Type 2 diabetes mellitus without complication)			
		4	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		5	E14.3 (Diabetes mellitus with retinopathy)			
		6	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		7	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		8	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
3	Chronic pain (arthritis or rheumatism, back problems including disk or spine, migraine headaches)	9	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	107,090	13.60	11.24 (11.17, 11.31)
		10	M15.9 (Osteoarthritis (OA) - generalized)			
		11	M19.99 (Arthritis, unspecified, site unspecified)			
		12	G43.9 (Migraine, unspecified)			
		13	G50.0 (Trigeminal neuralgia)			
4	Respiratory disorders (asthma, chronic lung disease such as chronic bronchitis or emphysema)	14	J30.4 (Allergic rhinitis, unspecified)	68,048	8.64	8.73 (8.65, 8.80)
		15	J44.9 (Chronic obstructive pulmonary disease, unspecified)			
		16	J45.9 (Asthma, unspecified)			
5	Cardiovascular disorders (stroke or major paralysis, heart attack, coronary heart disease, angina, congestive heart failure or other heart disease)	17	I25.9 (Chronic ischaemic heart disease, unspecified)	73,922	9.39	6.65 (6.60, 6.70)
		18	I48 (Atrial fibrillation and flutter)			
		19	I50.0 (Congestive heart failure)			
		20	I51.9 (Heart disease, unspecified)			
		21	G45.9 (Transient cerebral ischaemic attack, unspecified)			
		22	I64 (Stroke, not specified as haemorrhage or infarction)			
6	Cancer	23	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
7	Neurological disorders (epilepsy, convulsion, Parkinson's disease)	24	G20 (Parkinson's disease)	4,609	0.59	0.48 (0.46, 0.49)
		25	G40.90 (Epilepsy, unspecified, without mention of intractable epilepsy)			
8	Ulcer and chronic inflamed bowel (stomach ulcer, chronic inflamed bowel, enteritis or colitis)	26	K27.9 (Peptic ulcer, unspecified as acute or chronic, without haemorrhage or perforation)	3,131	0.40	0.34 (0.33, 0.35)
		27	K58.9 (Irritable bowel syndrome without diarrhoea)			

Appendix 2a: Literature Search Strategy

Database: Ovid MEDLINE(R): 1946 to March Week 1 2020

S/N	Search Terms	Results
1	exp comorbidity/ or multiple chronic conditions/ or multimorbidity	106,975
2	(multimorbid* or multi-morbid* or comorbid* or co-morbid*).ab,ti,kw.	144,228
3	((multiple or coexist* or co-exist* or concurrent* or simultaneous*) adj3 (disease* or illness* or diagnos* or condition* or morbid* or disorder*)).ab,ti,kw.	61,543
4	1 or 2 or 3	263,334
5	(prevalence or association).ab,ti,kw.	1,385,219
6	(Singapore).ab,ti,kw.	12,889
7	4 and 5 and 6	166
8	Set following limits: English language, Human studies, Full Text, 2010 to Current	29

Appendix 2b: PRISMA Flow Diagram



Appendix 3: A Summary of the Differences between Reported Studies on Multimorbidity

	Fortin et al. (Published in 2017)	Ge et al. (Published in 2018)	Ge et al. (Published in 2019)	Low et al. (Published in 2019)	Picco et al. (Published in 2016)	Quah et al. (Published in 2016)	Subramaniam et al. (Published in 2014)
Number of conditions	20	17	17	48	10	14	8
Definition of chronic disease	Conditions that usually last 12 months or more	Diseases that are irreversible and persistent throughout adulthood	Diseases characterised by a long duration and are of a generally slow progression that are irreversible and persistent throughout adulthood	No	No	No	No
Source of list of chronic conditions	Developed from a scoping review of 44 publications on multimorbidity	Not mentioned	Not mentioned	Selected from 3 indexes - the Singapore Chronic Disease Management Programme ¹ , the Charlson Comorbidity Index ² and the Elixhauser Comorbidity Index ³	Not mentioned	Conditions from Singapore Mental Health Study ⁴ 2010	Modified Composite International Diagnostic Interview (CIDI) ⁵
Sources of data	Self-reported* (conditions that have been confirmed by a doctor or for which they are on medications)	At least one of the sources was self-reported or from the NHG Chronic Disease Management System (CDMS) database ⁶	Self-reported	Singapore Eastern Regional Health System ⁷	Self-reported	Self-reported	Self-reported
Cut-point	Not mentioned	2 conditions	2 conditions	2 conditions	2 conditions	2 conditions	2 conditions
Reference population	Practice-based population	General population	General population	Practice-based population (tertiary hospitals, community hospitals, primary care polyclinics)	General population	Practice-based population (one primary care polyclinic)	General population
Age-group	Not mentioned	≥ 21 years old	≥ 21 years old	0 to 85+ years old	≥ 60 years old	≥ 65 years old	≥ 18 years old

¹ The Chronic Disease Management Programme (CDMP) is an initiative introduced by the Ministry of Health (MOH), Singapore, in 2016 and involves the development of evidence-based structured Disease Management Programmes required in the management of their chronic diseases.

² The Charlson Comorbidity Index is a weighted index of 19 chronic conditions that was originally developed to predict the risk of short-term mortality from comorbid disease among patients being treated for primary breast cancer at a single hospital in 1987.

³ The Elixhauser Comorbidity Index is an index of 30 chronic conditions that was developed to predict hospital charges, length of stay and in-patient mortality among patients 18 years and older from 438 hospitals in California in the year 1992.

⁴ The Singapore Mental Health Study (SMHS) is a nationwide epidemiological study undertaken in 2009-2010 that provides insight into some of the common mental health illnesses in the adult Singapore resident population.

⁵ The Composite International Diagnostic Interview (CIDI) was designed to allow investigators to reliably assess mental disorders according to the most widely accepted nomenclatures in different populations and cultures by combining questions from the Diagnostic Interview Schedule with questions designed to elicit Present State Examination items in 1988.

⁶ The NHG Chronic Disease Management System (CDMS) database is a chronic disease registry within NHG that was commissioned for use in 2014 linking administrative and key clinical data of patients with chronic diseases across the National Healthcare Group cluster in Singapore.

⁷ The Singapore Eastern Regional Health System was developed from the integration of the Singapore Health Services (SingHealth) and Eastern Health Alliance (EHA) in 2017.

Measured levels of multimorbidity⁸	No	No	Yes Disease count	Yes Disease count	No	Yes 1. Disease count 2. Drug count	No
Patient-reported outcomes	No	Yes Physical function	Yes 1. Health-related quality of life 2. Self-rated health	No	No	Yes 1. Health-related quality of life 2. Functional disability 3. Chronic musculoskeletal pain	Yes Health-related quality of life

⁸ Levels of multimorbidity refers to the combined effects of the multiple conditions that an individual has. This may be based on disease count, that is, the number of chronic conditions the patient has; or other variables such as drug count, which is the number of chronic medications an individual is prescribed.

Appendix 4: List of chronic conditions under Chronic Disease Management Programme (CDMP)

S/N	Conditions
1	Diabetes mellitus and pre-diabetes
2	Hypertension
3	Lipid disorders
4	Asthma
5	Chronic obstructive pulmonary disease (COPD)
6	Chronic kidney disease (nephritis/nephrosis)
7	Schizophrenia
8	Major depression
9	Bipolar disorder
10	Anxiety
11	Stroke
12	Dementia
13	Osteoarthritis
14	Parkinson's disease
15	Benign prostatic hyperplasia (BPH)
16	Epilepsy
17	Osteoporosis
18	Psoriasis
19	Rheumatoid arthritis (RA)
20	Ischemic heart disease (IHD)

Appendix 5a: List of ICD-10 diagnosis codes matched to the chronic conditions studied by each author

S/N	ICD-10 Codes	Fortin et al. 2017	Ge et al. 2018 and 2019	Low et al. 2019	Picco et al. 2016	Quah et al. 2016	Subramaniam et al. 2014
1	E78.5	✓	✓	✓		✓	
2	I10	✓	✓	✓	✓	✓	✓
3	E11.9	✓	✓	✓	✓	✓	✓
4	M19.99	✓			✓	✓	✓
5	J30.4					✓	✓
6	E66.9	✓					
7	J45.9	✓	✓	✓	✓	✓	✓
8	I25.9	✓	✓	✓	✓	✓	✓
9	K21.9	✓				✓	
10	K76.9	✓		✓		✓	
11	M10.99		✓				
12	N28.9			✓		✓	
13	N18.9	✓	✓	✓		✓	
14	I51.9	✓		✓	✓	✓	✓
15	M15.9	✓	✓	✓	✓	✓	✓
16	I64	✓	✓	✓	✓	✓	✓
17	E03.9	✓		✓		✓	
18	N40	✓		✓			
19	F32.90	✓	✓	✓	✓	✓	
20	Z22.51	✓				✓	
21	E05.9	✓		✓		✓	
22	H91.9					✓	
23	G43.9						✓
24	F41.1	✓	✓	✓		✓	
25	C80	✓	✓	✓	✓	✓	✓
26	I48	✓		✓	✓	✓	✓
27	M81.99	✓	✓	✓			
28	E14.31	✓	✓	✓	✓	✓	✓
29	G45.9	✓	✓		✓	✓	✓
30	J44.9	✓	✓	✓	✓	✓	✓
31	K82.9					✓	
32	G40.90			✓		✓	✓
33	F20.9		✓	✓		✓	
34	E10.9	✓	✓	✓	✓	✓	✓
35	I50.0	✓	✓	✓	✓	✓	✓
36	F03	✓	✓	✓		✓	
37	F32.20	✓	✓	✓	✓	✓	
38	I73.9	✓		✓			
39	K58.9	✓				✓	✓
40	M06.99	✓	✓	✓	✓	✓	✓
41	F29					✓	
42	E14.73	✓	✓	✓	✓	✓	✓
43	G20		✓	✓		✓	✓
44	K27.9	✓				✓	✓
45	G60.9					✓	
46	Q79.9					✓	
47	I70.20	✓					
48	E14.2	✓	✓	✓	✓	✓	✓
49	N03.9	✓		✓		✓	
50	G50.0						✓
51	Z89.5			✓			
52	E14.3	✓	✓	✓	✓	✓	✓
53	F31.9			✓		✓	
54	Z89.6			✓			
55	Z89.4			✓			
56	E14.64	✓	✓	✓	✓	✓	✓
57	L40.8			✓			

Appendix 5b: Descriptors of ICD-10 diagnosis codes

S/N	ICD-10 Codes	Descriptors
1	E78.5	Hyperlipidaemia, unspecified
2	I10	Essential (primary) hypertension
3	E11.9	Type 2 diabetes mellitus without complication
4	M19.99	Arthritis, unspecified, site unspecified
5	J30.4	Allergic rhinitis, unspecified
6	E66.9	Obesity, unspecified
7	J45.9	Asthma, unspecified
8	I25.9	Chronic ischaemic heart disease, unspecified
9	K21.9	Gastro-oesophageal reflux disease without oesophagitis
10	K76.9	Liver disease, unspecified
11	M10.99	Gout, unspecified, site unspecified
12	N28.9	Disorder of kidney and ureter, unspecified
13	N18.9	Chronic kidney disease, unspecified
14	I51.9	Heart disease, unspecified
15	M15.9	Osteoarthritis (OA) - Generalised
16	I64	Stroke, not specified as haemorrhage or infarction
17	E03.9	Hypothyroidism, unspecified
18	N40	Hyperplasia of prostate
19	F32.90	Depressive episode, unspecified, not specified as arising in the postnatal period
20	Z22.51	Carrier of viral hepatitis B
21	E05.9	Thyrotoxicosis, unspecified
22	H91.9	Hearing loss, unspecified
23	G43.9	Migraine, unspecified
24	F41.1	Anxiety disorder, unspecified
25	C80	Malignant neoplasm without specification of site
26	I48	Atrial fibrillation and flutter
27	M81.99	Other osteoporosis, site unspecified
28	E14.31	Unspecified diabetes mellitus with background retinopathy
29	G45.9	Transient cerebral ischaemic attack, unspecified
30	J44.9	Chronic Obstructive Pulmonary Disease, Unspecified
31	K82.9	Disease of gallbladder, unspecified
32	G40.90	Epilepsy, unspecified, without mention of intractable epilepsy
33	F20.9	Schizophrenia, unspecified
34	E10.9	Type 1 diabetes mellitus without complication
35	I50.0	Congestive heart failure
36	F03	Unspecified dementia
37	F32.20	Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period
38	I73.9	Peripheral vascular disease, unspecified
39	K58.9	Irritable bowel syndrome without diarrhoea
40	M06.99	Rheumatoid arthritis, unspecified, site unspecified
41	F29	Unspecified nonorganic psychosis
42	E14.73	Unspecified diabetes mellitus with foot ulcer due to multiple causes
43	G20	Parkinson's disease
44	K27.9	Peptic ulcer, unspecified as acute or chronic, without haemorrhage or perforation
45	G60.9	Hereditary and idiopathic neuropathy, unspecified
46	Q79.9	Congenital malformation of musculoskeletal system, unspecified
47	I70.20	Atherosclerosis of arteries of extremities, unspecified
48	E14.2	Diabetes mellitus with incipient diabetic nephropathy
49	N03.9	Unspecified nephritic syndrome, unspecified
50	G50.0	Trigeminal neuralgia
51	Z89.5	Acquired absence of leg at or below knee
52	E14.3	Diabetes mellitus with retinopathy
53	F31.9	Bipolar affective disorder, unspecified
54	Z89.6	Acquired absence of leg above knee
55	Z89.4	Acquired absence of foot and ankle
56	E14.64	Unspecified diabetes mellitus with hypoglycaemia
57	L40.8	Other psoriasis

Appendix 6: List of Chronic Conditions in Proposed Operational Definition of Multimorbidity

S/N	Conditions	S/N	ICD-10 Codes	Patient Count	Crude Prevalence Rate	Standardised Prevalence Rate (95% CI)
1	Hyperlipidaemia	1	E78.5 (Hyperlipidaemia, unspecified)	257,114	32.65	24.79 (24.86, 25.07)
2	Hypertension (high blood pressure)	2	I10 (Essential (primary) hypertension)	221,760	28.16	20.93 (20.84, 21.02)
3	Diabetes (including pre-diabetes)	3	E09 (Impaired glucose regulation)	150,294	19.09	14.28 (14.20, 14.35)
		4	E099 (Impaired glucose regulation without complication)			
		5	E10.9 (Type 1 diabetes mellitus without complication)			
		6	E11.9 (Type 2 diabetes mellitus without complication)			
		7	E14.2 (Diabetes mellitus with incipient diabetic nephropathy)			
		8	E14.3 (Diabetes mellitus with retinopathy)			
		9	E14.31 (Unspecified diabetes mellitus with background retinopathy)			
		10	E14.64 (Unspecified diabetes mellitus with hypoglycaemia)			
		11	E14.73 (Unspecified diabetes mellitus with foot ulcer due to multiple causes)			
4	Arthritis &/or rheumatoid arthritis	12	M06.99 (Rheumatoid arthritis, unspecified, site unspecified)	100,838	12.81	10.43 (10.36, 10.50)
		13	M15.9 (Osteoarthritis (OA) - Generalised)			
		14	M19.99 (Arthritis, unspecified, site unspecified)			
5	Obesity	15	E66.9 (Obesity, unspecified)	48,893	6.21	5.29 (5.24, 5.34)
6	Cardiovascular disease (angina, MI, AF, poor circulation of lower limbs)	16	I25.9 (Chronic ischaemic heart disease, unspecified)	43,559	5.53	3.74 (3.71, 3.78)
		17	I48 (Atrial fibrillation and flutter)			
		18	I70.20 (Atherosclerosis of arteries of extremities, unspecified)			
		19	I73.9 (Peripheral vascular disease, unspecified)			
7	Asthma, COPD, or chronic bronchitis	20	J44.9 (Chronic Obstructive Pulmonary Disease, Unspecified)	32,611	4.14	3.68 (3.63, 3.72)
		21	J45.9 (Asthma, unspecified)			
8	Chronic hepatitis	22	K76.9 (Liver disease, unspecified)	25,918	3.29	3.02 (2.98, 3.06)
		23	Z22.51 (Carrier of viral hepatitis B)			
9	Stomach problem (reflux, heartburn, or gastric ulcer)	24	K21.9 (Gastro-oesophageal reflux disease without oesophagitis)	22,233	2.82	2.52 (2.48, 2.56)
		25	K27.9 (Peptic ulcer, unspecified as acute or chronic, without haemorrhage or perforation)			
10	Thyroid disorder	26	E03.9 (Hypothyroidism, unspecified)	20,781	2.64	2.36 (2.32, 2.39)
		27	E05.9 (Thyrotoxicosis, unspecified)			
11	Stroke and TIA	28	G45.9 (Transient cerebral ischaemic attack, unspecified)	23,628	3.00	2.07 (2.04, 2.10)
		29	I64 (Stroke, not specified as haemorrhage or infarction)			
12	Heart failure (including valve problems or replacement)	30	I50.0 (Congestive heart failure)	20,538	2.61	1.97 (1.94, 2.00)
		31	I51.9 (Heart disease, unspecified)			
13	Kidney disease or failure	32	N03.9 (Unspecified nephritic syndrome, unspecified)	22,221	2.82	1.82 (1.79, 1.84)
		33	N18.9 (Chronic kidney disease, unspecified)			
14	Depression or anxiety	34	F32.20 (Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period)	14,910	1.89	1.81 (1.78, 1.84)
		35	F32.90 (Depressive episode, unspecified, not specified as arising in the postnatal period)			
		36	F41.1 (Anxiety disorder, unspecified)			
15	Chronic urinary problem	37	N40 (Hyperplasia of prostate)	13,031	1.65	1.07 (1.05, 1.09)
16	Physical disability	38	H91.9 (Hearing loss, unspecified)	10,514	1.34	1.05

		39	Q79.9 (Congenital malformation of musculoskeletal system, unspecified)			(1.03, 1.08)
17	Any cancer in the last 5 years	40	C80 (Malignant neoplasm without specification of site)	7,940	1.01	0.68 (0.66, 0.69)
18	Osteoporosis	41	M81.99 (Other osteoporosis, site unspecified)	7,283	0.92	0.57 (0.56, 0.59)
19	Dementia or Alzheimer's disease	42	F03 (Unspecified dementia)	3,571	0.45	0.27 (0.26, 0.28)
20	Colon problem (irritable bowel)	43	K58.9 (Irritable bowel syndrome without diarrhoea)	1,517	0.19	0.20 (0.19, 0.21)

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