Original Article

# Direct Cost of Ambulatory Care of Type 2 Diabetes in the Middle and High Income Group Populace of Delhi : The DEDICOM Survey

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## Abstract

Objective : To estimate the direct cost of ambulatory care in diabetes patients in the middle and high income group populace of Delhi.

Research Design and Methods : We analyzed the drugs, investigations, consultation and monitoring related data available from a survey of 35-65 year old known diabetes patients conducted using a probability-proportionate–to-size 2-stage cluster design to calculate the direct cost of ambulatory diabetes care.

Results : A total of 819 subjects were enrolled from 20,666 houses. The average estimate of direct annual expenditure on ambulatory care of diabetes was ~Rs. 6000 (~US$ 150). Time elapsed since diagnosis ($p<0.001$), education ($p=0.011$), gross family income ($p=0.002$), presence of co-morbidities ($p= 0.009$) and requirement for use of oral hypoglycemic agents ($p<0.001$) or insulin ($p<0.001$) were significant correlates. Direct ambulatory cost of care comprised 1-3% of the gross family income of the subjects.

Conclusion : Despite the limitations of the present study it may be concluded that a majority of the diabetes patients spend a significant proportion of their family income on diabetes related expenditure. The cost is higher for subjects with longer duration since diagnosis, those with higher education or income, those with co-morbidities and those requiring oral hypoglycemic agents or insulin. ©


There has been a rapid increase in the prevalence of type 2 diabetes mellitus, requirement of related health services and the cost of diabetes management in India and world wide.[1-3] Despite the progressive rise in expenditure on diabetes care,[1] the quality of diabetes care delivered to patients in India continues to be poor.[4] Relevant data from Europe[3,5-7] and North America[2,8] documents progressive increases in spending under various subheads following implementation of periodically upgraded recommendations of diabetes care. Studies on this subject from India do not segregate type 1 and type 2 diabetes patients and are restricted to patients who were being followed in hospitals, clinics or health centers or were known to community health workers[1,9-12] and offer no corresponding estimates of the quality of care being delivered or the factors predicting the expense. Further, subjects in these studies had poor socio-economic background which could severely limit their ability to seek appropriate diabetes care and make the necessary expenditure. In this report we analyze the community based data available from the middle and high income groups in Delhi (DEDICOM survey) to determine the direct cost of ambulatory diabetes care, to evaluate the socio-demographic associates of spending, and to ascertain the relationship of spending with the delivered quality of diabetes care.

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## Material And Methods

This study analyzes the data from the DElhi DIabetes COMmunity (DEDICOM) survey[4] which was conducted from September to December 2005 in socioeconomic category A,B,C or D areas (classification used in Delhi for determining property tax; range A to G; 'A' highest). Approximately 20-25% of Delhi's population resides in areas categorized as A to D[13] while on the basis of monthly per capita expenditure middle and high income groups constitute ~50% of Delhi's Population.[14]

The survey was based on a two-stage cluster randomized sample drawn by probability proportionate to size-systematic method. The study design, selection criteria and methodology have been detailed elsewhere.[4] The survey included patients with known diabetes for 1 year (diagnosed by a registered medical practitioner on the basis of blood glucose estimation), aged 35-65 years having a family-owned car, living in a "pucca" house (house with brick-plaster walls and a concrete roof). Subjects with type 1 diabetes, gestational diabetes, cancer, renal, hepatic or

intestinal disease requiring continuing treatment or hospital admission (>1 week in the last 1 year), and inability to communicate (due to mental illness or physical disability) were excluded. The survey was designed to study the quality of diabetes care,[4] cardiovascular risk profile[15] and the cost of diabetes care in the middle and high income areas of Delhi using the DQIP (now NDQIA) criteria.[16,17] The survey was restricted to the middle and high income areas to minimize the impact of frank non-affordability on quality of care.

The recorded socio-demographic information included age, sex, ethnicity, education, marital status, gross family income, duration since diagnosis (DSD), qualification of the primary care provider (PCP), place of health care (government or private institution, individual practitioner, alternative medicine practitioner or no provider) and number of visits to the PCP in the last year. Subjects were asked to classify their annual gross family income into one of four categories (< Rs. 0.36 million p.a., Rs 0.36 – 0.72 million p.a., Rs. 0.72 - 1.2 million p.a. and > Rs. 1.2 million p.a.) to avoid apprehension related to revealing of exact income. Information on self-reported pre-existing cardiovascular morbidity (coronary artery disease, myocardial infarction, stroke, and foot amputation) and use of medications was collected from records and by interview. Information on any kind of medical benefits received by the subjects including state sponsored medical insurance schemes like CGHS, ESI etc, personal medical insurance or any part or total reimbursements of medical bills by the employer. Morbidity was recorded using standardized colloquial descriptions for individual morbidities by patient recall and by record review. No standardization of medical diagnosis or treatment was considered feasible given the variable and often poor record maintenance, poor patient awareness levels and the multiplicity of health care systems (unorganized individual practitioners, private hospitals and government funded public hospitals) as had been documented in a pilot run (n=149) prior to the survey. For the purpose of the survey, dilated eye examination was defined as "any eye examination using a lighted device after putting pupil dilating eye drops (judged by name or whether it caused light sensitivity)" foot examination was defined as "an examination of the feet using weights placed on great toe, fork like vibration device, hammer pin, microfilament or plastic pin like device or hot/cold object", diabetes self management education as "any group or individual counseling on self management for a minimum of 15 min by a dietician, counselor, nurse or doctor" and nutrition counseling as "any group or individual counseling on diet for a minimum of 5 min by a dietician, counselor, nurse or doctor".

Information on diabetes related expenditure was collected in two parallel ways. First, the patients were asked to estimate their monthly expenditure on the care of diabetes after a detailed standardized explanation of the headings (medicines, injections (including insulin), tests and consultation) under which these expenses could have been incurred. Subjects were asked to provide this estimate to the nearest hundred rupees for the last three months which was totaled and extrapolated to one year to estimate the 'patients impression based direct expenditure' (PIBE).

Simultaneously, the expense was estimated using a semi-structured, 12 item sub-questionnaire in which information was recorded on the dose and type of the medications taken in the last three months, the frequency and type of the tests undergone in the last one year, the type of health care provider (classified in accordance with the qualification of the physician as detailed earlier[4]), number of consultation visits in the last one year, and the frequency and method of self monitoring of blood glucose used by the patient. As the data had to be collected as a part of larger quality of care questionnaire, which itself was estimated to take 45-50 minutes for administration information on expenses like travel, purchase of diabetes-specific foods or ingredients, disposables, one time expenses like home glucose-monitoring device, etc. was not collected. Hospitalization expenses were also not calculated for similar logistic reasons. Rates for each of the items (consultation, medications, tests and self monitoring blood glucose (SMBG)) were obtained from the receipts or other documentation where available. Where such documentation was not available pre-specified rates for each brand based on maximal retail prices (SMBG and medications) or estimated prevalent community rates (consultation and tests) calculated using data from a pilot run preceding the actual study were used. The maximum retail prices of various brands and salts of oral hypoglycemic drugs varied between Rs 0.90 to Rs 10 per tablet, antihypertensives Rs. 1.0 to 10.8 per tablet, lipid lowering drugs Rs 0.7 to 14.0 per tablet, aspirin Rs 0.20 to 1.80 and insulin varied Rs 0.32 to 2.8 per unit. The estimated prevalent community rates for consultation with a general physician (MBBS or equivalent) were estimated to be Rs. 100, with a specialist (MD or equivalent) Rs 200 and with an endocrinologist Rs.500/-. Similar estimates were obtained for possible investigations including Blood glucose (Rs.75/-), $HbA_1c$ (Rs.600/-), lipid profile (Rs.700/-), etc. The cost hence obtained is hereafter referred to as 'rate calculation based direct expenditure' (RCBE). This approach of calculating costs was decided based on the pilot study which documented that receipts or other documentation of expense were available with <10% of the patients and that there were gross inaccuracies when the subjects were asked to report by recall on expenditure incurred or rates of individual medications, tests, consultations or SMBG.

The recall was restricted to three months based on the experience from the pilot run prior to the survey where subjects found it difficult to recall beyond the past few months and >90% of the subjects did not have any documentation of expenses incurred. For subjects treated at 'government' facilities, only actual costs incurred by subjects were totaled. This cost was expected to be lower, since minimal or no consultation fee is charged in these facilities; several types of medicines and investigations are also not charged which varies across institutions. It was not considered feasible to calculate the provider costs in the absence of any uniformity or transparency in costs insured

by these institutions. For subjects receiving any other form of medical benefit like insurance or reimbursement of bills by the employer the total cost incurred by insurer and subject and/or employer was totaled excluding the premium or deduction paid by the beneficiary for the insurance or benefit.

Data entry and analysis was done using Epi-Info 2002 and SPSS v. 13.0. Complex sample procedure was used for correcting the estimates for the cluster design. Complex sample linear regression models were used to study the relationship of demographic characteristics with the calculated expenditure and to evaluate the association between the expenditure and the quality of diabetes care by NDQIA criteria.[17]

## Results

Of the 1529 diabetes patients contacted, 1,153 met the selection criteria. Complete consent including blood sampling was available from 819 subjects. The socio-demographic profile of the population is shown in Tables 1 and 2. The average age of the subjects was 53.6 years with mean duration since diagnosis of 8.1 years. About 52% of the subjects were seeing private individual practitioners in the community 18.7% were visiting a private institution, while 19.7% were using government facilities. 79.6% were on OHAs and 10.4% were on only insulin, 6.9% were on both OHAs and insulin. One-half of the subjects had received college education. 58.6% of the subjects had a gross family income of < Rs 0.36 million per annum.

The spending on diabetes care, stratified by various socio-demographic variables is presented in Table 2. The rate calculation based expenditure on ambulatory diabetes care patients was ~ Rs. 6000 per annum. The corresponding patient impression based expenditure was ~Rs 8500. Thus, the patient estimates of spending were higher than the calculated expenses by ~40%. Actual documentation or receipt were available in only 53 to 104 subjects (53 had consultation bills, 70 had bills for medicines, 74 had bills for tests while 104 had bills for purchase of glucose measurements strips allowing actual rates to be used). There was no significant difference between the bill based expenditure and the RCBE under each subheading for subjects for which both were calculable.

A break-up of proportional expenditure under the four sub-headings is presented in Fig. 1. As depicted, cost of medicines (including insulin) is the major fraction of spending comprising ~54% of the total expenditure.

The relationship of socio-demographic variables to the annual calculated expenditure RCBE was further explored using correlation and regression analysis. Duration of disease, education, gross family income, co-morbidities, use of oral hypoglycemic agents and use of insulin emerged as significant independent predictors of the annual RCBE on diabetes while age, gender, medical benefits, institutional care and compliance score (composite score calculated by assigning score of +1 for following advice on taking OHAs and insulin, SMBG, and visiting the PCP in last one year) did not have any significant independent association with the annual direct spending on diabetes (Table 3).

To analyze the relationship of annual RCBE to the quality of care received we conducted a sensitivity analysis comparing those who received recommended 'process of care' with those not receiving the same (Table 4). A similar exercise was conducted for recommended control targets comparing those achieving targets with those not achieving the same (Table 4). The same exercise was conducted with and without adjusting for possible co-variates. The results

Table 1 : Socio-demographic profile (Based on N=819)

| Characteristic | Overall | | | Men (n=404) | | | Women (n=415) | | | p-value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean/ Percentage | SE | N | Mean/ Percentage | SE | N | Mean/ Percentage | SE | N | |
| Age (years) | 53.6 | .4 | 819 | 53.4 | .6 | 404 | 53.9 | .5 | 415 | 0.413 |
| Sex (%) | — | — | — | 49.3 | 1.9 | 404 | 50.7 | 1.9 | 415 | — |
| Body Mass Index-Mean (Kg/m$^2$) | 28.7 | .3 | 819 | 27.5 | .3 | 404 | 29.8 | .4 | 415 | <0.001 |
| Waist Circumference (WC)$^{\beta}$ (cm) | 98.2 | .6 | 819 | 99.6 | .7 | 404 | 96.9 | .7 | 415 | 0.002 |
| Age at diagnosis (yrs) | 45.5 | .3 | 819 | 44.4 | .4 | 404 | 46.6 | .4 | 415 | <0.001 |
| Duration since diagnosis (yrs) | 8.1 | .3 | 819 | 9.0 | .4 | 404 | 7.3 | .4 | 415 | 0.002 |
| Prescribed-Oral hypoglycemic agent | 79.6 | 2.2 | 651 | 80.6 | 2.2 | 325 | 78.6 | 3.0 | 326 | 0.436 |
| - Insulin | 10.4 | 1.3 | 86 | 11.3 | 1.7 | 46 | 9.5 | 1.5 | 40 | 0.785 |
| - Oral hypoglycemic agent + insulin | 24.0 | 1.9 | 198 | 24.6 | 2.7 | 103 | 23.4 | 2.0 | 95 | 0.638 |
| Residing in Delhi* (%) | 39.0 | 2.8 | 356 | 42.1 | 3.7 | 186 | 36.0 | 3.0 | 170 | 0.126 |
| Gross Annual Income > 0.36 million (Rs.) (n=792)$^{\gamma}$ (%) | 38.1 | 2.7 | 314 | 42.6 | 3.1 | 173 | 33.7 | 3.2 | 141 | 0.014 |
| Medical Benefits @ (%) | 40.7 | 3.5 | 330 | 42.0 | 3.4 | 168 | 39.5 | 4.0 | 162 | 0.349 |
| Care by Endocrinologist$^{\alpha}$ | 21.3 | 2.3 | 175 | 22.4 | 3.0 | 91 | 20.2 | 2.6 | 84 | 0.276 |
| Current Smoker | 9.8 | 1.3 | 80 | 19.4 | 2.2 | 78 | .5 | .3 | 2 | <0.001 |
| Current Alcohol use | 16.8 | 1.6 | 137 | 33.1 | 2.5 | 133 | 1.0 | .6 | 4 | <0.001 |
| Co-morbidity | 68.0 | 1.7 | 557 | 62.1 | 2.5 | 251 | 73.9 | 2.1 | 306 | <0.001 |

β - Suggested action Level-II cut-offs for Indian adults are >80 cm in women and >90 cm in men; * - Residing in Delhi for the last two generations; $^{\gamma}$- Annual income of Rs 0.36 million corresponds to ~ USD 9,000 per annum; @ - Individuals receiving any medical benefit; α - Reported qualification of Primary care provider is DM (Endocrinology)

Table 2 : Annual Direct Cost of Ambulatory Care of Diabetes Mellitus (Rs.)

| Patient Category | % of Subjects | Assumption Based Expenditure (ABE) | | | | | Patient Estimate of Expenditure (PIE) |
|---|---|---|---|---|---|---|---|
| | | Calculated cost of consultation, mean (min-max) | Calculated cost of medicines | Calculated cost of tests | Calculated cost of monitoring | Total calculated cost | Total estimated cost[θ] |
| Gender | | | | | | | |
| Males | 49.3(1.9) | 865.0(184.9-1626.9) | 3311.8(231.2) | 1867.2(93.9) | 343.7(59.1) | 6331.5(356.7) | 8219.3(811.8) |
| Females | 50.7(1.9) | 886.7(184.7-1598.9) | 3337.1(266.4) | 1739.5(89.3) | 301.8(92.3) | 6093.3(385.8) | 8593.0(816.8) |
| Duration (years since diagnosis) | | | | | | | |
| 1-5 yrs | 46.2(2.2) | 613.4(128.6-1145.7) | 1988.6(191.8) | 1521.3(79.7) | 160.1(39.2) | 4224.2(251.9) | 5904.8(574.2) |
| 6-10 yrs | 27.3(1.2) | 908.9(193.4-1692.8) | 3497.9(225.1) | 1878.4(130.0) | 241.7(57.4) | 6474.8(372.9) | 7980.6(900.5) |
| 11-15 yrs | 14.3(1.3) | 1048.4(224.7-1950.7) | 4633.0(490.6) | 2128.9(207.9) | 355.0(64.1) | 8094.3(699.1) | 11777.5(1513.4) |
| ≥ 16 yrs | 12.2(1.4) | 1143.0(237.6-2008.3) | 6389.5(663.3) | 2324.0(166.3) | 1036.6(351.4) | 10834.5(953.1) | 14987.7(1873.7) |
| Gross Annual Family Income (Rs.) | | | | | | | |
| < 0.36 million | 58.3(2.7) | 765.5(161.2-1418.8) | 2952.8(212.2) | 1658.7(78.6) | 159.2(32.1) | 5470.1(294.4) | 7097.9(689.1) |
| 0.36-0.72 million | 28.9(1.7) | 944.9(200.9-1739.6) | 3554.4(278.6) | 2006.3(116.1) | 502.5(144.1) | 6948.6(409.8) | 9479.9(1005.8) |
| 0.72-1.2 million | 6.2(1.4) | 847.9(176.8-1498.9) | 3925.4(571.2) | 2038.4(238.0) | 508.6(127.0) | 7287.9(886.2) | 12160.4(2238.1) |
| >1.2 million | 3.0(0.8) | 1053.0(219.2-1884.8) | 5294.1(1588.4) | 2293.0(320.9) | 1165.3(631.8) | 9682.2(2364.7) | 14854.7(3294.9) |
| Education (maximum qualification) | | | | | | | |
| Illiterate | 5.6(1.4) | 474.6(101.7-1016.9) | 2575.8(376.4) | 1164.6(261.9) | 223.0(152.0) | 4397.1(647.1) | 6738.8(1293.7) |
| Primary school | 4.7(0.8) | 713.6(148.5-1284.6) | 3364.9(625.7) | 1331.5(228.5) | 228.3(122.6) | 5473.7(775.8) | 6775.1(1164.8) |
| Middle school | 7.4(1.4) | 917.6(195.7-1760.8) | 3836.1(983.0) | 166.3(207.2) | 122.5(35.9) | 6498.9(1148.5) | 10939.9(2053.6) |
| Higher secondary | 16.7(1.1) | 589.0(125.5-1040.4) | 3016.1(282.9) | 1846.4(154.2) | 480.1(215.8) | 5867.1(365.4) | 8384.7(1049.0) |
| Secondary school | 17.7(1.6) | 747.3(161.5-1485.5) | 3347.4(365.6) | 1669.9(99.1) | 100.2(23.9) | 5797.0(463.6) | 6934.9(1103.5) |
| Graduate | 32.1(2.3) | 973.4(206.9-1788.6) | 3265.6(275.9) | 1865.6(98.8) | 371.9(95.3) | 6428.0(413.9) | 9460.2(1046.4) |
| Post-graduate | 11.9(1.8) | 886.1(183.3-1536.2) | 3413.4(381.9) | 2041.0(202.0) | 459.8(123.7) | 6763.6(628.9) | 6725.5(994.3) |
| Professional | 3.9(0.7) | 1084.0(222.1-1813.3) | 4823.3(631.5) | 2696.4(405.7) | 455.7(160.6) | 9021.0(1111.8) | 10845.6(2701.5) |
| Employment status | | | | | | | |
| Never worked | 40.0(2.1) | 786.7(165.1-1439.8) | 3318.6(311.4) | 1716.9(105.5) | 329.9(119.1) | 6078.3(442.8) | 8513.2(908.8) |
| Retired | 18.1(1.8) | 994.8(205.6-1731.4) | 3263.0(325.8) | 1970.8(185.0) | 367.8(114.2) | 6555.5(558.2) | 8450.6(1085.6) |
| Unemployed | 0.5(2.0) | 0(0-0) | 5430.0(2401.5) | 2052.9(443.8) | 0(0) | 7482.9(2667.3) | 5093.0(3778.3) |
| Working full time | 37.2(2.3) | 821.4(176.4-1573.9) | 3316.5(245.2) | 1832.8(98.3) | 303.0(58.3) | 6205.3(357.0) | 8069.2(833.4) |
| Working part time | 4.3(0.7) | 569.5(123.6-1111.8) | 3464.3(835.3) | 1609.5(194.7) | 270.2(114.7) | 5913.8(1009.1) | 10531.9(2628) |
| Medical Benefits | | | | | | | |
| Availing | 40.7(3.5) | 597.3(125.1-1092.2) | 3804.2(319.5) | 2066.7(119.3) | 413.9(81.6) | 6882.1(454.5) | 7172.4(1030.8) |
| Not availing | 59.3(3.5) | 875.0(185.5-1618.5) | 3002.9(239.1) | 1635.5(83.8) | 206.1(36.4) | 5719.5(377.3) | 9331.7(826.3) |
| Place of diabetes care | | | | | | | |
| Institution | 38.4(2.7) | 719.3(154.7-1327.6) | 4089.0(307.0) | 2097.2(106.7) | 377.6(91.0) | 7283.1(433.5) | 8634.1(783.6) |
| Public | 19.7(2.7) | 0(0) | 3689.6(300.4) | 1974.9(135.9) | 252.7(66.1) | 5917.2(403.5) | 3923.8(676.7) |
| Private | 18.7(1.9) | 1479.0(317.9- 2722.8) | 4535.7(426.8) | 2247.4(135.6) | 520.4(169.9) | 8782.5(577.8) | 13564.9(1505.8) |
| Individual practitioners | 52.4(3.4) | 836.1(174.8-1543.0) | 2985.2(220.3) | 1690.5(96.8) | 250.6(53.2) | 5762.5(344.4) | 8059.3(956.1) |
| Current treatment | | | | | | | |
| OHA | 79.6(2.2) | 782.6(166.1-1465.3) | 3134.2(154.4) | 1866.3(79.7) | 228.8(31.2) | 6012.0(232.3) | 8072.8(620.0) |
| Insulin | 10.4(1.3) | 1588.7(340.0-2907.8) | 6845.6(1147.5) | 2207.4(343.9) | 1188.5(667.8) | 11830.0(1222.2) | 14757.8(3089.1) |
| OHA+ Insulin | 6.9(1.1) | 1271.5(262.5-2182.8) | 10523.7(934.9) | 2580.1(251.4) | 976.1(286.4) | 15351.3(1280.3) | 23534.8(3058.3) |
| Neither | 17.0(2.0) | 302.5(62.3-539.5) | 558.8(151.7) | 1187.9(93.6) | 80.4(36.6) | 2129.6(246.1) | 2573.5(556.9) |
| Co-morbidity | | | | | | | |
| Absent | 32.0(1.7) | 526.0(111.0-986.7) | 2654.7(245.0) | 1395.0(89.0) | 193.5(49.1) | 4724.8(348.8) | 5343.8(556.3) |
| Present | 68.0(1.7) | 961.3(203.0-1766.9) | 3638.7(249.5) | 1993.1(84.2) | 382.9(73.6) | 6906.8(360.7) | 9830.6(830.5) |

Data are percentage (SE of percentage) or Mean (SE); 1 dollar = 40 Indian rupees(approximately) by the current exchange rate

α Calculated by multiplying estimated consultation charges of the PCP with number of visits per year. The type of PCP was classified according to the qualification of the healthcare provider.

reveal that the annual RCBE for subjects achieving control did not differ significantly from those not achieving the same with the exception of lipid control (achievement of both HDL and LDL target levels) (Table 4). The covariates adjusted annual RCBE of subjects receiving DSME (Diabetes Self Management Education) was Rs. 1916 per annum more and the spending of those receiving an annual dilated eye examination was Rs. 2198 higher. The annual RCBE incurred by subjects receiving any three or more of the 7 analyzed 'process of care' measures was Rs.2527 per annum higher than 'others' after adjusting for covariates. The same comparison for subjects receiving all 7 analyzed

processes was Rs.15133/- higher. However, the annual calculated expenditure was not an independent predictor of the various measures of quality of diabetes care such as HbA1c, LDL cholesterol, systolic blood pressure etc. when incorporated as a continuous variable into models presented in an earlier publication (data not presented).[4]

From the information available a crude guesstimate of the average proportion of income spent on (by RCBE) diabetes care could be obtained by dividing the average spending of each income category with the mid-point of each income category. Based on this assumption, subjects with a gross family income of < Rs. 0.36 million p.a. were spending 3.03% of their incomes on ambulatory diabetes care, those in the Rs. 0.36 -0.72 million p.a. category were spending 1.28 % and those in the Rs. 0.72-1.2 million p.a. category were spending 0.76%. If the same calculation was done by dividing with the upper limit of each income category the corresponding proportion would be 1.51%, 0.64% and 0.38% respectively.

## Discussion

The current analysis documents the annual diabetes related expenditure on medicines, tests, consultation and SMBG of an average patient. These expenses themselves comprise > 3 % of the gross family income in ~60 % of the population living in the middle and high income areas of Delhi. The more educated people, those with higher income, those with longer duration or severity of disease and those achieving disease control targets spend more money. The higher estimates provided by the patients in comparison to calculated cost could be related to the exclusion of miscellaneous expenses like travel, purchase of diabetes-specific foods or ingredients, or one time expenses (e.g. glucometer) etc. from the calculations. The higher costs incurred by subjects achieving target lipid levels may be related to additional spending on 'lipid lowering drugs' or dietary advice. The higher costs incurred by subjects receiving the recommended process of care may be expected due to the higher consultation and investigation charges and the non inclusion of hospitalization and indirect costs.

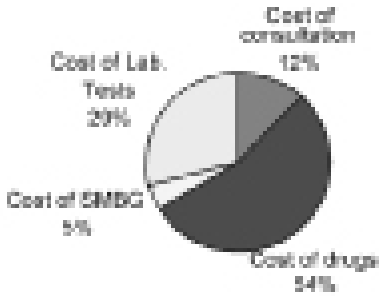


Fig. 1 : Relative contribution of each component of cost

It is the first community based study from India evaluating the direct cost of care of type 2 diabetes and its correlates in the context of the delivered quality of diabetes care. The study provides rate calculation and patient impression based estimates of direct spending on ambulatory care of diabetes and its correlates from a community survey restricted to the middle and high income group type 2 diabetes patients in Delhi. Rate calculation based estimates minimize subject and interviewer bias which may otherwise be important confounders. Although the instrument used for assessment was not validated indirect evidence of the accuracy of the estimates is provided by the lack of difference between the bill based expenditure and rate calculation based expenditure in individuals where both data were available.

The survey was restricted to the middle and higher income groups of the population to diminish the effect of poverty which is often cited as the primary reason for the poor quality of care. A high prevalence of obesity was observed in this population. This limits the generalizability

Table 3 : Factors influencing the total annual cost of diabetes (n=792)[β]

| Demographic characteristic | β-coefficient[α] | 95% CI | | P value |
|---|---|---|---|---|
| Age (per year increase) | -28.683 | -73.399 | 16.033 | 0.200 |
| Gender (Male vs. Female) | -116.831 | -861.428 | 627.766 | 0.751 |
| Duration Since (per year increase) | 182.807 | 122.301 | 243.313 | <0.001 |
| Compliance[μ] | 293.979 | -46.889 | 634.847 | 0.088 |
| Alcohol (current or former user vs. non user) | -396.291 | -1374.005 | 581.424 | 0.414 |
| Institutional care (received vs. not received) | 606.656 | -82.535 | 1295.848 | 0.082 |
| Medical benefit (received vs. not received) | 812.589 | -140.795 | 1765.972 | 0.092 |
| Education (graduate vs. school or lesser) | 817.755 | 202.497 | 1433.013 | 0.011 |
| Annual Gross family income (<0.36 vs. ≥ 0.36 mn) | 1085.437 | 449.117 | 1721.758 | 0.002 |
| Comorbidity (any vs. none) | 867.872 | 236.007 | 1499.737 | 0.009 |
| OHA use (taking vs. not taking) | 2666.432 | 1845.456 | 3487.407 | <0.001 |
| Insulin use (taking vs. not taking) | 7369.313 | 5497.162 | 9241.464 | <0.001 |

Multivariate linear regression analysis; $R^2$=0.365; Independent variables were age, gender, duration of diabetes, compliance score, alcohol intake, institutional care, medical benefits, educational qualification, gross family income, comorbid conditions, OHA and insulin use. Age and duration were taken as continuous variables while dummy variables were created for other variables. β = Out of 819 subjects 27 refused to comment on income. α = Beta co-efficient represents the change in cost per unit change in independent variable for continuous variables like age and duration while it represents the difference between the presence and absence of a factor in case of discrete variables (eg Institutional care – received vs. not received represents the average difference between those who received institutional care vs. those who did not after adjustment for co-variates). μ = composite score calculated by assigning score of + 1 for following advice on taking OHAs and insulin, SMBG and visiting the PCP in last one year).

Table 4 : Increment in direct ambulatory cost in subjects receiving quality care (n=792)[π]

| Targets of care | % of the population | Unadjusted | | | Co-variate adjusted | | |
|---|---|---|---|---|---|---|---|
| | | Mean difference (Rs.)[±] | 95% CI | P-value | Mean difference (Rs.)[α] | 95% CI | P-value |
| Achieving Targets of Care | | | | | | | |
| Glycemic Control (HbA1c < 7%) | 37.8(2.1) | -1445.3 | -2273.0 to -617.6 | 0.001 | -343.6 | -955.8 to 268.5 | 0.260 |
| Lipid Control (LDL < 100 mg/dl) | 31.9(1.8) | 1610.2 | 559.5 to 2660.8 | 0.004 | 513.1 | -130.6 to 1156.7 | 0.114 |
| Lipid Control (HDL > 45mg/dl for men and > 55 mg/dl for women) | 31.0(1.8) | 480.3 | -508.1 to 1468.7 | 0.329 | -468.5 | -1025.4 to 88.3 | 0.096 |
| Lipid Control (LDL HDL control) | 9.2(1.2) | 2821.9 | 820.2 to 4823.5 | 0.007 | 1700.3 | 469.7 to 2930.8 | 0.008 |
| Triglyceride ≤ 150 mg/dl | 58.1(1.8) | 69.2 | -700.5 to 838.9 | 0.855 | 36.0 | -634.4 to 706.4 | 0.913 |
| Systolic BP ≤ 130 mmHg | 26.2(1.8) | -456.4 | -1361.0 to 448.2 | 0.311 | 237.8 | -538.7 to 1014.4 | 0.536 |
| Diastolic BP ≤ 80 mmHg | 17.2(1.5) | 1022.3 | -149.5 to 2194.2 | 0.085 | 664.9 | -126.0 to 1455.7 | 0.096 |
| "Good glycemic, lipid and blood pressure control" (achieving –not acheiving) | 0.5(0.2) | 1243.8 | -3294.6 to 5782.2 | 0.579 | -554.6 | -5383.6 to 4274.3 | 0.816 |
| Receiving Recommended Process of Careψ | | | | | | | |
| HbA1c in last one year | 13.0(1.9) | 5753.5 | 4324.3 to 7182.8 | <0.001 | 3639.5 | 2668. 0 to4611.1 | <0.001 |
| Diabetes Self Management Education | 10.3(1.2) | 4371.9 | 2228.7 to 6515.1 | <0.001 | 1916.3 | 254.3 to 3578.3 | 0.025 |
| Annual Foot Examination | 26.1(2.0) | 2492.9 | 1015.4 to 3970.4 | 0.002 | 882.2 | 111.9 to 1652.6 | 0.026 |
| Nutrition counseling | 56.12.7) | 1877.4 | 1088.6 to 2666.2 | <0.001 | 880.5 | 336.0 to 1424.9 | 0.003 |
| Annual Dilated Eye Examination | 16.2(1.5) | 4042.5 | 2552.3 to 5532.7 | <0.001 | 2198.2 | 1086.6 to 3309.8 | <0.001 |
| Biannual lipid profile | 31.6(2.5) | 3190.1 | 2094.6 to 4285.6 | <0.001 | 2175.1 | 1433.3 to 2917.1 | <0.001 |
| Self monitoring of blood glucose ≥ once weekly | 7.5(1.1) | 5518.5 | 2694.3 to 8342.6 | <0.001 | 2719.1 | 83.6 to1372.5 | 0.028 |
| Recommended "process of care" (≥ 3) | 23.1(2.3) | 4789.0 | 3414.0 to 6164.0 | <0.001 | 2528.0 | 1679.0 to 3377.0 | <0.001 |
| Recommended "process of care"ψ | 0.3 (0.3) | 21466.1 | 20222.4 to 22709.8 | <0.001 | 15133.7 | 12285.5 to 17981.8 | <0.001 |

π = 27 subjects refused to divulge gross family income. α = Calculated by subtracting cost incurred by subjects achieving target levels or receiving analyzed "process of care" with those not achieving/receiving the same after adjusting for covariates. Co-variates : age, duration of diabetes, gender, BMI, waist circumference, compliance, smoking, alcohol use, education, state of origin, medical benefits, place of care, qualification of care provider, insulin and OHA use and gross family income. Note: state of origin was classified into 'migrated from Pakistan within last two generations' or 'the last two generations were born and brought up in India', qualification of PCP into 'endocrinologist' vs. 'other practitioners' and annual gross family income was classified into <Rs. 0.36 million and > Rs.0.36 million. ψ = Processes of care for the purpose of this analysis included nutrition counseling, annual foot examination, Diabetes Self Management Education, Annual Dilated Eye Examination, Biannual Lipid profile, HbA1c in last one year, Self Monitoring of Blood Glucose.

of the study and its comparability to existing studies from India. Data from the current survey reveals that recruitment from health facilities would exclude ~10% of the subjects in Delhi as this is the proportion of diabetes patients who are not visiting any health care professional for the management of diabetes.[4] This should have overestimated expenses in earlier studies as not only are these subjects spending less on diabetes care, they also have milder forms of disease and thus lower related expenses. The study is also limited by the lack of data on travel, food, disposables and 'one time' expenses which is further expected to underestimate the direct ambulatory expenditure.

Estimates of annual direct ambulatory health care expenses for care of type 2 diabetes patients from Europe[3,5-7] and North America[2,8] range from $ 1000 to $ 3500. In comparison the direct ambulatory expenses from the current study ($ 150) and those from other studies in India (~$ 90 to $ 250) are much lower. The estimates from the current study are comparable to previous studies from India on the subject[1,9-12] after adjusting for inflation (Table 4).The cost of drugs was the main contributor to the total direct cost in the cited studies which is in agreement with our study. The study by Ramachandran et al estimates in 309 urban patients from physician practices in Chennai that the direct ambulatory annual expenditure is ~ Rs.6500/- (not including travel, dietary management, food, paperwork and cost of treatment from other sources) while the hospitalization and surgery expenses add up to ~Rs.3500/-. Similarly, Kapur et al in an institutional study estimates that the total direct ambulatory annual expenses are Rs.9832/- (including travel, dietary management, food, paperwork and cost of treatment from other sources). Hospitalization

and surgical expenses were not estimated in the cited study while the indirect expenses were estimated to be Rs.4172/-. The corresponding estimates from the Cost of Diabetes In India study[10] are Rs.4724/- (direct ambulatory cost including consultation, monitoring, investigations and treatment), Rs.2434/- (hospitalization) and Rs.12756/- (indirect costs). The factors affecting cost of diabetes have been evaluated in much greater detail in our study in comparison to those studied by Rayappa et al[18] (duration of diabetes and number of complication), Ramachandran et al[1] (presence of complications, duration of diabetes, insulin treatment, urbanization, surgery and hospitalization) and CODI study (education, unemployment and complications) in earlier studies. None of the earlier studies from India have evaluated the impact of spending on the various aspects of quality of diabetes care.

On the basis of existing Indian and international literature[5,8,10] it can be presumed that the total direct expense on diabetes (including hospitalization, surgery and other expenses) is likely to be 1.5-4 times the annual direct ambulatory health care expenses. Further, indirect expenses may contribute financial losses 1.5-2.5 times the direct expenses.[19] Thus, 58.6 % of the population residing in the middle or high income areas and earning < Rs. 0.36 million pa may be directly or indirectly loosing 6-30 % of their gross family income to expenses related to diabetes care. The implications may possibly be compounded by the fact that the percentages estimated are related to the gross family income and not the personal income of the individual. Also, it is common for families to have two or three diabetes patients. Further, their corresponding proportion is very likely to be worse in lower income areas (housing 75-80% of Delhi's population). In comparison Ramachandran et al has documented that higher income diabetes patients (>0.12 million p.a.) spend ~ 4.8% of their family income on direct expenses related to diabetes. Kapur et al estimates that ~ 14 % of the income of the patient and caregiver is spent on direct and indirect ambulatory care expenses. Proportional total expenses estimates from western countries are much lower (2-10%; using a mean gross family income of $ 66750[20]).

To conclude the cost of the diabetes care in India is high. There is no direct association between higher spending and better glycemic or blood pressure control. Subjects receiving the recommended "process of care" have a higher direct annual expense. This underlines an urgent need for detailed sociological research to determine and eliminate factors restricting the achievement of good glycemic, lipid and blood pressure control and to decrease the cost of delivery of good quality of care. Also this study provides a base for longitudinal studies to determine the cost-benefit and cost-effectiveness of different community based intervention models targeted at improving quality of care.

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## References

1. Ramachandran A, Ramachandran S, Snehlata C, et al. Increasing expenditure on health care incurred by diabetic subjects in a developing country: a study from India. Diabetes Care 2007;30:252-6.
2. Johnson JA, Pohar SL, Majumdar SR. Health care use and costs in the decade after identification of type 1 and type 2 diabetes: a population-based study. Diabetes Care 2006;29:2403-8.
3. Rathmann W, Haastert B, Icks A, Giani G. Trends in outpatient prescription drug costs in diabetic patients in Germany, 1994-2004. Diabetes Care 2007;30:848-53.
4. Nagpal J, Bhartia A. Quality of diabetes care in the middle and high income group populace: The Delhi Diabetes Community (DEDICOM) survey. Diabetes Care 2006;29: 2341-8.
5. Oliva J, Molina B, Lobo F, Monereo S. Direct health care costs of diabetes patients in Spain. Diabetes Care 2004;27:2616-21.
6. Reunanen A, Kangas T, Martikainen J, Klaukka T. Nationwide survey of comorbidity, use, and costs of all medications in Finnish diabetic individuals. Diabetes Care 2000;23:1265-71.
7. Koster I, L. von Ferber, Ihle P, et al. The cost burden of diabetes mellitus: the evidence from Germany—the CoDiM study. Diabetologia 2006;49:1498-504.
8. Hogan P, Dall T, Nikolov P. American Diabetes Association. Economic costs of diabetes in the US in 2002. Diabetes Care 2003;26:917-32.
9. Grover S, Avasthi A, Bhansali A, et al. Cost of ambulatory care diabetes mellitus: a study from north India. Postgrad Med J 2005;81:391-5.
10. Rayappa PH, Raju KNM, Kapur A, et al. Economic cost of diabetes care: The Bangalore Urban Districts Diabetes Study. Int J Diab Dev Countries 1999;19:87-97.
11. Shobhana R, P Rama Rao, Lavanya A, et al. Expenditure on health care incurred by diabetic subjects in a developing country: a study from southern India. Diabetes Res Clin Prac 2000;48:37-42.
12. Bhaskaran VP, Rau NR, Satyashankar, et al. A study of the direct costs incurred by Type 2 Diabetes mellitus patients for their treatment at a large tertiary-care-hospital in Karnataka, India. J Acad Hospital Administration 2003;15: 7-12.
13. Property tax guide 2006-2007. Available from http://www.mcdonline.gov.in/mcd/adds/property%20tax%20guide%2006-07/Annexure-II%20List%20of%20 Colonies.xls. Accessed on 02 Sep 2006.
14. Report on household consumer expenditure in Delhi (based on NSS 60th round- State level). Available from http:// des.delhigovt.nic.in/Round/CE60.pdf. Accessed on 20 Mar 2007.
15. Nagpal J, Bhartia A. Cardiovascular risk profile of subjects with known diabetes from the middle- and high-income group population of Delhi: the DEDICOM survey. Diabetic Medicine (under publication).
16. Fleming BB, Greenfield S, Engelgau MM, et al. The Diabetes Quality Improvement Project: moving science into health policy to gain an edge on the diabetes epidemic. Diabetes Care 2001;24:1815-20.
17. National Diabetes Quality Improvement Alliance Performance measure set for adult diabetes [article online], 2005. Available from http://www.nationaldiabetesalliance.org/Final2005Measures.pdf. Accessed 20 May 2006.
18. Rayappa PH, Raju KNM, Kapur A, et al. The Impact of socio-economic factors on diabetes care. Int J Diab Dev Countries 1999;19:7-16.
19. Ettaro E, Songer TJ, Zhang P, Engelgau MM. Cost of illness studies in diabetes mellitus. Pharmacoeconomics 2004;22:

149-64.

20. Current Population Survey (CPS): A joint effort between the Bureau of Labor Statistics and the Census Bureau. Annual Social and Economic (ASEC) Supplement. Downloaded from URL http://pubdb3.census.gov/macro/032007/hhinc/new04_001.htm. Accessed on 2/11/2007.