

Multimorbidity and Mortality: A Data Science Perspective (Supplementary Material)

A Definitions

Table 1. Age groups based on MeSH definitions.

Group	Age
Infant	0 to 2 years
Child	2 to 13 years
Adolescent	13 to 19 years
Adult	19 to 45 years
Middle-Aged	45 to 65 years
Aged	65 to 80 years
Elderly	80 years and over

Table 2. List of morbidities and MedDRA System Organ Classes.

No.	Disease	MedDRA	Abbrv.
1	Angina	Cardiac Disorders	Card
2	Atrial Fibrillation	Cardiac Disorders	Card
3	Coronary Artery Disease	Cardiac Disorders	Card
4	Cardiac Arrhythmia	Cardiac Disorders	Card
5	Heart Failure	Cardiac Disorders	Card
6	Heart Valve Disorder	Cardiac Disorders	Card
7	Myocardial Infarction	Cardiac Disorders	Card
8	Cardiac-related	Cardiac Disorders	Card
9	Thyroid Cancer	Endocrine Disorders	En
10	Esophageal Cancer	Gastrointestinal Disorders	GI
11	Stomach Cancer	Gastrointestinal Disorders	GI
12	Liver Disease	Hepatobiliary Disorders	Hep
13	Liver-related	Hepatobiliary Disorders	Hep
14	Asthma	Immune System Disorders	Imm
15	HIV/AIDS	Immune System Disorders	Imm
16	Multiple Sclerosis	Immune System Disorders	Imm
17	Diabetes	Metabolism and Nutrition Disorders	Me
18	Lupus	Musculoskeletal and Connective Tissue Disorders	Mu
19	Breast Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
20	Cervix Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
21	Colorectal Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
22	Leukemias	Neoplasms Benign, Malignant and Unspecified	Neop
23	Liver Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
24	Lung Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
25	Melanoma	Neoplasms Benign, Malignant and Unspecified	Neop

26	Cancer-related	Neoplasms Benign, Malignant and Unspecified	Neop
27	Pancreas Cancer	Neoplasms Benign, Malignant and Unspecified	Neop
28	Encephalitis	Nervous System Disorders	Nerv
29	Parkinson's Disease	Nervous System Disorders	Nerv
30	Stroke	Nervous System Disorders	Nerv
31	Stroke Related	Nervous System Disorders	Nerv
32	Dementia	Psychiatric Disorders	Ps
33	Bladder Cancer	Renal and Urinary Disorders	Ren
34	Kidney Disease	Renal and Urinary Disorders	Ren
35	Kidney-related	Renal and Urinary Disorders	Ren
36	Ovarian Cancer	Reproductive System and Breast Disorders	Repr
37	Prostate Cancer	Reproductive System and Breast Disorders	Repr
38	Testicular Cancer	Reproductive System and Breast Disorders	Repr
39	Uterus Cancer	Reproductive System and Breast Disorders	Repr
40	Chronic Obstructive Pulmonary Disease	Respiratory, Thoracic and Mediastinal Disorders	Res
41	Respiratory-related	Respiratory, Thoracic and Mediastinal Disorders	Res
42	Aortic Aneurysm	Vascular Disorders	Vas
43	Hypertension	Vascular Disorders	Vas
44	Other Aneurysms	Vascular Disorders	Vas
45	Peripheral Artery Disease	Vascular Disorders	Vas
46	Transient Ischemic Attack	Vascular Disorders	Vas

B Sample Size for Index of Multiple Deprivation

Millions	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	5.1	5.1	5.0	5.0	4.9	4.6	4.2	3.5	3.1
With IMD	0.3	2.1	2.2	2.1	2.1	1.9	1.8	1.4	1.2
<i>% of Total</i>	<i>5.2</i>	<i>42.0</i>	<i>43.4</i>	<i>41.3</i>	<i>43.4</i>	<i>41.6</i>	<i>42.0</i>	<i>39.8</i>	<i>37.2</i>

C Supplementary Figures

Supplementary plots for all age groups and years at available at <https://doi.org/10.6084/m9.figshare.19799935.v1>.

D Survival Analysis

Table 3. Summary statistics of dataset used for survival analysis.

Proportion (%)	2010			2011			2012		
	Train	Test	All	Train	Test	All	Train	Test	All
<i>Sex</i>									
Male	44.8	44.9	44.9	44.9	45.0	44.9	45.0	45.3	45.1
Female	55.2	55.1	55.1	55.1	55.0	55.1	55.0	54.7	54.9
<i>Age Group</i>									
Aged	71.6	71.6	71.6	71.3	71.2	71.3	71.6	71.5	71.5
Elderly	28.4	28.4	28.4	28.7	28.8	28.7	28.4	28.5	28.5
<i>IMD</i>									
1	25.4	25.4	25.4	25.3	25.5	25.4	25.5	25.5	25.5
2	25.2	25.1	25.2	25.1	25.1	25.1	24.9	24.7	24.8
3	21.7	21.6	21.7	21.6	21.5	21.6	21.5	21.4	21.4
4	17.6	17.6	17.6	17.7	17.7	17.7	17.8	18.0	17.8
5	10.2	10.3	10.3	10.3	10.2	10.2	10.3	10.4	10.4
<i>Multimorbidity</i>									
0	20.5	20.6	20.5	20.1	20.3	20.2	20.2	20.3	20.3
1	27.2	27.1	27.2	27.0	26.8	26.9	26.7	26.8	26.7
2	21.2	21.2	21.2	21.2	21.4	21.3	21.3	21.3	21.3
3	13.7	13.6	13.7	13.8	13.8	13.8	13.8	13.7	13.8
4+	17.4	17.5	17.4	17.9	17.7	17.9	18.0	17.9	17.9
<i>Mortality</i>									
	12.1	12.1	12.1	11.7	11.7	11.7	9.9	9.9	9.9
Total (Mil)	261,862	112,226	374,088	273,596	117,255	390,851	271,812	116,490	388,302

Table 4. Test set C-index of survival models.

Year	Test Set C-index (95% CI)			
	Cox	Regularized Cox	Accelerated Failure Time	Neural Network Survival
2010	0.793 (0.790, 0.797)	0.793 (0.790, 0.797)	0.793 (0.790, 0.797)	0.794 (0.790, 0.797)
2011	0.798 (0.795, 0.802)	0.798 (0.795, 0.802)	0.798 (0.795, 0.802)	0.798 (0.794, 0.801)
2012	0.807 (0.803, 0.811)	0.807 (0.804, 0.812)	0.799 (0.795, 0.804)	0.806 (0.802, 0.810)

Table 5. Top ten risk factors of the Cox Proportional Hazards model for 2012. Asterisks denote factors that are significant after the Benjamini-Hochberg adjustment.

Factor	HR (95% CI)	
Pancreas Cancer	4.67 (3.61, 6.02)	*
Osophageal Cancer	4.42 (3.75, 5.22)	*
Lung Cancer	4.38 (3.99, 4.80)	*
Liver Cancer	4.35 (3.66, 5.16)	*
Multimorbidity (4+)	2.44 (2.22, 2.69)	*
Dementia	2.28 (2.18, 2.39)	*
Ovarian Cancer	2.21 (1.84, 2.65)	*
Multimorbidity (3)	2.16 (2.00, 2.34)	*
Parkinson's Disease	2.06 (1.91, 2.23)	*

Multimorbidity (2) 1.89 (1.76, 2.02) *