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# Examining catastrophic health expenditures at variable thresholds using household consumption expenditure diaries

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## Summary

**OBJECTIVE** Using uniform thresholds and a set of variable threshold levels, this study examined the incidence of catastrophe amongst households of different socio-economic status (SES) quintiles.

**METHODS** A household diary was used to collect illness and household consumption expenditure data from 1128 households over 1 month. Catastrophic health expenditure was examined based on uniform threshold levels of non-food expenditure and a novel set of variable thresholds in which the levels for various SES groups were weighted by the ratio of household expenditure on food.

**RESULTS** A total of 167 households (14.8%) experienced catastrophe at a non-food expenditure threshold of 40%, with 22.6% and 7.6% of the poorest and richest household quintiles experiencing catastrophe. For the first set of variable scenarios, the thresholds for the poorest and richest household quintiles were 5% and 29.6% and levels of catastrophe were 44.7% and 12.0%, respectively, while the overall level was 36.5%. In the second scenario, the thresholds were 6.8% and 40%, and the levels of catastrophe were 42.5% and 7.6%, respectively, while the overall level was 32.0%.

**CONCLUSIONS** High levels of catastrophic expenditure exist in Nigeria. Use of variable thresholds to measure catastrophe led to higher overall and disaggregated levels of catastrophe. Such a measure is argued to be more appropriate for the examination of catastrophe.

**keywords** out-of-pocket payment, catastrophe, socio-economic status, Nigeria

## Introduction

There is growing concern about the economic impact of healthcare expenditure on households who face illness, especially where prepayment systems do not exist and households have to pay out of pocket for health care when they use health services (Xu *et al.* 2003a, 2007; McIntyre *et al.* 2006; Onwujekwe *et al.* 2009). In Nigeria, per capita government expenditure on health is Int\$14 (WHO 2008). Private expenditure on health accounts for 69.1% of total expenditure on health, and 90.4% of this expenditure is out-of-pocket. The high level of private out-of-pocket expenditure implies that health care places a significant financial burden on households. The Nigerian national health financing policy recognizes the importance of efficient, fair and sustainable means of healthcare financing (FMOH 2006). Nevertheless, 4% of households in the country spend over half of their total household expenditures on health care.

Payment for health care is catastrophic when it exceeds a defined level of household income and so leads the

household to sacrifice the consumption of other goods and services necessary for their well-being (Ekman 2007; Flores *et al.* 2008; Wagstaff 2008). Globally, at a threshold level of 40% of non-food consumption expenditure, over 150 million people experience catastrophe because of health-care expenditure (Xu *et al.* 2007). Although the level of expenditure that defines catastrophe is still widely debated, there is an understanding that even low levels of expenditure on health care can tip a household to poverty depending on the household's income (Xu *et al.* 2003a; Goudge *et al.* 2009). The risk is heightened in settings where out-of-pocket payment for health care predominates (van Doorslaer *et al.* 2006; Limwattananon *et al.* 2007), highlighting the need to identify context specific levels of expenditure that can lead to financial catastrophe.

A further concern is the distribution of catastrophic levels of expenditure across socio-economic groups. The conventional approach to examining catastrophic expenditures is to use the same threshold for all socio-economic groups. For any given threshold (say 10% of total expenditure), we would expect a higher proportion of

households in the poorest quintiles to experience catastrophe. However, a household owning \$100 that has \$90 left has a different experience from one of \$1000 that has \$900 left. Thus, even an 'equitable' distribution of catastrophe would mean that the poorer households would have a greater need for financial protection from health expenditure than the richer ones. In this paper, we propose a method for analysing the socio-economic distribution of catastrophic expenditure which allows the threshold for assessing whether a level of expenditure is catastrophic to vary across socio-economic groups.

## Materials and methods

### Conceptual framework

The term 'effective income' refers to the total consumption expenditure of households and is argued to better depict a household's purchasing power compared with income (Xu *et al.* 2003b). 'Capacity to pay' at household level is defined as effective income remaining after spending on basic subsistence needs (Xu *et al.* 2003a). The World Health Organization recommends the use of non-food expenditure as the measure of a household's capacity to pay, and this serves as the denominator for assessing catastrophe (WHO 2000). Use of non-food expenditure is considered appropriate as food is seen as a basic necessity and constitutes a major share of household expenditure.

The threshold level recommended for the consideration of catastrophe is 40% of non-food expenditure. The numerator for the determination of catastrophe is the level of health expenditure and the resulting proportion is compared with the threshold level to determine the percentage of households who incur these catastrophic expenditure levels. There is some debate about the appropriate level to choose, with different authors using 40%, 15% or 5%; some have pointed out that different thresholds lead to different conclusions about the economic impact of health expenditure on households (Goudge *et al.* 2009). However, with such thresholds, the same proportion is used for all the SES groups.

But if the same threshold of 40% is used for all socio-economic groups, there is a challenge in interpretation: we argue that the remaining 60% of non-food expenditure means different things for households in the richest quintile and those in the poorest quintile. The choice of the threshold level is based on the idea that households will be left with a certain balance of their pre-expenditure income or capacity to pay that would allow them to spend on other needs in the household (Wagstaff & van Doorslaer 2003). Considerations regarding the value and usefulness of the balance form the basis for the choice of level by various

authors for different societies and value judgments (Feder *et al.* 1987). For the richest group, a balance of 60% of capacity to pay would be a substantial amount of money and would give a substantial leverage to trade-off household priorities; this would not be so for the poorest group because their pre-expenditure capacity to pay would be relatively quite small. With a threshold level of 10% for instance, a household with capacity to pay of \$1000 and another with \$100 and incurring expenditure of \$200 and \$20 would both be considered to have experienced catastrophe even though the richer household's balance of \$800 is eight times the pre-expenditure income for the poorer household. An alternative framing of the problem is that, assuming diminishing marginal utility of money, beyond a fixed threshold level, the marginal utility of the next dollar is much higher for the poorer households. Because the absolute amount left after the threshold level is exceeded, and its utility differs for different absolute levels of capacity to pay, it is more appropriate to consider catastrophe at different levels for different SES groups. This hypothesis is in line with the vertical equity principle, which would mean that higher expenditure proportions would be required to designate a richer household as having experienced a catastrophic event. This idea forms the basis for the novel approach used in this study.

Consumption expenditure is noted as the preferred measure of living standards especially in developing countries (O'Donnell *et al.* 2008). In particular, food consumption expenditure accounts for a large proportion of household expenditure and the limited economies of scale from its consumption would mean that such expenditure is likely to be sensitive to household size and access to cash. Wealthier families are likely to spend more on food in terms of quality and quantity. A household could do without savings and purchase of household assets for a month, but not without food. Food thus reflects expenditure that is most likely to be incurred by households. The level of consumption can reflect the level of access to cash for the household while the ratio across SES groups can reflect their relative level of access to cash. We have assumed that food expenditure is sensitive enough to capture the differences in access to funds and expenditure across various SES groups and have used it as a weight for the threshold level for assessing catastrophe.

### Study design, study area and sampling

This exploratory study was carried out in 2008 in Enugu and Anambra states, south-east Nigeria. Enugu and Anambra states have populations of 3.26 million and 4.18 million people, respectively (National Bureau of Statistics 2007). The study sites consisted of four purposively

selected local government areas (LGAs) (one rural and one urban LGAs from each state). The urban LGAs were the two state capitals, while the two rural LGAs were Udi in Enugu state and Awka south in Anambra state. The study LGAs were chosen as they represented LGAs where the major financing mechanisms including health insurance, out-of-pocket expenditure, payment in-kind and community supported payments were most likely to be operational. Overall, 1200 households were selected through a multi-stage process involving simple random selection and then systematic selection of one of every four households.

### Data collection and instruments used

Health and expenditure pictorial diaries were used for data collection to reduce the impact of recall on expenditure data (Wiseman *et al.* 2005). Data collection was performed over a 4-month period (March to June 2008). Diaries were placed in households at the beginning of each week to be filled by a trained household member under the supervision of the male or female household head. Diaries were pretested to ensure that the pictures were easily identifiable by individuals from various backgrounds and corresponded with the items also described in text format. Twice a week, field workers trained over a 4-week period monitored the entries. Information on illness, expenditure on health (including outpatient and inpatient costs), transportation, entertainment, food, education, clothing and cooking fuel were recorded, and the diaries were replaced weekly.

### Data analysis

Households were disaggregated into SES quintiles based on their monthly consumption expenditure. Adjusted adult equivalent values of consumption expenditure were used for the SES classification. The formula used to derive adult equivalent values (AE) was  $AE = (A + \alpha K)^\theta$ , where  $A$  = number of adults in household,  $K$  = number of children,  $\alpha$  = cost of children and  $\theta$  = the degree of economies of scale (Cirto & Michael 1995). The values used for  $\alpha$  and  $\theta$  were 0.4 and 1.0, and these were in line with values recommended by Cirto and Michael (1995) for developing countries.

Data analysis for examination of catastrophe was performed by considering whether out-of-pocket expenditure on health care in the month exceeded a defined share of non-food consumption expenditure. Two types of threshold were considered – a fixed threshold for all SES groups, and a variable threshold level for different groups. Three different fixed threshold levels were considered: 40%, 20% and 10%.

The variable thresholds were based on the ratio of food expenditure level between an ‘index’ quintile and the remaining quintiles. In the first scenario, we indexed the thresholds to the poorest quintile (Q1), setting the threshold for catastrophic expenditure at 5% ( $V_5$ ). The thresholds for quintiles 2 through 5 were then calculated by multiplying the index threshold (5%) by the ratio of mean adult equivalent expenditure on food for different quintiles, as follows:

$$V_i = 5\% \times (\text{Exp}_i/\text{Exp}_n)$$

where  $V_i$  = the threshold used for the  $i$ th quintile;  $\text{Exp}_i$  = food expenditure in the  $i$ th quintile;  $\text{Exp}_n$  = food expenditure in the index quintile.

An alternative procedure was also followed, indexing the thresholds to the least poor quintile (Q5), setting the threshold for this quintile at 40% ( $V_{40}$ ) and calculating the thresholds for the remaining quintiles using an analogous procedure.

The ratio of the lowest SES to the highest SES (Q1:Q5 ratio) was computed as the measure of inequity. In addition, further assessment of inequity was made based on concentration curves and concentration indices. The value for concentration index (CI) ranges from  $-1$  to  $+1$ ; if CI is less than 0, the outcome of interest is concentrated amongst poor groups and if  $>0$ , amongst rich groups (Chen & Roy 2009).

### Ethical considerations

Ethical approval for the study was obtained from the ethical committee of the University of Nigeria teaching hospital, Enugu, and from the Ethics Committee of the London School of Hygiene and Tropical Medicine, London, United Kingdom.

## Results

### Characteristics of households

Data were collected from 1128 households giving a population of 4988 individuals. As shown in Table 1, 595 (54.9%) of the household heads were men, and mean age of household heads was 50.3 years (SD = 16.1). Mean adult equivalent composition of households was 3.2 (SD = 1.2). About 44.1% were farmers followed by artisans and petty traders.

### Illness episodes that households had in the 1-month period

The most common reported illness suffered amongst households was malaria accounting for 47.1% of illnesses

**Table 1** Characteristics of households

Variable	N = 1128 Frequency (%)
Gender of head of household (male)	595 (54.9)
Mean age of head	50.3 (16.1)
Mean number of adults in household	2.7 (1.2)
Mean number of children	1.7 (1.5)
Mean number of household members	4.4 (1.9)
Mean composition (adult equivalent)	3.2 (1.3)
Occupation of head of household	
Unemployed	58 (5.5)
Student	38 (3.6)
Housewife	9 (0.89)
Farming	469 (44.1)
Artisan	171 (16.1)
Petty trader	133 (12.5)
Government worker	64 (6.0)
Private sector employee	43 (4.0)
Big business	41 (3.9)
Self-employed professional	15 (1.4)
Other	23 (2.2)
Ownership of household items	
Radio	968 (90.4)
Television	631 (58.9)
Air conditioner	18 (1.7)
Fridge	320 (29.4)
Fan	643 (60.0)
Bicycle	210 (19.6)
Car	118 (11.0)
Motorcycle	157 (14.7)
Mean equivalized monthly household consumption expenditure (SD)	8123.0 (9110.3)
Mean equivalized monthly per capita food consumption expenditure (SD)	3027.3 (2931.0)
SES classification	
Q1: Lowest	226 (20.0)
Q2: Second	226 (20.0)
Q3: Middle	225 (20.0)
Q4: Fourth	226 (20.0)
Q5: Highest	225 (20.0)

that occurred within the 1-month period (Table 2). This gave an illness episode of 518/1000 households per month. This was followed by respiratory tract infection and diarrhoea. There was no incidence of cancer, while HIV/AIDS and surgical interventions were rarely reported.

#### Household expenditure over the 1-month period by SES

Mean adult equivalent food consumption expenditure for the 1-month period was 3027.3 naira (US\$20.2). Mean adult equivalent total consumption expenditure was 1819.7 (US\$12.1) for the poorest households and 22 566.0 (US\$150) for the richest group (Table 3). Similarly, mean

**Table 2** Illness episodes that households had in the 1 month period

	Total (%)	Episodes of illness per 1000 household
Malaria	585 (47.1)	518.6
Respiratory tract infection	105 (8.5)	93.1
Diarrhoea	69 (5.6)	61.2
Cancer	0 (0)	0.0
Hypertension	18 (1.4)	16.0
Accidents/Trauma	14 (1.1)	12.4
HIV/AIDS	1 (0.1)	0.9
Surgery	3 (0.2)	2.7
Child birth	14 (1.1)	12.4
Other	433 (34.9)	383.9
Total	1242	1101.1

adult equivalent food consumption expenditure was 1105.3 (US\$7.4) and 6539.4 (US\$43.6) for the poorest and richest households with the expenditure for the richest households being 5.92 times that of the poorest. Correspondingly, mean expenditure on health care was 673.3 (US\$4.5) and 5325.6 (US\$21.3) in the poorest and richest households, respectively.

#### Incidence of catastrophic expenditure by SES

Of all the households studied, 167 (14.8%) experienced catastrophe at a non-food expenditure threshold level of 40% (Table 4). The highest proportion of 22.6% was amongst the poorest households and the difference with other groups was significant (chi-squared for trend 19.1,  $P < 0.0001$ ). At levels of 20% and 10% of non-food expenditure, overall level of catastrophe was 27.8% and 40.2%; the richest households had the lowest proportion of catastrophe, while the second quintile had the highest.

On the basis of a variable threshold of catastrophe using ratios of mean equivalized expenditure on food, the computed threshold for households of different SES groups in the first scenario (using the poorest quintile as the base group) ranged from 5.0% to 29.6% for the poorest and richest quintiles, respectively (Table 5). The corresponding levels of catastrophe were 44.7% for Q1 and 12.0% for Q5 (chi-squared for trend 97.8,  $P < 0.0001$ ), and the overall level of catastrophe was 36.5%.

In the second scenario, the richest quintile (base group) had a threshold level of 40%, while the level of the poorest quintile was 6.8%. The overall level of catastrophe was 32% with the level being highest amongst the second quintile (55.8%), 42.5% for the poorest quintile and the least amongst the richest quintile (7.6%). The difference in

**Table 3** Household expenditure over 1 month period by SES (SD)

	Q1	Q2	Q3	Q4	Q5	Total
Adult equivalent consumption expenditure	1819.7 (3199.5)	3230.7 (394.0)	4902.1 (595.6)	8146.4 (1477.2)	22 566.0 (11 419.5)	8123.0 (9110.3)
Adult equivalent non food consumption expenditure	714.4 (411.8)	1535.2 (558.8)	2501.4 (960.8)	4737.9 (1785.2)	16 105.2 (10 181.1)	5111.4 (7312.9)
Health consumption expenditure	673.3 (2279.5)	1043.1 (1789.8)	1495.0 (4373.2)	1984.2 (3623.6)	5325.6 (10 469.7)	2101.9 (5715.9)
Adult equivalent food consumption expenditure	1105.3 (462.9)	1695.5 (543.3)	2400.7 (924.9)	3408.5 (1600.1)	6539.4 (4564.7)	3027.3 (2931.0)
Ratio of expenditure on food (Qn/Q1)	1.00	1.55	2.18	3.08	5.92	
Ratio Qn/Q5	0.17	0.26	0.37	0.52	1	

**Table 4** Proportion of household with catastrophic expenditure by SES (based on uniform threshold)

SE classification	40%	20%	10%
Q1 (poorest)	51 (22.6)	72 (31.9)	91 (40.3)
Q2	38 (16.8)	95 (42.0)	130 (57.5)
Q3	29 (12.9)	58 (25.8)	86 (38.2)
Q4	32 (14.2)	51 (22.6)	82 (36.3)
Q5 (least poor)	17 (7.6)	38 (16.9)	64 (28.4)
All households	167 (14.8)	314 (27.8)	453 (40.2)
Q1:Q5 ratio	3.0	1.9	1.4
Chi square for trend ( <i>P</i> value)	19.1 (<0.0001)	27.4 (<0.0001)	18.9 (<0.0001)

levels of catastrophe was significant (chi-squared for trend 110.8,  $P < 0.0001$ ).

#### Equity analysis

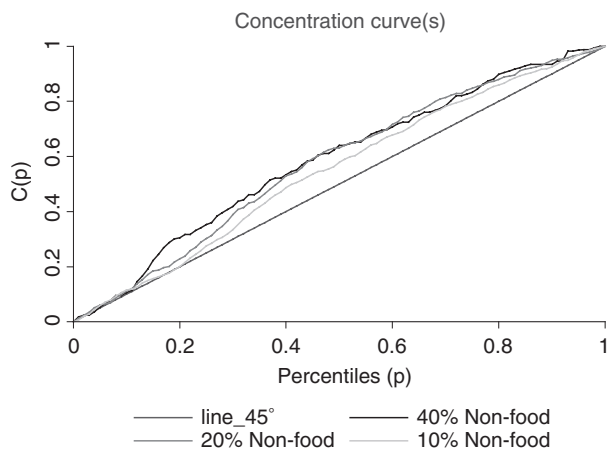
Computed quintile ratios (Q1:Q5) for catastrophe show that the poorest quintile faced catastrophe proportionately more than the richest households. The equity ratios based on variable threshold levels were 3.7 and 5.6 for V5 and V40, respectively (Table 5). At levels of 40%, 20% and 10% of non-food expenditure, the level of catastrophe shown by the concentration curve is slightly pro-poor (Figure 1). However, at the variable scenarios considered, the curve reveals a grossly pro-poor occurrence of catastrophe (Figure 2). Concentration indices (CI) at threshold levels of 40%, 20% and 10% of non-food expenditure were  $-0.18$ ,  $-0.14$  and  $-0.09$ , respectively. For the variable thresholds, this was  $-0.219$  and  $-0.259$  for V5 and V40, respectively.

#### Discussion

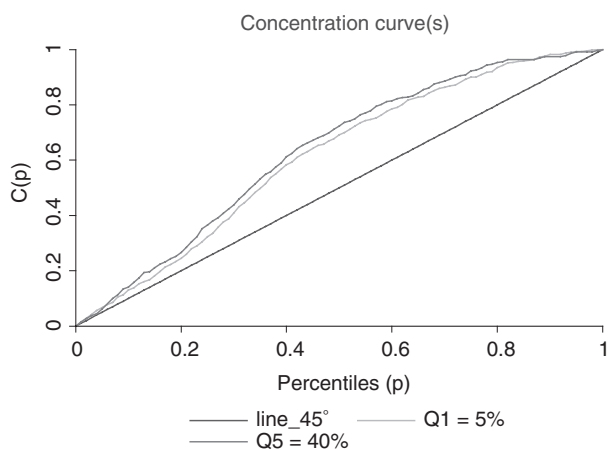
The level of catastrophic health expenditure found in this study was high and the value is much higher than reported elsewhere for developing countries (Xu *et al.* 2003a). The high level is however expected in a country with 70.8% of the population living below \$1 a day, a dominance of unregulated private providers of health care and out-of-pocket payment mechanism (World Bank 2007). Xu *et al.* (2003a) found high levels of catastrophe in several low income and transition countries, and note that where health services are available and households have a low capacity to pay for care, the incidence of catastrophe is more likely. With the exception of the second quintile, the level of catastrophe is very similar across socio-economic groups when a fixed threshold level of 10% of total consumption expenditure is used. This would mean that almost all SES groups would have similar risk of

**Table 5** Catastrophe at variable thresholds

SES classification	Variable threshold 1	Catastrophe level 1	Variable threshold 2	Catastrophe level 2
Q1 (poorest)	5.0	101 (44.7)	6.8	96 (42.5)
Q2	7.7	140 (62.0)	10.4	126 (55.8)
Q3	10.9	83 (36.9)	14.7	72 (32.0)
Q4	15.4	61 (27.0)	20.8	50 (22.1)
Q5 (Least poor)	29.6	27 (12.0)	40.0	17 (7.6)
All households		412 (36.5)		361 (32.0)
Q1:Q5 ratio		3.7		5.6
Chi square for trend ( <i>P</i> value)		97.8 (<0.0001)		110.8 (<0.0001)

**Figure 1** Concentration curves at fixed threshold levels.

catastrophe. However, this does not seem to reflect reality since as earlier noted, the utility of the post-healthcare expenditure balance varies. In this study, at a fixed threshold level of 40%, the remaining 60% of non-food

**Figure 2** Concentration curves at variable threshold levels (based two scenarios – Q1 = 5% or Q5 = 40%).

expenditure would amount to N1558.5 (US\$10.4) for the poorest groups and almost 20 times higher for the least poor group, N30532.4 naira (US\$203). Thus, the richer groups have significant resources to draw from after incurring health expenditure and cannot be said to be facing as great a catastrophe as the poorer ones. We earlier noted the incoherence of such assumptions with reality.

At a variable threshold level of 5% for the poorest considered, the richest household who are spending several times as much would need to spend about 30% of their total consumption expenditure on health before having the potential of being tipped into poverty. If, on the other hand, they are prone to poverty at health expenditure level of 40% of their non-food expenditure, it will be quite realistic to suppose that the poorest groups, whose non-food expenditure is about 5% (1/19) of that of the richest, would only need to spend a small fraction of their available cash before being thrown into poverty. Thus, use of variable threshold levels would be more realistic than using uniform values.

Use of expenditure on food might not be the best way of applying weights to the threshold levels for the examination of catastrophe. Better indicators might evolve over time to weigh threshold levels. This study has largely argued that using the same threshold for all households irrespective of the income or its proxy is inappropriate as a way of judging the impact of expenditure on the well-being of households of different SES groups. Following our argument to its logical conclusion, it would be optimal to calculate a different threshold for each household. The logical conclusion is a household-specific threshold; but it would be more complex to interpret. We opine that there is a trade-off between analytical complexity and ease of interpretation, and we feel that our presentation of variable thresholds by quintile is sufficient to demonstrate the merits of this more disaggregated approach.

Also, the negative impact of financing of health care through out-of-pocket payments is not exhaustively described by the consideration of catastrophe alone. For instance, it does not capture the cost to household of

forgone treatment (Xu *et al.* 2003a), the coping mechanism (Flores *et al.* 2008) and the effect of these strategies on household well-being. Such issues are better investigated through other study designs including longitudinal and qualitative studies (Chuma & Molyneux 2009; Goudge *et al.* 2009).

### Conclusions

This study has shown the existence of high levels of catastrophic expenditure amongst households in southeast Nigeria. Although fixed threshold levels are commonly used to examine financial catastrophe, this study also considered variable threshold levels, which led to high overall and disaggregated levels in the study area. It has been argued that this approach could better reflect reality and, if this is so, would mean that the financial burden of illness on households is more intense than currently estimated by the usual fixed thresholds. Use of a fixed threshold will underestimate the degree of inequality in the distribution of catastrophe between socio-economic groups.

Given the high level of catastrophic expenditure in the study area, particularly in the poorest quintile of population, there is an urgent need to revisit the existing health financing strategy that places the burden of payment on households. The expansion of the existing national health insurance scheme is advocated so that more people (especially the poor) would be provided with financial risk protection. Finally, the model we used should be tested with larger studies and compared across various regions of the country. It can also be compared with other models for estimating catastrophe to examine its robustness.

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