Inequalities in time spent in multimorbidity in Costa Rica and Mexico: a multistate modelling approach

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ABSTRACT

Multimorbidity – defined as the co-existence of two or more chronic diseases – is an important global public health issue, but our understanding of how it develops longitudinally, and in different low- and middle- income contexts is limited. We use nationally representative surveys from Mexico (Mexican Health and Aging Study) and Costa Rica (Costa Rican Study on Longevity and Healthy Aging) to investigate how time spent living with multimorbidity among those aged 60+ differed by gender and education, and if these differences could be explained by differential healthcare coverage and metabolic risk factors. Using discrete-time multistate modelling, we found that regardless of baseline health, BMI or socioeconomic status, Costa Ricans lived longer, and spent less time in multimorbidity than Mexicans. Time spent in multimorbidity in Mexico did not vary substantially by insurance status. People with hypertension in Mexico were more likely to transition into disease states than those in Costa Rica. Despite similar economic and demographic profiles, variations in multimorbidity are more likely driven by differential healthcare systems: Costa Rica has integrated universal healthcare, free at the point of delivery, better able to prevent, diagnose and manage chronic disease, compared with Mexico with a fragmented three-tier system and higher out-of-pocket expenditure. Future work will compare a third American country with heterogenous healthcare access, the United States. Debates about the expansion or compression of morbidity should consider multimorbidity an advanced morbid state of special policy and clinical concern, and refine healthy life expectancy estimates to take account of it.

INTRODUCTION

Multimorbidity – defined as the co-existence of two or more chronic diseases – is an important global public health issue (Academy of Medical Sciences, 2018, Whitty et al., 2020), the incidence of which is projected to increase as population ageing progresses (Kingston et al., 2018). Increased longevity may not universally be associated with better health across the lifespan; in many, typically lower-income, settings there is an expansion of morbidity (Kyu et al., 2018, Salomon et al., 2012). In debates about healthy life expectancy and the expansion or compression of morbidity, multimorbidity should be considered as an advanced state of morbidity that is of special policy and clinical concern: it is linked to higher mortality, poorer quality of life, and higher healthcare cost burden for societies (Makovski et al., 2019, Wang et al., 2018). Therefore, we may need to refine our estimates of healthy life expectancy to account for this advanced state of illness.

In the extant literature on multimorbidity, there are some notable gaps and weaknesses. First, great attention has been paid to prevalence and clustering of diseases at single time points, at the expense of longitudinal approaches (Cezard et al., 2021). The emphasis on cross-sectional analysis inhibits our understanding of individual and population-level risk factors for disease development, which would inform prevention programs (Head et al., 2020). Second, of the longitudinal multimorbidity research that has been conducted, most has been conducted in high-income settings (Cezard et al., 2021), where the availability of detailed administrative health data makes the topic easier to investigate. By contrast, in low- and middle-income settings, where disease constellations are likely to differ, and the epidemiological transition is more protracted, there is sparse evidence of how multimorbidity trajectories develop over time (Abebe et al., 2020). A better understanding of the complex longitudinal patterns of multimorbidity development in different global contexts will help inform preventive programs.

Analysis of inequalities in multimorbidity has tended to focus on individual-level factors, such as age, gender, and socioeconomic indicators such as education or income. Generally, studies have shown that multimorbidity increases with age, and is more common among women and those of lower socioeconomic status (Xu et al., 2017). Rather fewer studies have addressed contextual, rather than compositional factors influencing the development of population level multimorbidity, and these have tended to be limited to area-level indicators such as rural/urban geographies, urbanisation, and local area deprivation (Barnett et al., 2012, Xu et al., 2017). Among these contextual factors, the structure, management, and utilisation of a healthcare system and how it is adapted to cope with multiple diseases (Oni et al., 2014), may play an important role in primary prevention, diagnosis, and management of chronic conditions. Multiple reviews of healthcare system interventions suggest that there are mixed effects on multimorbidity outcomes (Xu et al., 2017). In any case, large-scale interventions are relatively unusual. Cross-national or cross-regional comparisons of multimorbidity outcomes, where healthcare systems may systematically differ, might provide useful insights. Several comparative cross-sectional studies have been conducted (Bezerra De Souza et al., 2021, Vancampfort et al., 2017), which generally show variations in the prevalence of multimorbidity, some of which correlate higher multimorbidity with higher GDP, and show that the social inequality gradient in multimorbidity is steeper in some countries than others (Afshar et al., 2015). Likewise, there are several cross-national evaluations of the state of chronic disease care, which address particular conditions (e.g. hypertension) (Geldsetzer et al., 2019).

To fill the gap for a longitudinal, cross-national study of the burden of multimorbidity outside of high-income settings, this study uses harmonised longitudinal data from two Central American countries – Mexico and Costa Rica. These were chosen as a comparative case study due to their geographic proximity yet varying health care system structures.
The study seeks to investigate the following questions:

- How long do older adults in Mexico and Costa Rica typically spend in multimorbid health states, and how does this vary by gender and education?
- Are any differences explained by differential health care coverage, and differential distributions of risk factors such as hypertension and obesity in the two settings?

Contexts of Mexico and Costa Rica

The two contexts compared here are relatively similar in terms of GDP (see Table 1), although Costa Rica started at a lower base in 2000 and has made bigger gains, just overtaking Mexico in 2018. TFR is below replacement rate in both countries. Mexico has a population several times larger than Costa Rica, and both are rapidly ageing.

Recent estimates of life expectancy and healthy life expectancy show that older people in Costa Rica tend to live longer, and in better health, than those in Mexico (Kyu et al., 2018). While in the early 1980s the countries had similar life expectancies at age 60, from 1985 onwards Costa Rican life expectancy has showed a sustained increase, diverging from Mexico whose life expectancy has increased more slowly and stagnated in the past two decades (United Nations, 2019). This can be seen in Table 1: for both men and women, life expectancy at birth is higher in Costa Rica, and Costa

Rica has made more sustained LE gains than Mexico, where LE has stagnated or even declined. Both countries are in intermediate to late stages of the epidemiological transition, having seen large reduction in infant mortality in the 1950s, and now non-communicable diseases are the leading causes of death, especially at older ages (e.g. cancer, diabetes mellitus, ischaemic heart disease).

Table 1. Economic and population indicators for Costa Rica and Mexico

	Costa Rica			Mexico		
	2000	2010	2018	2000	2010	2018
GDP per capita, PPP $	7,838	12,219	20,994	11,089	15,260	20,257
Health expenditure (% of GDP)	6.6	8.1	7.5	4.4	6.0	5.4
Out-of-pocket health expenditure (% of current health expenditure)	31.6	25.3	22.4	52.2	45.6	42.1
LE at birth, men	75.1	76.3	75.6	70.9	72.2	72.1
LE at birth, women	79.5	81.2	82.3	76.9	78.0	77.8
TFR	2.3	1.8	1.8	2.7	2.3	1.8
Population size (1000s)	3962	4577	4999	96056	114092	126190
% over 65	5.9	7.3	9.5	5.1	6.1	7.2

Source: compiled data from https://data.worldbank.org

Healthcare system differences

As you can see in Table 1, Costa Rica spends a larger share of GDP on health than Mexico, although in both countries this declined slightly post 2010. There is quite a stark difference in terms of the proportion of health spending that is out-of-pocket, which is twice as high in Mexico than in Costa Rica. Among American countries, Costa Rica is often singled out of performing particularly well on health metrics, outperforming the United States on life expectancy and health life expectancy, and has much less pronounced health inequalities than the United States, despite spending much less on healthcare (Rosero-Bixby and Dow, 2016).

Since the 1960s, Costa Rica has had a unified system of social security and healthcare, and in the 1990s primary care became integrated into this (Vargas and Muiser, 2013). This entitles all citizens to primary and secondary care access, and from 2005 full population coverage has been achieved (Atun et al., 2015). The Costa Rican government also placed primary care and public health prevention at the core of its health policy, and employs community health outreach workers to help monitor, diagnose, and treat conditions, which helps reach all community members (Pesec et al., 2017). Most medications to treat chronic diseases, such as blood pressure medication, are provided free under universal coverage. This comprehensive primary care framework is associated with positive outcomes for risk factors, such as hypertension care and fewer health inequalities (Geldsetzer et al., 2019, Rosero-Bixby and Dow, 2016).

By contrast, availability of health care in Mexico lags behind other middle-income countries. Mexico operates a segmented system of healthcare access, where employed citizens typically access healthcare through the government social security scheme (*Instituto Mexicano del Seguro Social [IMSS]*), while public health insurance (*Seguro popular*) covers the unemployed and those without social security, and the richest may choose to get private insurance (Atun et al., 2015). Because many older people did not participate in formal employment in their younger years, they either have no insurance coverage, or access healthcare through *Seguro popular*, through which they may incur substantial out-of-pocket expenditure. *Seguro popular* was expanded beyond ambulatory care in 2012 to include primary and secondary care interventions, but there are still concerns about the inequity in the quality of care for chronic diseases (Whittemore et al., 2019, Flores-Hernández et al., 2015). Multimorbidity and disability are important longitudinal predictors of higher out-of-pocket costs (Rivera-Almaraz et al., 2019) and catastrophic health care expenditure (Macinko et al., 2019). Furthermore, *Seguro popular* coverage is not associated with increased preventive care for non-communicable diseases including screening and check-ups (Rivera-Hernández et al., 2018).

Cross-national differences in the development of later life multimorbidity may be driven by a number of factors, including early life conditions, life course exposures, health behaviours and structural discrimination (Payne, 2015). While the two countries may vary systematically in these factors (e.g. obesity rates), one of the most striking systematic differences is in health care policy and access. Such health system differences would suggest that the two countries might diverge in the extent to which common chronic diseases are prevented, diagnosed, and managed. Transitioning between diseases states (i.e. moving from one chronic disease to having a second) might also vary due to the availability of care and medications to control the first disease and prevent the cascade. We return to discuss the potential role of healthcare system variations, compared with differences in risk factors, in the discussion.

METHODS

Data

Data are from waves 3-5 (2012, 2015, 2018) of the Mexican Health and Aging Study (MHAS) and waves 1-3 (2005, 2007, 2009) of the Costa Rican Study on Longevity and Healthy Aging (CRELES). Wave 3 (referred to as the baseline wave from this point forward) was chosen as the baseline wave for MHAS because wave 2 occurred nine years prior and our method required evenly spaced time intervals between waves (see Multistate modelling approach section). MHAS recruited participants aged 50 and older, and their spouses regardless of age, from across Mexico with the goal of understanding the ageing process and how disease impacts the health and mortality of older adults (MHAS Mexican Health and Aging Study, 2018). CRELES recruited participants aged 60 and older, with an oversampling of older ages (Rosero-Bixby et al., 2013). They aimed to understand what factors contribute to the length and quality of life for elderly Costa Ricans.

The initial sample of MHAS and CRELES included 22,016 and 5625 participants, respectively. We excluded anyone from MHAS who was no longer present past wave 3 or who died prior to wave 3 (n=5149), and in both MHAS and CRELES we excluded anyone who was present in only one wave and who did not have death record (MHAS n=527, CRELES n=2993) because we need at least one transition to occur across two or more waves. We excluded participants who were younger than 60 years in MHAS (n=3719) and older than 85 years in MHAS (n=522) and CRELES (n=535) at their first measurement wave. The lower bound was chosen to harmonise the age ranges between the studies, as CRELES only recruited participants aged 60 and over. The upper bound was set to age 85 due to small sample size in the oldest participants as well as fewer number of transitions that occurred past this age. After dropping anyone missing education or disease information (MHAS n=106, CRELES n=3), this resulted in a final total of 11,993 participants (27,611 transitions) from MHAS and 2095 participants (5091 transitions) from CRELES in the analytic sample. Preliminary analysis of the sociodemographic characteristics for the included and excluded samples showed similar age and gender distributions in MHAS, but in the excluded CRELES sample there were slightly more females and the average age was older. In both MHAS and CRELES, the excluded participants were more highly educated.

In the main analytic sample, 8.8% of MHAS participants and 9.8% of CRELES participants were missing BMI information. In MHAS, 21.1% of people were also missing health insurance information. Participants who were missing BMI were on average slightly older, less educated, and more likely to enter the study with multimorbidity. Participants in MHAS missing information on health insurance were on average seven years younger compared to those with insurance. They were also more educated and had less disease, particularly less arthritis, respiratory problems, hypertension, and multimorbidity generally. Therefore, for the analysis assessing BMI, we conducted a complete case analysis which restricted the main analysis sample to n=11,442 for MHAS and n=1989 for CRELES. A complete case analysis was also done to assess health insurance in Mexico, resulting in a sample of n=10,712.

Measures

Multimorbidity and mortality

We define multimorbidity as concurrently having two or more of the following diseases: diabetes, cancer, respiratory problems, heart problems (including heart attack), stroke, and arthritis. These diseases were chosen as they were the common chronic diseases across both surveys. They are also amongst the leading causes of morbidity and mortality in this region (Vos et al., 2020). A disease was indicated as present if the participant reported ever having been told by a doctor that they had that disease. All diseases were defined as being chronic and irreversible for the purposes of this analysis. Mortality information was obtained through next-of-kin or surviving family interviews.

Predictors

We included age as a continuous variable and gender was categorised as 'male' or 'female'. We defined education as the highest level of completed education, which was categorised into the following levels: 'Primary school or less', 'Secondary school', and 'Post-secondary school'. Hypertension status was dichotomised as whether or not someone reported being told by a doctor whether they had hypertension. BMI was measured based on participants' self-reported height and weight at each wave. BMI categories were defined as 'normal weight' with a BMI < 25, 'overweight' with a BMI ≥ 25 and < 30, and 'obese' with a BMI ≥ 30. In MHAS, participants were asked whether they had a right to medical care through government and/or private health insurance. We dichotomised this information by creating an overall 'health insurance' variable to indicate whether or not an individual was covered by any type of health insurance. This healthcare variable was created for MHAS only since Costa Rica has universal healthcare.

Statistical analysis

We obtained descriptive statistics for each country, stratified by gender, for age, education, baseline hypertension status, baseline obesity status, starting disease state, and health insurance status

(MHAS only). We also calculated disease prevalence at baseline and identified the most common multimorbid disease combinations.

Multistate modelling approach

To estimate the transitions and time spent in each disease state and the overall life expectancy of individuals with and without multimorbidity, we used discrete-time multistate Markov models. These models require the time intervals between waves to be evenly spaced (Schneider et al., 2021), and in our case the time between waves is two years (CRELES) or three years (MHAS). The states we included were 'no disease, 'one disease', and 'multimorbid', and individuals could remain in the same state throughout the study period, transition to a subsequent state, or die. We did not allow reverse transitions back to previous states, such as through cures or treatments. Multinomial logit models were used to compute transition probabilities based upon the aforementioned predictors. All models were run separately for MHAS and CRELES, and were stratified by gender, hypertension, and BMI category, thus allowing the comparison of estimates for men and women across the two countries and across the various predictors. For MHAS, we also stratified by insurance status. This multistate approach requires the proportions of people in each state at the starting age – 60 in our models. We estimated this proportion separately for men and women aged 60-65 to obtain a larger sample size. We obtained confidence intervals using a bootstrap approach with 1000 iterations.

RESULTS

Descriptive statistics

Table 2 provides descriptive characteristics of both the Mexican and Costa Rican samples, by gender. The Mexican participants were on average five years younger than the Costa Rican participants, likely due to the different sampling eligibility criteria of the surveys. Mexican participants were also more highly educated than Costa Ricans, particularly the men. There is also a larger gap in the percentage of post-secondary educated men and women in Mexico compared to Costa Rica, with Mexico having a six percentage point difference and Costa Rica having a 0.8 percentage point difference (Table 2). The majority of participants in both countries had an education of primary school or less. More than half of women from both countries had hypertension (Costa Rica: 58.1%, Mexico: 63.7%), but the difference between the countries is likely underestimated due to the Costa Rican sample being older and thus being more likely to have hypertension. Mexico also had higher percentages of overweight and obese participants compared to Costa Rica. In both countries, more men entered the study with no disease compared to women. The distribution of initial disease status across the two countries was comparable.

Disease distributions and common multimorbidity combinations

The prevalence of diseases at the baseline wave across the two countries was quite distinct. Diabetes and arthritis were more common in Mexico and cancer, respiratory problems, heart problems, and stroke were more common in Costa Rica (Figure 1). In Mexico, the five most common multimorbidity combinations are: diabetes and arthritis; respiratory problems and arthritis; diabetes and heart problems; diabetes and respiratory problems; and diabetes, respiratory problems, and arthritis. In Costa Rica, the five most common multimorbidity combinations are: diabetes and respiratory problems; diabetes and heart problems; diabetes and arthritis; respiratory problems and arthritis; and respiratory problems and heart problems.

Table 2. Descriptive statistics for CRELES and MHAS based on individual's first record

	CRELES		**MHAS**	
	Male (N=967)	**Female (N=1128)**	**Male (N=5256)**	**Female (N=6737)**
Age (years)				
Mean (SD)	73.2 (6.89)	73.0 (7.08)	67.9 (6.67)	67.5 (6.89)
Education level				
Primary school or less	819 (84.7%)	979 (86.8%)	3750 (71.3%)	5087 (75.5%)
Secondary school	87 (9.0%)	87 (7.7%)	908 (17.3%)	1283 (19.0%)
Post-secondary school	61 (6.3%)	62 (5.5%)	598 (11.4%)	367 (5.4%)
Hypertension status				
No hypertension	569 (58.8%)	470 (41.7%)	2766 (52.6%)	2435 (36.1%)
Hypertension	396 (41.0%)	655 (58.1%)	2483 (47.2%)	4292 (63.7%)
Missing	2 (0.2%)	3 (0.3%)	7 (0.1%)	10 (0.1%)
BMI category				
Normal weight	408 (42.1%)	347 (30.8%)	1791 (34.1%)	2003 (29.7%)
Overweight	385 (39.7%)	411 (36.4%)	2291 (43.6%)	2425 (36.0%)
Obese	144 (14.9%)	294 (26.1%)	1022 (19.4%)	1910 (28.3%)
Missing	30 (3.1%)	76 (6.7%)	152 (2.9%)	399 (5.9%)
Insurance coverage				
Not insured	-	-	623 (11.9%)	650 (9.6%)
Insured	-	-	4135 (78.7%)	5304 (78.7%)
Missing	-	-	498 (9.5%)	783 (11.6%)
Initial 'from' state				
0 disease	502 (51.9%)	440 (39.0%)	2819 (53.6%)	2669 (39.6%)
1 disease	322 (33.3%)	415 (36.8%)	1708 (32.5%)	2650 (39.3%)
Multimorbid	143 (14.8%)	273 (24.2%)	729 (13.9%)	1418 (21.0%)

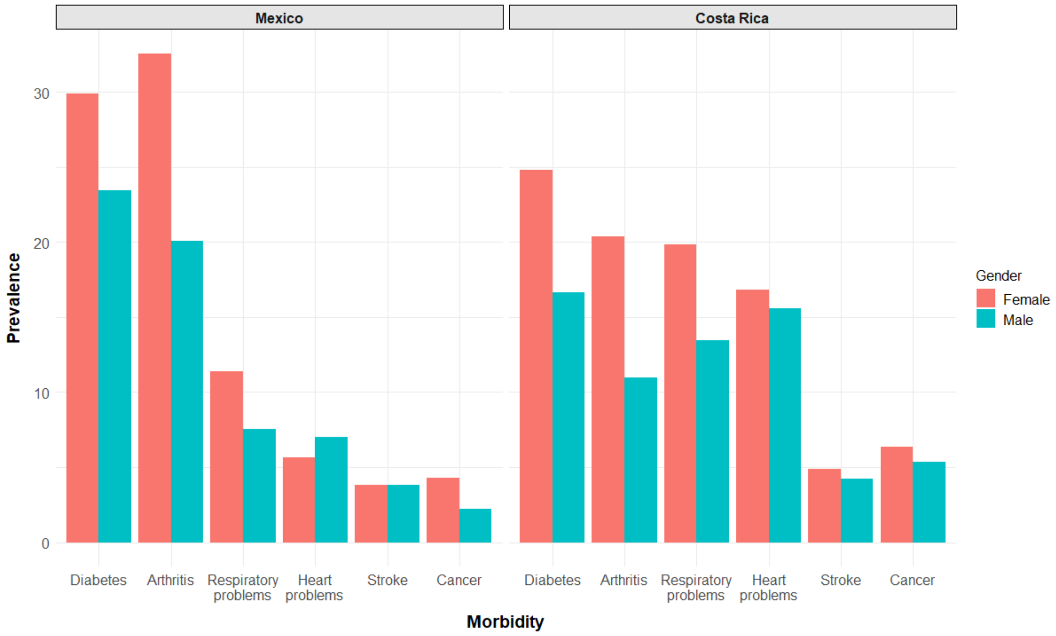

Figure 1. Prevalence of diseases in Mexico (MHAS) and Costa Rica (CRELES) at baseline.

Transition probabilities

When comparing the probabilities of either remaining in the same state or transitioning to a subsequent disease state or death, there are noticeable differences between the two countries. Costa Ricans have consistently higher probabilities of remaining with zero or one disease over time compared to Mexicans, whereas Mexicans have higher probabilities of transitioning from zero to one disease and from one disease to multimorbidity (Figure 2). There were no major differences between men and women in the likelihood of transitioning between disease states, or in the probabilities of transitioning to death in either country. This is likely due to there being more women than men who started with multimorbidity.

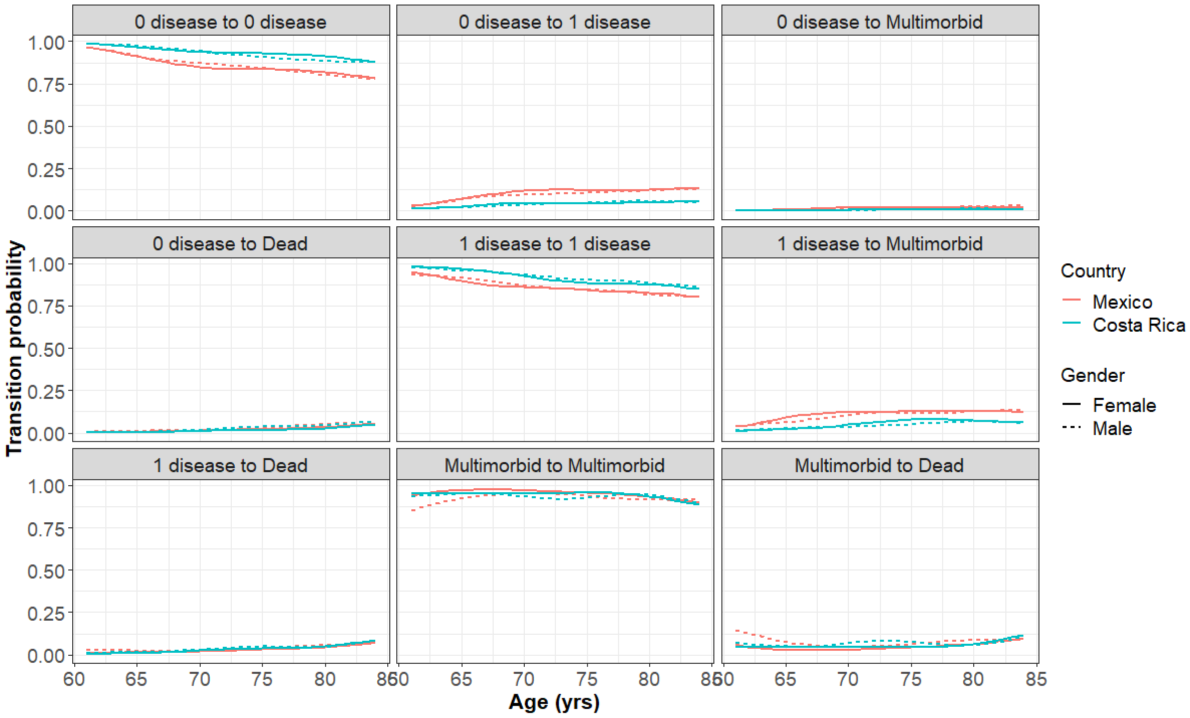

Figure 2. Probabilities of transitioning from one disease state to another, or of remaining in the same state, for Mexico and Costa Rica

Average life expectancy and proportion of time spent living with multimorbidity: country, gender and education variations

Overall, we found the average life expectancy at age 60 for Mexican men and women to be 16.9 (95% CI 16.4-17.6) and 18.6 (95% CI 18.2-18.8) years, respectively (Table 3). For Costa Rican men and women, we found the average life expectancy at age 60 to be 18.2 (95% CI 17.6-19.0) and 18.8 (95% CI 18.2-19.7) years, respectively. We expected Costa Rica to have higher life expectancy than Mexico, and the lack of major difference could be attributed to a combination of the Costa Rican sample being older as well as the surveys taking place several years prior to the Mexican surveys.

While the life expectancy estimates across the two countries are quite similar, the proportion of time spent in the different states differs significantly. Mexicans who do not have disease at age 60 spend about half their life expectancy remaining without disease. Comparatively, Costa Ricans spend about 70% of their life expectancy remaining with no disease (Figure 3). Costa Ricans also spend very little time with multimorbidity compared to Mexicans – about 25% compared to 50% in those who have one disease at age 60. In both countries, although women have higher life expectancy, they spend more of their life with multimorbidity compared to men, while men spend more time with no disease. An education gradient was only identified for Mexican women and Costa Rican men, with increasing life expectancy associated with increasing education. However, although post-secondary educated Mexican women have the highest average life expectancy of all groups (23.1 years, 95% CI 21.1-24.4), they also spend the greatest proportion of their life with multimorbidity compared to anyone else (60%).

Table 3. State and life expectancies for males and females in Mexico and Costa Rica, conditional on surviving to age 60

		Initial state at age 60			Expectancy independent of initial state (95% CI)
	Expectancies at age 60	**0 disease (95% CI)**	**1 disease (95% CI)**	**Multimorbid (95% CI)**	
Mexico	**Males**				
	Expected time with 0 disease	9.48 (9.22, 9.56)	0 (0, 0)	0 (0, 0)	5.93 (5.77, 5.98)
	Expected time with 1 disease	4.53 (4.39, 4.58)	8.79 (8.47, 9.29)	0 (0, 0)	5.34 (5.21, 5.49)
	Expected time with multimorbidity	4.48 (4.12, 4.9)	6.8 (6.17, 7.81)	9.98 (9.07, 12.2)	5.63 (5.22, 6.37)
	Total life expectancy	18.5 (18.1, 18.8)	15.6 (14.9, 16.5)	9.98 (9.07, 12.2)	16.9 (16.4, 17.6)
	Females				
	Expected time with 0 disease	9.07 (8.68, 9.06)	0 (0, 0)	0 (0, 0)	4.07 (3.9, 4.07)
	Expected time with 1 disease	4.84 (4.67, 5.07)	8.58 (8.46, 8.94)	0 (0, 0)	5.55 (5.49, 5.78)
	Expected time with multimorbidity	6.04 (5.78, 6.2)	9.67 (9.07, 9.89)	15.6 (14.8, 16.0)	8.98 (8.53, 9.15)
	Total life expectancy	19.9 (19.5, 20.2)	18.3 (17.9, 18.6)	15.6 (14.8, 16.0)	18.6 (18.2, 18.8)
Costa Rica	**Males**				
	Expected time with 0 disease	14.7 (12.9, 15.9)	0 (0, 0)	0 (0, 0)	8.49 (7.45, 9.17)
	Expected time with 1 disease	3.65 (3.25, 4.48)	13.3 (12.5, 14.4)	0 (0, 0)	6.04 (5.61, 6.54)
	Expected time with multimorbidity	1.52 (1.32, 1.87)	4.02 (3.53, 4.95)	12.5 (9.99, 15.5)	3.65 (3.09, 4.49)
	Total life expectancy	19.9 (19.2, 20.8)	17.3 (17.0, 18.7)	12.5 (9.99, 15.5)	18.2 (17.6, 19.0)
	Females				
	Expected time with 0 disease	14.9 (13.9, 15.4)	0 (0, 0)	0 (0, 0)	6.45 (6.05, 6.69)
	Expected time with 1 disease	3.93 (3.52, 4.56)	13.4 (12.6, 14.5)	0 (0, 0)	6.69 (6.34, 7.15)
	Expected time with multimorbidity	2.25 (1.93, 2.65)	5.19 (4.82, 5.96)	14.2 (12.3, 15.3)	5.67 (5.2, 6.18)
	Total life expectancy	21.0 (20.6, 21.6)	18.6 (17.6, 20.1)	14.2 (12.3, 15.3)	18.8 (18.2, 19.7)

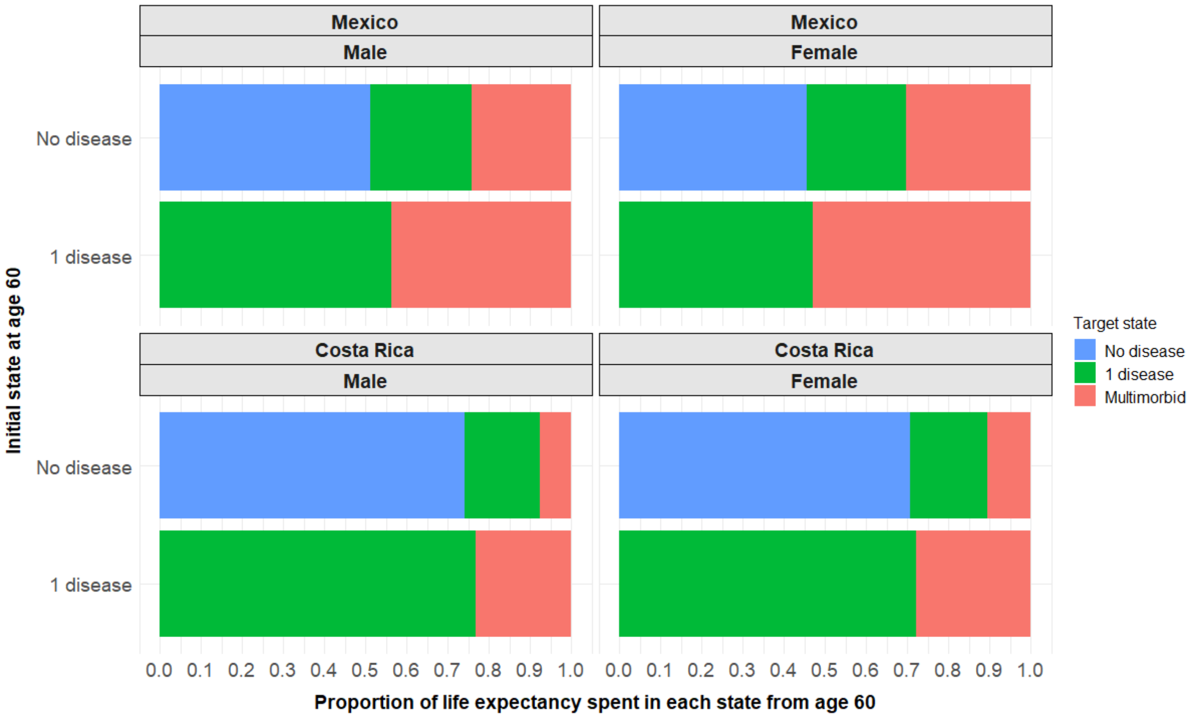

Figure 3. Proportion of life expectancy spent in each target disease state, from an initial state of either no or one disease at age 60. Stratified by country and gender.

The role of risk factors: variations by hypertension and obesity status

In both Mexico and Costa Rica, people with hypertension have slightly shorter life expectancies than people without hypertension, as expected. However, people with hypertension appear to spend more time living with multimorbidity (Figure 4). In Mexico, people with hypertension are more likely to develop multimorbidity whereas in Costa Rica, people are more likely to develop just one disease. Thus, variations in multimorbidity profiles are not attenuated when we stratify by hypertension status; regardless of having hypertension, Mexicans are more likely to transition into multimorbidity and spend longer living with it than Costa Ricans.

Mexican and Costa Rican men who start with no disease and are obese, and Mexican and Costa Rican women who start with no or one disease and are overweight, have the highest life expectancy compared to men and women with lower BMI. In Mexico, the proportion of time spent with multimorbidity increases with increasing BMI, whereas that trend is not seen in Costa Rica (Figure 5). Comparing Mexicans and Costa Ricans across similar strata of BMI, we see that multimorbidity disparities persist regardless of adiposity profile, supporting the idea that such disparities are not explained by differences in common risk factors such as overweight and obesity.

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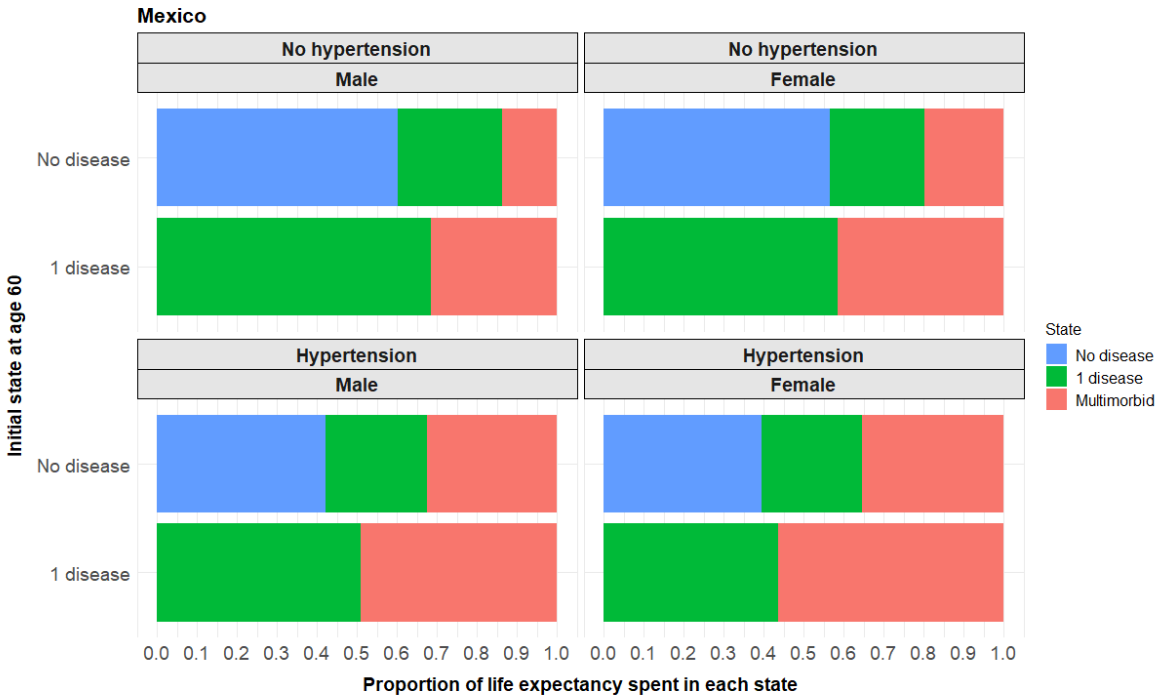

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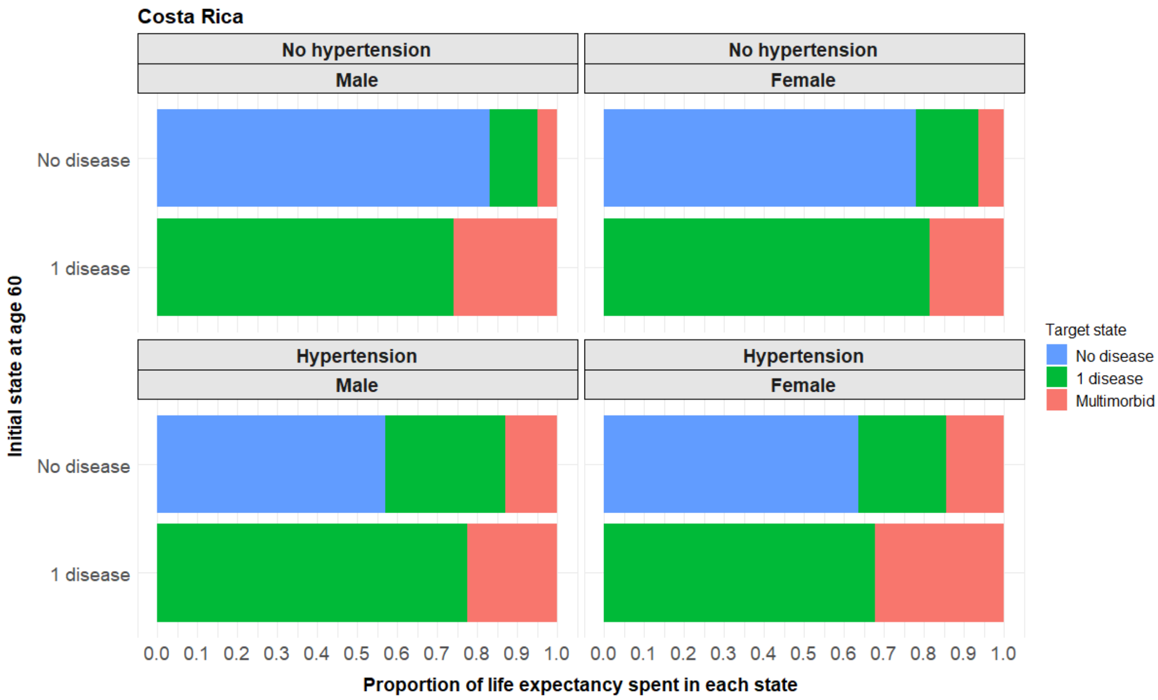
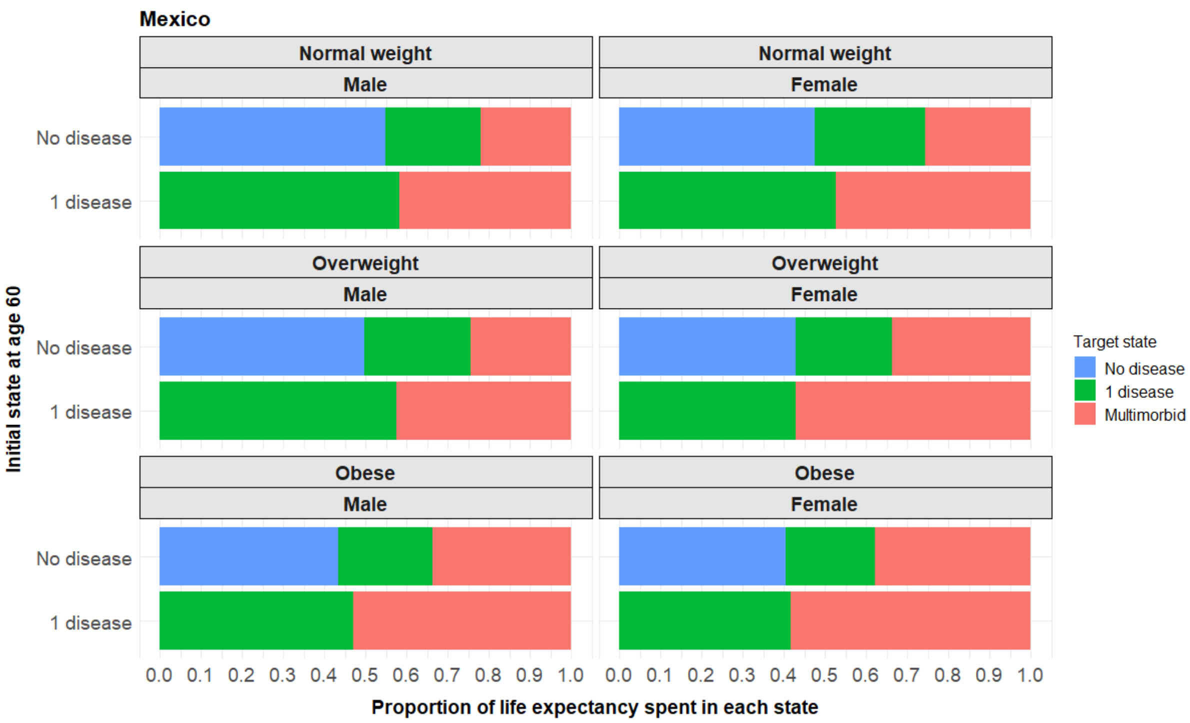


Figure 4. Proportion of life expectancy spent in each target disease state, from an initial state of either no or one disease at age 60. Stratified by gender and hypertension status in Mexico (A) and Costa Rica (B).

A)



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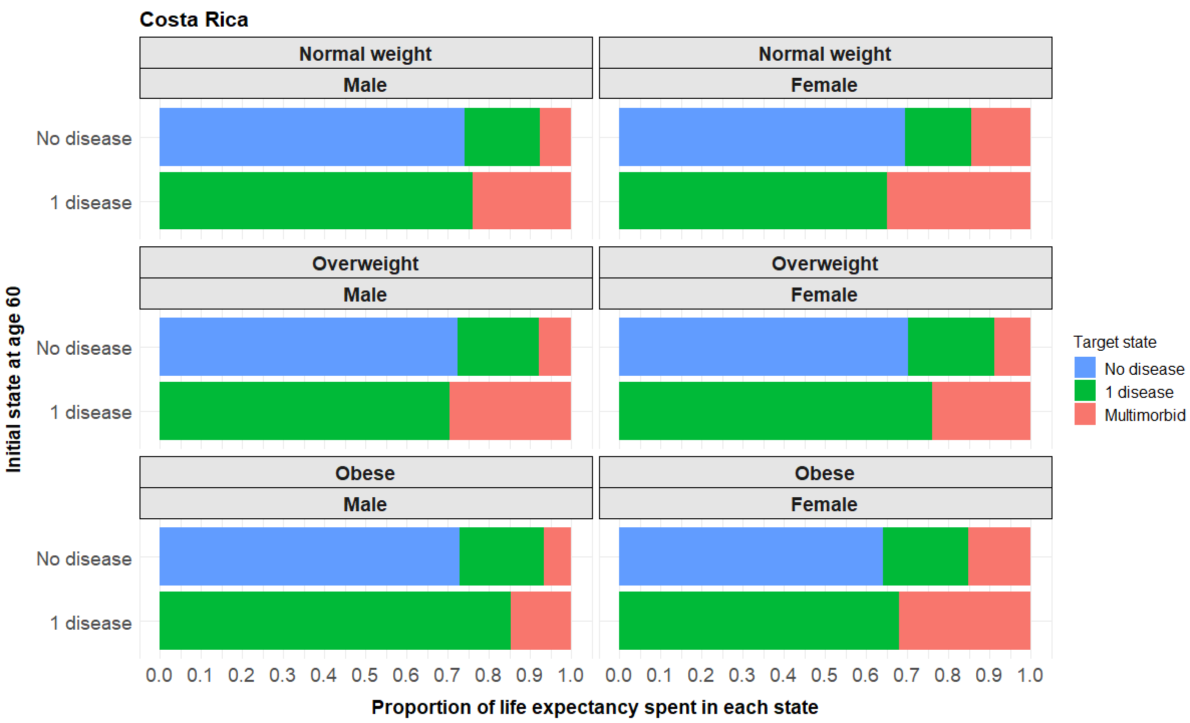

Figure 5. Proportion of life expectancy spent in each target disease state, from an initial state of either no or one disease at age 60. Stratified by gender and obesity status in Mexico (A) and Costa Rica (B).

Differences by insurance status

Mexicans with any type of health insurance have slightly higher life expectancy than those without, but confidence intervals overlap which prevents us from drawing any solid conclusions (Figure 6). Those with multimorbidity at age 60 seem to benefit the most from having health insurance, as they showed the greatest gain in life expectancy compared to those who had no or one disease at age 60. These differences may also be due to differences in socioeconomic characteristics of the people who have health insurance versus those who do not, rather than in having the actual insurance itself.

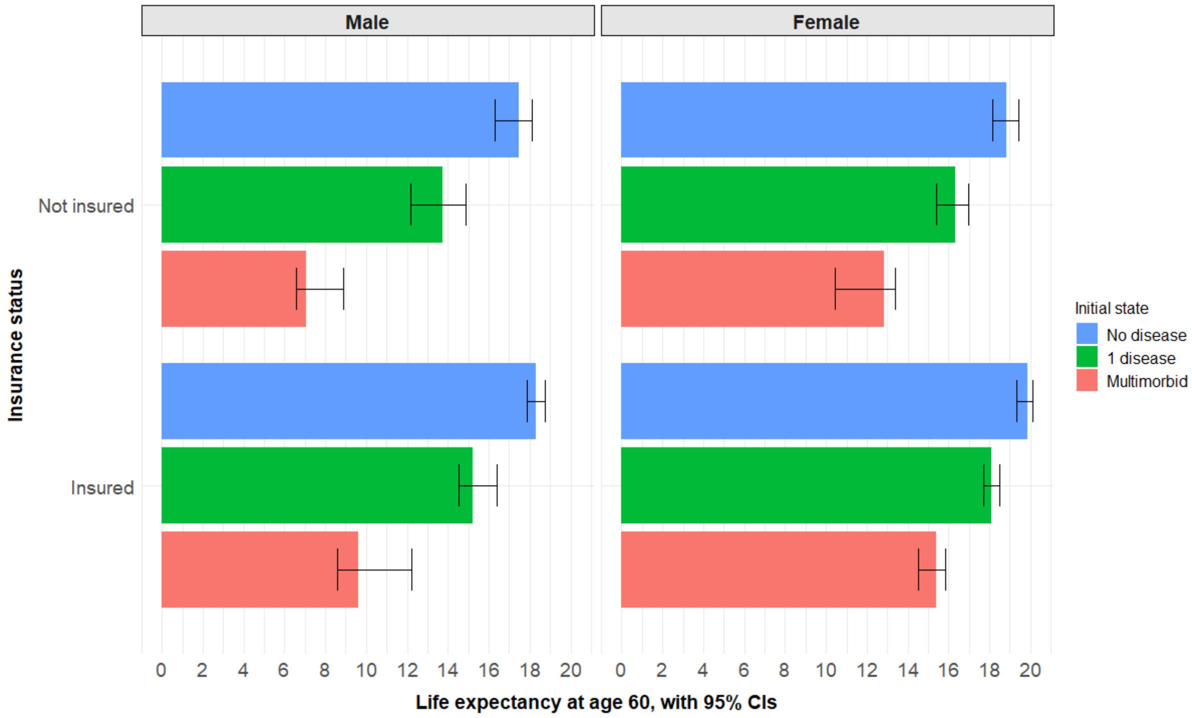

Figure 6. Life expectancy at age 60, for not insured and insured Mexican men and women, from initial disease states of no disease, 1 disease, or multimorbidity.

DISCUSSION

Multimorbidity is a complex health issue and its impact on life expectancy is influenced by a variety of factors, including health behaviours and differences in socioeconomic status and national health systems. In this paper, we used two national surveys from Mexico and Costa Rica to examine how time spent living with multimorbidity might differ by gender and education, and if these differences could be explained by differential health care coverage and metabolic risk factors. By taking a discrete-time multistate modelling approach, we were able to estimate the probability for people to transition across states of disease accumulation and use those probabilities to compute total life expectancy and the time spent in a state of multimorbidity. Overall, we found that regardless of health or socioeconomic risk factor, Costa Ricans lived longer, healthier lives than Mexicans, corroborating previous studies (Kyu et al., 2018). Women in both countries also had longer life expectancies than men, but spent more time living with multimorbidity. People with hypertension in Mexico were more likely to develop and live longer with multimorbidity compared to Costa Ricans with hypertension who were more likely to develop just one disease. Men with obesity and women who were overweight in both countries had longer life expectancies than those with lower BMI, however comparing similar strata of BMI across countries suggested the differences in multimorbidity were not explained by different distributions of BMI. In Mexico only, people who were overweight and obese spent longer living with multimorbidity than those with a normal weight. Lastly, we identified that people with health insurance in Mexico had better life expectancy than those without insurance. However, the benefit from health insurance did not improve life expectancy to the level of Costa Rica, indicating that having health insurance alone will not lead to vast improvements.

Although Costa Rican life expectancy was not drastically higher than Mexican life expectancy, Costa Ricans spent significantly less time living with multimorbidity. There were clear differences in the probability of either remaining in a disease state or transitioning to a subsequent state and accumulating disease, with Costa Rica consistently more likely to remain and Mexico more likely to transition. These results may highlight that a major driver for these inequalities is the difference in healthcare systems between the countries. Health policy analysis supports this: Costa Rica, with its integrated, universal healthcare system may perform better at preventing, diagnosing, and managing chronic diseases, and preventing the disease cascade which is typical in multimorbidity. Hypertension care reviews would suggest this (Geldsetzer et al., 2019), and our own analysis provides empirical support, by showing that Costa Rican individuals with hypertension are less likely to transition to one or two diseases. Further work will investigate disease-specific transitions and hypertension as a specific risk state to better understand the disease cascade and how this varies between health systems.

Our finding that life expectancy is higher in people with overweight or obesity in both countries is contradictory to what is generally expected. One potential explanation may be that in Mexico and Costa Rica, those who are overweight or obese are of higher socioeconomic status (Cohen et al., 2013), which may outweigh the expected decrease in life expectancy due to obesity. In older ages, obesity may have a protective effect on life expectancy (Winter et al., 2014, Diehr et al., 2008), as frailness and weight loss are often associated with ill health. Thus, another explanation could be that due to the way we categorised BMI, people who were underweight were grouped into the normal weight group. This could have biased the life expectancy of the normal weight group downwards, as these people might be more ill or frailer than what would be expected of someone with a normal BMI.

Limitations

This study has several limitations. First, we used self-report longitudinal survey data which is prone to recall bias, loss to follow-up, and survival bias because in order to be included participants had to have survived to at least age 60. Second, the time frame for comparison of the two surveys was different, which may contribute to the sociodemographic and life expectancy differences we observed. In future work we will also address variations in age structure between the two samples using standardisation. Third, we were limited to only six chronic diseases that were asked about in the questionnaires and that were common across the surveys. Thus, we are likely overestimating the number of people without disease and underestimating the number of people with one disease and multimorbidity. Fourth, the small sample size, particularly in the CRELES data, resulted in wide confidence intervals which precluded us from finding significant differences between several estimates. Lastly, there was a non-negligible amount of missing data for BMI and health insurance indicators, and across diseases in the participants that were not included in the main analysis sample, which could have introduced bias. In this paper, we conducted preliminary complete case analyses for BMI and health insurance, but next steps are to use a robust method to handle the missing data.

CONCLUSION

Our results have shown that variances in the time spent with multimorbidity between Mexico and Costa Rica are more likely related to health system differences rather than any individual risk factor. This highlights the importance of health systems, and potentially universal healthcare, in improving access to care and providing services to prevent and manage multiple chronic conditions. Risk factors such as hypertension and obesity have major roles in the development of multimorbidity, but Costa Rica has shown that if those conditions are properly managed, then multimorbidity can be prevented or at least postponed.

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