**Introduction**

Out of Pocket (OOP) payments are the primary source of health care financing in many low- and middle-income countries, resulting in a financial burden on many households each year. Financial burden of health care is calculated by the widely used index – catastrophic health expenditure (CHE). Two methods are commonly used to estimate the CHE index, namely the capacity-to-pay and budget share method. The capacity to pay approach defines CHE as health care expenditures that exceeds 40% of a household’s capacity to pay, while the budget share method defines CHE as health care expenditures that exceeds a specified proportion of annual household income ranging between 10% and 25%. The budget share approach is easy to calculate, requires limited data, but is not sensitive to poor. Estimates based on capacity to pay are pro-poor, address equity concerns and are recommended by WHO[-].

Many previous studies have explored the risk of OOP payments and their impact on CHE and impoverishment among several populations using available data, including Living Standard Measurement Survey, Household Budget Survey, Income and Expenditure Surveys and Socio-Economic Surveys. In India, consumer expenditure surveys conducted by the National Sample Survey Organization (NSSO) have been the main basis of estimating CHE. However, these surveys were originally designed to measure consumer price index, living standards, and household consumption, but not to specifically measure OOP expenditure for health care or financial burden to households due to health care. So the information collected on household expenditures in different domains, healthcare utilization patterns for illness and related expenditures in these surveys is limited or often available only as an aggregate [pandey A, PlosONe 2018]. Hence most studies use budget share methods owing to the non-availability of detailed information that is required for using the capacity to pay approach. Further, these data sources also do not capture important non-medical direct expenditures such as for travel, food or lodging and indirect costs such as income loss. It is likely that non-medical and indirect expenditures could form a significant portion and lead to underestimation of financial burden to households. Studies that take into all of these measures for measuring CHE using the same data source are limited. Therefore, in the present study, we aimed to compare estimates of CHE using both approaches and by considering direct, non-direct and indirect health expenditures to highlight implications of these approaches on the identification of CHE.

**Methods**

Setting, design and participants: A population based household survey was conducted between August 2019 and July 2020 in the Vellore Health Unit District (HUD), a health unit in Vellore district, Tamilnadu, India. The Vellore HUD has a total population of 2,814,922 with 2,280,864 in rural and 762,902 in urban communities. The HUD has 10 community health centres, 37 primary health centres, 231 health sub-centres, and 2 medical colleges.

Expecting that 15% of households suffer catastrophic health expenditures[-], with 95% confidence intervals and a 5% margin of error, adjusting for a design effect of 2 and a non-response rate of 10%, the minimum sample size was estimated as 900 households. Overall, 900 households were selected using a stratified multi-stage sampling process. Vellore HUD was classified into urban and rural regions. From the stratified urban and rural regions, 30 primary sampling units of urban wards (n=10) or rural villages (n=20) were selected, followed by systematic random selection of 30 households from each primary sampling unit. To ensure study quality and close monitoring of households, households were selected for three phases that spanned a 12-month period: first phase of 270 households were recruited during August 2019 and followed up till November 2019; in the second phase, 360 households were recruited during December 2019 and followed up till March 2020; and in the third phase, 270 households were recruited in April 2020 and followed up till July 2020.

Survey instruments and Data Collection: The first part of the questionnaire – ‘household rooster’ asked details about baseline socio-demographic characteristics of household members, their self reported health status, and presence of any major health condition. The second part - ‘acute illness history’ asked about household members’ illness experience in the past month, health seeking behaviour for each illness, and out-of-pocket expenditures directly towards receiving health care, and related to health care, such as transportation, food costs, work time and income loss. The third part – ‘hospitalizations’ covered similar questions related to hospitalizations in the past year. The fourth part c – ‘consumption’ covered information on household consumption on food and non-food items and recall period was dependent on the frequency of consumption. The final section – ‘ses’ focused on information of possession of different assets.

Survey instruments were coded into electronic data collection forms created using Open Data Kit (ODK) (24). Field workers approached the selected household. From each household, a member who was 18 years or older and aware of household expenditures and health service use was eligible for participation. After obtaining consent, data were collected using ODK interface through face-to-face interviews.

Outcome variable – CHE calculation

CHE was set as outcome variable. There are two definitions of CHE. In the first, health expenditures are estimated as proportion of total household expenditure (as budget share), and under the second it is estimated as proportion of household’s capacity to pay. CHE-1 is a binary outcome variable coded as ‘1’ if the total health expenditure is more than 10% of annual household total expenditure; and coded as ‘0’ if equal to or less than 10%.

Estimation of total health expenditures: Household health expenditures comprised direct medical paid out-of-pocket directly to health service providers (medicines, diagnostics or other services) and direct non-medical expenses included expenditures incurred for events such as travel, lodging or food expenses. Indirect costs were estimated as total time spent away from daily routine due to out-patient visits or hospitalizations or care giving during the reference period.

Estimation of total expenditures: Household total expenditures comprised of both frequent and non-frequent items. Non-frequent items had a reference period of preceding 12 months, and frequent items were collected either weekly or monthly. And all expenditures were aggregated and annualized.

CHE -2 is coded as ‘1’ If total heath expenditure is more than 40% of the annual capacity to pay; and coded as ‘0’ if it is equal or less than 40%. The calculation for the second definition is based on two basic measures: total household food expenditure, and household size. Household size is assumed to overestimate the household needs, and hence a scale parameter – is used to calculate household equivalence as The food expenditure of each household is divided by equivalent size to arrive per-capita food expenditure. Then, for each household, the ratio of food expenditure to the total household expenditure was estimated, and next the households were ordered from the smallest to the largest ratio. The average food expenditure (the part of the total household expenditure spent on the food) of households in the 45th to 55th percentile was calculated. The subsistence expenditure (SE) for each household was estimated separately using the following formula: ; The capacity to pay was calculated as *CTPi = EXP i - SEi .* Then, the ratio of each household's health expenditures to its capacity to pay was calculated.

Explanatory variables

The explanatory variables are classified as household heads’ characteristics, household level characteristics, community and health service characteristics. Household heads’ characteristics include age, gender, marital status, education, and employment status. Household level variable include number of household members, number of members over 65 years, number of members with disability, socio-economic status, family income, and religion. Urban- rural residence is included as community level variable. Health service variable include source of care.

Data Analysis

Preliminary analyses of all variables were conducted using descriptive statistical methods. Logistic regression analysis was used to understand the role of the explanatory variables on the CHE. The dependent variable is a dichotomous variable indicating whether the household experienced catastrophic health expenditures. We considered both definitions of thresholds: health expenditures over 10 per cent of the total expenditure and over 40 per cent of non-food expenditure. The explanatory variables of the mode included a set of characteristics of the head of the household (age, gender, level of education, marital status, employment status), and a set of characteristics of the household, wealth index, and area of residence (urban/rural), presence of elderly people (aged 60 and more). Bivariate analyses was used to identify potential covariables in the multivariable analyses. The empirical analyses were performed in Stata V.14.

Results

Household characteristics

The average household size was 4.6 and 4.7 in urban and rural areas of Vellore, with approximately 49.6% of households having at least one member equal to or less than 5 years old or more than 65 years old. We found most of the households were headed by male member (82% in urban; 84 in rural), and 17.2% household heads had primary or lower level of education. Heads of households were employed in 69.5% and 70.0% of households in urban and rural areas, respectively.

Health-seeking behaviour

We identified a total of 439 illness episodes (over prior 4 weeks) distributed across 1,390 individuals in 300 households in urban areas. And in rural areas, it was 673 over 2,833 individuals in 600 households. The average number of illness episodes per person per year was found to be 3.8 and 2.9 in urban and rural areas, respectively.

On average, 90% of individuals who reported having a illness episode sought health care services. Of those who sought healthcare, a majority (65%) used private, one-tenth used public facilities, and the remaining used other service providers in urba

n areas. In rural areas, public facilities captured a quarter of illness episodes, 70% treated at private, and the remaining used other services.

Health Expenditures

Around 65% and 53% of urban and rural households incurred health expenditures for OPD services in the prior four weeks. Among households that incurred health expenditures for OPD services, the average household OOP direct medical and non medical expenditure was 1,112 rupees (USD $14) and 150 rupees (USD $2) in urban and 1,880 rupees (USD $24) and 230 rupees (USD $3) in rural areas. Across both urban and rural areas, the highest average amounts related to direct medical expenses were paid for medicines (605 rupees) and registration or user fees (412 rupees), followed by diagnostic tests (232 rupees), and follow-up visits (290 rupees). Travel constituted as the single most factor of direct non-medical expenditures (150 rupees). The average household indirect expenditure was 435 rupees (USD $6) and 386 rupees (USD $5) in urban and rural areas respectively. All above mentioned direct medical, non-medical, and indirect expenses were added up and reported as total health expenditure for OPD services. The average total health expenditure for OPD services was 1,697 rupees (USD $22) in urban and 2496 rupees (USD $32) in rural areas.

About 20% and 24% of urban and rural households incurred health expenditure for hospitalizations in the past year. The average direct medical expenditure was twice higher in urban (45, 599 rupees) than in the rural areas (22,936 rupees). Majority of this was occurred in bed charges, followed by medicines and surgical costs. Across urban and rural areas, average direct non-medical expenditure was 1,960 rupees. And the average indirect expenditure due to hospitalization was estimated to be 4,369 rupees in urban and 1,759 rupees in rural areas. Summing all of the above expenses, the average total health expenditures for hospitalization was 51,780 for urban and 26,718 rupees for rural households.

CHE estimates

The prevalence of CHE is presented in Table 3 using two approaches by including direct medical only in the numerator, and then adding direct non-medical and indirect expenditures. Using budget share approach, the incidence was 24.7%, 27.3%, and 31.6% for including only direct medical in the numerator, direct medical and non-medical, and both total direct and indirect health expenditures, respectively. For capacity-to-pay approach, it was 15.0%, 17.0% and 19.8% for direct medical, total medical, and indirect health expenditures.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 10% cut-off (budget share) | | | 40% cut-off (capacity to pay) | | |
|  | Direct medical | Direct medical + non-medical | Direct medical+ non-medical + indirect | Direct medical | Direct medical + non-medical | Direct medical+ non-medical + indirect |
| Urban (300) | 61 (20.3) | 71 (23.7) | 87 (29.0) | 38 (12.7) | 41 (13.7) | 55 (18.3) |
| Rural  (600) | 161 (26.8) | 175 (29.2) | 197 (32.8) | 97 (16.2) | 112 (18.7) | 123 (20.5) |
| Total  (900) | 222 (24.7) | 246 (27.3) | 284 (31.6) | 135 (15.0) | 153 (17.0) | 178 (19.8) |

Predictors

Table ## shows factors associated with prevalence of CHE using both approaches only using direct medical expenditures (model 1), and using both direct and indirect expenditures (model 2).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Predictors |  | 10% cut-off | | 40 % cut-off | |
|  | N | Direct Medical expenditure (As numerator) | Total (As numerator) | Direct Medical expenditures (As numerator) | Total (as numerator) |
|  |  | OR (95% CI) |  |  |  |
| Number of family members |  |  |  |  |  |
| Overall | 900 | 1.13 (1.03,1.24) | 1.13 (1.03, 1.23) | 1.16 (1.04, 1.29) | 1.16 (1.06, 1.29) |
| Urban | 300 | 1.18 (0.98,1.41) | 1.17 (0.99,1.38) | 1.13 (0.91,1.39) | 1.19 (0.99,1.43) |
| Rural | 600 | 1.11 (0.99,1.24) | 1.11 (1.00,1.23) | 1.17 (1.03,1.32) | 1.15 (1.03,1.30) |
| Age group |  |  |  |  |  |
| Age <15(Child) |  |  |  |  |  |
| Overall (Yes) | 900 | 1.4 (0.94, 2.11) | 1.57 (1.09, 2.27) | 1.68 (1.00, 2.82) | 1.70 (1.08, 2.67) |
| Urban | 300 | 1.61 (0.71,3.64) | 1.64 (0.82,3.24) | 2.37 (0.74,7.57) | 2.70 (1.03,7.04) |
| Rural | 600 | 1.38 (0.86,2.22) | 1.58 (1.02,2.44) | 1.58 (0.87,2.85) | 1.50 (0.89,2.52) |
| Age >60(Elderly) |  |  |  |  |  |
| Overall (Yes) | 900 | 1.65 (1.02, 2.67) | 1.34 (0.85, 2.11) | 1.69 (0.91, 3.14) | 1.33 (0.76, 2.33) |
| Urban | 300 | 1.67 (0.66,4.19) | 1.38 (0.62,3.06) | 2.80 (0.80,9.81) | 2.65 (0.92,7.66) |
| Rural | 600 | 1.80 (1.01,3.20) | 1.39 (0.79,2.42) | 1.58 (0.87,2.85) | 1.02 (0.51,2.06) |
| *Both* |  |  |  |  |  |
| *Overall (Yes)* | 900 | 2.25 (1.43,3.53) | 1.95 (1.28, 2.97) | 3.08 (1.78, 5.33) | 2.89 (1.77, 4.70) |
| *Urban* | 300 | 3.45 (1.42,8.36) | 2.76 (1.25,6.06) | 6.41 (1.95,21.04) | 6.09 (2.20,16.8) |
| *Rural* | 600 | 1.93 (1.14,3.26) | 1.69 (1.03,2.79) | 2.43 (1.29,4.56) | 2.23 (1.27,3.92) |
| *Age between 15-60 yrs (Adult) (No)* |  | Ref. | Ref. | Ref. | Ref. |
| Illiteracy in household |  |  |  |  |  |
| Overall (Yes) | 900 | 1.12 (0.82,1.54) | 1.01 (0.75, 1.36) | 1.26 (0.86, 1.84) | 1.20 (0.85, 1.68) |
| Urban | 300 | 1.41 (0.79,2.49) | 1.33 (0.80,2.21) | 1.58 (0.79,3.13) | 1.62 (0.90,2.93) |
| Rural | 600 | 1.03 (0.71,1.51) | 0.89 (0.62,1.28) | 1.16 (0.74,1.83) | 1.04 (0.68,1.58) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Divorce or Widowhood in household |  |  |  |  |  |
| Overall (Yes) | 900 | 1.51 (0.81, 2.81) | 1.40 (0.77, 2.53) | 2.41 (1.26, 4.61) | 2.06 (1.10, 3.83) |
| Urban | 300 | 1.13 (0.43, 2.94) | 1.03 (0.43, 2.45) | 1.22 (0.39, 3.75) | 1.30 (0.50, 3.40) |
| Rural | 600 | 2.35 (0.99, 5.56) | 2.10 (0.89, 4.94) | 4.70 (1.97, 11.22) | 3.42 (1.44, 8.13) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Unemployment in households |  |  |  |  |  |
| Overall (Yes) | 900 | 0.59 (0.38, 0.90) | 0.59 (0.40, 0.87) | 0.54 (0.31, 0.93) | 0.48 (0.29, 0.79) |
| Urban | 300 | 0.55 (0.24,1.24) | 0.63 (0.32, 1.25) | 0.44 (0.15,1.30) | 0.35 (0.13,0.93) |
| Rural | 600 | 0.60 (0.36,0.99) | 0.57 (0.36,0.91) | 0.58 (0.31,1.09) | 0.54 (0.31,0.97) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Government Employee in households |  |  |  |  |  |
| Overall (Yes) | 900 | 1.29 (0.78,2.14) | 1.07 (0.66, 1.73) | 0.96 (0.50, 1.84) | 0.89 (0.50, 1.61) |
| Urban | 300 | 0.83 (0.23, 2.98) | 0.74 (0.23,2.34) | 0.91 (0.20,4.16) | 0.95 (0.26,3.43) |
| Rural | 600 | 1.34 (0.  77, 2.34) | 1.13 (0.66,1.94) | 0.93 (0.45,1.90) | 0.86 (0.44,1.67) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Any Disease in households |  |  |  |  |  |
| Overall (Yes) | 900 | 1.95 (1.42,2.69) | 1.92 (1.44, 2.58) | 1.64 (1.12, 2.41) | 1.79 (1.27, 2.53) |
| Urban | 300 | 1.24 (0.67, 2.27) | 1.19 (0.70,2.02) | 1.19 (0.57, 2.47) | 1.25 (0.66, 2.34) |
| Rural | 600 | 2.52 (1.73, 3.68) | 2.49 (1.75, 3.54) | 1.97 (1.25, 3.09) | 2.17 (1.43, 3.28) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Health rate |  |  |  |  |  |
| Overall (Yes) | 900 | 1.66 (0.94, 2.93) | 1.70 (0.99, 2.92) | 2.54 (1.39, 4.62) | 2.68 (1.53, 4.69) |
| Urban | 300 | 1.88 (0.91, 3.88) | 1.74 (0.89, 3.41) | 2.92 (1.32, 6.46) | 2.90 (1.42,5.92) |
| Rural | 600 | 2.44 (0.87, 6.86) | 2.39 (0.85, 6.70) | 3.61 (1.25, 10.41) | 3.53 (1.25,9.95) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Health insurance in households (Govt. policy) |  |  |  |  |  |
| Overall (Yes) | 900 | 1.11 (0.81, 1.50) | 1.22 (0.92, 1.62) | 0.93 (0.64, 1.35) | 1.01 (0.73, 1.41) |
| Urban | 300 | 1.13 (0.64,1.98) | 1.47 (0.89, 2.42) | 0.95 (0.48, 1.89) | 1.24 (0.69, 2.22) |
| Rural | 600 | 1.21 (0.78,1.61) | 1.14 (0.81, 1.60) | 0.94 (0.60, 1.46) | 0.93 (0.62, 1.38) |
| No |  | Ref. | Ref. | Ref. | Ref. |
| Wealth index |  |  |  |  |  |
| Overall (Yes) |  |  |  |  |  |
| *Poorest* | 900 | 0.94 (0.57, 1.55) | 1.01 (0.64, 1.60) | 1.25 (0.68, 2.28) | 1.33 (0.77, 2.29) |
| *Second* | 900 | 1.17 (0.71, 1.93) | 1.10 (0.69, 1.76) | 1.50 (0.82, 2.74) | 1.28 (0.73, 2.25) |
| *Middle* | 900 | 1.10 (0.67, 1.81) | 1.21 (0.76, 1.92) | 0.89 (0.47, 1.70) | 1.21 (0.69, 2.12) |
| *Fourth* | 900 | 1.05 (0.63, 1.76) | 1.14 (0.71, 1.84) | 1.17 (0.62, 2.20) | 1.40 (0.79, 2.47) |
| *Urban* |  |  |  |  |  |
| *Poorest* | 300 | 1.19 (0.51, 2.75) | 1.08 (0.51,2.31) | 2.33 (0.69,7.87) | 2.66 (0.97,7.31) |
| *Second* | 300 | 2.15 (0.89, 5.14) | 1.64 (0.73,3.69) | 4.97 (1.48,16.61) | 3.2 (1.10,9.30) |
| *Middle* | 300 | 0.96 (0.40, 2.31) | 1.08 (0.50,2.31) | 1.90 (0.54,6.65) | 2.16 (0.76,6.10) |
| *Fourth* | 300 | 0.36 (0.10,1.20) | 0.74 (0.31, 1.78) | 1.26 (0.29,5.31) | 1.77 (0.57,5.51) |
| *Rural* |  |  |  |  |  |
| *Poorest* | 600 | 0.81 (0.44, 1.51) | 0.96 (0.54,1.72) | 0.94 (0.47,1.91) | 0.93 (0.48,1.80) |
| *Second* | 600 | 0.88 (0.47, 1.62) | 0.92 (0.51,1.64) | 0.89 (0.43,1.81) | 0.84 (0.43,1.63) |
| *Middle* | 600 | 1.13 (0.61, 2.08) | 1.27 (0.71, 2.27) | 0.64 (0.29,1.37) | 0.90 (0.46,1.77) |
| *Fourth* | 600 | 1.28 (0.70,2.36) | 1.30 (0.72,2.33) | 1.02 (0.49,2.09) | 1.18 (0.61,2.30) |
| *Richest (No)* |  |  | Ref. | Ref. | Ref. |
| *SES (PCA)* |  |  |  |  |  |
| *Overall (Yes)* |  |  |  |  |  |
| *Poorest* | 900 | 0.67 (0.41, 1.08) | 0.81 (0.52, 1.27) | 0.90 (0.52, 1.55) | 1.07 (0.64, 1.78) |
| *Second* | 900 | 0.53 (0.32, 0.88) | 0.67 (0.42, 1.06) | 0.47 (0.25, 0.88) | 0.76 (0.44, 1.30) |
| *Middle* | 900 | 0.78 (0.48, 1.25) | 0.91 (0.58, 1.42) | 0.71 (0.40, 1.27) | 0.93 (0.55, 1.56) |
| *Fourth* | 900 | 0.98 (0.62, 1.55) | 1.09 (0.71, 1.70) | 0.83 (0.48, 1.45) | 0.93 (0.55, 1.57) |
| *Urban* |  |  |  |  |  |
| *Poorest* | 300 | 1.75 (0.76,4.03) | 1.87 (0.86,4.06) | 2.05 (0.80,5.21) | 3.2 (1.31,7.81) |
| *Second* | 300 | 0.65 (0.24,1.78) | 0.97 (0.41, 2.26) | 0.40 (0.10,1.56) | 1.54 (0.58,4.10) |
| *Middle* | 300 | 1.24 (0.49,3.13) | 1.51 (0.65,3.48) | 0.66 (0.19,2.28) | 1.24 (0.42,3.60) |
| *Fourth* | 300 | 1.35 (0.59,3.11) | 2.17 (1.03,4.57) | 1.12 (0.41,3.02) | 1.42 (0.54,3.68) |
| *Rural* |  |  |  |  |  |
| *Poorest* | 600 | 0.39 (0.21,0.71) | 0.50 (0.28,0.87) | 0.56 (0.28,1.12) | 0.58 (0.30,1.10) |
| *Second* | 600 | 0.43 (0.24,0.77) | 0.51 (0.29,0.89) | 0.44 (0.21,0.89) | 0.52 (0.27,0.99) |
| *Middle* | 600 | 0.57 (0.32,1.00) | 0.64 (0.37,1.10) | 0.63 (0.33,1.23) | 0.73 (0.40,1.34) |
| *Fourth* | 600 | 0.79 (0.45,1.39) | 0.72 (0.41, 1.25) | 0.69 (0.35,1.36) | 0.74 (0.39,1.38) |
| *Richest (No)* |  | Ref. | Ref. | Ref. | Ref. |

Discussion