Household catastrophic health expenditure: a multicountry analysis

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Summary

Background Health policy makers have long been concerned with protecting people from the possibility that ill health will lead to catastrophic financial payments and subsequent impoverishment. Yet catastrophic expenditure is not rare. We investigated the extent of catastrophic health expenditure as a first step to developing appropriate policy responses.

Methods We used a cross-country analysis design. Data from household surveys in 59 countries were used to explore, by regression analysis, variables associated with catastrophic health expenditure. We defined expenditure as being catastrophic if a household's financial contributions to the health system exceed 40% of income remaining after subsistence needs have been met.

Findings The proportion of households facing catastrophic payments from out-of-pocket health expenses varied widely between countries. Catastrophic spending rates were highest in some countries in transition, and in certain Latin American countries. Three key preconditions for catastrophic payments were identified: the availability of health services requiring payment, low capacity to pay, and the lack of prepayment or health insurance.

Interpretation People, particularly in poor households, can be protected from catastrophic health expenditures by reducing a health system's reliance on out-of-pocket payments and providing more financial risk protection. Increase in the availability of health services is critical to improving health in poor countries, but this approach could raise the proportion of households facing catastrophic expenditure; risk protection policies would be especially important in this situation.

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Introduction

Health systems can deliver health services, preventive and curative, that can make a difference to peoples' health. However, accessing these services can lead to individuals having to pay catastrophic proportions of their available income and push many households into poverty. The potential impact of how health systems are financed on the wellbeing of households, particularly poor households, has affected the design of health systems and insurance mechanisms in countries as diverse as the USA, Australia, India, and Indonesia.[1–6] The protecting of people from catastrophic payments is widely accepted as a desirable objective of health policy.[7–13] Catastrophic health expenditure is not always synonymous with high health-care costs.[14] A large bill for surgery, for example, might not be catastrophic if a household does not bear the full cost because the service is provided free or at a subsidised price, or is covered by third-party insurance. On the other hand, even small costs for common illnesses can be financially disastrous for poor households with no insurance cover.

Little, however, is known about which health-system characteristics protect households from catastrophic payments, or the factors that lead some households to face such payments while others are protected. Most of the limited evidence comes from case studies. For example, in two US studies,[15,16] households headed by older people, people with disabilities, the unemployed, or poor people, and those with reduced access to health insurance were more likely to be affected than other households.

In Georgia, the results of a survey undertaken after the transition to a decentralised, market-driven system showed that 19% of households seeking care had to borrow money or sell personal items to pay, and that 16% were unable to afford the medications prescribed.[17] The characteristics of the households were not reported. In Thailand, the poor have been reported as more likely to have to pay for health services from their own household income than richer people, which, when combined with lower incomes, places these people at higher risk of catastrophic health payments.[18,19]

In designing their health systems, policy makers need to understand whether any characteristics make people more vulnerable to catastrophic payments. Knowledge is also necessary of which households are more vulnerable for any set of system characteristics. We aimed to quantify the extent of catastrophic payments and explore the conditions under which they are most likely to occur, taking advantage of the increasing number of available household income and expenditure surveys.

Methods
Household assessments
Health spending is taken to be catastrophic when a household must reduce its basic expenditure over a

period of time to cope with health costs,[14] but there is no consensus on the threshold proportion of household expenditure. In past studies,[14,20] the threshold has varied from 5% to 20% of total household income. We used a higher threshold of payments of at least 40% of a household's capacity of pay.

A household's capacity to pay is defined as effective income remaining after basic subsistence needs have been met. Effective income is taken to be the total consumption expenditure of the household, which in many countries is a more accurate reflection of purchasing power than income reported in household surveys.[21] To determine poverty and to measure household subsistence expenditure, we based the poverty line on the share of total expenditure spent on food. We defined subsistence expenditure and the poverty line for each country separately to account for different consumption patterns, prices, and household sizes. Given that the poorer the household the higher the share of total income or consumption devoted to food,[22] we established the poverty line as being the average food expenditure of households whose food share was in the 45th to 55th percentile range (used in preference to that for one household at the 50th percentile). Capacity to pay of the ith household is, therefore:

$$CTP_i = EXP_i - SE_{45-55i},$$

	Code	Year	Survey name	Sample size
Country				
Argentina	ARG	1996/97	Encuesta nacional de gastos de los hogares	27 108
Azerbaijan	AZE	1995	The Azerbaijan survey of living conditions	2015
Bangladesh	BGD	1995/96	Household expenditure survey	7420
Belgium	BEL	1997/98	Household budget survey	2212
Brazil	BRA	1996	Living standards measurement studies	4850
Bulgaria	BGR	2000	Bulgarian integrated household survey	5701
Cambodia	KHM	1999	Cambodia socioeconomic survey 1999	6000
Canada	CAN	1997	Survey of household spending	16 495
Colombia	COL	1997	National quality of life survey	9042
Costa Rica	CRI	1992	Encuesta nacional de los hogares	2472
Croatia	HRV	1999	Household budget survey	2935
Czech	CZE	1999	Household budget survey	2675
Denmark	DNK	1997	Danish household budget survey	2862
Djibouti	DJI	1996	Enquête Djiboutienne auprès des ménages	2378
Egypt	EGY	1997	Egypt integrated household survey	2733
Estonia	EST	1995	Household budget survey	2816
Finland	FIN	1998	Consumption expenditure survey (ces98)	4348
France	FRA	1995	Household budget survey	9607
Germany	DEU	1993	Income and consumption survey	48 270
Ghana	GHA	1998/99	Ghana living standards survey	5998
Greece	GRC	1998	Household expenditure survey	6235
Guyana	GUY	1992	Living standards measurement studies	1499
Hungary	HUN	1993	Household budget survey	8094
Iceland	ISL	1995	Household budget survey	1352
Indonesia	IDN	1999	National socioeconomic survey	61 328
Israel	ISR	1999	Household expenditure survey	5904
Jamaica	JAM	1997	Survey of living conditions	1984
Kyrgyz	KGZ	1998	Poverty monitoring survey	1891
Latvia	LVA	1997/98	Household budget survey	7684
Lebanon	LBN	1999	National household health expenditure and use of services	6540
Lithuania	LTU	1999	National household budget survey	8250
Mauritius	MUS	1996/97	Household budget survey	6233
Mexico	MEX	1996	National income expenditure survey	13 661
Morocco	MCO	1991	Living standards measurement studies	5131
Namibia	NAM	1994	Household income and expenditure survey	4384
Nicaragua	NIC	1993	Living standards measurement studies	4144
Norway	NOR	1998	Consumer expenditure survey	1180
Panama	PAN	1997	Encuesta nacional de niveles de vida	4904
Paraguay	PRY	1996	Household survey	2588
Peru	PER	1994	Encuesta nacional de niveles de vida	3615
Philippines	PHL	1997	1997 family income and expenditure survey	39 520
Portugal	PRT	1994/95	Income and expenditure survey	10 450
Republic of Korea	KOR	1999	Household income and expenditure survey	62 946
Romania	ROM	1994	Integrated household survey	2291
Senegal	SEN	1994	Enquête sénégalaise auprès des ménages	3274
Slovakia	SVK	1993	Family expenditure survey	2129
Slovenia	SVN	1997	Annual household budget survey	2577
South Africa	ZAF	1995	South africa income expenditure survey	29 594
Spain	ESP	1996	Encuesta continua de hogares	3104
Sri Lanka	LKA	1995/96	Household income and expenditure survey	19 631
Sweden	SWE	1996	Household expenditure survey	1103
Switzerland	CHE	1998	Swiss survey on income and expenditure	9295
Thailand	THA	1998	Thailand socio-economic survey	24 977
UK	GBR	1999/2000	Family expenditure survey	7074
Ukraine	UKR	1996	Income expenditure survey	2272
USA	USA	1997	Consumer expenditure survey	7083
Vietnam	VNM	1997	Vietnam living standard survey	5966
Yemen	YEM	1998	Household budget survey	13 638
Zambia	ZMB	1996	Living conditions monitoring survey	10 921

Table 1: **Data sources and country codes**

where subsistence expenditure (SE_{45-55i}) corresponds to the average food expenditure of households in the 45th to 55th percentile, adjusted for the size of the ith household.

Subsistence expenditure was adjusted for household size according to a consumption equivalence scale:

$$eqsize = hhsize^{\beta},$$

where *eqsize* represents the number of consumption-equivalents in the household and *hhsize* is the actual size. To account for differences in country-specific consumption patterns, we estimated the value of β for the 59 countries with a fixed-effects regression:

$$\ln food = \ln k + \beta \ln hhsize + \sum_{i=1}^{N-1} \gamma_i country_{I},$$

where k is a constant, *food* is the value of total household food consumption, and all variables are in natural logarithms (ln).

The value of β was 0·56 (95% CI 0·556–0·572), which implies that food consumption increases with additional household members, but that the increase in consumption is less than proportional to the increase in household size. We estimated subsistence expenditure for each household separately, adjusting for household size and country of residence. A household was deemed poor if its total expenditure was less than the basic subsistence expenditure. If food expenditure was lower than this threshold, we used the household's observed food expenditure to define its basic subsistence needs, and its capacity to pay was its total expenditure minus its food expenditure.

Health expenditures requiring out-of-pocket payments included all types of health-related expenses incurred at the time the household received the service, including consultation fees, purchase of medications, and hospital bills. We deducted any reimbursement from health insurance schemes.

WHO systematically identifies household income and expenditure surveys providing enough detail to assess whether households face catastrophic health spending. For this analysis, we included surveys if they met the criterion that rates of missing data were low (3%) and aggregates obtained by scaling up the survey data to the national level were similar to those reported in national accounts. Particular attention was paid to the quality of private consumption expenditure data if the scaled-up aggregates exceeded the estimates of the gross domestic product (GDP) from official national account statistics.

We estimated each household's financial contribution, how much of total health expenditure came from out-of-pocket payments, and the proportion of households below the poverty line from the survey results scaled to the national level. The share of total health expenditure in the GDP, which was used as one of the explanatory variables in the regression analysis, was estimated from survey data and published national health accounts.[13] The private health expenditure part was obtained from the surveys, whereas national health accounts information was used for public health expenditure and GDP. Since many of the surveys did not include measures of health-care use, we used total health expenditure as a share of the GDP, as an indirect measure of the relative degree of health-service delivery. The logic is that the higher this ratio, the more services are used at any given level of GDP, so households are more likely to face catastrophic spending.

Country	Proportion of households (%)	Uncertainty Interval (80%)	
		Lower (%)	Upper (%)
Argentina	5·77	5·51	6·02
Azerbaijan	7·15	6·43	7·86
Bangladesh	1·21	1·01	1·41
Belgium	0·09	0·01	0·18
Brazil	10·27	9·49	11·04
Bulgaria	2·00	1·77	2·23
Cambodia	5·02	4·57	5·47
Canada	0·09	0·06	0·13
Colombia	6·26	5·88	6·64
Costa Rica	0·12	0·00	0·23
Croatia	0·20	0·10	0·29
Czech	0·00	0·00	<0·01
Denmark	0·07	0·00	0·14
Djibouti	0·32	0·17	0·47
Egypt	2·80	2·39	3·21
Estonia	0·31	0·13	0·49
Finland	0·44	0·25	0·62
France	0·01	0·00	0·02
Germany	0·03	0·02	0·04
Ghana	1·30	1·11	1·49
Greece	2·17	1·93	2·40
Guyana	0·60	0·33	0·87
Hungary	0·20	0·11	0·29
Iceland	0·30	0·10	0·50
Indonesia	1·26	1·20	1·32
Israel	0·35	0·23	0·46
Jamaica	1·86	1·45	2·28
Kyrgyz	0·62	0·38	0·86
Latvia	2·75	2·47	3·04
Lebanon	5·17	4·81	5·53
Lithuania	1·34	1·15	1·54
Mauritius	1·28	1·10	1·46
Mexico	1·54	1·36	1·71
Morocco	0·17	0·10	0·25
Namibia	0·11	0·04	0·18
Nicaragua	2·05	1·76	2·34
Norway	0·28	0·08	0·49
Panama	2·35	2·07	2·62
Paraguay	3·51	3·04	3·98
Peru	3·21	2·84	3·58
Philippines	0·78	0·71	0·85
Portugal	2·71	2·42	3·01
Republic of Korea	1·73	1·65	1·80
Romania	0·09	0·01	0·17
Senegal	0·55	0·38	0·72
Slovakia	0·00	0·00	<0·01
Slovenia	0·06	0·01	0·12
South Africa	0·03	0·02	0·04
Spain	0·48	0·31	0·64
Sri Lanka	1·25	1·13	1·37
Sweden	0·18	0·06	0·42
Switzerland	0·57	0·47	0·68
Thailand	0·80	0·70	0·89
UK	0·04	0·01	0·07
Ukraine	3·87	3·36	4·39
USA	0·55	0·42	0·69
Vietnam	10·45	9·90	11·00
Yemen	1·66	1·46	1·86
Zambia	2·29	2·03	2·54

Table 2: **Proportion of households with catastrophic health expenditures**

Statistical analysis

We calculated uncertainty intervals around the reported proportion of households with catastrophic expenditure with bootstrap methods.[23] In each country survey this involved taking 1000 resamples with replacements from the original sample. For each of these resamples the proportion of households with catastrophic expenditure was recalculated. The highest and lowest 10% of estimates were eliminated to define the 80% uncertainty interval.

	Coefficient (SD)	p
Variable		
Out-of-pocket payment share of total health expenditure	2·161 (0·199)	0·001
Total health expenditure share of GDP	1·645 (0·362)	0·001
Proportion of households below poverty line	0·173 (0·045)	0·001
Constant	2·733 (1·141)	0·02

Table 3: **Determinants of catastrophic health expenditure**

Multivariate ordinary-least-squares regression was used for the cross-country analysis. Different specifications were used, but a double-logarithmic model described best the underlying data. The proportion of households with catastrophic expenditures was regressed on the share of out-of-pocket payments in total health expenditure, the share of total health expenditure in GDP, and the proportion of households below the estimated poverty line. Since all variables were transformed into logarithms, the estimated regression coefficients are elasticities—eg, the proportional change in the dependent variable associated with a 1% change in the independent variable.

We explored the sensitivity of the results to changes in the thresholds used to define poverty (average food expenditure of households in the 35th to 45th percentiles and the 55th to 65th percentiles) and catastrophic expenditure (30% and 50% of households' capacity to pay).

Role of the funding source
The study sponsor had no role in the study design, data collection, data analysis, data interpretation, or in the writing of the paper, or the decision to publish.

Results
We considered 65 surveys for inclusion; six surveys did not meet the inclusion criteria and were excluded, leaving 59 for analysis. Table 1 provides a summary of the years, type, sample size, and key attributes of the included surveys. Some national surveys were part of international survey initiatives or were part of continuing national survey programmes including the Living Standards Measurement Studies, Household Budget Surveys, and Household Income and Expenditure Surveys. All surveys provided some basic socioeconomic information about the household, including education, place of residence, household size, and age and sex of household members.

The proportion of households facing catastrophic payments from out-of-pocket health expenses varied widely between countries, from less than 0·01% in Czech Republic and Slovakia to 10·5% in Vietnam (table 2). Most developed countries have advanced social institutions such as social insurance or tax-funded health systems that protect households from catastrophic spending. Among these countries, only Portugal, Greece, Switzerland, and the USA had more than 0·5% of households facing catastrophic health spending. Among developing countries, the lower limit was less than 0·5% in Namibia and Djibouti, and ten countries had more than 3% of households facing catastrophic health expenditures (table 2).

Two groups of countries have high rates of catastrophic spending: countries in transition, such as Azerbaijan, Ukraine, Vietnam, and Cambodia, although several other countries in transition do not have substantial catastrophic health spending; second, is in Latin America (Argentina, Brazil, Colombia, Paraguay, and Peru). As with the first group, not all countries in Latin America suffer from high levels of catastrophic spending. Finally, one country, Lebanon, does not fall into these groups but nevertheless has high levels of catastrophic spending.
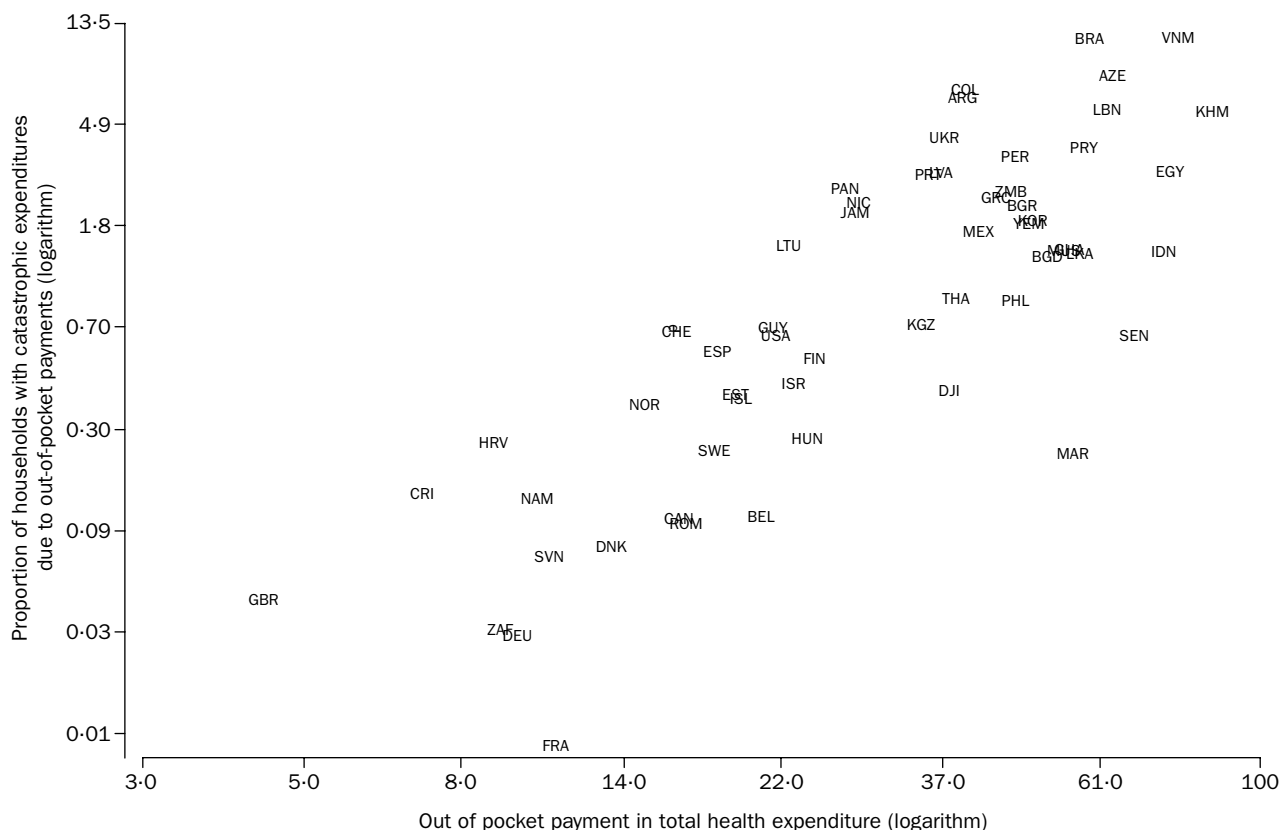
Proportion of households with catastrophic expenditures vs share of out-of-pocket payment in total health expenditures
Log-log plot is used because the relation not linear. See table 1 for definitions of country codes.

The figure shows that there is an overall positive relation between the proportion of households with catastrophic health expenditures and the share of out-of-pocket payments in total health expenditure. At any level of the share of out-of-pocket payments in total health expenditure, the proportion of households facing catastrophic health expenditure varies substantially. For example, in Belgium, Hungary, Israel, USA, Guyana, and Lithuania out-of-pocket payments range from 20% to 25% of total health expenditure. In these countries, catastrophic payments range from 0·09% in Belgium to 1·34% in Lithuania; despite the small volume of health payments through out-of-pocket expenditures the consequences could be on selected households. As the volume of total health expenditure met by out-of-pocket payments increases, the range of catastrophic payments also increases. Argentina, Colombia, Mexico, and Thailand have between 40 and 45% of total health expenditure through out-of-pocket payments and catastrophic expenditures ranging from 0·8% in Thailand to 6·3% in Colombia. Additional factors must, therefore, play a part in leading to catastrophic payment.

Given that catastrophic payments occur when households pay large shares of their capacities to pay for health services, we expected, holding everything else constant, that the probability of catastrophic payments would be greater where levels of poverty and health-care use are higher. The ordinary-least-squares multivariate regression using these variables is shown in table 3 and the raw data are reported in the webtable (http://image. thelancet.com/extras/02art12246webtable.pdf).

The results are robust to changes in the cut-off points used to define poverty and catastrophic payments. They confirm that countries with a higher share of out-of-pocket payments in total health expenditures are more likely to have a higher proportion of households facing catastrophic expenditure after controlling for other possible determinants. A 1% increase in the proportion of total health expenditure provided by out-of-pocket payments is associated with an average increase in the proportion of households facing catastrophic payments of 2·2%. The coefficients of the proportion of the population living below the poverty line and the share of total health expenditure in the GDP are significant, and positively correlated with the proportion of households with catastrophic expenditure as postulated. A 1% increase in poverty will increase catastrophic payments by 0·2% and a 1·0% increase in the share of the gross domestic product spent on health will increase catastrophic payment by 1·6%.

The overall fit of the equation is good, with 77·2% of the variation in the share of households facing catastrophic payments across countries explained by variation in the independent variables. About 23% of the variation is not, however, explained by the chosen explanatory variables and other possible determinants need to be identified. Geographical or regional dummies were not significant, and some additional explanatory power might be found by including country-specific factors that influence the way that health systems are organised and funded. These are not, however, easy to define in a way that is amenable to cross-country regression analysis and remain a priority for future analysis.

Discussion

The results, although powerful, should be interpreted in view of several qualifications. For example, no information on the distribution of payments within households was available, so some members of households without catastrophic expenditure could, individually, be placed at financial risk because of health payments. On the other hand, although financial transfers between households are captured in the survey data, some non-financial transfers that might enable households to survive the consequences of unexpected health payments were not fully captured. In addition, the consequences of high payments spread over a long period of time may not be as debilitating as unexpected high payments that must be met in the short term.

The definition of catastrophic payments we used was, however, conservative. It used a higher threshold than earlier studies, and income and expenditure surveys do not typically seek information on the indirect costs of seeking care, such as those associated with transport, food, and accommodation, or lost earnings associated with illness. Accordingly, the estimates of the proportions of households facing catastrophic expenditure reported in this report probably underestimate the financial consequences of out-of-pocket payments on households.

Despite this underestimation, our analysis shows that catastrophic payments are, unfortunately, common in middle-income countries, countries in transition, and in several low-income countries. This negative impact of health systems on households that can lead to impoverishment has long been ignored on the health-policy agenda. Our results are consistent with earlier studies, in which poor households were less able to cope with any given level of health expenditure than richer households.[24–26] Once the issue has been identified, however, catastrophic payments can quickly become priorities in national health-policy debates, such as in Mexico and Iran.

There is no mystery in understanding the presence of catastrophic health payments. Overall, we expected the key factor explaining cross-national variation in the extent of catastrophic payments to be the proportion of total health spending that is through out-of-pocket payments as opposed to the proportion through social insurance, taxation, or private insurance. The latter types of health payments are not made at the point of service, can be anticipated in advance, and are not normally related to an individual's health status or service use. Prepayment through social insurance, taxation, or private insurance are mechanisms by which to achieve financial risk pooling. The strong relation between the proportion of households with catastrophic health expenditures and the share of out-of-pocket payments in total health expenditure supports the hypothesis that prepayment and risk pooling can protect households from facing catastrophic financial consequences of illness.

Out-of-pocket payments are not, however, the only important determinant of catastrophic payments. The triad of poverty, health-service access and use, and the failure of social mechanisms to pool financial risks account for most of the variation across countries. Catastrophic payments are the biggest issue when all three of these factors are strong. Therefore, we would expect to see high rates of catastrophic spending in countries with high rates of poverty, groups excluded from financial risk protection mechanisms such as social insurance, and moderate to high levels of health-care access and use. Notably, several Latin American countries fulfil these criteria, as do selected countries in transition. The combination of poverty and lack of financial risk pooling also means that a relatively high

proportion of households in many of the poorest countries in Africa, where survey data are not yet available, also probably face financial catastrophe because of health payments.

Catastrophic spending is not a new problem, although it may be getting worse in some regions because of the collapse of mechanisms for risk pooling. In developed countries, health systems and financial risk pooling mechanisms evolved in parallel over more than a century. In many middle-income countries, however, health-service use has expanded rapidly, and the development of social institutions, such as social insurance or tax-financed health services, have been left behind. The problem of catastrophic health payments will not simply go away with rising income; rather, the complex process of developing social institutions to effectively pool financial risk must be placed on the agenda.

The impact of out-of-pocket payments is not fully captured by examining catastrophic spending. Many poor households will choose to not seek care rather than become impoverished.[27,28] Making the users of health services pay out of pocket for the services they receive has a potential dual effect at the population level—impoverishing some households that choose to seek services and excluding others from seeking health care. Both reasons are important for arguing that health systems are better financed through prepayment mechanisms such as social insurance and general taxation than through user-fees.

We used household survey data on expenditures by consumption category. Measurement error for expenditures is a well recognised difficulty.[29,30] If the random component of expenditure recall varies across countries, comparisons of the proportion of households facing catastrophic health spending could be complicated. The strong cross-country relation found by use of simple aggregate data, however, suggest that across this set of countries, this difficulty may not be a dominant issue. As issues of health financing become more central to health policy, public-health researchers need to understand and develop improved household survey instruments that capture household health spending for inclusion in various national health surveys.

Although most of the variation in catastrophic spending can be explained by the triad of poverty, health-service use, and the absence of risk pooling mechanisms, important unexplained variation remains. Analysis of which households in a country are at particular risk of catastrophic spending through logistic regression can provide insights into other national determinants of catastrophic spending. Such detailed national assessments can also provide direct input into the design of national policies to increase financial risk protection.

National health systems can be financed in ways that protect households from catastrophic spending and provide access to needed services. The most straightforward approach is to reduce out-of-pocket spending through the development of social insurance or funding through general taxes. The relation we noted between catastrophic expenditure and the share of out-of-pocket payment in total health expenditure suggests that, if out-of-pocket spending could be reduced to levels lower than 15% of total health spending, few households would be affected by catastrophic payments. The cross-country variation, however, shows that other more complex strategies can protect households against catastrophic spending, such as progressive fee schedules, highly subsidised or free hospital services, and the provision of certain health services to the poor. These strategies will limit the financial consequences of payment for services, although the additional financial consequences of ill health should be recognised, in terms of lost earnings and expenses involved in seeking care for example, which could not be included in this study. Irrespective of the strategy used, catastrophic health spending is a neglected problem in many parts of the world.

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Clinical picture

High resolution CT of Weil's disease

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A 39-year-old man, recently rescued from massive flooding in the northern territory of Hong Kong, was referred to our institution with 7 days' history of fever, mild upper respiratory symptoms, increasing calf swelling, and muscle pain. He had raised bilirubin (970 μmol/L) and creatine kinase (3000 units/L), thrombocytopenia (97×10^9/L), mildly deranged clotting profile (INR=1·4), and acute renal failure (serum urea 37·5 mmol/L; creatinine 410 μmol/L) requiring haemodialysis. ELISA tests confirmed the presence of IgM antibody to *Leptospira interogans*. High resolution CT thorax performed 16 days after the onset of disease showed subpleural nodular areas of consolidation (figure, upper) together with more diffuse areas of ground glass opacification (figure, lower) in both lungs. These features were compatible with acute and resolving haemorrhagic pneumonitis respectively, characteristic of pulmonary Weil's disease. Immersion in water contaminated with urine or tissues from animals infected with leptospira, most commonly rats, is a known risk factor for contracting leptospirosis. Although pulmonary involvement is rare, a mixed pattern of ground glass opacities and nodular consolidation on high resolution CT, in the presence of acute renal failure and liver dysfunction in a person with the appropriate history should alert one to the diagnosis of Weil's disease. Preliminary treatment should be initiated prior to serological confirmation as Weil's disease carries a 10% mortality rate. Our patient survived after treatment with antibiotics, haemodialysis, and plasma exchange.
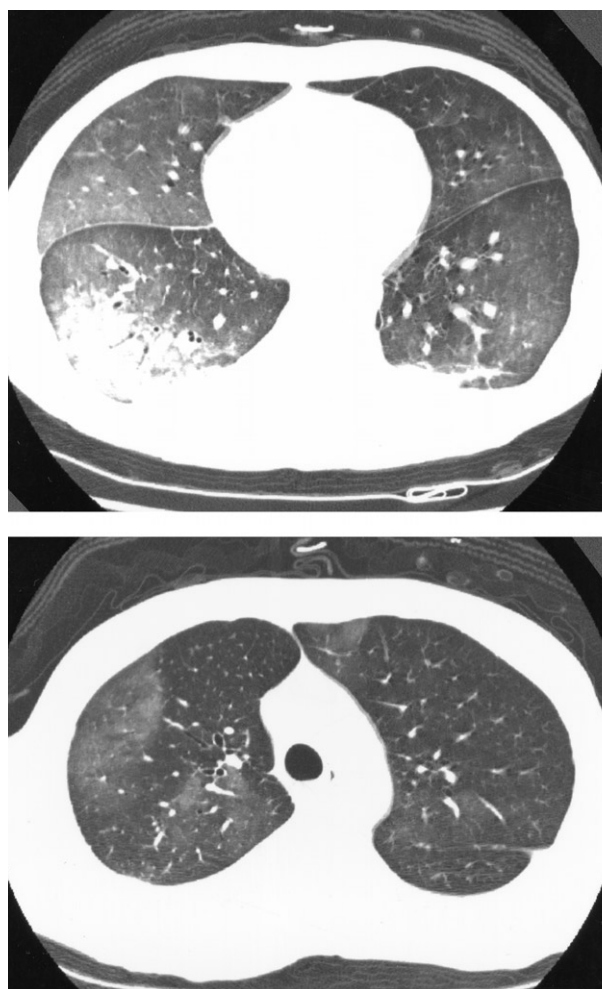
High resolution CT scan of thorax

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