

RESEARCH ARTICLE

An assessment of direct and indirect costs of dementia in Brazil

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Abstract

Background

To analyze costs associated with dementia based on a cross-sectional study in the Brazilian health system.

Methods

Direct and indirect costs were estimated by conducting comprehensive interviews on the use of resources in a sample of 156 patients with dementia treated at an outpatient memory clinic of a tertiary hospital. A regression model was used to determine the main determinants of costs associated with dementia.

Results

Global costs of dementia were US\$1,012.35; US\$1,683.18 and US\$1,372.30 per patient/month for mild, moderate and severe stages, respectively. Indirect costs ranged from US\$536.62 to US\$545.17 according to severity. Dementia costs were influenced by medication, FAST score, and educational level of caregiver.

Discussion

The study represents an original contribution toward establishing direct and indirect costs of dementia in Brazil. Results indicate significant economic impacts, including projection of annual costs of US\$16,548.24 per patient.

Introduction

Recent estimates of the prevalence of dementia and Alzheimer's disease (AD) have risen dramatically around the world, increasing from 47.47 million individuals in 2015 to a predicted 75.63 million in 2030 and 135.46 million in 2050 [1]. In Latin America (LA) as a whole, the number of patients with dementia was approximately 3 million in 2010, with Brazil accounting

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Data Availability Statement: The minimal anonymized data set necessary to replicate our study findings is available as a supporting information files accompanying the manuscript. It is important to point out that the research is still ongoing to identify transitional states of dementia, thus, additional data and variables are included in the same dataset for further analysis.

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for over 1 million cases [2,3]. Evidence shows variations in prevalence according to region of the country, although 12% is the currently accepted rate [4–6].

Recent studies indicate escalating costs for treatment of dementia rising from US\$604 billion in 2010 to US\$818 billion in 2015 [7–10]. With regard to projections of demographic transition, particularly among upper-middle-income countries (UMICs), the financial burden associated with the emergence of non-communicable diseases (NCDs) associated with human aging may have a substantial economic impact within public national health systems.

Brazil is the largest country in LA, with a population of approximately 207 million, comprising 24 million elderly individuals. Major changes in terms of life expectancy and population dependency ratio have occurred in Brazil over the last few decades, posing a challenge to the national health system, which is predominantly based on public funding associated with universal health care coverage [11–13].

The onset of dementia compromises patient quality of life, family relationships, and productivity of patients' relatives and caregivers. Based on epidemiological data [1,2], governments worldwide are discussing the need for health policies related to dementia, to ensure provision of adequate care and support to patients diagnosed with dementia and to their respective caregivers [10,14–16].

Assessments of the economic impact of diseases on national health systems yield evidence to inform public policies on health, allowing the improvement of health strategies based on a "societal" perspective. Regarding Alzheimer's disease, there are few studies discussing the costs of dementia in LA, whether direct, indirect or societal costs, due to methodological difficulties involving monetary valuation methods and cost-effectiveness analysis [13,15].

The present study represents an original contribution toward establishing the direct and indirect costs of dementia in Brazil, adopting a methodological framework internationally recommended by experts in the field of knowledge [17,18], using societal perspective to assess the burden of the disease on patients and caregivers. The results reported are drawn from the first phase (cross-sectional stage) of a longitudinal investigation entailing the description of methods and the cost analysis associated with dementia within the Brazilian health system (CAAD project) [18].

Methods

Sample selection

A sample of 156 patients attending outpatient health care at the Neurology and Cognitive Behavior Unit of Hospital das Clinicas (Sao Paulo, Brazil) was selected after individual assessment by a neurologist. Comprehensive interviews were performed between November 2011 and May 2015.

The inclusion criteria for patient participation in the study were having a diagnosis of dementia at mild, moderate or severe stages with formal or informal caregivers who cared for the patient. The exclusion criteria were patients diagnosed with Mild Cognitive Impairment (MCI).

The statistical precision for estimation of direct and indirect costs of dementia was based on hypothesis test to calculate sample size and infer expected values of the target variable: considering one single sample, the idea was to estimate the distance between true value (population) and the sample value by controlling the statistical significance and power. According to Chow et al. [19] and Chow and Liu [20], the sample size may be calculated from the following hypotheses:

$$H_0 : |\bar{x} - \mu_0| \geq \delta \text{ versus } H_a : |\bar{x} - \mu_0| < \delta,$$

Where $\bar{x} - \mu_0$ is the meaningful difference between the population mean μ_0 and the observed value \bar{x} (null hypothesis). The constant δ is the statistical precision measuring the distance between the real value and the value obtained from sample of size n_s .

The study was based on calculation of the sample size taking into account both the Type I error (α) and the Type II error (β). In this case, it is important to specify the statistical power $(1 - \beta)$ 100% and the confidence level $(1 - \alpha)$ 100%. [19] derived the following expression to the sample size n_s :

$$n_s \geq \frac{(t_{\alpha, n_s - 1} + t_{\beta, \frac{n_s}{2}, n_s - 1})^2}{\theta^2} \tag{Eq 1}$$

Where $\theta = \frac{\delta}{s_N}$. We denote by S the sample standard deviation and $s_N^2 = S^2 \frac{N - n_s}{N - 1}$ is the corrected variance. The correction factor $pcf = \sqrt{\frac{N - n_s}{N - 1}}$ is applied for finite population of size N , which is the present case. We assumed that the variance is unknown. The scores $t_{\alpha, n_s - 1}$ and $t_{\beta/2, n_s - 1}$ are calculated from a t-distribution with $(n_s - 1)$ degrees of freedom.

The average value for treatment cost found from our sample was $\bar{x} = \$1,405.72$; the standard deviation $S = \$1,376.28$; corrected standard deviation $S_N = \$1,300.04$; and the population $N = 1,440$.

Using Eq 1, we estimated n_s by controlling θ , the significance level α and statistical power $1 - \beta$ simultaneously. Setting $\alpha = 5\%$ and $1 - \beta = 80\%$ and $\theta = 0,2$; the sample size $n_s = 156$. That means the precision of estimates is $\delta \sim \$260.00$; which leads to the conclusion that the population costs should not exceed \bar{x} by the amount of $\delta \sim \$260.00$; i.e., $|\bar{x} - \mu_0| < 260$. Of course, if there is need of higher precision, the sample size must be increased according to Eq 1.

The population size was calculated using information from the Hospital das Clinicas, the largest hospital in Brazil, based on the assessment of 15 elderly patients per week during the period of two years (24 months).

The protocol of the study established that the nurse responsible for diagnosis of dementia among elderly patients in the hospital should invite all caregivers to participate in the study during the period of research. Caregivers who accepted participation in the study were included in the sample, except if patients were diagnosed with Mild Cognitive Impairment (MCI). Thus, every patient diagnosed with mild, moderate or severe dementia and his/hers relatives or caregivers were included in the study.

Patients and caregivers were verbally informed on the details of the project and interviewed only after signing a consent form agreeing to participate in the study. Caregivers responsible for patients' care signed the consent form, in case of impaired capacity of the patient, being certified that caregivers understood the terms of the research and the rights of participants.

The study was submitted to the Ethics Committee of Hospital das Clinicas of the University of Sao Paulo (HC-FMUSP) and approved under process number 368.096/2013.

Data collection and processing

Data collection was performed using a research protocol based on semi-structured questionnaire designed to gather information on sociodemographic, economic and health characteristics of patients and caregivers, information on health resources utilization and results of clinical assessment of patients and their respective caregivers, applied by a nurse specialized in dementia.

Clinical data included variables related to disease progression and comorbidities of the patients and their respective caregivers. Detailed information on the research protocol is

available within a study published with preliminary results of the research, referring to indirect costs of dementia in Brazil, including a fraction of the planned sample regarding data from caregivers [14].

Disease severity was categorized using the Functional Assessment Staging—FAST scale [21], which allows observation of cognitive impairment due to dementia and dependency stage of the patient, categorizing into seven stages (1 to 7f). In the study, the seven stages were aggregated into three levels (mild, moderate and severe), considering the following scores: “1–4” = mild; “5a–5e” = moderate; and “7a–7f” = severe.

Caregiver burden due to the patient condition was assessed by the ZARIT Burden Interview Scale and categorized into four levels: light to moderate burden (score ranging from 0 to 40), moderate to severe burden (score 41–60) and severe burden (score 61–88) [22].

Information on health resource utilization was based on the Resource Utilization in Dementia (RUD) scale, including variables related to direct costs associated with patient disease and indirect costs related to the relatives' and caregivers' job abandonment, early retirement and productivity loss due to burden associated with patient care [23].

Costs estimates were calculated using the information on health resource utilization for direct and indirect costs due to patient condition from a societal perspective. Values were expressed in Brazilian currency (*Reais*), corrected for inflation to February 2016, and converted into U.S. dollars using the official exchange rate released by the Brazilian Central Bank.

Direct costs included costs of patients' medication, health care, and other resources (excluding medication and health care, e.g., diapers, transportation, and other). Costs on medication prescribed for patients' treatment were calculated for daily recommended dosage based on patient medical records and caregiver information, using market prices. Costs of health service utilization by patients were estimated using information on health care provided by the Brazilian government within the national health system encompassing specialized inpatient and outpatient health care. In summary, the direct costs included direct private costs (covered by patients' families) or direct public costs (covered by government funding of national health system).

Indirect costs included costs of caregivers' health care due to health problems related to burden of patients' care, costs due to job abandonment or early retirement related to patients' care and productivity losses of relatives and/or caregivers due to the burden of patients' condition.

Estimates of economic losses due to job abandonment and early retirement were based on hourly wages according to respective caregiver's salary, and economic losses due to productivity losses of relatives and/or caregivers time for patients' care were based on hourly wages per capita, according to reported household income and number of salaried workers reported in the family unit, in order to account for rotation of the task among diverse individuals in the household and to consider differences in wages of household members among formal and informal labor activities.

The calculation of monthly hours related to activities of daily living (ADL), instrumental activities of daily living (IADL) and supervision of the patient was made using previously tested methodology [14].

Statistical procedures

Data on patients' and caregivers' sociodemographic, economic and health characteristics, clinical assessments of patients, and direct and indirect costs due to dementia, according to FAST category, were analyzed by descriptive statistics and partial correlations in order to allow analysis of differences between groups of patients and caregivers, adopting a significance level of 0.05.

Additionally, robust multiple regression models were estimated using the Stata software version 11.2, in order to identify main determinants of dementia costs in the sample of patients in Brazil, adopting 0.05 significance level for inclusion of variables in the models.

Results

One hundred and fifty-six interview protocols were performed with informal caregivers of outpatients with dementia, categorized according to severity into mild (n = 61), moderate (n = 74) and severe (n = 21) stages of the disease. Five protocols were excluded: one due to missing information and four to duplicate interviews where, in these cases, only data from the latest interview were considered for the data analysis.

Sociodemographic and clinical characteristics of patients indicated that average time of progression of dementia was 60.13 (±41.44) months; and main comorbidities were systemic arterial hypertension (60.26%), followed by cardiovascular disease (40.15%), and diabetes mellitus (27.56%) (Table 1).

Regarding caregiver characteristics, caregivers had predominantly female gender (82.69%), mean age of 54.21 (±14.28) years, and educational level of 9.43 (±5.68) years. Most caregivers

Table 1. Sociodemographic characteristics and clinical status of patients, according to patient FAST category. Brazil, 2016.

Patient characteristics		Patient dementia stage				Sig.
		Mild	Moderate	Severe	Total	
Patients	N	61	74	21	156	
	%	39.10	47.44	13.46	100.00	
Sex						
Male	(%)	39.34	43.24	42.86	41.67	#
Female	(%)	60.66	56.76	57.14	58.33	#
Age (years)	Mean	72.23	72.97	74.57	72.90	#
	SD	9.99	10.62	9.57	10.20	
Retired	(%)	85.25	79.73	76.19	81.41	#
Income (US\$)	Mean	273.04	323.12	195.92	286.41	#
	SD	233.91	444.56	163.60	345.74	
Diagnosis						
Alzheimer's disease	(%)	63.93	74.32	57.14	67.95	#
Vascular dementia	(%)	4.92	0.00	0.00	1.92	#
Frontotemporal dementia	(%)	4.92	2.70	19.05	17.10	#
Lewy Body dementia	(%)	0.00	1.35	0.00	0.64	#
Other	(%)	26.23	21.62	23.81	23.72	#
Disease evolution (months)	Mean	51.48	60.82	82.86	60.13	*
	SD	39.04	39.39	47.99	41.44	
Comorbidities (n)	Mean	2.13	2.12	1.38	2.03	#
	SD	1.36	1.32	1.50	1.38	
Diabetes	(%)	32.79	25.68	19.05	27.56	#
Hypertension	(%)	62.30	67.57	28.57	60.26	*
Cerebrovascular disease	(%)	22.95	17.57	23.81	20.51	#
Cardiovascular disease	(%)	44.26	52.70	28.57	46.15	#
Other	(%)	50.82	45.95	38.10	46.79	#

Note

* p<0.05

p>0.05. SD = standard deviation.

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Table 2. Sociodemographic characteristics, level of caregiver burden and disease after initiating care. Brazil, 2016.

Caregiver characteristics		Patient dementia stage				Sig.
		Mild	Moderate	Severe	Total	
Sex						
Male	(%)	19.67	14.86	19.05	17.31	#
Female	(%)	80.33	85.14	80.95	82.69	#
Age (years)	Mean	55.62	53.11	54.00	54.21	#
	SD	13.43	14.73	15.39	14.28	
Educational level (years)	Mean	8.69	10.22	8.81	9.43	#
	SD	6.46	5.26	4.35	5.68	
Marital status						
Married/Living with partner	(%)	59.02	72.97	66.67	66.67	#
Divorced/Widower/Bachelor	(%)	40.98	27.03	33.33	33.33	#
Number of children	Mean	0.84	0.81	0.67	0.80	#
	SD	1.02	0.81	0.80	0.89	
Salaried work	(%)	40.98	36.49	33.33	37.82	#
Living with patient	(%)	72.13	75.68	66.67	73.08	#
Relationship with patient						
Spouse	(%)	39.34	36.49	23.81	35.90	#
Son/Daughter	(%)	52.46	51.35	52.38	51.92	#
Other	(%)	8.20	12.16	23.81	12.18	#
ZARIT score						
Mild burden	(%)	72.13	36.49	57.14	53.21	*
Moderate burden	(%)	24.59	58.11	19.05	39.74	*
Severe burden	(%)	3.28	5.41	23.81	7.05	*
Disease diagnosed after initiating patient care	(%)	32.79	33.78	66.67	37.82	*
Lag period from diagnosis (months)	Mean	9.03	11.64	18.62	11.56	#

Note

* $p \leq 0.05$

$p > 0.05$. SD = standard deviation.

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lived with the patient, were generally the patient’s sons/daughters, and reported mild or moderate burden of disease, independently of patient dementia stage. Almost 38% of caregivers reported having a diagnosed illness within approximately 12 months of initiating patient care. Main complaints reported were psychological distress and depressive disorders, while 70.51% of caregivers were in use of prescribed medication at the time of interview (Table 2).

Utilization of health care resources by patients with dementia and their respective caregivers showed that most medication was provided by the public funded health system (26.28%) or acquired using public and private resources (62.18%). Regarding use of health care resources, statistically significant differences among patients at different severity stages were identified for use of medication, physician visits, and need for professional support of a nurse; whilst among caregivers, no significant differences in utilization of health services were found (Table 3).

Productivity losses of caregivers for patient care were analyzed in relation to total or partial job abandonment data, allowing the estimation of indirect costs of dementia: a total of 373.04 (± 251.29) hours dedicated to ADLs, IADLs and supervision of patients, comprising 87.75 hours on ADLs, 129.44 hours on IADLs, and 161.26 hours on supervision (Table 4).

Global costs attributable to dementia were US\$1,405.72 ($\pm 1,376.28$) per month, comprising US\$562.09 (± 434.82) direct costs and US\$843.63 ($\pm 1,172.11$) indirect costs (Table 5). Significant

Table 3. Use of health care resources by patients with dementia and respective caregivers, according to patient FAST category, Brazil, 2016.

Variables	Patient dementia stage				Sig.	
	Mild	Moderate	Severe	Total		
Utilization of health system resources for patient care						
Medications prescribed (per day)	Mean	3.43	4.78	2.43	3.94	*
	SD	3.28	4.07	1.80	3.62	
Private purchase only	(%)	13.11	6.76	23.81	11.54	*
Public health system only	(%)	32.79	21.62	23.81	26.28	*
Both public and private	(%)	54.10	71.62	52.38	62.18	*
Hospitalizations (n)	Mean	0.07	0.12	0.10	0.10	#
	SD	0.25	0.37	0.30	0.32	
Inpatient stay (days)	Mean	0.13	0.28	0.10	0.20	#
	SD	0.64	1.38	0.30	1.04	
Emergency room (n)	Mean	0.23	0.24	0.10	0.22	#
	SD	0.62	0.46	0.30	0.51	
Health professional consultations						
Specialized physician (n)	Mean	0.95	0.74	0.95	0.85	#
	SD	1.63	0.68	0.86	1.16	
Physician visits (n)	Mean	0.13	0.50	0.90	0.41	*
	SD	0.39	1.20	2.61	1.29	
Nurse visits (n)	Mean	0.08	0.20	0.67	0.22	#
	SD	0.28	0.89	2.61	1.15	
Professional support						
Nurse	(%)	9.84	18.92	38.10	17.95	*
Household/hospital assistance	(%)	1.64	0.00	0.00	0.64	#
Public/private transportation	(%)	21.31	24.32	9.52	21.15	#
Other	(%)	14.75	29.73	14.29	21.79	#
Utilization of health system resources by caregiver due to caregiving						
Hospitalization (n)	Mean	0.00	0.01	0.00	0.01	#
	SD	0.00	0.12	0.00	0.08	
Inpatient stay (days)	Mean	0.00	0.01	0.00	0.01	#
	SD	0.00	0.12	0.00	0.08	
Emergency room (n)	Mean	0.18	0.38	0.48	0.31	#
	SD	0.47	0.79	1.44	0.81	
Health professional consultations						
Specialized physician (n)	Mean	0.52	0.81	0.43	0.65	#
	SD	0.72	2.03	0.75	1.50	

Note

* $p \leq 0.05$

$p > 0.05$. SD = standard deviation.

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part of costs attributable to dementia was indirect costs (60.0%), being mostly due to time spent in patients' care (89.8% of indirect costs); whilst major part of the direct costs was attributable to other resources for patients' care (72.6%). That is, there is significant burden to private household expenditures due to dementia, considering that substantial share of direct and indirect of dementia costs (approximately 83%) concentrate on utilization of private resources.

The main determinants of costs due to dementia were medication, dementia severity and caregiver educational level (Table 6). Patients' sociodemographic characteristics, patients'

Table 4. Characteristics of productivity losses and economic impact for caregivers, according to patient FAST category. Brazil, 2016.

Variables		Patient dementia stage				Sig.	
		Mild	Moderate	Severe	Total		
Caregiver job abandonment	(%)	40.98	45.95	47.62	44.23	#	
Reasons for job abandonment							
Retirement	(%)	16.39	13.51	4.76	13.46	#	
Early retirement	(%)	0.00	1.35	0.00	0.64	#	
Dismissal	(%)	1.64	0.00	4.76	1.28	#	
Health problems	(%)	8.20	2.70	4.76	5.13	#	
Patient care	(%)	11.48	14.86	4.76	12.18	#	
Other	(%)	3.28	13.51	28.57	11.54	#	
Caregiver working hours lost on patient care		Mean	3.57	3.84	4.95	3.88	#
		SD	11.02	14.94	14.36	13.38	
Estimated time spent on patient support (hours) monthly		Mean	243.28	460.74	440.95	373.04	*
		SD	222.18	222.36	275.93	251.29	
Activities of daily living (hours)		Mean	35.90	115.43	140.81	87.75	*
		SD	64.93	92.48	103.48	94.06	
Instrumental activities of daily living (hours)		Mean	91.15	160.66	130.67	129.44	*
		SD	95.27	104.03	111.73	106.13	
Supervision activities (hours)		Mean	123.11	207.76	186.62	171.81	*
		SD	144.75	168.68	150.25	161.26	

Note

* $p \leq 0.05$

$p > 0.05$. SD = standard deviation.

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comorbidities, utilization of health services by patients and/or caregivers and other resources did not represent significant influence on the burden of disease. That is, costs of dementia were independent in relation to other health conditions and other health care costs incurred by patients and caregivers; representing costs specifically linked to burden of dementia in the Brazilian health system, instead of being overestimated due to occurrence of other health problems among the patients in the sample.

Discussion

The majority of dementia patients have AD (65%) worldwide [1], where an AD prevalence of 68% was detected in the present study sample recruited from a tertiary outpatient memory clinic in Brazil. Regardless of type of dementia, there are numerous concerns over projections of incidence in UMICs, particularly the ageing process. Life expectancy in Brazil has increased in the last few decades, with future increases in the risk of dementia expected [12].

Considering the lack of evidences on dementia costs in Brazil, a previous study was published presenting preliminary findings of the research project referring to indirect costs of dementia in Brazil [14], including a fraction of the planned sample regarding data from caregivers.

Characteristics of patients and caregivers

Demographic data on patients and caregivers regarding age and gender proved similar to the findings of other studies conducted in LA [1,12,16] and in high-income countries (HICs) [1,24]. Patients and caregivers interviewed in the present study were younger in comparison to

Table 5. Monthly direct, indirect and global costs due to dementia and regression model with caregiver burden, according to patient FAST category. Brazil, 2016.

Variables		Patient dementia stage				Sig.
		Mild	Moderate	Severe	Total	
Direct costs due to dementia (US\$)						
Cost of patient medication	Mean	65.06	68.42	84.42	69.26	#
	SD	50.70	64.79	95.72	64.75	
Cost of health services for patient treatment	Mean	20.62	18.67	20.84	19.84	#
	SD	27.55	17.31	24.68	22.62	
Cost of other resources for patient care, excluding medication and health services	Mean	27.86	8.27	0.00	15.05	*
	SD	43.62	7.01	0.00	30.16	
Total Direct Costs	Mean	53.14	62.96	78.47	61.21	*
	SD	50.45	67.39	99.35	66.82	
Indirect costs due to dementia (US\$)						
Cost of health services for caregiver treatment	Mean	29.89	59.17	62.10	48.12	#
	SD	55.60	103.03	168.47	100.37	
Costs of productivity loss for patient care	Mean	22.79	51.25	37.02	38.21	#
	SD	56.98	132.05	107.98	105.59	
Costs of time spent on patient support	Mean	525.19	1,013.26	529.64	757.31	*
	SD	580.35	1,552.30	475.49	1,163.57	
Total Indirect Costs	Mean	577.87	1,123.68	628.75	843.63	*
	SD	585.81	1,554.53	493.21	1,172.11	
Global costs due to dementia (US\$)						
Direct and indirect monthly costs due to dementia	Mean	1,023.71	1,724.01	1,393.79	1,405.72	*
	SD	719.01	1,780.26	860.61	1,376.28	

Note

* $p \leq 0.05$

$p > 0.05$. SD = standard deviation.

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other studies conducted in HICs (72.9 years versus ≥ 75 years, and 54 years versus 65 years, respectively), and in Brazil (42.1 years) [3,25–28]; however, it was consistent with the previous study performed using subsample of the research [14]. Most patients and caregivers were female, and a higher percentage of retirees was observed among the patients in comparison to other studies [3,14].

The educational level of caregivers in the study was lower in comparison to previous studies [26–29]. Some sociodemographic characteristics were consistent with findings from other studies: married caregivers (66.7%), living with the patient (73.1%), spouses (35.9%) and sons/daughters (51.9%), reflecting cultural aspects of the duty to provide elderly with care seen in LA [14], as well as Asian and Eastern countries [27].

Table 6. Regression model for global costs due to dementia. Brazil, 2016.

Independent variables	β	SE	95%CI	Sig.
Medications prescribed (per day)	0.35	0.07	0.21–0.48	*
FAST score	4.21	0.27	3.68–4.74	*
Educational level of caregiver	0.27	0.04	0.19–0.35	*
R^2	0.9138			

Note

* $p \leq 0.05$; SE = standard error; CI = confidence interval.

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A high proportion of caregivers reported leaving formal jobs to take care of patients, and changes in type of formal/informal work were also observed among caregivers with patients at the mild stage (41% versus 11% in other studies [3], including 36% in the preliminary results of the study [14]). Caregivers supporting patients at the severe dementia stage in the sample worked 4.95 fewer hours per month (formal or informal), providing more than one hour of care above the average for the sample.

Comorbidities

A meta-analysis involving 13,978 elderly individuals in the Brazilian population showed a 68% prevalence of high blood pressure (HBP), a similar rate to the present study in which HBP was the most prevalent comorbidity [29]. Diabetes mellitus (DM) has 6.2% prevalence in Brazil's adult population and ranges from 14.5% to 19.6%, depending on age group [30]; whilst in the sample analyzed the proportion of patients with DM was significantly higher (27.6%).

Considering evidence on average survival rates after diagnosis (48–96 months) [31,32], the evolution of dementia reported among patients in the sample (60.1 months) is consistent with other studies, including the preliminary results reported in previous study [14].

The long-term evolution of AD may lead to the occurrence of acute conditions coexisting with chronic diseases or, rarely, with dementia only, exposing patients to situations of advanced frailty [33,34]; resulting in additional hidden costs which cause collateral burden to society [35,36].

A recent study involving a sample of 68,844 elderly individuals indicated that patients with dementia had, on average, 3.69 comorbidities versus 2.44 comorbidities among individuals without dementia [25].

The present study found an average of 2.03 (± 1.38) comorbidities and a lower prevalence of DM (27.6% vs. 36.1%) and HBP (60.3% vs. 83.5%) compared to the cited study. By contrast, there was a higher prevalence of cardiovascular disease (46.2% vs. 41.2%), and cerebrovascular disease (20.5% vs. 11.3%) [25].

The lower rates of HBP and DM may be due to actions in primary care [25,37]; although the significant prevalence of DM indicates the need for public policies to reduce and/or control complications (including cardiovascular and cerebrovascular diseases), thus avoiding overload of the health system at secondary and tertiary levels [25,27,29,31].

Caregiver overload

Psychological overload of caregivers in attending dementia patients, economic impacts of the disease, and insidious evolution of AD may be factors contributing to excessive burden among caregivers [14,38]. The time lag between the initiation of patient care and the onset of caregiver illness was 11.56 (± 20.90) months, showing that one year of care may be sufficient to cause health problems in caregivers of dementia patients.

Caregivers reported mostly emotional overload and depression; conditions associated with low individual resilience capacity, related to the need to change work hours or to abandonment of profession, leisure activities and ongoing life projects [39–41]. Usual work capacity was preserved for most caregivers of productive age; however, a significant proportion of caregivers reported the need to abandon formal work due to the sick relative.

A pioneering study evaluating the presence of comorbidities among caregivers of dementia patients in Brazil compared to individuals from the general population, indicated higher prevalence of depression (23% versus 11%), major depression (29% versus 20%), decline in physical health (7.3% versus 5.5%), obesity (23% versus 18%), and HBP (23% versus 15%) in caregivers than in non-caregivers, respectively [28]. In the present study, there was higher prevalence of

depression (66.7%) than that found by Laks et al. [28]; however, the results were based on self-reported information from the caregiver about diseases diagnosed and on assessment of caregiver burden using a psychometric instrument.

Informal caregivers were more likely to report health problems; information that should be analyzed prospectively by general practitioners, especially considering the need for disease prevention. The risk of onset of physical or mental illness among caregivers may be elevated for numerous reasons ranging from a lack of resources for appropriate caregiving to individual predisposition associated with previous history of life and feeling of loneliness due to the responsibility of caregiving [32,36,40].

Informal care

Estimation of time dedicated to care of dementia patients and its economic evaluation may be subject to controversies over the methods employed for assessing hours (including ADL, IADL, supervision, or all) and appraisal of hourly costs, including issues related to country economic classification [8,9,14].

This study was based on measurement of global number of hours per month dedicated to ADLs, IADLs and supervision of dementia patients, which totaled 373.04 hours per month as reported by caregivers, 23.5% higher than the average in North America (87.60 hours per month) [3]; however, lower in comparison to the preliminary results (438.37 hours per month) of the research previously reported [14].

The annual time spent by Brazilian caregivers in the sample (4,476.5 hours per year) represents 393% of the average time reported in studies performed in USA (1,139.0 hours per year) [1,3], and approximately double the daily hours (12.4 hours per day), which may explain the overload perceived by caregivers.

Direct and indirect costs of dementia

A recent 2015 study based on a top-down approach to estimate costs of dementia reported that a significant percentage (87.4%) of costs worldwide were attributable to high-income countries (HICs), comprising predominantly social direct costs (US\$308.1 billion, 43.1%) and informal care costs (US\$271.1 billion, 37.9%), whilst direct medical costs (US\$136.0 billion, 19.0%) accounted for a lower proportion [8]. Informal care of dementia patients is usual in LA, due to low family income and high costs of hiring formal caregivers [14,41,42].

In Brazil, the Ministry of Health provides without charge medication for treatment of dementia, hospitalization, specialist consultations and outpatient follow-up for patients and caregivers [43–45]; the present study is pioneer in estimating direct social costs of health care supported by government funding within the Brazilian health system.

Although estimation of costs using the top-down approach (macro-costing technique) may not be as good as estimates based on the bottom-up approach (micro-costing technique) used in the study, the results showed that the economic impact of health care provided by the Brazilian government (direct medical costs) is equivalent to approximately 24% of household income per capita at the mild stage, 21% at the moderate stage, and 43% at the severe stage; representing a significant reduction in health expenditure for dementia patients and their respective families, in contrast to conditions prevailing in other upper-middle income countries (UMICs) [46–48].

Direct costs of dementia reported in the study accounted for US\$562.09 (40.0% of global dementia costs). A substantial proportion of dementia costs estimated in the context of the study were attributable to indirect costs; i.e., social costs associated with caregiver productivity loss and time spent by caregiver on patient support. It is important to highlight that total

indirect costs per month reported in the study (US\$843.63) were higher than family income per capita reported (US\$286.41); representing losses of income of US\$577.87 for patients at mild stage, US\$1,123.68 at moderate stage, and US\$628.75 for patients at severe stage.

In comparison to previous study based on preliminary data referring to indirect costs of caregivers [14], the present study showed higher costs due to time spent in patients' support and productivity losses due to job abandonment (considering solely cases attributable to patients' care); that is, the partial sample initially interviewed in the research probably present underestimation of indirect costs of dementia in the Brazilian health system.

Based on estimates provided for UMICs [8], global costs of dementia represent approximately US\$5,284 per person, of which 57.1% represents informal care costs; 22.4% direct medical costs; and 20.5% social costs. The study indicated that, in Brazil, global costs of dementia are significantly lower (US\$1,405.72 per person), with 56.6% attributable to informal care costs; 15.1% direct medical costs; and remaining 37.3% social costs.

Additionally, according to the regression model estimated, the progression of dementia (FAST score) had significant influence on economic impact of the disease, followed by use of medication and educational level of the caregiver. The last two variables represent increased costs associated with direct utilization of resources of the health system and the patient's family, respectively; whilst the first variable is probably associated with the social burden of dementia, since FAST score showed a significant positive association with ZARIT score on the analysis performed.

The results obtained also highlight the need to improve the quality of basic health care, especially regarding dissemination of information to the population on protective factors to delay the onset of dementia [48,49]. Simple, low-cost interventions may be effective strategies for UMICs, resulting in policies with a positive impact on aging which is inversely associated with exposure to risk of dementia [47].

Global costs of dementia represent a substantial economic and social burden, and comparisons with the impact caused by other diseases may encourage discussion on societal onus, toward prioritizing long-term health strategies to reduce health care costs through disease prevention and health promotion, thereby minimizing the risks of deterioration in the quality of health care [10,33].

The study showed that the global costs of dementia in Brazil already outstrip available resources within Brazilian society, calling for the development of health care strategies based on education programs on dementia (especially in primary care) and training of health professionals to provide caregivers with information, constituting useful approaches to attenuate the current and future impact of dementia in UMICs over the coming decades [14,35,42,47,50].

Limitations

The main limitation of the study was the utilization of a cross-sectional study design with convenience sampling; given that longitudinal analysis would provide additional evidence on determinants of health care costs and progression of the disease, while random sampling could provide information to perform further extrapolation in the statistical analysis from a societal perspective.

However, considering that the data presented relates to the first stage of the CAAD project, the research group is expected to be able to carry out further economic analysis based on longitudinal data.

Thus, in view of the dearth of evidence on dementia costs in Brazil, it was considered important to disseminate these initial findings on the economic impact of dementia, including direct and indirect costs, in the context of a publicly financed health system with universal coverage.

Supporting information

S1 Table.
(DOCX)

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