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ORIGINAL ARTICLE

Contribution of chronic conditions to gender disparities in disability in the older population in Brazil, 2013

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Abstract

Objectives To assess the contribution of chronic conditions to the disability burden in the older men and women in Brazil.

Methods Data from 10,290 participants of the Brazilian National Health Survey in 2013 aged 60 years or older were used. Disability was defined based on limitations in activities of daily living (ADL) and instrumental activities of daily living (IADL). Binomial additive hazards models were fitted to assess the contribution of chronic conditions to the disability prevalence.

Results Back pain was the most common condition, followed by diabetes and heart diseases in men and arthritis and diabetes in women. Stroke and mental disorders were by far the most disabling conditions in men and women. A higher disability prevalence was observed in women (34.4 %, CI 32.4; 36.2 %) compared to men (28.4 %; CI 25.9; 30.8 %). The most important contributors to the disability prevalence were stroke, back pain, and arthritis among men, and diabetes, heart diseases, and arthritis in women.

Conclusions Interventions to reduce disability in the older population in Brazil should take into account the gender gap in the occurrence of chronic conditions, focusing on the main contributors to the disability burden.

Keywords Disability · Chronic conditions · Older population · ADL · IADL · Brazil

Introduction

Population ageing is a reality in both developed and developing countries, including Brazil. Currently, Brazil is facing an epidemiological transition, with an increase in life expectancy from 51 years in 1950 to 74.9 years in 2013

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(Romero et al. 2005; Gragnolati et al. 2011). It is expected that the increase in the proportion of older individuals in Brazil will be significantly faster than in most developed countries, mainly due to the decline in infant mortality, which decreased from 135/1000 births in 1950 to 20/1000 births in 2010, followed by the reduction in fertility rates from 6.2 to 1.8 children born/woman in the same period (Gragnolati et al. 2011). A fundamental issue related to this fast increase in longevity in developing countries like Brazil is the restricted ability to provide access to appropriate heath care for the older population (Chatterji et al. 2014).

As part of the demographic transition scenario in Brazil, the increase in survival is accompanied by a growing proportion of older individuals living with chronic conditions (Schmidt et al. 2011) and, consequently, by an increased disability burden in the older population. Chronic diseases are the main sources of the disease burden in Brazil (Schmidt et al. 2011) and are among the main causes of disability at old ages, being associated with a high social burden: increased health care costs, dependence, and institutionalization (Chatterji et al. 2014).

Women tend to live longer than men, but this mortality advantage is balanced with a disability disadvantage in several countries: these "extra" years are often lived with chronic conditions and disability by women (Van Oyen et al. 2013). Women tend to report more disability than men and this has been associated with higher survival; higher prevalence of chronic conditions; and reduced bone density and muscle strength in women (Belon et al. 2014; Alexandre et al. 2014; Zunzunegui et al. 2015). In Brazil, life expectancy at age 20 was estimated as 57.8 years for women and 51 years for men in 2003. Although the gender gap in life expectancy at age 20 was approximately 7 years, the gender difference in unhealthy life years at age 20 was estimated to be 2.1 years (10 years for women and 7.9 years for men) (Romero et al. 2005). According to the study conducted with the older population in a large city in Brazil, women tend to live 4 years more in good health, 3 years longer with mild or moderate limitations, and 2 years more with severe limitations compared to men (Belon et al. 2014).

The attribution method has been proposed to assess the contribution of chronic conditions to the disability burden using cross-sectional data (Nusselder and Looman 2004). Although the method has been used in several studies to assess the disability burden, most of them applied the method to the data of developed countries (Nusselder et al. 2005; Klijs et al. 2011; Strobl et al. 2013; Yokota et al. 2015a, b), with the exception of China (Chen et al. 2014). Besides the higher disability prevalence in women, most of these studies showed gender differences in the main contributors to the disability burden (Klijs et al. 2011; Chen et al. 2014; Yokota et al. 2015a).

In this study, we investigated the gender differences in the contribution of chronic conditions to the disability prevalence in the older population in Brazil.

Method

Study population

Individuals aged 60 years or older who participated in the National Health Survey (*Pesquisa Nacional de Saúde*—PNS) conducted in Brazil in 2013 were included in the analysis. The survey was carried out by the Ministry of Health in collaboration with the Brazilian Institute of Geography and Statistics. A multistage sampling design with simple random sampling (census tracts) and clustering (households and adults) was applied to obtain a representative sample of the Brazilian adult population (≥18 years). A master sample was used to select the census tracts stratified by state, municipality, and urban and rural areas. Within each stratum, census tracts were sampled with probability proportional to size (Souza-Júnior et al. 2015). The response rate was 77 % and the sample size was 60,202 individuals. Survey weights were used to take into account the complex sample design in the analysis. Participation to the survey was voluntary and informed consent was obtained from all survey participants. The survey was approved by the National Commission on Ethics in Research and the National Health Council in Brazil. Further details about the survey methodology can be found in previous publications (Szwarcwald et al. 2014; Souza-Júnior et al. 2015).

This study included only individuals aged 60 years or older, as the questions about activities of daily living (ADL) and instrumental activities of daily living (IADL) were restricted to this subgroup.

Among the 11,177 individuals aged 60 years or older who participated in the PNS, information on chronic conditions was missing in 887 (8 %), resulting in a sample of 10,290 older individuals (Online Resource 1).

Disability

Disability was defined based on seven ADL (Katz et al. 1963)—feeding, bathing, toileting, dressing, transferring from one place to another, getting in and out of chair, and getting in and out of bed—and five IADL (Lawton and Brody 1969)—shopping, handling finances, taking own medications, going to the doctor, and using transportation. When asked about the degree of difficulty in performing ADL and IADL tasks, participants could answer: "1. Unable", "2. A lot of difficulty", "3. Some difficulty", or "4. No difficulty". Disability was considered present in

individuals who answered 1, 2, or 3 to at least one ADL or IADL question.

Chronic conditions

Participants were asked about the medical diagnosis of 11 chronic conditions: diabetes, heart diseases (heart attack, angina, or heart failure), stroke, arthritis, back pain, depression, mental disorders (schizophrenia, bipolar disorder, psychosis, or obsessive–compulsive disorder), asthma, chronic respiratory diseases (emphysema, chronic bronchitis, or chronic obstructive pulmonary disease), cancer, and chronic renal failure. The questions about chronic conditions referred to the entire lifespan: “Has a doctor ever given you the diagnosis of … (chronic condition)?”, with possible answers: “1. Yes”; “2. No”. For diabetes, a third option was added for women: “3. Only during pregnancy”. The cases of gestational diabetes were not classified as diabetes ($n = 6$).

Statistical analysis

The attribution method was used to assess the contribution of chronic conditions to the disability prevalence in the Brazilian older population. The method aims to attribute the disability cases reported in a survey to chronic conditions, taking into account multimorbidity and that disability can occur even in the absence of any reported condition. The disability that is not associated with any condition included in the analysis is labelled “background”. The background can represent underdiagnosed or underreported diseases in the surveys, other causes of disability that were not included in the analysis (e.g. birth defects), disability that is not associated with any condition, and the effect of age-related losses in functioning (Nusselder and Looman 2004, 2010).

The method assumes that: (1) the distribution of disability by cause (chronic conditions) is entirely explained by the conditions that are still present at the time of the survey and the background; (2) the distribution of disability by cause is proportional to the distribution of the risk to become disabled in the period preceding the survey; (3) the start of the time at risk for disability from each cause is the same; (4) the causes of disability (chronic conditions and background) act as independent competing causes; and (5) the background and disability rates for each condition are similar for individuals aged 60 years or older.

The attribution method is based on the binomial additive hazards model, as shown in (1).

$$Y_i \sim \text{Bernoulli}(\pi_i)$$

$$\pi_i = 1 - (\exp(-\eta_i))$$

$$\eta_i = \alpha + \sum_{d=1}^{m} \beta_d X_{di} \quad (1)$$

In model (1), Y_i is the binary response variable for disability (0: not disabled; 1: disabled) for each individual i; π_i is the probability of being disabled for each individual i; η_i is the linear predictor—cumulative rate of disability—for each individual i; α is the background disability rate; β_d is the disability rate (disabling impacts) of each condition $d(d = 1, \ldots, m)$, i.e. the rate of disability among diseased individuals; and X_{di} are the indicator variables for each chronic condition d and individual i.

The calculation of the prevalence of disability by cause is described in the Online Resource 2. More details about the attribution method can be found elsewhere (Nusselder and Looman 2004, 2010; Nusselder et al. 2005).

Separate models were fitted for men and women. Confidence intervals for the prevalence of chronic conditions, disability rates, and contributions were calculated via bootstrapping using 1000 replicates of the same size of the original data (Efron and Tibshirani 1994). Non-significant conditions for men and women (asthma, chronic respiratory diseases, cancer, and depression) were excluded from the models.

The analysis was carried out in R, version 3.2.3 (R Core Team 2015), using the R package “addhaz” (Yokota et al. 2016) to fit the binomial additive hazards models and to calculate the contribution of chronic conditions to the disability burden.

Results

A higher proportion of older individuals, with low education attainment and widowed was observed among disabled individuals compared to subjects without disability. A higher proportion of ADL limitations was observed in men compared to women. In contrast, the proportion of IADL limitations was larger in women than in men. The most commonly reported ADL limitations were difficulties in dressing/undressing in men and in getting in or out of bed in women. For IADL, difficulties in going to the doctor and using transportation were by far the most frequent limitations in men and women (Table 1).

Back pain, diabetes, and heart diseases were the most common conditions in men while back pain, arthritis, and diabetes were the most frequent conditions in women. A higher prevalence of arthritis (men = 10.1 %, CI 8.3–11.8 %; women = 22.2 %, CI 20.5–23.8 %), back pain (men = 24.7 %, CI 22.3–26.9 %; women = 31.6 %, CI 29.7–33.5 %), and depression (men = 5.1 %, CI 3.8–6.6 %; women = 13.6 %, CI 12.1–15.2 %) was observed in women

Table 1 Characteristics of the study population according to gender, National Health Survey, Brazil, 2013

Characteristic	Men					Women				
	Not disabled		Disabled		p value[a]	Not disabled		Disabled		p value[a]
	N	%	N	%		N	%	N	%	
Age group (years)										
60–64	1031	35.7	222	20.0	<0.001	1523	37.8	391	17.2	<0.001
65–69	816	28.3	204	18.4		1142	28.4	400	17.6	
70–74	542	18.8	210	19.0		698	17.3	435	19.2	
75–79	312	10.8	188	17.0		408	10.1	382	16.9	
≥80	187	6.5	284	25.6		256	6.4	659	29.1	
Education attainment										
Illiterate	323	11.2	284	25.6	<0.001	466	11.6	599	26.4	<0.001
No diploma	133	4.6	77	6.9		163	4.0	162	7.1	
Primary	1212	42.0	477	43.1		1593	39.6	932	41.1	
Secondary	668	23.1	153	13.8		1061	26.3	338	14.9	
Tertiary	412	14.3	58	5.2		578	14.4	104	4.6	
Missing information	140	4.8	59	5.3		166	4.1	132	5.8	
Ethnicity										
White	1403	48.6	511	46.1	0.037	2060	51.2	1075	47.4	0.0165
Black	244	8.4	94	8.5		362	9.2	244	10.8	
Asian	36	1.2	7	0.6		44	1.1	17	0.7	
Brown	1200	41.6	489	44.1		1542	98.3	921	40.6	
Indigenous	5	0.2	6	0.5		18	0.4	10	0.4	
Missing information	0	0.0	1	0.1		1	0.0	0	0.0	
Marital status										
Single	398	13.8	166	15.0	<0.001	652	16.2	357	15.7	<0.001
Married	1806	62.5	631	56.9		1486	36.9	527	23.2	
Divorced	323	11.2	96	8.7		454	11.3	173	7.6	
Widowed	361	12.5	215	19.4		1435	35.6	1210	53.4	
ADL limitations[b]	–	–	567	51.2	–	–	–	1048	43.2	–
Eating	–	–	189	17.1	–	–	–	268	11.8	–
Bathing	–	–	224	20.2	–	–	–	427	18.8	–
Toileting	–	–	190	17.1	–	–	–	397	17.5	–
Dressing/undressing	–	–	328	29.6	–	–	–	544	24.0	–
Transferring	–	–	274	24.7	–	–	–	547	24.1	–
Getting in/out of chair	–	–	274	24.7	–	–	–	536	23.6	–
Getting in/out of bed	–	–	289	26.1	–	–	–	568	25.1	–
IADL limitations[c]	–	–	960	24.0	–	–	–	2075	33.0	–
Shopping	–	–	509	45.9	–	–	–	1221	53.9	–
Handling finances	–	–	381	34.4	–	–	–	791	34.9	–
Taking own medications	–	–	292	26.4	–	–	–	499	22.0	–
Going to the doctor	–	–	727	65.6	–	–	–	1621	71.5	–
Using transportation	–	–	674	60.8	–	–	–	1590	70.1	–
Total	2888	72.3	1108	27.7		4027	64.0	2267	36.0	

Non-weighted proportions presented

[a] p value based on the χ^2 test or Fisher's exact test comparing disabled and non-disabled individuals

[b] ADL limitations: activities of daily living limitations—difficulty in performing at least one of the seven ADL tasks

[c] IADL limitations: instrumental activities of daily living—difficulty in performing at least one of the five IADL tasks

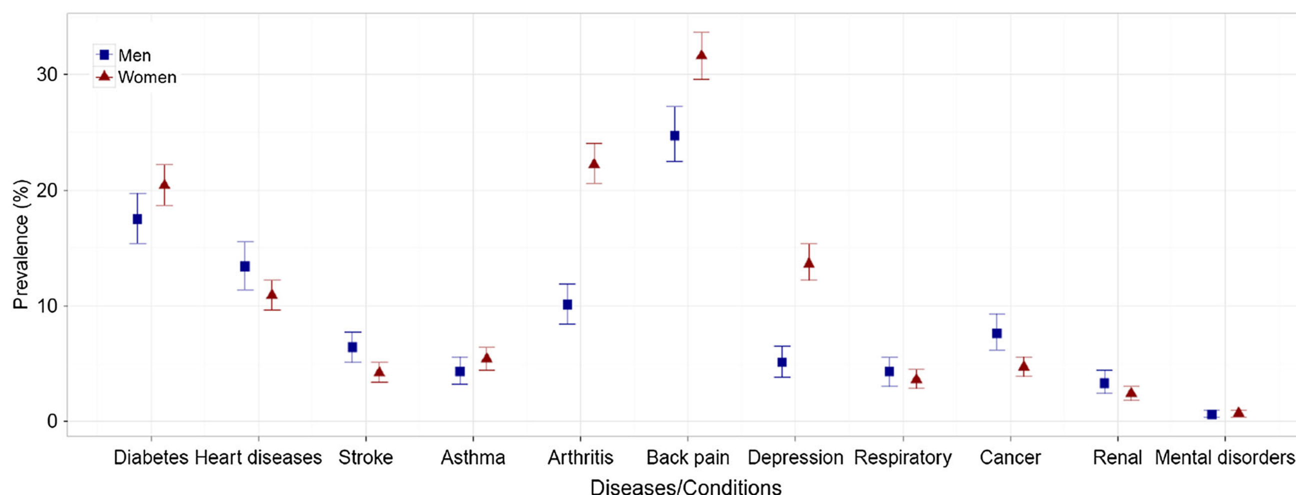

Fig. 1 Prevalence of chronic conditions according to gender, National Health Survey, Brazil, 2013. Heart diseases: heart attack, angina, or heart failure; respiratory: chronic respiratory diseases (emphysema, chronic bronchitis, or chronic obstructive pulmonary disease); renal: chronic renal failure; mental disorders: schizophrenia, bipolar disorder, psychosis, or obsessive–compulsive disorder. The *bars* represent the bootstrap percentile confidence interval

compared to men, while men showed a higher prevalence of stroke (men = 6.4 %, CI 5.1–7.7 %; women = 4.2 %, CI 3.4–5.1 %) and cancer (men = 7.6 %, CI 6.2–9.1 %; women = 4.7 %, CI 3.8–5.5 %) compared to women. A low prevalence (<3 %) of self-reported mental disorders was observed in men and women (Fig. 1).

Stroke and mental disorders were the most disabling conditions in men and women, followed by arthritis in men and chronic renal failure in women. Diabetes and heart diseases showed the lowest disabling impact in men while arthritis and back pain were the least disabling conditions in women (Table 2).

The disability prevalence in women (34 %) was 1.2 times higher than in men (28 %). Background was the main contributor to the disability burden in men and women, while the chronic conditions accounted for 39 and 34 % of the disability prevalence in men and women, respectively. Stroke, back pain, and arthritis were the most important contributors to the disability burden in men, representing 30 % of the disability prevalence. In contrast, diabetes, heart diseases, and arthritis were the main contributors among women, contributing to 21 % of the disability prevalence. Diabetes and mental disorders showed the lowest contribution to the disability prevalence in men and women, respectively (Table 2; Fig. 2).

Discussion

To our knowledge, this was the first study to assess the contribution of chronic diseases to the disability prevalence in Brazil. To date, only one study investigated the impact of chronic conditions on the disability burden in Brazil, but it was based on the cause-elimination method, with data restricted to São Paulo (Campolina et al. 2014). One study used longitudinal data, but it was also based on the data from São Paulo (Alexandre et al. 2014). Most of the cross-sectional studies conducted in Brazil with focus on the association of chronic conditions and disability were based on logistic regression (Rosa et al. 2003; Giacomin et al. 2008; Bensenor et al. 2015).

Our results showed that approximately one-third of the older men and women in Brazil reported ADL or IADL limitations. In addition, different contributors to the disability burden were identified for men and women: while stroke, back pain, and arthritis were the main contributors in men, diabetes, heart diseases, and arthritis contributed most in women.

We defined disability based on ADL and IADL limitations. While ADL limitations refer to basic tasks of daily life, IADL are related to independent living skills, which are more complex than ADL. Both ADL and IADL limitations are considered measurements of functioning and they have been widely used to assess disability in studies conducted in Brazil (Rosa et al. 2003; Giacomin et al. 2008; Alexandre et al. 2014; Campolina et al. 2014; Virtuoso Júnior et al. 2015). In Brazil, the ADL scale showed a reasonable validity compared to the short form 36 (Nigri et al. 2007). A good validity has also been reported for the IADL scale compared to lower body performance tests (Santos and Júnior 2012). Since there is some overlap of ADL and IADL limitations in terms of disability, the use of a combination of both instruments has been recommended

Table 2 Disabling impact and absolute contribution of chronic conditions to the disability prevalence according to gender, National Health Survey, Brazil, 2013

Rank	Disabling impact (DI)[a]					
	Men			Women		
	Condition	DI	CI	Condition	DI	CI
1	Stroke	1.06	0.78; 1.42	Stroke	0.52	0.26; 0.85
2	Mental disorders	1.06	0.40; 2.28	Mental disorders	0.51	0.09; 1.27
3	Arthritis	0.27	0.12; 0.44	Chronic renal failure	0.38	0.06; 0.81
4	Chronic renal failure	0.23	0.01; 0.55	Heart diseases	0.32	0.19; 0.48
5	Background[b]	0.20	0.17; 0.24	Background[b]	0.28	0.25; 0.32
6	Back pain	0.15	0.07; 0.25	Diabetes	0.17	0.07; 0.27
7	Heart diseases	0.09	−0.03; 0.23	Arthritis	0.13	0.06; 0.21
8	Diabetes	0.05	−0.03; 0.14	Back pain	0.09	0.02; 0.16
Rank	Absolute contribution (AC)[c]					
	Men			Women		
	Condition	AC	CI	Condition	AC	CI
1	Background[b]	17.26	14.83; 20.03	Background[b]	22.84	20.46; 25.32
2	Stroke	3.62	2.67; 4.66	Diabetes	2.60	1.35; 3.85
3	Back pain	3.01	1.29; 4.71	Heart diseases	2.43	1.41; 3.35
4	Arthritis	2.01	0.89; 3.14	Arthritis	2.19	0.93; 3.55
5	Chronic renal failure	0.54	0.02; 1.15	Back pain	2.13	0.50; 3.67
6	Mental disorders	0.31	0.10; 0.55	Stroke	1.39	0.84; 2.00
7	Heart diseases	0.89	−0.23; 2.11	Chronic renal failure	0.59	0.13; 1.13
8	Diabetes	0.71	−0.44; 1.88	Mental disorders	0.23	0.05; 0.45
–	Total disability prevalence	28.36	25.94; 30.99	Total disability prevalence	34.39	32.44; 36.23

Heart diseases: heart attack, angina, or heart failure; mental disorders: schizophrenia, bipolar disorder, psychosis, or obsessive–compulsive disorder

[a] Disabling impact (DI): disability rate among diseased individuals

[b] Background: disability causes not included in the model

[c] Absolute contribution (AC): the contribution of each condition sum to the total disability prevalence

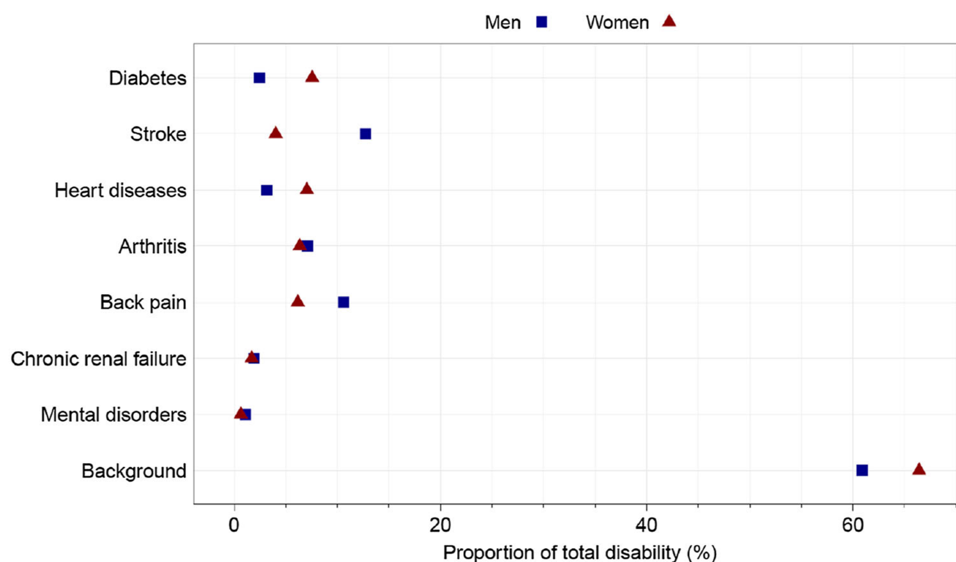

Fig. 2 Relative contribution of chronic conditions to the disability prevalence according to gender, National Health Survey, Brazil, 2013. Heart diseases: heart attack, angina, or heart failure; mental disorders: schizophrenia, bipolar disorder, psychosis, or obsessive–compulsive disorder. Background: disability that is not associated with any disease/condition included in the analysis. Relative contribution: the contribution of the background and chronic conditions sum to 100 %

(Spector and Fleishman 1998), as a higher range of disability can be assessed.

The attribution of disability to chronic conditions depends on the prevalence of chronic conditions and their disabling impacts (Nusselder et al. 2005). Therefore, the main contributors to the disability burden are not necessarily the most prevalent conditions or the most disabling conditions. For example, stroke showed a moderate prevalence (6.4 %) in men, but a very high disabling impact ($\beta_{\text{Stroke,men}} = 1.06$), resulting in a high contribution to the disability prevalence in men. In women, diabetes was the most important contributor to the disability burden, as result of its high prevalence (20 %) and moderate disabling impact ($\beta_{\text{Diabetes,women}} = 0.17$).

Stroke and mental disorders showed a very high disabling impact, i.e. among the individuals with these conditions, the disability risk was high. The interpretation of the disability rates can be easier in the probability scale. For instance, the total disability rate (η_i) in men who reported stroke was 1.26 $(0.20(\alpha_{\text{men}}) + 1.06(\beta_{\text{Stroke,men}}))$. The exponential transformation can be used to convert the total disability rate to the probability of being disabled $(\pi_i) = 1 - \exp(-1.26) = 0.72$, i.e. the probability of being disabled or the risk of disability in men who reported stroke is 0.72. Likewise, the disability rate in women who reported stroke was 0.80 $(0.28(\alpha_{\text{women}}) + 0.52(\beta_{\text{Stroke,women}}))$, resulting in a disability probability of 0.55 $(1 - \exp(-0.80))$.

Stroke is among the leading causes of mortality and disability worldwide (Park and Ovbiagele 2015). In Brazil, the disability prevalence among individuals aged 18 years or older who reported a previous stroke episode was 29.5 % in men and 21.5 % in women (Bensenor et al. 2015). Mental disorders have also been associated with functional limitations (Mack et al. 2015) and were among the leading causes of years lived with disability in Brazil (Institute for Health Metrics and Evaluation 2013). Despite the low contribution of mental disorders to the disability prevalence, probably due to their low prevalence (<1 %), the high disabling impact of these conditions indicates that individuals with mental disorders are at high risk of disability.

Chronic renal failure also showed a high impact on disability in women. Chronic kidney diseases are associated with impaired cognition, reduction in lower extremity functions, and frailty in older individuals, especially in those treated with dialysis (Weiner and Seliger 2014).

Stroke, back pain, and arthritis were the main contributors to the disability burden in the Brazilian older men. Stroke was previously considered a determinant of ADL (Alexandre et al. 2012) and IADL (Alexandre et al. 2014) limitations in a longitudinal study conducted in São Paulo, Brazil. Low back pain was the main cause of years lived with disability (YLD) in developing countries and arthritis are also among the leading causes of YLD (Hoy et al. 2014).

In women, diabetes, heart diseases, and arthritis were the major contributors to the disability prevalence. In older individuals with diabetes, disability can occur due to decreased cardiovascular function, such as heart disease, and disease complications, such as neuropathy (Dhamoon et al. 2014). In a study conducted in São Paulo, Brazil, the elimination of heart diseases and diabetes showed the highest impact in the reduction of disability-free life expectancy in women aged 60–74 years (Campolina et al. 2014).

Comparison of our findings with previous studies that used the attribution method is limited due to differences in the disability definition, chronic conditions included in the analysis, and target population. Despite the methodological differences, musculoskeletal conditions and cardiovascular diseases were also among the top contributors to the disability prevalence in developed countries, such as Belgium (Yokota et al. 2015a), the Netherlands (Klijs et al. 2011), and Germany (Strobl et al. 2013). Diabetes was also an important contributor to the disability burden in older women in the Dutch study (Klijs et al. 2011). Similar to our findings, cancer was not an important contributor to the disability prevalence in previous studies (Klijs et al. 2011; Strobl et al. 2013; Yokota et al. 2015a). Cancer is among the main causes of death in Brazil (Schmidt et al. 2011) and its low contribution can be related to the high case–fatality rate for most type of cancers (Soerjomataram et al. 2012).

Despite the high contribution of chronic respiratory diseases found in developed countries (Klijs et al. 2011; Strobl et al. 2013; Yokota et al. 2015a), these conditions were not significant in the models for men and women in Brazil. The low importance of chronic respiratory diseases to the disability burden in Brazil can be associated with the recent reduction in the prevalence of smoking in adults (≥18 years) observed in the country (1989:34.8 %; 2013:15 %) (Schmidt et al. 2011; Instituto Brasileiro de Geografia e Estatística (IBGE) 2014).

Only one study reported the use of the attribution method using data from a developing country—China (Chen et al. 2014). In the Chinese study, the main contributors to the disability burden were presbycusis and cataracts, which may probably be related to the broad disability definition used, including sensorial limitations, physical limitations, and cognitive impairments. Similar to our findings, stroke and osteoarthritis were also among the main contributors in older men and women, respectively.

Limitations and strengths

This study had several limitations that should be considered when interpreting the results. According to the

disability model proposed by Verbrugge and Jette (1994), the causal relationship between chronic conditions and disability is plausible. Despite the causality assumption of the attribution method, we were not able to assess it due to the cross-sectional nature of the data. Consequently, disability may be incorrectly attributed to chronic diseases in cases where disability occurred before chronic conditions.

Furthermore, the disability prevalence might be underestimated as a result of (1) use of self-reported disability, as a weak to moderate relation between self-reported and the performance of ADLs in older individuals was previously observed (Kempen et al. 1996); and (2) the use of a restricted disability definition, based on ADL and IADL limitations, excluding social participation (World Health Organization 2001). Moreover, the use of self-reported medical diagnosis of chronic conditions may result in underestimation of the contribution of chronic conditions to the disability burden, as the validity of self-reports is disease-specific (Leikauf and Federman 2009) and it depends on the access to health care services. An overestimation of the background contribution might have occurred as important disability causes at old ages, such as dementia, were not included in the analysis. Finally, the limited sample size did not allow us to take into account: (1) stratification by age group and education attainment, although previous studies showed an increasing trend of disability with age (Klijs et al. 2011; Yokota et al. 2015a) and a higher disability burden among the low educated (Nusselder et al. 2005); and (2) disability severity, as different contributors to the disability burden according to disability severity levels have been identified (Yokota et al. 2015b).

Among the strengths of this study, it is worthy to mention the use of a representative sample of the older population from Brazil. Despite the exclusion of older individuals living in institutions in the sample, this proportion is very low in Brazil (<1 % in 2008) (Belon et al. 2014). Furthermore, the high response rate of the survey reduces the probability of selection bias. An overrepresentation of men, single individuals, and of participants with low education attainment was observed in individuals with missing information on chronic conditions (Online Resource 3). However, since the proportion of individuals with incomplete data was small (8 %) and did not depend on the outcome studied (ADL or IADL limitations), the missing completely at random mechanism can be assumed and the likelihood theory is considered valid (Molenberghs et al. 2015). Another added value of the present study is the inclusion of mental disorders, which was among the most disabling diseases in men and women.

Conclusions

Our findings provide a better understanding of the role of chronic conditions on the disability burden in the older population in Brazil. The high disability prevalence observed indicates that disability should be prioritized in the public health agenda of the country.

In 2011, a National Plan of Rights for Individuals with Disability called "Living without limits" (*Viver sem limites*) was released by the Brazilian government to implement new interventions and reinforce existing strategies to support individuals with disability at all ages, with focus on health, education, social participation, and accessibility. As part of the disability agenda, a health care network for individuals with disability was created in 2012, which includes financial support for Brazilian states and municipalities to build disability-inclusive environments and to improve capacity building of health care professionals (Campos et al. 2015).

Given the fast population ageing expected to occur in Brazil in the next decades, an increased disability burden is also expected in the country. In this scenario, our findings can support policies that reduce gender inequalities in this subgroup, by focusing on the main contributors to the disability burden and considering the conditions with high impact on disability in the clinical practice. Furthermore, this analysis can be repeated periodically to monitor the disability burden and to evaluate the progress in the implementation of the National Plan for Individuals with Disabilities in the older population in Brazil.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical approval The survey was approved by the National Commission on Ethics in Research and the National Health Council in Brazil.

Informed consent Participation to the survey was voluntary and informed consent was obtained from all survey participants.

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