Does socioeconomic status moderate the effect of increasing chronic disease burden on three-year survival in a population-based cohort?

Natasha Lane MSc [1], Andrea Gruneir PhD [1,2,3], Colleen Maxwell PhD [2,4], Susan Bronskill PhD [1,2], Walter Wodchis PhD [1,2]

[1] Institute of Health Policy, Management and Evaluation, University of Toronto; [2] Institute for Clinical Evaluative Sciences; [3] Women's College Research Institute; [4] School of Pharmacy, University of Waterloo

HSPRN health system performance research network

OBJECTIVES

- The prevalence of **multimorbidity** (co-occurrence of 2 or more medical conditions) is increasing in Canada and abroad.[1]
- Income level is a common measure of individuals' **socioeconomic status** (SES) and has been consistently shown to be associated with incidence and prevalence of multimorbidity[2-4]
  - Prevalence of multimorbidity is higher among people in low-income neighborhoods than people in affluent ones.[2-4]
  - Among lower income individuals, onset of multimorbidity occurs 10 to 15 years earlier than in their more affluent counterparts[2]
- The direct link between the SES gradient in multimorbidity and survival has not been well described.

This study sought to determine whether the effect of increasing multimorbidity on patient survival is moderated by SES.

DATA SOURCES & STUDY POPULATION

Data sources included but were not limited to:
- CIHI Discharge Abstract Database: for inpatient hospitalization records
- Ontario Health Insurance Plan claims: for physician billings
- Registered Persons Database: for basic demographics
- 2006 Canadian census: for neighborhood income quintiles

The **study sample** consisted of a 5% random sample (n = 181,670) of all Ontario residents who met the following criteria on April 1, 2009:
- aged 45 to 105 years; and
- at least one of the following chronic conditions: cardiac arrhythmia, acute myocardial infarction, hypertension, chronic coronary syndrome, congestive heart failure, stroke, asthma, chronic obstructive pulmonary disorder, diabetes, osteoporosis, rheumatoid arthritis, osteo- and other arthritis, depression, dementia, cancer, or renal failure.
- Still living in Ontario and eligible for OHIP coverage as of March 31st, 2012.

MEASURES & ANALYSES

Measures
- Dependent variable:
  - Survival to end of three year of follow-up period
- Key independent variables:
  - Neighborhood income quintile (SES proxy)
  - Number of chronic conditions (1, 2, 3, 4, 5+)

Analyses
- Descriptive characterization of sample by age group: 45 – 64 and 65 – 105 (Table 1)
- Univariate **Kaplan-Meier curves** to estimate survival, stratified by number of chronic conditions and neighborhood income quintiles (Figure 1) in whole sample
- Age-stratified multivariate **Cox proportional hazards models** to estimate hazard of death during follow-up, examine significance of interaction terms between income quintiles and number of chronic conditions (Table 2, Figure 2)
- Covariates included in age-stratified Cox proportional hazards models: sex, urban vs. non-urban location of dwelling, number of days prior to April 9, 2009 with current number of conditions presence of usual provider of care

RESULTS

Table 1: Age Stratified Sample Characteristics

Characteristic	45 – 64 Years Old (n = 108,139)	65 – 105 Years Old (n = 73,531)
Age		
65 – 74	-	37,777 (51.4%)
75 – 84	-	26,155 (35.6%)
85 – 105	-	9,599 (13.0%)
Sex		
Male	50,483 (46.7%)	32,064 (43.6%)
Female	57,656 (53.3%)	41,467 (56.4%)
Number of chronic conditions		
1	50,677 (46.9%)	14,400 (19.6%)
2	32,263 (29.8%)	19,156 (26.1%)
3	15,645 (14.5%)	16,812 (22.9%)
4	6,241 (5.8%)	11,064 (15.1%)
5+	3,313 (3.1%)	12,099 (16.4%)
Days prior to April 1, 2009 with number of current number of chronic conditions		
Mean (SD)	1,413.3 (1391.5)	1,361.9 (1376.6)
Median (25th, 75th percentile)	778 (442, 2115)	734 (421, 2004)
Income quintile		
1	19,314 (17.9%)	14,106 (19.2%)
2	20,650 (19.1%)	15,365 (20.9%)
3	21,473 (19.9%)	14,236 (19.4%)
4	22,668 (21.0%)	14,567 (19.8%)
5	23,124 (21.4%)	14,791 (20.1%)
Missing	910 (0.84%)	466 (0.6%)
Location of dwelling		
Non-urban (RIO ≥10)	29,670 (27.4%)	22,545 (30.7)
Urban (RIO <10)	76,904 (71.1%)	50,137 (68.2)
Missing	1,565 (1.4%)	849 (1.1)
Individual has usual provider of care (is rostered/virtually roistered)		
Yes	82,866 (76.6%)	57,977 (78.8%)
No	25,273 (23.4%)	15,554 (21.1%)
Recorded vital status on March 31, 2012		
Dead	1,698 (1.6%)	8,859 (12.0%)
Alive	106,441 (98.4%)	64,672 (87.9%)

Figure 1: Univariate Kaplan-Meier Curves for Whole Sample (aged 45+) by (i) Number of chronic conditions and (ii) income quintile
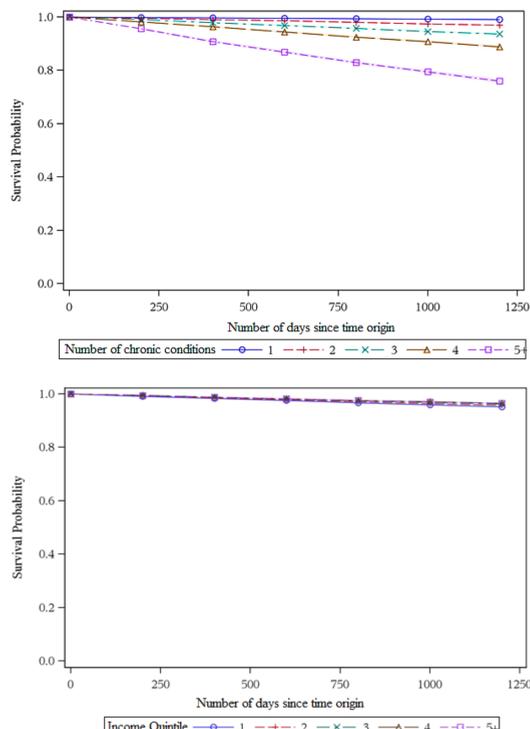
(i) There is **clear separation** of the survival functions over time for individuals with **1, 2, 3, 4, or 5+ conditions**.

Survival trajectories differ significantly between individuals in the study sample depending on how many chronic conditions they have.

(ii) There is minimal **separation** of the survival functions over time for individuals in **different income quintiles**

Income quintile has a relatively small effect on three-year survival among individuals with multimorbidity.

Figure 2: Adjusted Hazard Ratios for Number of Chronic Conditions (CC) in 1st and 5th Income Quintiles (Whole Sample aged 45+)
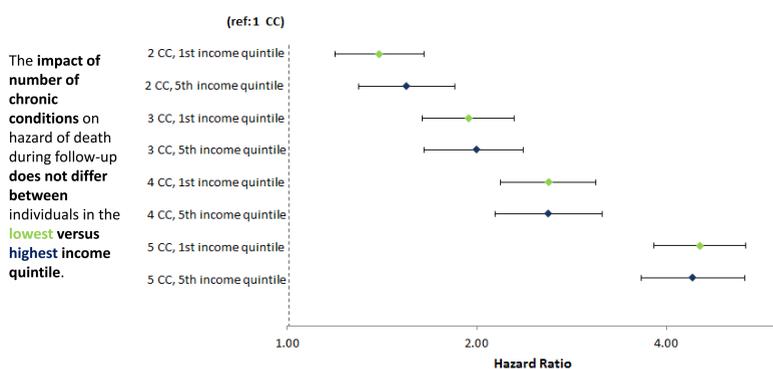
The impact of number of chronic conditions on hazard of death during follow-up **does not differ between** individuals in the **lowest versus highest income quintile**.

Table 2: Parameter Estimates and Hazard Ratios from Multivariate Cox Proportional Hazards Models in Different Age Stata

Parameter	45 – 64 Years Old (n = 108,139)				65 – 105 Years Old (n = 73,531)			
	Parameter Estimate	Hazard Ratio (HR)	95% Confidence Intervals on HR	Pr > Chi-Sq	Parameter Estimate	Hazard Ratio (HR)	95% Confidence Intervals on HR	Pr > Chi-Sq
Sex								
Female	Ref.				Ref.			
Male	0.378	1.46	(1.33, 1.61)	<.0001	0.084	1.09	(1.04, 1.13)	<.0001
Number of chronic conditions								
1	Ref.				Ref.			
2	0.323	1.38	(1.06, 1.81)	0.019	0.413	1.51	(1.24, 1.84)	<.0001
3	0.491	1.63	(1.20, 2.22)	0.002	0.822	2.27	(1.88, 2.76)	<.0001
4	1.217	3.38	(2.46, 4.63)	<.0001	1.152	3.16	(2.61, 3.84)	<.0001
5+	1.956	7.07	(5.26, 9.50)	<.0001	1.784	5.95	(4.97, 7.13)	<.0001
Income quintile								
1st	Ref.				Ref.			
2nd	-0.284	0.75	(0.57, 0.99)	0.046	0.020	1.02	(0.82, 1.27)	0.859
3rd	-0.423	0.65	(0.49, 0.87)	0.004	-0.111	0.89	(0.71, 1.12)	0.339
4th	-0.572	0.56	(0.42, 0.75)	0.000	-0.283	0.75	(0.60, 0.95)	0.018
5th	-0.630	0.53	(0.40, 0.71)	<.0001	-0.245	0.78	(0.62, 0.98)	0.036
Location of dwelling								
Non-Urban	Ref.				Ref.			
Urban	-0.292	0.75	(0.67, 0.83)	<.0001	-0.163	0.85	(0.81, 0.89)	<.0001
Has Usual Provider of Care								
No	Ref.				Ref.			
Yes	-0.170	0.84	(0.76, 0.94)	0.002	-0.318	0.73	(0.76, 0.69)	<.0001
Interactions between Income Quintile and Number of Conditions								
2nd income quint* 2 conditions	0.144	1.15	(0.78, 1.71)	0.470	-0.146	0.86	(0.66, 1.13)	0.292
2nd income quint* 3 conditions	0.371	1.45	(0.94, 2.23)	0.090	-0.183	0.83	(0.64, 1.08)	0.167
2nd income quint* 4 conditions	-0.154	0.86	(0.53, 1.40)	0.536	-0.189	0.83	(0.64, 1.08)	0.159
2nd income quint* 5 conditions	0.050	1.05	(0.68, 1.64)	0.823	-0.132	0.88	(0.69, 1.12)	0.286
3rd income quint* 2 conditions	0.073	1.08	(0.72, 1.61)	0.721	-0.072	0.93	(0.70, 1.23)	0.618
3rd income quint* 3 conditions	0.373	1.45	(0.93, 2.26)	0.098	-0.054	0.95	(0.72, 1.24)	0.696
3rd income quint* 4 conditions	-0.125	0.88	(0.53, 1.46)	0.630	0.050	1.05	(0.80, 1.38)	0.717
3rd income quint* 5 conditions	0.054	1.06	(0.66, 1.68)	0.819	-0.023	0.98	(0.76, 1.26)	0.857
4th income quint* 2 conditions	0.182	1.20	(0.80, 1.80)	0.504	0.097	1.10	(0.83, 1.47)	0.504
4th income quint* 3 conditions	0.431	1.54	(0.98, 2.41)	0.060	0.097	1.10	(0.84, 1.45)	0.490
4th income quint* 4 conditions	-0.345	0.71	(0.41, 1.23)	0.222	0.077	1.08	(0.82, 1.43)	0.591
4th income quint* 5 conditions	0.350	1.42	(0.89, 2.26)	0.140	0.097	1.10	(0.85, 1.43)	0.462
5th income quint* 2 conditions	0.282	1.33	(0.89, 1.98)	0.168	0.012	1.01	(0.76, 1.34)	0.936
5th income quint* 3 conditions	0.348	1.42	(0.90, 2.24)	0.137	-0.021	0.98	(0.75, 1.28)	0.879
5th income quint* 4 conditions	0.088	1.09	(0.65, 1.84)	0.742	0.052	1.05	(0.80, 1.39)	0.711
5th income quint* 5 conditions	0.122	1.13	(0.68, 1.88)	0.639	0.093	1.10	(0.85, 1.41)	0.471

KEY FINDINGS

Having more chronic conditions is consistently associated with poorer three-year survival
- In both univariate Kaplan-Meier survival curves and multivariate regression analyses, each additional chronic condition increased individuals' hazard of death during three-year follow-up.

Socioeconomic status does not moderate the effect of increasing multimorbidity on survival
- Among Ontarians aged 45 to 105, the impact of increasing number of chronic conditions on three-year survival is the same across neighborhood income strata.

Controlling for the number of chronic conditions and demographic variables, high neighborhood income is associated with improved survival over three years of follow-up
- The protective effect of high income is greater among those aged 45 – 64 than those aged 65 and over.

IMPLICATIONS

Low SES individuals have poorer survival outcomes than their high SES counterparts, even when number of conditions is controlled for, however the detrimental effect of increasing multimorbidity burden on survival does not differ among low versus high SES people.

These findings have implications for targeted interventions among lower SES populations. Targeting multimorbidity prevention efforts at low SES groups is likely to reduce disparities in multimorbidity incidence. Once individuals have multimorbidity however, targeted multimorbidity treatment strategies are unlikely to reduce disparities because the impact of income on survival is independent of multimorbidity burden.

This study highlights the need for further research to better understand the pathways through which income impacts health outcomes among multimorbid individuals.

ACKNOWLEDGEMENTS

REFERENCES

1. Boyd & Fortin. Future of multimorbidity research: How should understanding of multimorbidity inform health system design? Public Health Reviews 2010; 32(2): 451-74. **2.** Barnett et al. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet 2012; 380(9836): 37-43. **3.** Agborsangaya et al. Multimorbidity prevalence and patterns across socioeconomic determinants: a cross-sectional survey. BMC Public Health 2012; 12: 201. **4.** Schäfer et al. The influence of age, gender and socio-economic status on multimorbidity patterns in primary care. First results from the multicare cohort study. BMC Health Services Research 2012; 12: 89.

Additional information:
natasha.lane@mail.utoronto.ca

Institute of Health Policy, Management & Evaluation
UNIVERSITY OF TORONTO