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Research Article

Changes in Alzheimer Disease, Associated Factors, and Hospital Cost among Elderly Patients in 2007 and 2010

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Abstract

Objective: We examined variations in the prevalence of Alzheimer disease (AD), associated factors, and hospital cost among California patients over time (2007 and 2010) by ethnicity and gender.

Methods: California Hospital Discharge Data files (HDDS) for 2007 and 2010 patients (aged 60+ years) were examined with a diagnosis of Alzheimer disease (ICD-9 code 331.0). Patients diagnosed with AD comprised 14,423 of 212,284 in 2007 and 11,133 of 181,674 in 2010; female 59% and 58% respectively, with a mean age of 84 in both years.

Results: AD prevalence declined by 9.4%, from 6.4% in 2007 to 5.8% in 2010. Further, in both years, prevalence was higher among females than males, and was slightly higher among Asian/Pacific Islanders (AP) compared to other ethnic groups. Significant factors associated with AD in both years included: stroke (OR = 1.74 in 2007 and OR = 1.46 in 2010), diabetes mellitus (OR = 1.08 and OR = 1.15) and depression (OR = 1.66 and OR = 1.51). Further, hyperlipidemia (OR = 1.13) was related to AD only in 2010. The hospital cost for AD in 2007 was $151,280 per patient, and it declined to $140,580 in 2010. The cost in both years was higher ($p < .001$) for Asian/Pacific Islanders compared to other ethnic groups and higher for males compared to females.

Conclusions: AD prevalence declined from 2007 to 2010, and its associated factors (stroke, diabetes, hyperlipidemia) require clinical studies to determine whether preventive programs aimed at reducing these risk factors might reduce the burden of AD among the elderly.

Keywords: *Dementia; Alzheimer; Associated Factors; Ethnicity; Gender; Hospital Costs*

Background

Alzheimer disease (AD) currently affects approximately 5.4 million American elderly (ages 50 years and older), and it is the 6th leading cause of death among them. By 2050, the AD population is expected to increase by another 1 million per year. AD covers 80% - 90% of dementia and it includes loss of memory, loss of language skills, and skills related to problem solving and self-management. AD is a multifactorial disease, without a known single causal factor. AD is reported in all social classes, ethnic groups, and is reportedly higher among females than males [1-8].

Previous research has pointed to a number of factors that might elevate the risk of AD. These factors include family history, head injury, limited education, and older age [9-12]. In addition, recent studies have also pointed to significant associations between AD and various cardiovascular factors including hypertension [13,14], diabetes mellitus [15-18], high cholesterol [19,20], chronic heart disease [21,22],

heart failure [23-25], atrial fibrillation [26-28], chronic kidney disease [29,30], stroke [31,32], depression [33-35] and obesity [36,37]. While these findings are robust, their variation by ethnicity and gender remains largely unknown. Thus, this paper examines patients data regarding changes in AD prevalence, associated factors, and hospital costs by ethnicity and gender.

Method

Sample

We obtained discharged patient files from the California's Office of State Planning and Development (OSHPD) on elderly (aged 60+ years, for years 2007 and 2010) with a diagnosis of Alzheimer (ICD-9 codes 331.0). The AD patients sample in 2007 included 14,423 from a total of 212,284 patients. The 2010 sample had 11,133 AD patients from a total of 181,674 patients with a mean age of 84 in both years. Included in the AD sample were 59% and 58% females each time. We collected patients' demographics, number of hospital admissions, days in hospital, charges/costs ($) for each discharge, all secondary diagnoses (summed as co-morbidities). We computed two indices of co-morbidities: (i) an index composed of a simple count of all secondary diagnoses that were identified by ICD-9-CM codes for each patient, and (ii) a Charlson Index of co-morbidity severity [38] whereby higher index scores stood for higher severity of the disease. Further, two types of hospital costs were developed: (i) costs associated with the 1st AD admission alone or when a patient was discharged with a diagnosis of AD, and (ii) total hospital cost for the entire year in 2007 and 2010 (Total Cost in USD), that is, when the same AD patient was discharged with other diagnoses during the year.

Statistical analyses

Differences in the prevalence of AD risk factors by ethnicity/gender were evaluated with Pearson Chi Square and Fishers Exact Tests. Multiple logistic regression models were used to examine the likelihood of AD association with risk factors, and cost differences were examined with ANOVA.

Results

AD prevalence by ethnicity and gender

Two characteristics were noticeable regarding changes in AD prevalence: a decline in AD prevalence (from 2007 to 2010), and an exponential increase with age. Table 1 (col. 2) shows that AD prevalence among the patients had declined from 6.4% in 2007 to 5.8% in 2010; this decline of 9.4% is supported by a decline in the number of hospitalized AD patients that dropped from 14,423 patients in 2007 to 11,133 AD patients in 2010. Further, AD prevalence declined in all ethnic and gender groups. For example, among whites, AD prevalence declined from 6.4% in 2007 to 5.8% in 2010 (a decline of 9.4%); among black patients AD declined from 6.6% in 2007 to 5.5% in 2010 (a decline of 16.7%). Further, decline among Hispanics occurred from 6.3% in 2007 to 5.6% in 2010 (a decline of 11.1%), and among Asian/Pacific islanders (AP), AD declined from 6.3% in 2007 to 5.9% in 2010 (a decline of 6.3%) (Table 1, cols. 5-8). In both years, females had a higher prevalence of AD than males (F:M; 6.9% vs. 5.7% in 2007; 6.3% vs. 5.1%, in 2010, cols. 9-10). Further, AD declined among both males and females; among females the decline was 11.6% while among males it was 10.5% (Table 1, cols. 9-10).

We examined the issue of exponential AD increase with age in our data for three age categories: 60 - 70 years old, 71 - 80 and 81+ years old. In both years, we noted an exponential increase in AD with increasing age. For example, in 2007 the AD prevalence increased with age from 1.6% among 60 - 70 years old to 4.7% among 71 - 80 years old to 9.8% among 81+ years old patients. Similarly, in 2010 AD prevalence varied from 1.3% to 4.2% to 9.1% per three age categories. This disproportionate increase in AD with age existed in each ethnic and gender group.

Associated factors in 2007 and 2010: Table 1 (col. 3) shows that three of 12 factors associated ($p < .001$) with AD in both years included: stroke (OR = 1.74 and OR = 1.46), diabetes mellitus (OR = 1.08 and OR = 1.15) and depression (OR = 1.66 and OR = 1.51). Further, while in 2010, diabetes among Hispanics (OR = 1.13), and Asian Pacific Islanders (OR = 1.42) predicted AD, among the females both diabetes (OR = 1.16) and cholesterol (OR = 1.13) were associated with AD (Table 1, col. 10).

Variable	All AD			White	Black	Hisp	AP	Male	Female
Col->	2	3	4	5	6	7	8	9	10
N->									
2007	14423		---	9932	1168	2200	1123	5887	8536
2010	11,133			7450	877	1842	84964	4646	6487
Age									
2007	84	----	----	84	82	83	84	82	84
2010	84			85	82	83	85	83	85
AD		- - -	----						
2007	6.4%			6.4%	6.6%	6.3%	6.3%	5.7%	6.9%*
2010	5.8%			5.8%	5.5%	5.6%	5.9%	5.1%	6.3%*
		OR	**CI**	**OR/CI→**	→	→	→	**OR/CI**	**OR/CI**
Stroke									
2007	26%	1.74*	1.67 - 1.81	1.60*/1.5 - 1.7	1.90*/1.5 - 2.1	2.20*/1.9 - 2.4	1.80*/1.5 - 2.0	1.88*/1.77 - 2.0	1.64*/
2010	22%	1.46*	1.37 - 1.56	1.43*/1.34 - 1.52	1.60*/1.36 - 1.87	1.87*/1.67 - 2.09	1.69*/1.45 - 1.97	1.67*/1.55 - 1.79	1.46*/1.37 - 1.56
HTN									
2007	83%	1.01	.96 - 1.06	1.01/.95 - 1.06.	1.05/.85 - 1.31	.93/.80 - 1.05	1.03/.84 - 1.3	1.10*/1.02 - 1.18	.96/.90 - 1.02
2010	83%	.92	.85 - .98	.92/.86 - .97	1.00/,77 - 1.29	1.04/.89 - .22	.80/.66 - .99	.99/.91 - 1.07	.92/.85 - .98
DM									
2007	38%	1.08*	1.04 - 1.12	1.05+/1.0 - 1.10	.97/.86 - 1.10	1.03/.93 - 1.14	1.18+/1.03 - 1.4	1.01/.95 - 1.07	1.13*/1.07 - 1.18
2010	38%	1.15*	1.03 - 1.22	1.04/,99 - 1.10	.99/.78 - 1.04	1.13+/1.02 - 1.25	1.42*/1.23 - 1.63	1.03/.96 - 1.10	1.16*/1.09 - 1.22
Chol									
2007	12%	.99	.94 - 1.04	1.0/.93 - 1.07	.99/.82 - 1.20	.99/.87 - 1.13	.96/.80 - 1.14	1.04/.96 - 1.12	.96/.89 - 1.03
2010	10%	1.13*	1.03 - .23	1.05/.97 - 1.15	1.22/.97 - 1.54	1.12/.96 - 1.31	1.08/.88 - 1.34	1.04/.94 - 1.15	1.13*/1.03 - 1.23
CHD									
2007	55%	.94	.91 - .98	.91/.87 - .95	.96/.83 - 1.08	1.01/.92 - 1.14	1.19+/1.04 - 1.4	.88/.82 - .93	.98/.93 - 1.02
2010	56%	.96	.91 - 1.1	.93/,88 .98	.91/.78 - 1.05	.99/.88 - 1.09	.99/.86 - 1.15	.91/,85 - .97	.96/.91 - 1.01
HF									
2007	18%	.73	.69 - .76	.76/.62 - .69	.64/.55 - .75	.69/,62 - .78	.61/.51 - .72	.71/.66 - .76	.74/.69 - .78
2010	21%	.72	.67 - .75	70/.66 - .75	.73/.61 - .86	.71/.6 - .79	.76/.65 - .89	.71/.66 - .77	.72/.67 .76
MI									
2007	11%	.99	.94 - 1.04	.06/.98: 1.13	.93/.75 - 1.16	.89/.76 - 1.03	.80/.71 - 1.04	.94/.86 - 1.02	1.05/.97 - 1.13
2010	12%	1.05	.92 - 1.05	1.02/,94 - 1.10	1.39*/1.12 - 1.74	.95/.81 - 1.11	.94/.77 - 1.15	.99/.90 - 1.09	1.05/.97 - 1.15
AFib									
2007	53%	.98	.94 - 1.02	.96/.92 - 1.01	.1.08/.05 - 1.23	1.01//92 - 1.10	1.08/.94 - 1.21	.98/,92 - 1.03	.98/.93 - 1.02
2010	57%	.97	.92 - 1.03	.93/,88 - .97	1.16+/1.01 - 1.33	1.05/.95 - 1.15	1.04/.91 - 1.19	.94/.89 - 1.00	.97/.93 - 1.03
CKD									
2007	33%	.98	.94 - 1.02	.95/.9201.01.	.97/.85 - 1.10	.96 - .87 - 1.06	1.02/.89 - 1.15	.95/.90 - 1.01	.99/.04 - 1.04
2010	42%	1.00	.97 - 1.03	.97/.93 - 1.03	90/,.8 - 1.04	1.08/.97 - 1.19	.94/.82 - 1.08	.96/.90 - 1.02	1.00/.95 - 1.05
COPD									
2007	34%	1.06*	1.02 - 1.09	.99/.95 - 1.04	1.10/.07 - 1.75	1.20*/1.09 - 132	1.28*/1.12 - 1.45	1.05/.99 - 1.10	1.06/1.01 - 1.11
2010	32%	1.03	.95 - 1.06	.95/.89 - .99	10/.94 - 1.28	1.18*/1.06 - 1.31	1.33*/1.16 - 1.54	1.01/.95 - 1.07	1.03/.97 - 1.09
DEP									
2007	26%	1.66*	1.60 - 1.73	1.68*/1.60 - 1.76	1.47*/1.21 - 11.67	1.77*/1.60 - 1.97	1.86*/1.56 - 2.20	1.97*/1.84 - 2.10	1.52*/1.44 - 1.60
2010	25%	1.51*	1.14 - 1.59	1.56*/1.48 - 1.65	1.62*/1.34 - 1.94	1.76*/1.57 - 1.97	1.87*/1.55 - 2.25	1.75*/1.62 - 1.89	1.51*/1.42 - 1.59
Obese									
2007	0.5%	1.05	.81 - 1.36.	1.12/.83 - 1.50	.43/.11 - 1.82	.44/.20 - 1.19	3.45+/1.22 - 4.94	1.24/.87 - 1.77	.90/.61 - 1.29
2010	0.4%	.98	64 - 1.50	1.16/.81 - 1.66	.50/.12 - 2.10	1.03/.49 - 2.1	.99/.90 - 1.1	1.10/.72 - 1.69	.98/.64 - 1.51

Table 1: *Odds ratios and 95% Confidence Interval of CVD factors associated with Alzheimer disease.*

Abbreviations for table 1: HTN: Hypertension; DM: Diabetes Mellitus; Chol: Hyperlipidemia; CHD: Coronary Heart Disease; HF: Heart Failure; MI: Myocardial Infarction; Afib: Atrial Fibrillation; CKD: Chronic Kidney Disease; COPD: Chronic Obstructive Pulmonary Disease; DEP: Depression; Obese: Obesity

Hospital cost of AD: We examined three determinants of hospital costs namely severity of medical conditions (Charlson Index), number of hospital admissions, and length of hospital stay. Table 2 show that the average cost of AD patient in 2007 was higher ($p < .001$) compared to non-AD patients ($151,280 vs. $126,880). However, this AD cost declined from $151,280 in 2007 to $140,580 in 2010. The decline in cost reflected a decline in AD patients from 14,423 in 2007 to 11,133 in 2010. Further, the AD cost decline was further supported by a drop in the length of hospitalization which dropped from 25 days in 2007 to 18 days in 2010 without any changes in the severity of co-exiting medical conditions (Table 2, col. 2).

Additionally, the AD cost was higher ($p < .001$) in both years for Asian/Pacific Islanders (AP) compared to other ethnic groups (Table 2, col. 6) and it was also higher for males ($p < .001$) compared to females (M:F; $165,280 vs. $141,630 in 2007 and $150,290 vs. $133,630 in 2010). The higher male cost reflected their higher severity of co-existing conditions which added to their prolonged hospitalization. In brief, the hospital cost was higher for males and for Asian/Pacific Islanders.

Cost Factors	No-AD	ALL AD →	White →	Black →	Hisp →	Asian/PI →	Male →	Female →
Cols.->	1	2	3	4	5	6	7	8
N = →2007	212,284	14,423	9,932	1,168	2,200	1,123	5,887	8.536
2010	181,674	11,133	7,450	877	1,842	964	4,646	6,457
Age→2007	78	84	84	82	83	84	82	84
2010	78	84	85	82	83	85	83	85
Comorb: 2007	3.8	3.9	3.8	4.1	4,1	4.3*ß	4.1	3.8
2010	3.9	4.0	3.8	4.2	4.3*	4.2	4.1*	3.9
Charlson:2007	3.3	3.7*	3.5	4.1	3.9	4.2	3.9	3.5
2010	3.7	4.0*	3.8	4.2	4.4*	4.4	4.3*	3.8
#Adm: 2007	2.1	2.6*	2.5	2.9	2.8	2.9	2.7	2.6
2010	1.6	1.9*	1.8	2.1	2.1+	2.0	1.9*	1.8
LOS: 2007	15.7	24.8*	24.0	25.6	26.0	29.4*	26.4	23.7
2010	12.2	17.9*	16.8	17.7	22.6*	18.1	17.3	18.5
AD Cost 1st Adm: 2007	---------	$54,035	51,707	48,907	59,439	75,410	56,588	52,455
2010	---------	$74,103	69,213	79,604	5,748	108,550*	77,146	72,038
Total Cost $: 2007	126,880	151,280*	138,610	179,270	151,800	213,159	165,280*	141,630
2010 $	130,060	140,580*	124.540	163,840	166,500	193,910*	150,290*	133,630

Table 2: *Hospital cost of Alzheimer patients by ethnicity and gender in 2007 and 2010*

*Differences between adjacent columns are significant: + at p<.01, * at p<.001.*

Abbreviations; comorb = # of comorbidities; Charlson = Charlson Index of comorbidity severity; # Adm = Number of adhospital admissions; LOS = Length of hospital stay (days); AD cost- Cost of first AD discharge; Total cost $ = Total cost of year in USD.

Discussion

Our findings are relevant from several perspectives: First they are consistent with the prevalence of AD as reported by other studies. For example, AD prevalence of 4.9% among 70+ year old as reported by Katz and colleagues [39] is closer to our 5.8% estimate in 2010. Secondly, we found a disproportionate increase in AD with three age categories (from 60 - 70, 71 - 80 and those 81+ years old) which also existed within each ethnic and gender group. These finding are similar to other reports [40-44] of age and gender effects on dementia rates.

Thirdly, our findings show that AD prevalence among the elderly patients (60+ years old) had declined by 9.4% from a prevalence of 6.4% in 2007 to 5.8% in 2010. This finding is consistent with 15.4% drop in AD among 80+ Canadians as reported by Cerasuolo and colleagues [45].

The AD decline in our 2010 sample may be related to increasing use of cholesterol controlling prescriptions (statins). Using a National Health Survey data, Gu and colleagues [46] reported that statin prescriptions (among 40+ years old) had increased from 18.9% in 2007 to 23.2% in 2011. While the effect of statins in reducing CVD including stroke has been reported by several studies [47-49], most recently a study of Medicare patients (65+ years old) by Zissimopoulos [50] found that a regular use of statins (such as atorvastatin and simvastatin) lowered the risk of AD by 12% among males and 14% among females and this lower risk prevailed across all ethnic groups [50]. Thus, it is plausible that the AD decline in our sample (from 6.4% to 5.8%) may be due to an increased use of statins by the elderly in California. Since data pertaining to statin use by our patients is not available, this issue requires further examination.

Finally, other risk factors including hypertension and heart disease did not seem to have significant direct associations with AD. However, stroke had a direct association which might imply that risk factors that help reduce stroke may also help reduce the prevalence of AD [51-55].

Limitations of the Study

The HDDS files do not provide patients' clinical data relative to type and length of treatment including pharmaceuticals provided, or their associated costs. Further, these administrative files neither provide patients' marital status nor their education attainment nor their annual income. Despite these and other limitations, the current findings are highly relevant from both programmatic perspective and for developing new clinical studies.

Conclusion

AD prevalence among patients discharged from California hospitals declined from 2007 to 2010. The associated factors (stroke, diabetes, hyperlipidemia, depression) require analytic epidemiologic and clinical studies to begin to determine whether preventive programs aimed at reducing these risk factors can lower the burden of AD.

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