

Determinants and trends in dental expenditures in the adult US population: Medical Expenditure Panel Survey 1996-2006

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Objectives: To estimate dental expenditures in 2006, to analyse dental expenditures by potential explanatory factors for 2006 and to explore trends in dental expenditures from 1996-2006. **Methods:** Medical Expenditure Panel Survey (MEPS) data were used. T-tests and analysis of variance were used to test for significance. Multivariable linear regression analysis was conducted to identify independent predictors of dental expenditures. The trend analysis was conducted for the 11-year period, 1996-2006, on adults aged 25 years and older. Expenditures were inflation adjusted to 2006 dollars using the annual average Consumer Price Index. Data were analysed using the MEPS query tool and SASv9.2®. **Results:** In the 2006 MEPS sample, 8,001 adults had dental expenditures and when weighted represented about 93 million non-institutionalised adult US civilians. The mean dental expenditures for this weighted sample were \$611 (sd 1,309), median \$233 (inter-quartile range 466). As expected, in 2006, dental expenditures increased with age. Those adults who reported their self-perceived health status as 'excellent' were observed to have lowest dental expenditures in this category. After adjusting for other variables in the multivariable linear regression analysis of dental expenditures, age, race/ethnicity, income, geographic location, perceived health status and dental insurance coverage remained significant. **Conclusion:** Dental expenditures for 2006 were \$611 (mean) and \$233 (median). The time-trend showed substantial but non-uniform annual changes in real dental expenditures between 1996 and 2006.

Key words: health services research, expenditures, dental health services, epidemiologic factors, healthcare disparities

Introduction

In the health care industry, both providers of a health service and recipients of the service incur expenditures. Three commonly used proxies for expenditures are: a, Costs - the money spent to produce health care services; b, Charges - the monetary amount providers charged for services rendered; and, c, Payments - the sum of amounts actually paid by patients or third party providers for care received (Anderson and Anderson, 1999). Each of these proxies has its inherent strengths and weaknesses. Usage depends to an extent on the monetary structure of the particular healthcare delivery system and more on the preference of the researcher(s). For example, in 1977 during a time when the predominant mode of payment in the US was fee-for-service, the Agency for Health Care Research and Quality's National Medical Care Expenditure Survey (NMCES) used charges as a proxy for expenditures. By 1996, in an effort to contain increasing health care costs, re-structuring of the health care delivery system in the US resulted in a majority of people being enrolled in managed care programs. This change resulted in the national expenditure survey of the time using payments as the proxy because charges were no longer considered a reliable indicator of how much was being paid for medical care (Anderson and Anderson, 1999).

Expenditures are particularly relevant to dental care which in the US is primarily financed through private sources – either through out-of-pocket payments directly to the dentist or through employer-based dental insur-

ance which also includes a percentage of out of pocket expenditure (U.S. Department of Health and Human Services, 2000). This method of payment for dental care favours the insured and those who can afford the out of pocket cost for the service, which means that lower-income individuals and individuals with or without dental insurance will tend to seek dental care for pain or infection relief in emergency rooms. This pattern of care-seeking may result in costly and episodic care thus placing additional economic burden on the poor. The impact of the Affordable Care Act enacted recently in the US on utilisation and expansion of care related coverage is awaited. In general, increasing dental insurance coverage is associated with increased utilisation of dental services (Wall and Brown, 2008); however, data suggest that an estimated 35% of the American population has no dental coverage (Manski and Brown, 2007). Characterisation of expenditure patterns by socio-demographic and economic factors is of prime importance to ensure that health planners and policy makers have the appropriate information to efficiently and effectively improve accessibility to dental services, which in turn ensures timely oral health advice and intervention.

Dental expenditures among US adults vary according to socio-demographic-economic factors (Manski and Brown, 2007; Vargas and Manski, 1999). For example, the mean dental expenditure in 2004 for White non-Hispanics in the US was \$599 compared to \$367 for Black non-Hispanics and the proportion with a dental visit were approximately 49% for White non-Hispanics compared to 30% for Black

non-Hispanics. By income, average dental expenditure for 2004 was \$646 for those in the high income category compared to \$427 for those in the low-income category (Manski and Brown, 2007).

Disparities in oral health are well documented (Chatopadhyay, 2008) and tend to reflect the inter-relatedness between factors such as disease prevalence, dental visits, dental expenditures and socio-economic standing, and hence, multi-pronged initiatives are required to achieving equity. An enhanced understanding of factors that drive expenditures for oral health will prove useful by providing information to evaluate existing health programs and policy and also help to plan and develop effective, equitable and appropriate health services and policies.

The purpose of this study is to augment existing research on dental expenditures and to explore dental expenditure trends before the onset of the 2007-2009 global financial crises. Study objectives: to describe dental expenditures for 2006, to analyse expenditures, by factors such as age, gender, race/ethnicity, education, income, geographic location, perceived health status and insurance coverage, and to explore trends in dental expenditures from 1996-2006, among US civilian non-institutionalised adults.

Methods

Data from the Medical Expenditure Panel Survey (MEPS), designed to produce unbiased nationally representative estimates of health care utilisation, expenditure, sources of payment and health insurance coverage for the US civilian non-institutionalised population were analysed for 1996 - 2006. The survey is administered using Computer Assisted Personal Interviewing (CAPI). MEPS sample is a sub-sample of respondents from the previous year's National Health Interview Survey, sponsored by National Center for Health Statistics (Center for Financing Access and Cost Trends, 2008).

A detailed description of MEPS methodology is provided with the public use 2006 household data files (Center for Financing Access and Cost Trends, 2008). This study focused only on those with dental expenditures. Data for the 2006-specific analysis were from the Household Component of the 2006 survey. There were 34,145 persons who completed the survey of which 32,577 were assigned a positive person level weight. The complex sample design of MEPS includes stratification, clustering, multiple stages of selection, and disproportionate sampling. These survey design complexities were taken into consideration in this analysis for developing estimates of effect. SAS v9.2[®] was used in this analysis and survey procedures were employed to deal with the complex sampling methodology.

For the trend analysis, per-capita dental expenditures (CPI inflation-adjusted to 2006 dollars) for each year were calculated and compared for differences across years and by source of payment (U.S. Bureau of Labor Statistics). Per-capita expenditures for each year were also computed for those adults twenty five years and older, and compared across years by factors such as gender, race/ethnicity, income and economic status.

For the 2006-specific analysis dental expenditures were defined as the sum of payments for care received and include out-of-pocket payments, payments by private insurance provider, Medicare, and Medicaid. This outcome

variable was analysed only among those people with expenditures. Income level was based on family income as a percent of the Federal Poverty Level (FPL). Those individuals below 100% of the FPL were classified as 'Poor' and those between 100-199% of the FPL were classified as being 'Low' income. Several insurance coverage variables were used to create the dental coverage variable with three levels: private dental; public dental; and, no dental coverage. An individual was considered to have public dental insurance coverage with a self or proxy report of any public coverage (includes Medicaid/SCHIP, Medicare, TRICARE and other public hospital/physician coverage) in 2006. Respondents who reported being covered by a private plan with dental insurance were coded as 'Private dental'. Those respondents with no health insurance or private health insurance only (no dental) were coded as 'No dental insurance'.

Univariate analyses were conducted on the cleaned dataset to analyse the frequency and distribution of variables. Estimates and 95% confidence intervals were calculated after accounting for the sampling method and using appropriate standard errors employing the MEPS query tool and SASV9.2[®]. Based on this analysis, decisions were made combining variable levels and also the positively skewed dependent dental expenditures variable was log transformed (natural log) to approximate a normal distribution, the necessary requirement for parametric tests to be conducted. Bivariate analyses were conducted and differences in mean dollar amounts were test for significance using T-tests and ANOVA. The median dollar amount was also computed to more clearly demonstrate the central tendency and dispersion of this outcome. Prior to multivariable modelling correlation between the independent variables was assessed to avoid multicollinearity. Based on the bivariate and correlation analysis variables were selected for the regression analyses. Multivariable linear regression analysis was performed to identify independent predictors of dental expenditures using full models with the intention to backward eliminate some variables. Based on the test of model effects, variables were selected for the final "reduced model".

Results

All given percentages are weighted to reflect the civilian non-institutionalised US population as per analysis guidance provided by MEPS (Center for Financing Access and Cost Trends, 2008). Differences in dental expenditure estimates illustrated in the figures are significant ($p < 0.05$).

Table 1, provides statistics for dental expenditures in 2006, both overall, and by the various socio-economic and demographic variables. The total number of sampled adults with a positive person level weight was 22,721, representing 222,539,134 non-institutionalised adult US civilians. Of these, 41% or 8,001 reported having dental expenditures representing approximately 93 million non-institutionalised adult US civilians. The mean dental expenditure for 2006 was \$611 (sd \$1,309) and the median was \$233 (inter-quartile range \$466). This sample of adults with dental expenditures comprised 43% male, 50% ages between 35 and 60 years, 80% non-Hispanic White, 63% with more than high school education, and 56% classified as high income.

Table 1. Weighted mean dental expenditures (dollars) among adults with expenditures by potential explanatory factors for 2006

<i>Variables and Levels</i>	<i>Sample Size</i>		<i>Dental Expenditures in 2006</i>		
	<i>Unweighted n</i>	<i>Weighted %</i>	<i>Mean (sd)</i>	<i>p-value[†]</i>	<i>Median (IQR)</i>
All	8,001	100	611 (1,309)		233 (466)
Age group				<0.001	
18-24 years	806	10	549 (902)		192 (326)
25-34 years	1,083	15	538 (1,051)		206 (361)
35-44 years	1,538	19	498 (894)		215 (346)
45-54 years	1,759	21	648 (1,458)		242 (470)
55-64 years	1,402	18	701 (1,223)		275 (662)
65 and over	1,413	17	698 (1,539)		272 (668)
Gender				0.816	
Female	4,653	57	622 (1,209)		236 (478)
Male	3,348	43	596 (1,251)		230 (446)
Race/Ethnicity				<0.001	
Non-Hispanic White	5,604	80	620 (1,312)		239 (473)
Non-Hispanic Black	916	7	596 (799)		220 (441)
Other (non-Hispanic)	475	6	640 (1,132)		226 (648)
Hispanic	1,006	7	506 (1,706)		192 (362)
Education level				0.043	
More than high school	4,608	63	624 (1,272)		235 (444)
High school	2,176	26	589 (1,254)		232 (485)
Less than high school	1,184	11	585 (1,057)		219 (490)
Income - % FPL *				<0.001	
High income (400 and over)	3,974	56	642 (1,324)		246 (493)
Middle income (200-399)	2,219	28	586 (1,043)		228 (465)
Low income (100-199)	1,081	10	532 (996)		203 (391)
Poor (under 100)	727	6	575 (1,336)		195 (402)
Metropolitan service area				<0.001	
Metropolitan service area	6,727	85	624 (1,277)		240 (4750)
Non-metropolitan service area	1,274	15	540 (880)		199 (395)
Census region				<0.001	
South	2,514	32	606 (1,229)		215 (446)
West	2,076	23	669 (1,003)		285 (590)
Midwest	1,959	25	542 (799)		223 (392)
Northeast	1,452	21	638 (1,842)		228 (420)
Health status				0.005	
Excellent	1,973	27	551 (1,101)		222 (337)
Good	5,049	63	631 (1,292)		234 (510)
Fair	968	10	649 (1,050)		266 (533)
Employment status				0.025	
Employed	5,699	74	621 (1,305)		229 (434)
Unemployed	2,280	26	608 (996)		249 (547)
Dental insurance				<0.001	
Private dental §	4,283	57	635 (1,321)		238 (474)
Public dental ‡	1,783	19	620 (1,269)		243 (546)
No dental	1,935	24	548 (1,287)		213 (374)

† Based on the natural log transformed dental expenditures variable.

* Family income as a percentage of the federal poverty level.

§ Includes those respondents who reported dental coverage by a private health insurance plan that included at least some dental coverage.

‡ Includes those individuals reporting coverage under TRICARE, Medicare, Medicaid or SCHIP, or other public hospital/physician.

sd, standard deviation; IQR, inter-quartile range

Mean dental expenditures for the 45 year olds and older were greater than for lower age groups: e.g. \$701 for 55-64 year olds and \$538 for 25-34 year olds (Table 1). Hispanics were observed to have the lowest expenditures at \$506 with differences by ethnic group being significant ($p < 0.001$). Expenditure for those educated beyond high school was at \$624 higher than for those with either high-school (\$589) or less education (\$585). Those reporting their self-perceived health status as excellent have the lower mean dental expenditure for this category, \$551.

Tables 2 to 4 present the results of the multivariable linear regression analysis. The source table (Table 2) indicates that the model significantly accounted for the variation in the dependent variable-dental expenditures ($p < 0.001$). Table 3 shows the effects of each variable adjusted for that of the other variables in the model. Education and employment status, which were significant in the bi-variate analysis now become non-significant ($p = 0.680$ and 0.976 , respectively). Table 4 gives the regression estimates for our 'final model', which excludes those non-significant

Table 2. Analysis of variance (ANOVA) source table

<i>Source</i>	<i>Degrees of freedom</i>	<i>Sum of squares</i>	<i>Mean square</i>	<i>F statistic</i>	<i>Pr>F</i>
Model	23	4,074,934	177,171	11.8	<0.001
Error	7,911	1.1879	15,015		
Corrected total	7,934	1.2286			

For the full model see Table 3.

Table 3. Test of model effects for “full model” (difference in dental expenditures)

<i>Effect</i>	<i>Degrees of freedom</i>	<i>F statistic</i>	<i>Pr>F</i>
Model	23	10.22	<0.001
Intercept	1	29,927.20	<0.001
Age group	5	9	<0.001
Gender	1	1.13	0.289
Race/ethnicity	3	11.99	<0.001
Education	2	0.39	0.680
Employment status	1	0.00	0.977
Income-%FPL	3	4.75	0.003
Metropolitan Service Area	1	18.64	<0.001
Census region	3	15.73	<0.001
Health status	2	4.65	0.010
Dental insurance	2	6.29	0.002

*Statistically non-significant factors are not included in the “reduced model” (see Table 4)

Table 4. Estimated regression coefficients for the reduced model of dental expenditures (outcome=log of dental expenditures)

<i>Variables and Levels</i>	<i>Reduced Model</i>			
	<i>Estimate</i>	<i>Standard Error</i>	<i>t value</i>	<i>p> t </i>
Intercept	5.60	0.06	88.07	<0.001
Age group				
18-24 years	0	0		
25-34 years	0.01	0.06	0.12	0.907
35-44 years	-0.32	0.06	0.56	0.573
45-54 years	0.10	0.05	1.96	0.051
55-64 years	0.22	0.06	3.56	<0.001
65 and over	0.33	0.08	4.27	<0.001
Race/Ethnicity				
Non-Hispanic White	0	0		
Non-Hispanic Black	-0.11	0.05	-2.41	0.016
Other (non-Hispanic)	-0.06	0.07	-0.85	0.397
Hispanic	-0.34	0.06	-5.84	<0.001
Income - % FPL				
High income (400 and over)	0	0		
Middle income (200-399)	-0.06	0.07	-2.01	0.045
Low income (100-199)	-0.16	0.05	-3.28	0.001
Poor (under 100)	-0.17	0.03	-2.46	0.014
Metropolitan service area				
Metropolitan service area	0	0		
Non-metropolitan service area	-0.18	0.04	-4.27	<0.001
Census region				
South	0	0		
West	0.20	0.04	5.13	<0.001
Midwest	-0.03	0.04	-0.85	0.394
Northeast	-0.01	0.05	-0.27	0.785
Health status				
Excellent	0	0		
Good	0.08	0.04	2.23	0.026
Fair	0.15	0.05	3.07	0.002
Dental insurance				
Private dental	0	0		
Public dental	-0.17	0.06	-2.73	0.006
No dental	-0.09	0.04	-2.40	0.017

variables in Table 3. For age group it is observed that a significant change in dental expenditures per unit increase in age group occurs above 54 years. By income as we move from the 'high' to the 'middle' income (a unit increase in middle income level) dental expenditures decrease by US\$ 2.86. Based on this analysis being older, Hispanic, low income, living in a non-metropolitan service area in the West census region, having fair self-perceived health status and having public dental cover, were the factors most significantly associated with changes in dental expenditures, after adjusting for all other factors in this model.

Table 5 gives the results for the dental expenditure trend analysis. Real per-capita dental expenditures between 1996 and 2006 increased by about 23% from \$493 to \$607 ($p < 0.001$). In nominal dollars, this was a 58% increase. Annual percent change in per-capita expenditures varied across years. Whereas dental expenditures increased by 10.21% from 1999 to 2000, they declined by 1.07% from 2000 to 2001 (Figure 1). Out of pocket expenditures increased by approximately 18%, from \$254 (95%CI \$241, \$267) in 1996 to \$299 (\$278, \$320) in 2006 (Figure 2). Out of pocket payments for dental health continued to be the major source of dental expenditures across the years. In this period, private insurance expenditures for dental care increased by 23% from \$209 (95%CI \$198, \$220) in 1996 to \$258 (\$245, \$271) in 2006 (Figure 2).

Discussion

This analysis, using a representative sample of the US non-institutionalised civilian population, found significant differences in dental expenditures by factors such as age, race/ethnicity, socio-economic status, geographic location, perceived health status, employment status and insurance coverage. Several factors were found to be significantly associated with higher dental expenditures and included, being older (45 years and over), being non-Hispanic White, having a high income level, residing in a metropolitan service area, residing in the West Census Region, having a self-perceived health status of 'fair', and being covered by private dental insurance.

The results of this study indicate lower dental expenditures among persons belonging to racial/ethnic minority groups. Numerous studies have documented similar differences by certain minorities (Chattopadhyay *et al.*, 2003; Davidson and Andersen, 1997; Manski and Brown, 2007; Manski and Magder, 1998; Vargas and Manski, 1999). Vargas and Manski (1999) identified a possible reason for this difference being the socio-economic values placed on a discretionary service such as dentistry by the different racial groups. For example, studying racial differences in illness behaviour, Wolinsky (1982) identified that non-Hispanic blacks were more likely to respond to need, whereas non-Hispanic whites were more likely to utilise services for prevention (Wolinsky, 1982). Another reason for the racial/ethnic minorities such as the Hispanics having lower dental expenditures could be the lack of private dental health cover among these groups. Private health insurance is a well-documented driver of health expenditures.

Table 5. Overall annual nominal and real mean dental expenditures among those adults 25 years and adults with a dental expenditure, 1996-2006, US\$

Year	n	Nominal expenditure, \$ mean (95%CI)	Inflation factors ‡	Real expenditure, 2006 \$ mean (95%CI)
1996	8,424	384 (364, 403)	1.2849	493 (474, 512)
1997	11,832	405 (386, 424)	1.2561	509 (490, 527)
1998	8,346	435 (409, 462)	1.2368	538 (512, 565)
1999	8,946	451 (424, 478)	1.2101	546 (519, 573)
2000	8,712	498 (469, 526)	1.1707	582 (554, 611)
2001	12,070	506 (483, 529)	1.1383	576 (553, 599)
2002	13,928	529 (509, 549)	1.1206	593 (573, 613)
2003	11,884	540 (518, 562)	1.0957	591 (569, 613)
2004	11,976	575 (551, 598)	1.0672	613 (590, 637)
2005	11,729	579 (553, 605)	1.0323	597 (571, 623)
2006	11,840	607 (580, 634)	1.0000	607 (580, 634)

‡ Inflation adjustment (to 2006 dollars) factors based on the average annual Consumer Price Index (U.S. Bureau of Labor Statistics)

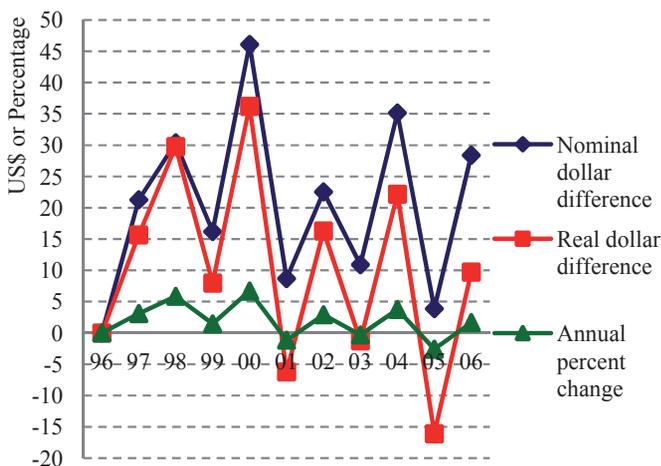


Figure 1. Annual dollar difference in nominal and real dental expenditures and annual percentage changes in those real differences, in US\$, 1996 to 2006

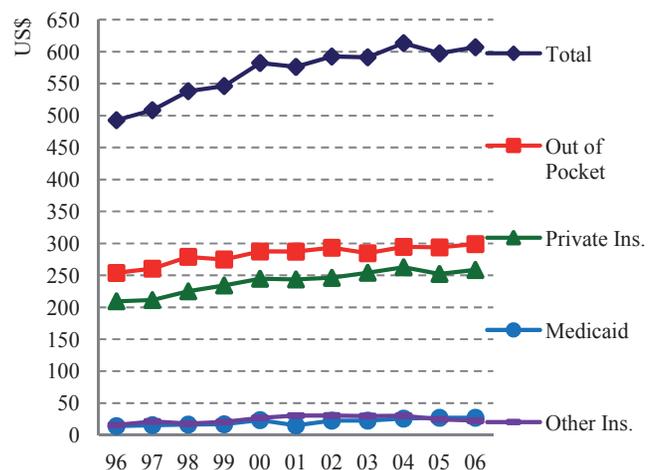


Figure 2. Annual total mean dental expenditure and mean dental expenditure by source of payment, US\$, 1996 to 2006

An interesting finding was that those adults classified as ‘poor’ (<100% FPL) had higher dental expenditures than the low-income group and an almost similar expenditure level to those individuals classified as middle income. This could be explained by the known fact that when cost is a barrier people visit the dentist only for emergency care, at an advanced disease state which requires complicated and expensive procedures. Unfortunately, as the cost for dental care continues to increase this pattern of people visiting only for emergency care will correspondingly increase unless a major effort to educate people about the benefits of preventive dental visits is initiated. However, it is also possible that such a situation is being driven by lack of resources/competing priorities than a lack of knowledge of the importance of preventive dental visits. A similar finding was also observed, where, individuals who identified themselves (self-perceived) as being in “fair” health were observed to have higher dental expenditures compared to those in “excellent” health. This finding re-enforces the case for increasing preventive dental service use, which in the long run may help to reduce expenditures for dental care and would be particularly beneficial to low-income families. Though it is often stated that preventive dental visits can help reduce future dental expenditures that result from treating advanced stages of a disease, the evidence to support such a situation is scarce. A recent study on children reported that while preventive visits were associated with lower non-preventive dental expenditures, overall dental expenditures did not change (Sen *et al.*, 2013).

As expected, those adults with private dental cover reported significantly higher dental expenditures compared to adults with public cover or no dental cover. Some caution is required when interpreting the public dental insurance coverage information reported in this study. Since public insurance plans (Medicaid/SCHIP) make payments directly to the providers, patients may not know with accuracy how much was actually paid on their behalf by the public coverage provider to the dentist. In contrast, patients are much more likely to know the amounts that they pay out of pocket and how much was paid by their private insurance.

It was interesting to observe that while dental expenditures increased between 1996 and 2006, this change was not uniform year on year. These annual variations in dental expenditures (not always in the same direction) are important to capture as they could give an indication of the annual drivers of health expenditures. It also appears from this analysis that the gap between out-of-pocket expenses for dental care and expenditures through private dental insurance are narrowing with the indication that (at the present rate of increase) dental expenditures through private dental insurance will surpass out-of-pocket dental expenditures. Whether this will drive the cost of dental expenditures higher and create an even larger burden on the uninsured is yet to be seen. While this analysis is based on 2006 information and relevant to the time, it will be important to examine the effects of the 2007-2009 global financial crises on dental expenditure patterns.

Conclusion

Estimates of mean dental expenditures for 2006 were \$611, median \$233. Independent predictors of dental expenditures were, age, race/ethnicity, income, geographic location, perceived health status and dental insurance coverage.

The time-trend showed a substantial increase in real dental expenditure between 1996 and 2006. However, this was not a uniform year on year change. The share of expenditures for dental care paid out of pocket was the largest and has remained so over time. Differences in dental expenditures by sources of payment and factors such as race/ethnicity, SES, and insurance coverage, remained relatively unchanged over this period

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