Original Research

Polypharmacy among older Brazilians: prevalence, factors associated, and sociodemographic disparities (ELSI-Brazil)

Brayan V. SEIXAS (iD), Gabriel R. FREITAS (iD).

Abstract

Background: Polypharmacy has become an increasingly public health issue as population age and novel drugs are developed. Yet, evidence on low- and middle-income countries (LMIC) is still scarce.

Objective: This work aims to estimate the prevalence of polypharmacy among Brazilians aged 50 and over, and investigate associated factors.

Methods: A cross-sectional study was conducted using data from the baseline assessment of the Brazilian Longitudinal Study of Aging (ELSI-Brazil), a nationally representative study of persons aged 50 years and older (n=9,412). Univariate and bivariate analyses described the sample. Robust Poisson regression was used to estimate prevalence ratios and predict probabilities of polypharmacy.

Results: Prevalence of polypharmacy was estimated at 13.5% among older adults in Brazil. Important disparities were observed in regard to gender (16.1% among women and 10.5% among men), race (16.0% among whites and 10.1% among blacks) and geographic region (ranging from 5.1% in the North to 18.7% in the South). The multivariate analysis showed that polypharmacy is associated with various sociodemographic/individual factors (age, gender, race, education, region, health status, body mass index) as well as with several variables of healthcare access/utilization (number of visits, same physician, provider's knowledge of patient's medications, gate-keeper, and difficulty managing own medication). Overall, the more utilization of health services, the higher the probability of polypharmacy, after adjusting for all other model covariates.

Conclusions: Polypharmacy prevalence is relatively low in Brazil, compared to European countries. After controlling for variables of healthcare need and demographic characteristics, there is still substantial residual variance in polypharmacy prevalence. Policies to identify inappropriate prescribing and reduce regional discrepancies are necessary.

Keywords

Polypharmacy; Prevalence; Multimorbidity; Socioeconomic Factors; Age Factors; Race Factors; Sex Factors; Health Services Accessibility; Multivariate Analysis; Cross-Sectional Studies; Brazil

INTRODUCTION

Healthcare interventions are designed to benefit patients, but they can also do harm. That is the case of polypharmacy, which broadly refers to the concurrent use of multiple medicines.[1] Despite a longstanding discussion about the formal meaning of this term, no consensual understanding has been established.[2,3] One widely used definition of polypharmacy is "the administration of more medicines than are clinically indicated, representing unnecessary drug use".[4] A recent study on interventions to improve the appropriate use of polypharmacy for older people relied on the definition of polypharmacy as "the concomitant ingestion of four or more medicines".[5] Nonetheless, a systematic review of polypharmacy definitions found that the most commonly reported definition was the daily use of five or more medications.[6]

Population aging, which increases the prevalence of chronic diseases, and the development of novel drugs represent important factors that contribute to the practice of polypharmacy among older adults.[7] However, medicines are generally designed and proved effective and safe with a group of patients with a given disease and not necessarily with multiple other conditions. The lack of guidance and information on these different scenarios also seems to boost the practice of polypharmacy.[8]

Thus, the presence of multiple morbidities can lead to inappropriate prescribing that, due to drug interaction or potentially inappropriate medication, increases the incidence of adverse events.[9] Benzodiazepines, non-steroidal anti-inflammatories, anti-histaminic agents and anti-psychotic drugs constitute the potentially inappropriate medications more commonly associated with adverse events.[10] Moreover, polypharmacy has been found to be associated with a variety of negative outcomes in older adults, such as falls, mental impairment, cognitive decline, increase of hospital length-of-stay and readmission.[11-13] Another important problem is the lack of therapy adherence, given that complex therapeutic regimes are difficult to manage properly.[14,15] A systematic review has shown that a complex regimen, consisting of several medications, different dosage forms, complicated schedules and the need for special administration information, tends to affect adherence to pharmacotherapy.[16]

A previous study showed that the prevalence of polypharmacy among middle-aged adults and seniors varies substantially across European countries, ranging from 26.3 to 39.9%.[17] An investigation conducted with data from the English Longitudinal Study of Aging revealed a prevalence

Brayan V. SEIXAS. BPharm, MSc. Department of Health Policy and Management, Fielding School of Public Health, University of California, Los Angeles (UCLA). Los Angeles, CA (United States). brayanseixas@ucla.edu

Gabriel R. M. FREITAS. BPharm, MSc, PhD. Graduate Program of Public Health, Department of Pharmaceutical Sciences, Federal University of Paraíba. João Pessoa (Brazil). gabriel.freitas@academico.ufpb.br

of polypharmacy of 24.1% among older adults and identified several associated factors, like lower wealth, obesity, increasing age and chronic conditions.[18]

Despite existing evidence on polypharmacy in high-income countries, information is scarce for Latin American, including Brazil. No study with a representative sample of the population of older Brazilians has been conducted to this date. Our study aims to fill precisely this gap, estimating the prevalence of polypharmacy among middle-aged adults and seniors in Brazil and investigating the associated factors.

METHODS

Data

The Brazilian Longitudinal Survey of Aging (ELSI-Brazil) constitutes a longitudinal household survey of Brazilians aged 50 and over, aiming to understand the social and biological aspects involved with aging. A multi-stage cluster sample, stratified by municipality, census tract and residence, was developed to draw participants. We relied on data from the baseline wave assessment that was carried out in 2015-2016. Further data collection is planned to occur every 3-4 years. A total of 9,412 people, across 70 municipalities and all five major geographic regions in Brazil were part of the initial assessment, which included; 1) household interviews; 2) individual interviews; 3) physical measurements; and 4) blood tests. A more detailed methodological description of ELSI-Brazil can be found elsewhere.[19]

Measures

Our main outcome is a binary variable for polypharmacy, defined here as taking five or more medicines concurrently. The variable was operationalized through the following survey question: "How many medications of regular or continuous use, prescribed by your physician, have you taken in the past two weeks?" For the descriptive and bivariate analysis, we also used an outcome variable with three levels of medicine consumption (none, one to four medicines, and five or more).

The explanatory variables were schematically divided into two sets: (1) those related to demographic and personal characteristics of our sample participants, and (2) variables related to health services utilization. The first set includes age, gender, race, educational attainment, geographic region, household income (expressed as multiples of the federally established monthly minimum wage), whether or not the participant lives with a partner, poor self-rated health status (coded as "yes" for regular, bad and very bad, and "no" for good or very good), daily smoking, drinking (categories: never, occasionally, regularly), body mass index (normal, overweight and obese) and number of chronic diseases (categorized as none, one, and three or more upon consideration of the following diseases: asthma, arthritis, cancer, depression, diabetes, heart disease, hypertension, kidney disease, Parkinson's, and Alzheimer's). The set of independent variables related to utilization of health services includes: overall number of medical office visits in the past 12 months (categories: none, 1-2 visits, 3-visits, 5 or more); number of specialist

visits in the past 12 months (categories: none, 1-2 visits, 3-visits, 5 or more); whether or not the participant has to see a general practitioner to book an appointment with a specialist; having a usual source of care; seen by the same physician (two categories: "rarely or never", and "always or most of the time"); any hospital admission in the past 12 months; physicians' knowledge of all current medication (two categories: "rarely or never", and "always or most of the time"); care coordination between primary care provider and specialists (operationalized into two categories "rarely or never" and "always or most of the time" from the question "How often does the physician talk about the results of your visit with the specialist?"); any difficulty in managing own medication; and any barrier to medicine access.

Statistical analysis

Descriptive statistics for demographic and personal health characteristics as well as variables related to health services were obtained as weighted proportions. Given the complex survey data, statistical significance for bivariate analysis was calculated through a corrected weighted chi-square statistic (often referred to as design-based F) while for individual variables in the multivariate model we used the adjusted version of the Wald test.[20] Prevalence ratios (PR) were estimated using robust Poisson regression since our outcome variable has rates of over 10%. Model specification was determined using a combination of backward and forward stepwise variable selection and assessment of goodness-of-fit. The main findings were obtained from a multivariate regression model with complete cases using listwise deletion. As a robustness check, we also ran a multivariate regression model with imputed values using multiple imputation by chained equations (MICE). All analyses were carried out in Stata 15 using the 'svy' command to account for the complex survey design, and data visualization was carried out in R using ggplot2.

Ethics

The ELSI-Brasil study was approved by the Committee on Research Ethics of the Fundação Oswaldo Cruz, Minas Gerais (CAAE: 34649814.3.0000.509).

RESULTS

The overall prevalence of polypharmacy among Brazilians aged 50 and over was estimated at 13.5%. As we can see in Table 1, there are substantial disparities in regard to different sociodemographic factors. Polypharmacy is significantly higher among women (16.1%) than among men (10.5%). Its prevalence increases markedly with increases in age (from 8.0% in the 50-59 years group to 29.4% in the over 80 years group). In terms of race, there are also statistically significant differences in the occurrence of polypharmacy, being more common among white people (16.0%) and less among blacks (10.1%). Significant differences are also found in regard to educational attainment, although no clear gradient is observed. Overall, polypharmacy is less prevalent among those in the group with the highest number of schooling years. Important geographic disparities were also detected: prevalence varies from 5.1% in the North to as high as

18.7% in the South. We also found that those live with a partner have a statistically significant lower prevalence of polypharmacy. As one would expect, polypharmacy was found to be more prevalent among those with worse health conditions. That is observed both in terms of self-rated health status (17.2% of prevalence among individuals with poor health status in comparison to 8.8% among those with good health) and in terms of number of chronic conditions (there is a clear positive gradient that indicates the higher the number of diseases, the larger the prevalence of polypharmacy). Polypharmacy was also found to have a negative bivariate association with alcohol consumption. In terms of body mass index, a clear positive gradient was found. In other words, as we go up in the BMI

categories, we find significantly higher prevalence rates of polypharmacy. Meaningful differences in the occurrence of polypharmacy were not found in regard to household income and daily smoking.

Table 2 presents descriptive statistics of the independent variables related to health care utilization vis-à-vis the number of medicines currently being taken. First, we see that polypharmacy is significantly more prevalent among individuals with private health plans. Second, we see a positive gradient of polypharmacy prevalence rate in regard to the number of medical office visits, varying from 2.3% among those who report no visit in the past year to 27.1% among those who have seen a provider five or more

Table 1. Descriptive statistics for demographic and personal characteristics according to number of medicines				
	No medication	1-4 medicines	5+ medicines	
Gender (%)				***
Female	22.40	61.48	16.13	
Male	38.45	51.04	10.50	
Age groups (%)				***
50-59	40.08	51.89	8.03	
60-69	24.33	60.43	15.24	
70-79	16.17	63.80	20.03	
80+	13.48	57.14	29.38	
Race (%)				***
White	26.74	57.24	16.01	
Black	29.71	60.19	10.10	
Brown	32.66	55.50	11.84	
Others	29.55	55.94	14.52	
Education (Years of schooling) (%)				**
Less than 5	28.21	57.53	14.26	
Between 5 and 8	28.00	56.86	15.14	
9 or more	32.98	55.67	11.35	
Household income (%)				.
Less than 2 Minimum Wages	32.12	55.11	12.77	
2-5 Minimum Wages	29.09	57.25	13.66	
5-9 Minimum Wages	28.59	57.20	14.21	
9+ Minimum Wages	30.67	54.90	14.43	
Region (%)				***
North	45.77	49.13	5.10	
Northeast	35.22	56.64	8.14	
Southeast	26.12	58.02	15.86	
South	27.16	54.14	18.69	
Central-West	29.06	60.00	10.94	
Living with partner(%)				**
No partner	28.11	56.40	15.49	
Living with partner	30.73	56.84	12.42	
Chronic conditions (%)				***
None	70.01	28.61	1.39	
One	25.44	68.50	6.07	
Two	10.42	72.03	17.55	
Three or more	5.64	57.25	37.11	
Poor self-rated health (%)				***
No	38.39	52.78	8.83	
Yes	23.07	59.69	17.24	
Daily smoking (%)				***
No	26.68	59.42	13.89	
Yes	32.96	53.85	13.19	
Drink (%)				***
Never	24.74	59.41	15.85	
Eventually	37.52	52.65	9.83	
Regularly	43.29	49.30	7.41	
Body Mass Index (%)				***
Normal	38.32	52.32	9.36	
Overweight	30.28	57.26	12.46	
Obese	21.68	59.87	18.46	
Weighted and survey-adjusted means and proportions and 95% confidence intervals. Design-corrected F-test *= p<0.05; **=p<0.01; ***p<0.001.				

times. The pattern is also observed for visits with specialist physicians only. In regard to point-of-access to the system, we see that polypharmacy is significantly more common among individuals who can book an appointment with a specialist physician without going through a general practitioner (17.5% in contrast to 12.1% for those who face gate-keepers in moving to more specialized care). Polypharmacy is also more prevalent among those who report having a usual source of care. The prevalence of polypharmacy is nearly three times bigger among those had at least one hospital admission in the previous year (28.6% versus 11.9%). Higher prevalence rate of polypharmacy is also found among individuals who report having physicians that know all their medications (16.1% among who answered "always or most of the time" versus 5.7% among who answered "rarely or never"). There is also a statistically significant difference in regard to care coordination, although the difference does not seem meaningful. A large difference in the polypharmacy prevalence was found in regard to the difficulty in managing own medication. The group of individuals who report having any difficulty managing all their medication exhibits a substantially larger prevalence rate of polypharmacy (22.6%) in comparison to those who do not have problems dealing with their own therapeutic regimes

(12.0%). Interestingly, the polypharmacy is significantly more prevalent among individuals who report no barrier to medicine access.

Table 3 presents the prevalence rations and 95% confidence intervals obtained from the multivariate Poisson regression using listwise deletion of incomplete cases. Another model fitted with imputed values using MICE was also built and is shown in the supplementary material. Findings were not meaningfully different among the models in terms of magnitude and direction of association. The only relevant discrepancy occurred in the confidence interval of the variable 'usual source of care'. While in the Table 3 model we found no statistically significant association with usual source of care (PR=1.134, 95%CI 0.987: 1.304), the model with imputed values (supplementary material) estimated a very similar point estimate for the prevalence ratio but returned a confidence interval that does not cross the value 1, making the association technically significant (PR=1.138, 95%CI 1.006: 1.287). So, considering that applying imputation methods in survey data may be controversial, the results and discussions are based on the model without imputed values.[21,22] Please note that no single variable had more than 5% of missing data. Two of the independent variables related to health services were not included due to no

Table 2. Descriptive statistics for variables related to health services, stratified by the number of medicines				
	No medication	1-4 medicines	5+ medicines	
Private Health Plan (%)				***
no	32.10	55.58	12.32	
yes	22.67	60.02	17.31	
Medical office visits (%)				***
No visit	62.88	34.80	2.32	
1-2 visits	33.90	58.39	7.70	
3-4 visits	19.53	65.54	14.92	
5+ visits	12.72	60.19	27.09	
Need to see GP to book specialty care (%)				***
No	25.68	56.79	17.53	
Yes	30.68	57.26	12.06	
Specialist visits (%)				***
No visit	31.51	59.96	8.53	
1 visit	27.88	61.80	10.31	
2 visits	18.64	63.77	17.59	
3+ visits	32.98	49.76	17.25	
Usual source of care (%)				***
No	37.99	52.05	9.96	
Yes	25.28	59.26	15.46	
Seen by the same physician (%)				***
Rarely or never	42.02	49.81	8.17	
Always or most of the time	21.67	61.40	16.93	
Admitted to a hospital (%)				***
No	31.32	56.82	11.87	
Yes	15.57	55.84	28.59	
Physicians know all medication (%)				***
Rarely or never	53.23	41.12	5.65	
Always or most of the time	21.10	62.82	16.08	
Care coordination (%)				*
Rarely or never	30.51	56.22	13.27	
Always or most of the time	26.85	58.85	14.30	
Any difficulty managing all medication (%)				***
No	31.24	56.73	12.03	
Yes	20.58	56.82	22.60	
Any barrier to drug access (%)				***
No	0.00	84.66	15.34	
Yes	53.67	34.29	12.04	
Weighted and survey-adjusted means and proportions and 95% confidence intervals. Design-corrected F-test *= p<0.05; **=p<0.01; ***p<0.001.				

contribution to model fit: daily smoke and care coordination.

Overall, we found polypharmacy among Brazilians aged 50 and over to be associated with the following factors: age, race, geographic region, education, multimorbidity, poor health status, regular alcohol consumption, obesity, utilization of health services, seen by the same physician, physicians' awareness of all medication, existence of gate-keeper to access specialty services, and difficulty managing own medication. Regarding age, we found a consistent

gradient of association with polypharmacy. After adjusting for all other variables in our model, we found an increase of 44% in the prevalence of polypharmacy in the group aged 60-69, an increase of 64% in the group 70-79 and of 104% in the group aged over 80 in comparison to the group aged 50-59. In terms of race, we found that black people have on average 26% lower prevalence of polypharmacy in comparison to white, holding all else equal. The association with geographic region indicates that the prevalence of polypharmacy is expected to be twice as large as among those who live in the South (PR = 2.49) and Southeast

Table 3. Prevalence ratios and 95% confidence intervals from the multivariate Poisson regression for polypharmacy defined as five or more medicines concomitantly		
Variables	**Prevalence ratio**	**95%CI**
Age (ref: 50-59)		
60-69	1.441***	1.279 - 1.622
70-79	1.641***	1.375 - 1.959
80+	2.049***	1.660 - 2.530
Gender (ref: Female)	1.008	0.883 - 1.150
Race (ref: White)		
Black	0.744*	0.574 - 0.962
Brown	0.974	0.845 - 1.122
Others	1.010	0.718 - 1.422
Region (ref: North)		
Northeast	1.378	0.925 - 2.053
Southeast	2.181***	1.500 - 3.173
South	2.492***	1.628 - 3.815
Central-West	1.591*	1.067 - 2.373
Education (ref: < 5 years of schooling)		
Between 5 and 8 years	1.185*	1.025 - 1.370
9 or more years	1.073	0.934 - 1.233
Household income (ref: < 2 Minimum Wages)		
2-5 Minimum Wages	0.994	0.853 - 1.158
5-9 Minimum Wages	1.067	0.858 - 1.327
9+ Minimum Wages	1.094	0.880 - 1.361
Living with partner (ref: No)	0.916	0.794 - 1.056
Chronic conditions (ref: None)		
One	3.388***	2.259 - 5.082
Two	7.549***	5.200 - 10.96
Three or more	12.44***	8.701 - 17.80
Poor self-rated health (ref: No)	1.201**	1.057 - 1.364
Drink (ref: no)		
Eventually	0.802	0.621 - 1.036
Regularly	0.715**	0.586 - 0.872
Body Mass Index (ref: Normal)		
Overweight	1.135	0.959 - 1.344
Obese	1.373***	1.170 - 1.611
Private Health Plan (ref: no)	0.861	0.720 - 1.030
Medical office visits (ref: none)		
1-2 visits	2.389**	1.405 - 4.062
3-4 visits	2.920***	1.844 - 4.623
5+ visits	3.584***	2.252 - 5.703
Specialist visits		
1 visit	1.103	0.854 - 1.424
2 visits	1.419*	1.084 - 1.859
3+ visits	1.578***	1.278 - 1.949
Usual source of care (ref: no)	1.134	0.987 - 1.304
Seen by the same physician (ref: never or rarely)		
Always or most of the time	1.259**	1.097 - 1.445
Physicians know all medication (ref: never or rarely)		
Always or most of the time	1.440*	1.076 - 1.928
Need to see GP to book specialty care (ref: no)	0.799**	0.695 - 0.919
Admitted to a hospital in the past 12 months (ref: no)	1.151	0.978 - 1.355
Any difficulty managing all medication (ref: no)	1.191*	1.030 - 1.376
Any barrier to drug access (ref: no)	1.077	0.958 - 1.210
Observations	7,877	
Adjusted prevalence rations from survey-adjusted Poisson regression. *** p<0.001, ** p<0.01, * p<0.05		

(PR=2.18) in comparison to those living in the North region, after controlling for covariates. For education, there is no consistent pattern across different variable categories. Those who have between five and eight years of schooling have on average 19% higher prevalence of polypharmacy in comparison to those with less than five years of school attendance, all else equal. Expectedly, a factor strongly associated with polypharmacy is the number of chronic conditions. The higher the number of existing morbidities, the larger the prevalence ratio (PR=3.39 for one disease, PR=7.55 for two diseases and PR=12.44 for three or more diseases, in comparison to no chronic disease). Even after adjusting for that, having a poor self-rated health status is also associated with polypharmacy (PR=1.20). The expected prevalence rate of polypharmacy among individuals who drink regularly is 28% lower than those who never drink, holding all else equal. Obesity was also found to be associated with polypharmacy among older adults (PR=1.37). In regard to utilization of health services, there are also important associations. First, we found that the higher the rate of utilization, the higher the probability of polypharmacy. Among those who had one or two medical office visits in the past year, the expected prevalence rate of polypharmacy is more than twice as large (PR=2.39) the prevalence observed among those who had no visit to a healthcare facility, after adjusting for all other covariates. The prevalence ratio grows as the number of visits increases (PR=2.92 for three or four visits and PR=3.58 for five or more visits). Apart from the association with overall utilization of health services, we still find statistically

significant association with specialist visits. Seen by the same physician was also found to be associated with increased prevalence rates of polypharmacy (PR=1.26). Similarly, polypharmacy is expected to be 44% more prevalent among those who report having physicians who know all their medication always or most of the time in comparison to individuals whose physicians rarely or never know about their entire therapeutic regimes, holding all else constant. Polypharmacy is also expected to be more prevalent among those who have difficulties managing their own medication (PR=1.19). On the other hand, having a gate-keeper to access specialty services is associated with 20% lower prevalence of polypharmacy, after controlling for all covariates.

Figure 1 shows the predicted probabilities of polypharmacy stratified by number of chronic conditions, number of physician visits in the past year and providers' knowledge of all patient's medication. It helps us visualize not only that polypharmacy is more likely when multiple morbidities coexist, as one would expect, but also that among groups with the same number of chronic conditions the probability of polypharmacy grows as the number of physician visits grows. And on top of that, when physicians know of all of the patient's medication, polypharmacy is even more likely to occur.

In Figure 2 we can see another important phenomenon related to variation in care delivery. Considering individuals with the same number of chronic conditions, which can be understood as a proxy for healthcare need, the probability
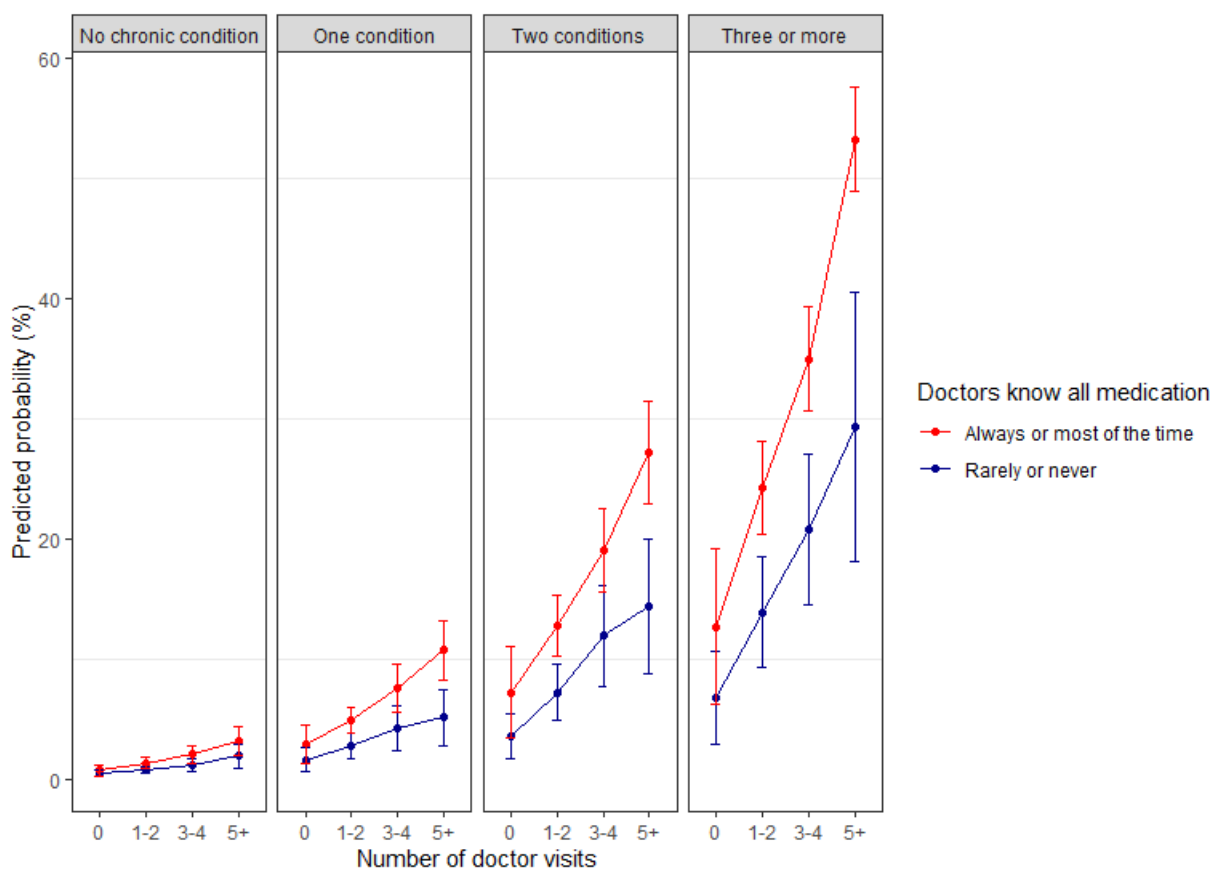

Fig. 1 Predicted probability of polypharmacy obtained from model of table 3, stratified by number of chronic conditions, number of physician visits in the past year and providers' knowledge of all patient's medication.
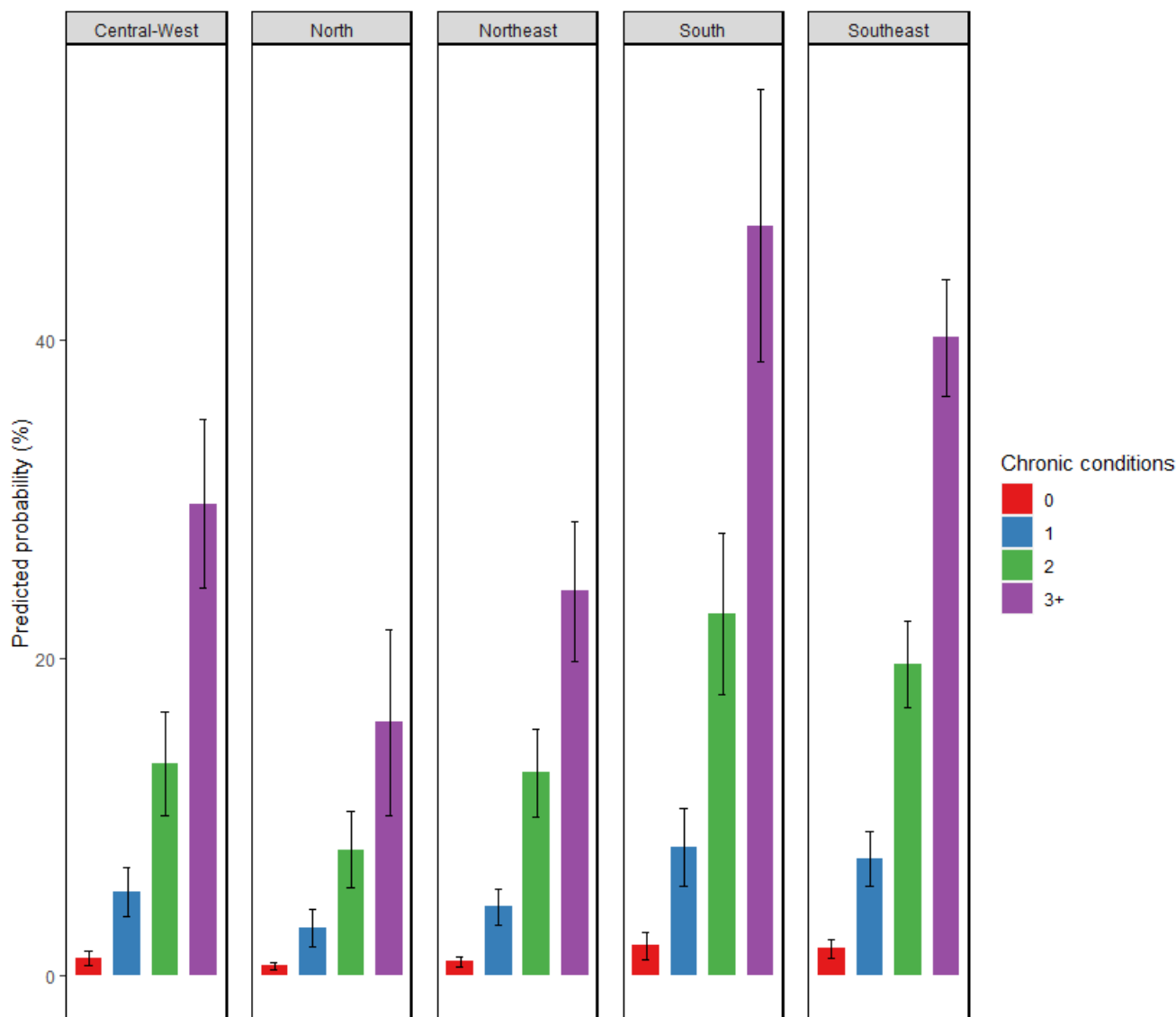Error bars refer to 95% confidence interval.

Figure 2. Predicted probability of polypharmacy obtained from model of table 3, stratified by number of chronic conditions and geographic region.

of polypharmacy varies enormously across geographic regions. For instance, while an individual with three or more chronic conditions that lives in the North region has a predicted probability for polypharmacy of 16%, a similar individual that lives in the South has a probability of 47%.

DISCUSSION

The presented work estimated the prevalence of polypharmacy (defined as the concomitant use of five or more medicines) at 13.5% among Brazilians aged 50 and over, with notable disparities found in terms of age, gender and race. Expectedly, strong associations were found between polypharmacy and poor health, manifested in different variables, like number of chronic conditions, self-rated health status and obesity. We also found that the more utilization of health services an individual pursues, the higher his/her probability of polypharmacy, after adjusting for all other factors in the multivariate model.

Our work has several strengths that deserve mentioning. To our knowledge, this is the first study of polypharmacy with a representative sample of older adults not only in Brazil but in the entire Latin America region. And as such, our findings are generalizable for the entire population of Brazilians aged 50 and over. Second, the study design followed a rigorous analytical plan to evaluate the robustness of the associations under investigation. Apart from the model whose results are shown in Table 3, we also ran a model with imputed values using MICE. The estimations were not meaningfully different, either in terms of direction and magnitude of association. Third, unlike other studies on polypharmacy in high-income countries that relied solely on sociodemographic characteristics, we also included variables related to utilization of health services.[18,23] Fourth, the multivariate analysis results were not only expressed as prevalence ratios to investigate associations with individual independent variables (Table 3), but were also unpacked in terms of predicted probabilities vis-à-vis multiple covariates (Figures 1 and 2). That allows a more refined assessment of

the joint impact of multiple variables on the dependent variable.

Nonetheless, the study has some limitations that bring caution in interpreting its findings. Due to the cross-sectional nature of the study design, the relationships investigated cannot be interpreted in a causal manner. There may be issues of reverse causality and unobserved confounding. The next waves of ELSI-Brazil may allow novel research projects to confirm the directionality of some associations found here. Furthermore, the variables are based on a survey and were all self-reported, therefore, recall and social desirability biases may not be completely ruled out. It is difficult to comment on the direction and magnitude on these possible biases, but we believe that they would likely contribute to underestimates of the prevalence rates of polypharmacy. Another limitation is that the variable for number of chronic conditions could only include the diseases about which participants are asked in the survey. Study participants might have other health conditions that have not been captured.

Other studies on polypharmacy among older Brazilians exist but none of them relied on a nationally representative sample. Almeida et al. found a polypharmacy prevalence of 10.3% among individuals aged 60 and over in the city of Cuiabá (Central-West region).[24] Pizzol et al. found a prevalence rate of 13.9% in a small city in the South, while another study estimated the prevalence of polypharmacy at 32.7% among the elderly in the city of Rio de Janeiro.[25,26]

There is a lack of information on comparable countries, in terms of income, institutions and demographic characteristics. Nonetheless, the prevalence rate of polypharmacy among Brazilians aged 50 and over was substantially lower than the rates observed in other nations. A previous work based on SHARE (the Survey of Health, Aging and Retirement in Europe, a study belonging to the same family of ELSI-Brazil and that includes 27 European countries and Israel) found national prevalence rates of polypharmacy varying between 27% and 40%.[17] Another study estimated the polypharmacy prevalence in Iran at 23.1%.[27] The overall prevalence rate in Brazil has to be understood bearing in mind the considerable internal geographic disparities, ranging from 5% in the North to 19% in the South.

In terms of associated factors, we found results for sociodemographic factors similar to studies from other countries. Polypharmacy is consistently associated with age, gender, obesity, poor self-rated health status and multimorbidity.[17,18,23,28-31] Our work went beyond that and also evaluated the relationship between polypharmacy and variables related to healthcare access and utilization. That revealed an important phenomenon suggestive of inappropriate prescribing or supplier-induced demand. Given that substantial variance in the polypharmacy prevalence remains unexplained after controlling for demographic characteristics and for variables that knowingly indicate need for healthcare and given that the probability of polypharmacy increases with healthcare utilization, inappropriate prescribing is likely taking place. In particular, there is evidence of some degree of supplier-induced demand.

Differentiating the appropriate, needed polypharmacy from the inappropriate (potentially harmful) polypharmacy is absolutely important. The adequacy of polypharmacy can be assessed through different domains, such as need, effectiveness, safety, cost-benefit and person-centered care. Optimizing care for polypharmacy with valid and applicable measures is essential to improve health outcomes.[32] Inappropriate polypharmacy among older Brazilians could be addressed with better medication review practices. Previous studies have shown that medication review is one of the fundamental strategies for improving adherence and reducing unnecessary polypharmacy.[33,34] Nonetheless, despite recent legislation from the Federal Pharmacy Council which lays out the clinical duties of the pharmacist, its role is not yet well-established in Brazil. In addition, coordination among healthcare providers is often recommended as a way to improve quality of care and pharmacotherapy adherence.[10,14] Our study found, however, that coordination of care is associated with increased prevalence of polypharmacy. Further research is required to investigate if this additional occurrence of polypharmacy represents better responses to patients' needs or if there is another important phenomenon related to care coordination taking place among older Brazilians that might be leading to increased inappropriate polypharmacy.

Further studies remain necessary to understand the reasons that explain the exceptionally low prevalence rate of polypharmacy among older adults in Brazil in contrast with existing data on other countries. It does not seem plausible that it has to do with poorer access given that our analysis showed that reporting any barrier to access medicines was not associated with polypharmacy. Furthermore, sizable variations in care remain statistically significant after adjusting for sociodemographic and health characteristics that largely explain healthcare need. It suggests that the phenomenon of polypharmacy is seemingly related to the dynamics of the healthcare system and not necessarily related to individual characteristics.

The present study has valuable implications for policy and clinical practice. First, it shows that Brazil has a national prevalence of polypharmacy considerably lower than other countries. Efforts to understand this discrepancy are necessary and may reveal important elements for policy making. Second, there are major geographical disparities that indicate the need of national benchmarks in management of chronic disease and more coordination of care delivery among different areas. This is particularly important to address care variations in a country with a vastly spread territory and a highly decentralized health system. Lastly, we found robust evidence that the practice of polypharmacy increases with more services utilization, regardless of actual need for care. This suggests that policy measures are necessary to curb inappropriate prescribing and supplier-induced demand.

Polypharmacy has been increasingly a challenge in the clinical practice. Several interventions have been proposed to mitigate its potential negative effects: 1) reduction of novel prescriptions of potentially inadequate medications; 2) identification and curbing of prescriptions that may cause adverse events; 3) development of monitoring systems that allow regulating authorities to monitor

prescriptions in real-time to decrease the rates of inadequate prescriptions; and 4) construction of robust measures to evaluate and improve adherence to complex regimes.[35,36] The overall aim is not to create barriers to medicine access, but rather to limit undue polypharmacy and guarantee necessary and appropriate polypharmacy with proper adherence.

CONCLUSIONS

Our study suggests that Brazil has a relatively low prevalence of polypharmacy with remarkable internal geographical disparities. It also shows that polypharmacy is strongly associated with increased utilization of health services, irrespective of care need. Policies to identify and reduce the undue variations of care are necessary.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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