

Article

Noncommunicable disease-attributable medical expenditures, household financial stress and impoverishment in Bangladesh

Biplab Kumar Datta^a, Muhammad Jami Husain^{a,*}, Muhammad Mudabbir Husain^b,
Deliana Kostova^a

^a Global Noncommunicable Diseases Branch, Division of Global Health Protection, Center for Global Health, Centers for Disease Control and Prevention, 1825 Century Boulevard, Mailstop: E-98, Atlanta, GA 30345, USA

^b Department of Economics, Johns Hopkins University, 3400 North Charles Street, Wyman Park Building 535, Baltimore, MD 21218, USA

A B S T R A C T

Background: Treatment of noncommunicable diseases (NCDs) in low-income countries can entail large out-of-pocket (OOP) medical expenditures, which can increase the likelihood of household impoverishment and perpetuate the poverty cycle. This paper studies the implications of NCDs on household medical expenditure, household financial stress (e.g. selling assets or borrowing for treatment financing), catastrophic OOP expenditure, and impoverishment in Bangladesh.

Methods: We used self-reported health status and household expenditure survey data from 12,240 households in Bangladesh. NCD-afflicted households were defined by presence of at least one of the following conditions within the household – heart disease, hypertension, asthma, diabetes, cancer, or kidney disease. Using linear regression models, we examined whether NCD households incur more medical expenditures, allocate a larger budget share on medical expenditures, and have greater probability of experiencing catastrophic medical expenditure or financial stress from OOP spending than non-NCD households. Finally, using survey weights, we extrapolated how NCD-attributable medical expenditure can result in impoverishment and downward movement in net consumption status at the population level.

Results: NCD-afflicted households allocate a greater share of household expenditures for medical care than households without NCDs, and their probability of incurring catastrophic medical expenditure is higher by 6.7 percentage points compared to the households with no reported conditions. NCD households are 85% more likely to sell assets or borrow from informal sources to finance treatment cost. Household spending on NCD care is estimated to account for the impoverishment of 0.66 million persons in Bangladesh in 2010, and for reducing the net consumption status of 7.63 million persons on both sides of the poverty line after accounting for NCD-related OOP expenditures.

Conclusion: NCD-related household medical expenditure is associated with experiencing financial distress and aggravating poverty in Bangladesh.

1. Introduction

Noncommunicable diseases (NCDs) are the leading cause of death globally. In 2012, 38 million deaths worldwide were caused by NCDs, with three quarters of these occurring in low-and-middle-income countries (LMICs) (World Health Organization, 2014). As the epidemiological burden in LMICs shifts from infectious to noncommunicable diseases, health systems are often unprepared to accommodate the resulting change in healthcare needs (Bollyky, Templin, Cohen & Dieleman, 2017). Public health spending on chronic care in low-income countries (LICs) is scant, and people have limited resources for out-of-pocket (OOP) treatment costs (Bollyky et al., 2017). In the absence of adequate health insurance coverage, OOP medical expenditures can be a major economic burden to households in LMICs, where over a quarter of households have been estimated to finance OOP medical expenditures by selling assets or borrowing money (Kruk, Goldmann & Galea, 2009). Compared to other types of illness, NCDs are associated

with greater OOP spending (Mahal, Karan & Engelgau, 2010), contributing to household impoverishment in LICs (World Health Organization, 2011a).

With a growing population of over 166 million, Bangladesh is a large lower-middle-income country that is increasingly affected by NCDs (Karar et al., 2009). Nearly all adults in Bangladesh are affected by at least one NCD risk factor such as tobacco use, obesity, hypertension, or diabetes, and a large majority are affected by at least two (World Health Organization, 2011b). The current health system in Bangladesh is focused primarily on addressing communicable diseases and on maternal and child health care (Islam & Biswas, 2014), with NCD care lagging far behind despite the associated rise in mortality (Bleich, Koehlmoos, Rashid, Peters & Anderson, 2011). Inadequacies in health system capacity in accommodating rising NCD care needs in Bangladesh are exacerbated by high out-of-pocket treatment costs, which make up more than 60% of total health expenditure (Ministry of Health and Family Welfare, 2015). Increased understanding of NCD-

* Corresponding author.

E-mail address: MHusain@cdc.gov (M.J. Husain).

<https://doi.org/10.1016/j.ssmph.2018.10.001>

Received 14 June 2018; Received in revised form 9 October 2018; Accepted 10 October 2018

2552-8273/ Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

attributable OOP medical expenditures and their role in households' economic wellbeing in Bangladesh would inform policies for NCD prevention and control, as well as policies for reducing financial hardship from excessive medical expenditures in LMICs – a core concern behind the UN Sustainable Development Goals' (SDG) universal health coverage component.

This study examines NCD-attributable OOP expenditure in Bangladesh and its implications on household financial stress (e.g. selling assets or borrowing in order to pay for treatment) and extrapolates its macro-level effects on poverty and impoverishment. The contribution of the study is twofold. First, it expands the current literature by assessing OOP expenditures that can be attributed to NCDs specifically. Unlike other studies, which have described overall trends in OOP medical expenditures and their correlates (Khan, Ahmed, & Evans, 2017; Mahumud et al., 2017; Molla, et al., 2017; Rahman, Gilmour, Saito, Sultana & Shibuya, 2013), we separate the contribution of NCDs to household's OOP burden. Second, this is the first study to link NCD-induced financial expenditure to macrolevel poverty rates in Bangladesh. We extrapolate how NCD-attributable OOP medical expenditure can result in impoverishment and downward movement in net consumption status, estimating that NCDs contribute to the impoverishment of 0.66 million persons in Bangladesh and to net consumption reductions for over 7 million persons in the survey year.

2. Data and methods

We analyzed data from the 2010 Bangladesh Household Income and Expenditure Survey (HIES 2010), a nationally representative survey of 12,240 households (Bangladesh Bureau of Statistics, 2011; World Bank, 2011). Households were defined as NCD-afflicted if any member of the household reported having at least one of the following conditions during last 12 months or in the last 30 days – heart disease, hypertension, asthma, diabetes, cancer, or kidney disease. OOP medical expenditures were reported by households for 11 expense categories, including doctor fees, other practitioner fees, medicines, traditional/herbal medicine, diagnostic tests, hospitalizations, dental care, vision care, hearing aids, crutches, and health-related travel or incidental expenses. Expenses were combined and converted into average monthly amounts from self-reported annual estimates. Reported sources of household financing of medical treatment in the last 30 days included regular income, household savings, selling of assets (personal belongings, livestock, agricultural products, permanent assets), informal borrowing (mortgaging of assets or land to non-bank entities, borrowing from friends, relatives, or money lenders), and assistance from friends or relatives.

The analysis was structured as follows. First, we examined whether NCD households incurred more medical expenses compared to non-NCD households, controlling for household socio-demographic and health characteristics. This was done by evaluating the relationship between household NCD status and three household medical expenditure outcomes: medical expenditure, the share of medical expenditure in total household expenditure, and the probability of experiencing catastrophic medical expenditure. Following Wagstaff and van Doorslaer (2003), catastrophic medical expenditure was defined as household's medical expenditure share being 10% or more of the total household consumption expenditure. Second, we assessed NCD-attributable financial stress on households by modeling the likelihood of selling off personal belongings and assets and/or borrowing from informal sources to cover the treatment costs of NCDs. Finally, we used macrolevel extrapolation to examine how NCD-related OOP medical expenditure can result in impoverishment and overall reduction in net consumption status.

2.1. NCDs and medical expenditure outcomes

We used the following regression specification to assess the

relationship between presence of NCDs and three household expenditure outcomes: monthly medical expenditure, medical expenditure share, and experiencing catastrophic medical expenditure:

$$Y_i = \beta_0 + D_i H + X_{Gi} \beta_2 + X_{Si} \beta_3 + \beta_4 Rural_i + District_i \Gamma + \varepsilon_i \quad (1)$$

In alternate specifications, Y_i represents one of the three expenditure outcomes for household i . D_i is a vector of binary variables, D_{ji} , representing illness category j of household i , where j denotes the following illness categories: no reported diseases (reference category), NCD only present in household, both NCD and non-NCD present in household, and non-NCD only present in household. D_{ji} takes the value 1 if household i is of type j , and 0 otherwise. The vector H contains parameters η_j , one for each of the illness categories except the reference group. X_{Gi} is a vector of household demographic characteristics that includes the number of elderly members (age 60 and above), number of reproductive-age females (age 15–49), number of infants (age 0–2), and household size. X_{Si} is a vector of household socioeconomic variables including income per capita, household head's education, major source of income, whether the household has electricity connection, type of latrine facility, source of drinking water, and roof material of the dwelling. $Rural_i$ indicates whether the household resides in rural areas, $District_i$ controls for administrative district fixed effects across 64 districts, and ε_i is idiosyncratic error term. Positive and statistically significant estimates of coefficients η_j would suggest that households of illness category j incur larger expenditure outcomes relative to households with no reported diseases.

2.2. NCDs and financial stress

Household financial stress occurs when households need to sell assets or borrow money in order to pay for medical treatment. The association between household NCD status and experiencing financial stress was evaluated using a linear probability model specified as

$$FS_i = \alpha_0 + \alpha_1 D_i + MI_i A + X_i \alpha_2 + District_i \Gamma + \xi_i \quad (2)$$

where the outcome FS_i is a binary variable that takes the value of 1 if household i reports selling assets or borrowing from informal sources to cover medical expenditures in the past 30 days, and 0 otherwise. The analysis sample only includes households with any reported illness during the last 30 days. The main variable of interest, D_i , takes the value of 1 if household i has at least one incidence of NCD, and 0 otherwise. MI_i is a vector of binary variables, MI_{ki} , describing the presence of multiple illnesses in the household, with k used to denote the following household types: households with a single illness (reference category), households with multiple illness of the same person, and households with illnesses of multiple persons. MI_{ki} takes the value 1 if household i is of type k , and 0 otherwise. X_i is a vector of household characteristics, including household size, household head's working status, household head's education, whether household head is female, proportion of working age (15–64) members in the household, household income per capita, household's major source of income, and whether the household receives remittance from abroad. $District_i$ controls for district fixed effect, and ξ_i is idiosyncratic error term. A positive and statistically significant estimate of α_1 indicates higher probability of experiencing financial stress from OOP medical expenditures for NCD households. The model was applied to all households in analysis sample, and for rural and urban households separately.

2.3. NCDs and impoverishment

NCD-related impoverishment occurs when per capita household expenditure goes below the poverty line after subtracting NCD-attributable medical expenditure. The estimation of impoverishment follows an approach used in Wagstaff and van Doorslaer (2003) and Xu (2005), as follows:

Table 1
Average medical expenditure of NCD and non-NCD households.

	Proportion of Households (%)	Average medical expenditure (BDT)	Medical expenditure share (%) in total expenditure	Proportion of households incurring catastrophic expenditure
All households				
HH has no diseases (N = 3465)	29.03 (27.27, 30.79)	202.2 (178.0, 226.5)	1.94 (1.78, 2.09)	0.022 (0.017, 0.027)
HH has non-NCD only (N = 5844)	48.31 (46.84, 49.78)	371.9 (346.2, 397.6)	3.67 (3.48, 3.86)	0.074 (0.065, 0.082)
HH has NCD only (N = 997)	7.88 (7.29, 8.48)	666.6 (517.4, 815.8)	4.09 (3.63, 4.55)	0.095 (0.071, 0.119)
HH has NCD & non-NCD (N = 1934)	14.78 (13.81, 15.75)	855.6 (526.9, 1184.3)	5.18 (4.75, 5.61)	0.131 (0.113, 0.149)
Urban households				
HH has no diseases (N = 1429)	38.30 (34.85, 41.74)	231.8 (174.9, 288.6)	1.54 (1.27, 1.82)	0.015 (0.007, 0.022)
HH has non-NCD only (N = 1783)	37.06 (34.34, 39.78)	399.4 (341.9, 456.9)	2.96 (2.68, 3.25)	0.056 (0.040, 0.071)
HH has NCD only (N = 464)	11.15 (9.73, 12.56)	845.9 (514.8, 1177.0)	3.57 (2.75, 4.38)	0.089 (0.046, 0.131)
HH has NCD & non-NCD (N = 724)	13.50 (11.51, 15.48)	1340.5 (29.6, 2651.4)	4.54 (3.40, 5.69)	0.083 (0.061, 0.106)
Rural households				
HH has no diseases (N = 2036)	25.64 (23.58, 27.69)	186.1 (165.2, 206.9)	2.15 (1.97, 2.33)	0.026 (0.019, 0.033)
HH has non-NCD only (N = 4061)	52.43 (50.68, 54.18)	364.8 (336.0, 393.6)	3.85 (3.63, 4.08)	0.078 (0.068, 0.088)
HH has NCD only (N = 533)	6.69 (6.06, 7.31)	557.0 (426.5, 687.6)	4.41 (3.86, 4.96)	0.099 (0.071, 0.127)
HH has NCD & non-NCD (N = 1210)	15.25 (14.13, 16.36)	698.2 (613.1, 783.4)	5.39 (4.95, 5.82)	0.146 (0.124, 0.168)

Notes: HH: household. 95% confidence interval in parenthesis. Proportion of households and other estimates obtained using survey weights.

$$Impoverishment_i = \begin{cases} 1 & \text{if } \frac{C_{i,z,q,s}^{Total}}{Z_{i,z,q,s}} > PL_s \text{ and } \frac{C_{i,z,q,s}^{Total} - C_{i,z,q,s}^{NCD}}{Z_{i,z,q,s}} < PL_s \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

where $C_{i,z,q,s}^{Total}$ is the total consumption expenditure of household i , $C_{i,z,q,s}^{NCD}$ is the medical expenditure incurred by household i due to NCD-related treatment costs, $Z_{i,z,q,s}$ is the household size of household i , and PL_s is the poverty line of stratum s as defined by the Bangladesh Bureau of Statistics (2011). Subscripts z and q refer to household size group (< 2 , 3–5, 6–9, < 10 household members) and consumption per capita quartile. The NCD-attributable additional medical expenditure incurred by household i is estimated using the following equation:

$$C_{i,z,q,s}^{NCD} = \begin{cases} C_{i,z,q,s}^M - C_{z,q,s}^{Non-NCD} & \text{if } C_{i,z,q,s}^M > C_{z,q,s}^{Non-NCD} \\ 0 & \text{if } C_{i,z,q,s}^M \leq C_{z,q,s}^{Non-NCD} \\ 0 & \text{if } D_{i,z,q,s} = 0 \end{cases} \quad (4)$$

where, $C_{i,z,q,s}^M$ is the total medical expenditure of household i , and $C_{z,q,s}^{Non-NCD}$ is the average medical expenditure of non-NCD households of size z at consumption quartile q of stratum s . If a household does not report NCDs, or an NCD household's total medical expenditure is less than the average non-NCD medical expenditure, then NCD-attributable additional medical expenditure is 0. Otherwise, the NCD-attributable additional medical expenditure is the difference between an NCD household's total medical expenditure and the average medical expenditure of non-NCD households in the same household group. Complex survey weights were used for all calculations in estimating both the number of impoverished households and the corresponding percentage of the population.

While NCD-related impoverishment refers to the transition of households to a consumption level that is below the poverty line after adjusting for NCD medical expenditure, it is likely that NCD-related expenditure can contribute to reducing the consumption of households on both sides of the poverty line even without affecting their formal poverty status. We refer to these broader NCD-related consumption effects as reduction in net consumption, or the downward movement of NCD households to a lower consumption range after household consumption is adjusted for NCD medical expenditure. To capture this, we categorized households in several mutually exclusive bands based on consumption expenditure relative to the poverty line. Household i is assigned to band b with lower bound B_l^b and upper bound B_u^b if:

$$\frac{1}{PL_s} \left(\frac{C_{i,z,q,s}^{Total}}{Z_{i,z,q,s}} \right) \times 100\% \in [B_l^b, B_u^b) \quad (5)$$

After adjusting for NCD-related additional medical expenses, household i could move to band b^* if:

$$\frac{1}{PL_s} \left(\frac{C_{i,z,q,s}^{Total} - C_{i,z,q,s}^{NCD}}{Z_{i,z,q,s}} \right) \times 100\% \in [B_l^{b^*}, B_u^{b^*}) \quad (6)$$

If $b = b^*$, then household i remains in the same band; if $b > b^*$, then household i moves to a lower band. This movement indicates reduction in net consumption associated with NCD medical expenditure. The bands are: 1) below poverty line, 2) at or above poverty line but below 125% of the poverty line, 3) at or above 125% but below 150% of the poverty line, 4) at or above 150% but below 200% of the poverty line, and at 5) or above 200% but below 300% of the poverty line. Since $C_{i,z,q,s}^{NCD}$ is zero for households without any reported diseases and households with non-NCD only, this analysis, along with the impoverishment analysis, is only applicable to NCD households. Using survey weights, we estimate the population of NCD households in each band and calculate how many persons are expected to move to a lower consumption band after accounting for NCD-related expenditure.

3. Results

Table 1 reports unadjusted means for the examined medical expenditure outcomes. NCD households were estimated to incur higher OOP expenditure compared to households without NCDs. The average monthly medical expenditure for NCD-only households was 667 BDT, compared to 372 BDT and 202 BDT spent by non-NCD-only households and no-disease households, respectively. The Medical expenditure as a fraction of total household expenditure is 4.09% for NCD-only households, 5.18% for households with both NCDs and non-NCDs, and 1.94% for households reporting no diseases. The proportion of households incurring catastrophic medical expenditure is 9.5% for NCD-only households and 13.1% for NCD and non-NCD households, both of which are higher than those for households with no diseases or with non-NCD only (2.2% and 7.4%, respectively). We observe similar patterns for rural and urban households. However, while the absolute amount of money spent on medical expenditures is lower for rural households, the medical expenditure as a share of total expenditure, and the proportion of households facing catastrophic medical expenditure are higher for rural households than their urban counterparts.

Adjusted differences in medical expenditure outcomes between disease-affected households and no-disease households were obtained from Eq. (1). Compared to no-disease households, NCD-only households were estimated to spend 345 BDT per month more on medical treatment, to allocate 1.92 percentage points more of household budget on medical spending, and to have a 6.7 percentage points higher probability of incurring catastrophic medical expenditure. The differences are higher for households reporting dual disease burden, and lower for households reporting non-NCDs only (Table 2). As a sensitivity check, we performed quantile regressions for medical expenditure at the 10th, 25th, 50th, 75th, and 90th quantiles (results not reported here), and find that the differences between NCD and non-NCD households are positive and statistically significant at every quantile estimates.

Table 3 reports the association between presence of NCDs in the household and the probability of experiencing medically-related financial stress. NCD households were more likely to sell assets or borrow from informal sources to cover medical expenses. Their probability of doing so was estimated to be 3.6 percentage points higher than that for non-NCD households, representing a near-doubling of the risk of financial stress relative to the baseline rate of 4.22% for non-NCD households. The estimate is higher (4.1 percentage points) for households in rural areas and not statistically significant for households in urban areas. As expected, the presence of multiple illnesses in the household increases the probability of medically-related financial stress.

Estimates of NCD-related impoverishment are reported in Table 4. Of the 36.4 million people living in NCD households, 24.5% are below the poverty line, as defined by their total consumption expenditure. This proportion increases to 26.3% after subtracting NCD-related additional medical expenditure, translating into impoverishment for 0.66 million people, or a 7.4% increase in the poverty rate for persons in NCD households (1.37% increase in the overall poverty rate). As a percentage of the total Bangladesh population of 148.49 million persons in 2010, 5.99% live in NCD households below the poverty line, which increases to 6.44% after adjusting for NCD-related medical spending.

Fig. 1 illustrates the relationship between NCD-related medical expenditure and household's net consumption reduction (loss of consumption of other commodities). Total household-level expenditure per capita as percentage of the poverty line is represented by the solid markers before adjusting for NCD-related expenditure per capita and by the hollow markers after adjusting for NCD-related expenditure per capita. The transition from solid to hollow markers across households illustrates the downward movement in consumption after netting out NCD-related expenses. Households above the poverty line could either

Table 2

Adjusted differences in medical expenditure, medical expenditure share, and the probability of experiencing catastrophic medical expenditure between households with reported diseases relative to no-disease households.

	Medical expenditure (BDT per month)	Medical expenditure share (percentage points)	Experiencing catastrophic medical expenditure (percentage points)
Adjusted Differences			
HH has NCD only	345.20*** (185.38, 505.02)	1.917*** (1.450, 2.385)	0.0672*** (0.0425, 0.0918)
HH has NCD & non-NCD	537.84*** (204.69, 870.99)	2.690*** (2.244, 3.136)	0.0953*** (0.0773, 0.1133)
HH has non-NCD only	153.86*** (100.94, 206.77)	1.246*** (1.030, 1.463)	0.0406*** (0.0300, 0.0512)
Estimates of Control Variables			
No. of elderly (age 60 +)	106.97* (-4.84, 218.77)	0.319*** (0.115, 0.524)	0.0115** (0.0008, 0.0223)
No. of reproductive age female	49.11** (3.86, 94.37)	-0.007 (-0.148, 0.135)	-0.0028 (-0.0103, 0.0047)
No. of infant ()	39.71 (-25.46, 104.88)	0.398*** (0.203, 0.592)	0.0154*** (0.0052, 0.0256)
Household Size			
3–5	161.71* (-25.44, 348.87)	-0.492*** (-0.851, -0.132)	-0.0250*** (-0.0440, -0.0060)
6–9	243.93*** (106.47, 381.40)	-0.809*** (-1.224, -0.393)	-0.0385*** (-0.0599, -0.0170)
10 and more	313.52*** (85.26, 541.77)	-1.526*** (-2.311, -0.741)	-0.0581** (-0.1049, -0.0112)
Household Income per capita			
BDT 700–999	48.48** (1.11, 95.86)	0.300* (-0.039, 0.639)	0.0191** (0.0002, 0.0380)
BDT 1000–1499	88.25*** (40.74, 135.76)	0.405** (0.067, 0.744)	0.0183** (0.0006, 0.0360)
BDT 1500–2499	107.52*** (61.38, 153.65)	0.380** (0.049, 0.710)	0.0278*** (0.0108, 0.0449)
BDT 2500–4999	167.58*** (72.17, 262.98)	0.596*** (0.218, 0.975)	0.0326*** (0.0141, 0.0512)
BDT 5000 & more	529.33*** (293.62, 765.03)	0.769*** (0.253, 1.284)	0.0399*** (0.0158, 0.0639)
Household Head's Education			
Primary	-13.52 (-66.04, 38.99)	-0.111 (-0.374, 0.152)	-0.0100 (-0.0227, 0.0028)
Secondary/Higher Secondary	89.31*** (29.09, 149.53)	0.071 (-0.155, 0.296)	0.0010 (-0.0114, 0.0134)
Bachelors	-150.60 (-476.36, 175.17)	-0.263 (-0.787, 0.261)	-0.0020 (-0.0317, 0.0277)
Graduate or Professional	-237.32 (-714.60, 239.95)	-0.610* (-1.327, 0.107)	-0.0348** (-0.0624, -0.0072)
Electricity Connection			
	29.11 (-30.29, 88.50)	-0.022 (-0.263, 0.220)	0.0030 (-0.0101, 0.0162)
Latrine Type			
Pacca	-53.54 (-179.62, 72.53)	-0.294* (-0.594, 0.006)	-0.0077 (-0.0220, 0.0066)
Sanitary	150.16 (-59.05, 359.38)	-0.180 (-0.581, 0.222)	-0.0008 (-0.0183, 0.0167)
Open space	-29.02 (-87.56, 29.53)	-0.216 (-0.710, 0.278)	-0.0163 (-0.0402, 0.0075)
Source of Drinking Water			
Tube-well	-171.23 (-623.43, 280.97)	0.296 (-0.384, 0.976)	0.0199* (-0.0023, 0.0421)
Other	-235.43 (-585.92, 115.05)	-0.702* (-1.431, 0.027)	-0.0038 (-0.0339, 0.0263)

(continued on next page)

Table 2 (continued)

	Medical expenditure (BDT per month)	Medical expenditure share (percentage points)	Experiencing catastrophic medical expenditure (percentage points)
Roof Type			
<i>CIS/wood</i>	-308.88* (-628.50, 10.73)	-0.021 (-0.435, 0.393)	0.0080 (-0.0084, 0.0245)
<i>Straw/hay/other</i>	-338.32** (-635.25, -41.39)	-0.018 (-0.585, 0.549)	0.0048 (-0.0208, 0.0303)
Household's major source of income			
<i>Agricultural Production</i>	-265.60** (-483.17, -48.03)	-1.130*** (-1.546, -0.715)	-0.0495*** (-0.0681, -0.0310)
<i>Nonagricultural Production</i>	-328.30** (-626.64, -29.95)	-1.177*** (-1.576, -0.778)	-0.0499*** (-0.0661, -0.0338)
<i>Wages & Salaries</i>	-328.32*** (-567.28, -89.36)	-0.988*** (-1.349, -0.628)	-0.0443*** (-0.0595, -0.0291)
Rural	57.29 (-21.23, 135.81)	0.506*** (0.199, 0.813)	0.0208*** (0.0067, 0.0348)
Constant	673.21* (-40.07, 1386.49)	5.700*** (4.154, 7.246)	0.1814*** (0.0860, 0.2767)
Observations	12,240	12,240	12,240
R-squared	0.05	0.122	0.0589

Notes: HH: household. 95% confidence interval in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. All models control for district fixed effects.

Table 3

Presence of NCD in household and experiencing financial stress (selling of assets or borrowing to pay for medical treatment).

	All households	Rural households	Urban households
HH has NCD	0.036*** (0.013,0.059)	0.041*** (0.013,0.068)	0.020 (-0.015,0.055)
Multiple illness in HH (relative to single illness)			
<i>Multiple illness of same person</i>	0.047*** (0.020,0.075)	0.054*** (0.020,0.087)	0.021* (-0.004,0.045)
<i>Illness in multiple persons</i>	0.022*** (0.010,0.034)	0.026*** (0.012,0.041)	0.006 (-0.007,0.019)
# Observations	6645	4542	2103

Note: HH: households. 95% confidence interval in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. All models control for district fixed effects. All models control for the following variables, not included in the table: household Size (3–5, 6–9, 10 and more), household income per capita (BDT 700–999, 1000–1499, 1500–2499, 2500–4999, 5000 & more), household's major source of income (agricultural production, non-agricultural production, wages & salaries) household head's education (primary, secondary, baccalaureate, graduate or professional), household head's work status (wage or salary earner, self-employed, employer), proportion of working age member (15–64), female headed household, whether the household receives remittances from abroad.

Table 4

Estimates of NCD-related impoverishment.

	% of people living below poverty line		Difference (percentage points)	Relative difference (%)
	Estimate based on total HH expenditure before adjusting for NCD-related expenditure	Estimate based on total HH expenditure after subtracting NCD-related expenditure		
Population in HHs with NCD				
As % of total population (148.49 million persons)	5.99 (5.39, 6.60)	6.44 (5.80, 7.07)	0.44 (0.28, 0.60)	7.41
As % of the population in HHs with NCD (36.35 million persons)	24.48 (22.16, 26.80)	26.29 (23.89, 28.69)	1.81 (1.16, 2.46)	7.41

Notes: 95% confidence interval in parentheses.

experience impoverishment or draw nearer to the poverty line, while households below the poverty line further widen the gap between their consumption expenditure and the poverty line.

Table 5 provides detail on reduction in net consumption for different household groups by consumption expenditure band. For households with total expenditure between 200% and 300% of the poverty line, the average gap between total expenditure and the poverty line shrinks by about 7.9 percentage points after accounting for NCD-related spending. For households below the poverty line, the average expenditure gap is widened by 1.3 percentage points, pushing 4.66 million people deeper into poverty. Table 6 reports the estimated number of people being displaced from an upper consumption band to a lower band after accounting for NCD-related medical expenditure. For households below the poverty line, no downward mobility is shown in the absence of any lower band. 646,000 (11.6%) of the 5.56 million people in the consumption band of 200% to 300% of the poverty line move to a lower band category due to NCD-related medical expenditure. 17.5% of the 2.99 million people in consumption band of 175% to 200% of the poverty line move to a lower band category. Across all consumption bands above the poverty line, net consumption reduction would affect 2.97 million persons (including impoverishment of 0.66 million and excluding 4.66 million persons below the poverty line pushed further into poverty).

4. Conclusion

The growing prevalence of NCDs exposes households in developing countries to increased OOP spending on medical treatment, raising the risk of catastrophic medical expenditure and impoverishment (Saksena, Hsu & Evans, 2014). In 2010, 12% of the world population incurred catastrophic medical spending, which is a particular concern for low-income countries where medically-related impoverishment can interfere with economic development (Wagstaff et al., 2017a). However, evidence on the link between OOP medical expenditure and impoverishment in LICs is limited. This study investigates the association of NCD-related household medical spending to poverty in Bangladesh, and the role of NCDs in experiencing catastrophic expenditure and financial stress at the household level. The findings indicate that the presence of NCDs is significantly associated with higher OOP medical expenditure, higher risk of catastrophic medical expenditure, and higher risk of having to finance medical treatment through borrowing or selling of personal assets. At the population level, NCD-related OOP medical spending is associated with the impoverishment of 0.66 million persons and with the increase of financial vulnerability of many more from the reduction of the net consumption of 7.63 million persons on both sides of the poverty line.

The overall population increase in financial vulnerability from NCD-related OOP spending may have larger economic significance than the estimated increase in impoverishment. As Wagstaff et al. (2017b) have shown, OOP medical spending in low-income countries is likely to contribute more to increasing the depth of poverty than to transitions into poverty. Our findings are consistent with the implication that in

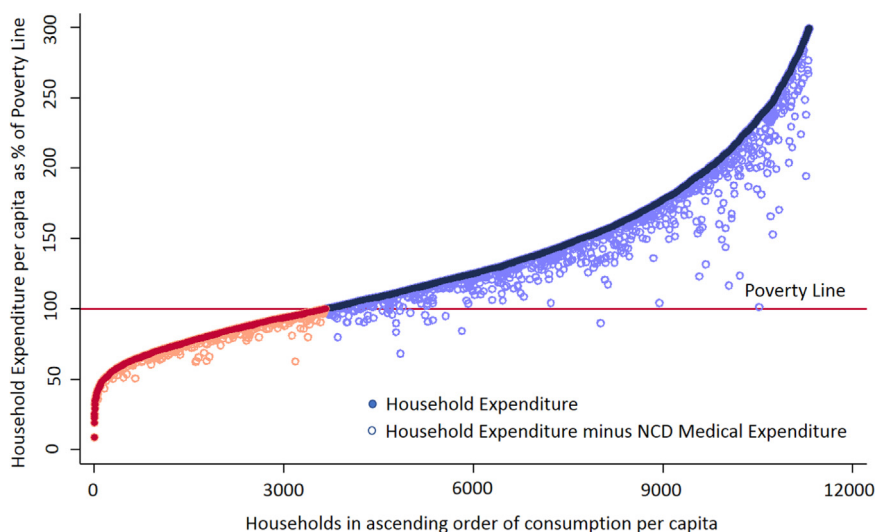


Fig. 1. NCD medical cost and reduction in net consumption. Note: Households are represented in the horizontal axis in ascending order of per capita consumption expenditure. Households with total expenditure per capita above 300% of poverty line are not shown in the figure.

Table 5
NCD-related consumption displacement by household expenditure band.

HH expenditure bands	Average gap between HH expenditure per capita and the poverty line (% of Poverty Line)		
	Estimate based on total HH expenditure before adjusting for NCD-related expenditure	Estimate based on total HH expenditure after subtracting NCD-related expenditure	NCD-related reduction in HH expenditure
≥ 200% and < 300% of PL	139.85 (136.91,142.78)	131.92 (128.32,135.52)	7.93 (6.05,9.82)
≥ 175% and < 200% of PL	86.87 (85.85,87.89)	82.12 (80.20,84.03)	4.75 (3.08,6.43)
≥ 150% and < 175% of PL	61.58 (60.66,62.50)	57.55 (56.10,58.99)	4.03 (2.94,5.13)
≥ 125% and < 150% of PL	36.15 (35.34,36.96)	33.25 (32.32,34.18)	2.90 (2.34,3.45)
≥ 100% and < 125% of PL	11.91 (11.16,12.67)	9.44 (8.51,10.38)	2.47 (1.84,3.09)
< 100% of PL	-20.73 (-22.01,-19.44)	-22.06 (-23.34,-20.79)	1.34 (1.11,1.57)

Notes: HH: household. PL: poverty line. 95% confidence interval in parentheses.

Table 6
NCD-related consumption status displacement (million persons) by household expenditure band.

HH expenditure bands	Population in band (million)	Population moved to a lower band after adjusting for NCD-related expenditure (million)	% change
≥ 200% and < 300% of PL	5.56 (5.02,6.10)	0.646 (0.432,0.860)	11.62
≥ 175% and < 200% of PL	2.99 (2.51,3.46)	0.524 (0.317,0.730)	17.53
≥ 150% and < 175% of PL	3.58 (3.09,4.08)	0.505 (0.328,0.681)	14.08
≥ 125% and < 150% of PL	4.95 (4.61,5.29)	0.661 (0.464,0.859)	13.36
≥ 100% and < 125% of PL	6.39 (5.87,6.91)	0.636 (0.408,0.865)	9.96
< 100% of PL	8.90 (8.24,9.56)	–	–

Notes: HH: household. PL: poverty line. 95% confidence interval in parentheses.

Bangladesh, the NCD-related deepening of poverty (in 4.7 million persons) is likely to outpace NCD-related impoverishment (affecting 0.66 million persons). Both of these effects reinforce the poverty cycle for vulnerable households in Bangladesh.

Similar to other lower-income countries, Bangladesh is experiencing a double epidemiological burden of communicable and non-communicable diseases, which existing health systems are not equipped to address (Bygbjerg, 2012; Beaglehole et al., 2011). The lack of resources for addressing NCDs has implications for our findings. Under-resourced health systems entail high rates of NCD under-diagnosis: in Bangladesh, 83% of adults have never had a blood glucose measurement, 33% have never had a blood pressure measurement, and

asymptomatic conditions such as hypertension often remain undiagnosed and untreated (World Health Organization, 2011b). As awareness of NCDs grows, increased rates of NCD diagnosis without corresponding rise in incomes would correspond to a rise in the number of households with NCD-related impoverishment due to treatment costs. Thus, our estimates represent a lower bound of NCD-related financial vulnerability in Bangladesh, and the effects of NCD-related OOP expenditure on impoverishment and household financial stress are likely to grow in the future as awareness of NCDs improves. Productivity and income loss due to NCD related morbidity and premature mortality could further aggravate household consumption, which remained beyond the scope of this paper, and subject to further research.

Also intra-household risk factor exposure, comorbidity and between-member disease dependencies remained beyond the scope of our analysis. Our findings emphasize the forthcoming need for public policy response to the expected rise in economic vulnerability due to NCDs in Bangladesh.

As a way forward towards mitigating NCD-related economic vulnerabilities, cost-effective interventions have been identified by the World Health Organization to prevent or slow down the rise in NCDs in developing countries (Kostova et al., 2017). Suitable approaches include policies to reduce tobacco use, excessive alcohol use, unhealthy diets, and physical activity, as well as patient-level actions to control cardiovascular disease, diabetes, and some cancers (World Health Organization, 2017). Prevention of NCDs in Bangladesh can help enhance population wellbeing.

Ethics approval statement

Ethics approval not required.

Ethics approval was not required for this paper, since publicly available secondary survey data has been used for this study.

Declarations of interest

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

- Bangladesh Bureau of Statistics (2011). *Report of the household income and expenditure survey 2010* People's Republic of Bangladesh: Bangladesh Bureau of Statistics, Ministry of Finance.
- Beaglehole, R., Bonita, R., Horton, R., Adams, C., Alleyne, G., Asaria, P., ... Cecchini, M. (2011). Priority actions for the non-communicable disease crisis. *The Lancet*, 377(9775), 1438–1447.
- Bleich, S. N., Koehlmoos, T. L. P., Rashid, M., Peters, D. H., & Anderson, G. (2011). Noncommunicable chronic disease in Bangladesh: Overview of existing programs and priorities going forward. *Health Policy*, 100(2–3), 282–289.
- Bollyky, T. J., Templin, T., Cohen, M., & Dieleman, J. L. (2017). Lower-income countries that face the most rapid shift in noncommunicable disease burden are also the least prepared. *Health Affairs*, 36(11), 1866–1875.
- Bygbjerg, I. C. (2012). Double burden of noncommunicable and infectious diseases in developing countries. *Science*, 337(6101), 1499–1501.
- Islam, A., & Biswas, T. (2014). Chronic non-communicable diseases and the healthcare system in Bangladesh: Current status and way forward. *Chronic Diseases – International*, 1(2), 6.
- Karar, Ahsan Z., Alam, N., & Kim Streatfield, P. (2009). Epidemiological transition in rural Bangladesh, 1986–2006. *Global Health Action*, 2(1), 1904.
- Khan, J. A., Ahmed, S., & Evans, T. G. (2017). Catastrophic healthcare expenditure and poverty related to out-of-pocket payments for healthcare in Bangladesh—an estimation of financial risk protection of universal health coverage. *Health Policy and Planning*.
- Kostova, D., Chaloupka, F., Friedena, T., Henninge, K., Paul, J., Oseweg, P., & Asma, S. (2017). Noncommunicable disease risk factors in developing countries: Policy perspectives. *Preventive Medicine*, 105, S1–S3.
- Kruk, Margaret E., Goldmann, Emily, & Galea, Sandro (2009). Borrowing and selling to pay for health care in low-and middle-income countries. *Health Affairs*, 28.4, 1056–1066.
- Mahal, A. S., Karan, A., & Engelgau, M. (2010). *Economic implications of non-communicable disease for India*. Washington, DC: World Bank.
- Mahumud, R. A., Sarker, A. R., Sultana, M., Islam, Z., Khan, J., & Morton, A. (2017). Distribution and determinants of out-of-pocket healthcare expenditures in Bangladesh. *Journal of Preventive Medicine and Public Health*, 50(2), 91.
- Ministry of Health and Family Welfare (2015). *Bangladesh National Health Accounts 1997–2012 (Research Paper No. 42a)* Dhaka: Health Economics Unit, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh.
- Molla, A. A., Chi, C., & Mondaca, A. L. N. (2017). Predictors of high out-of-pocket healthcare expenditure: An analysis using Bangladesh household income and expenditure survey, 2010. *BMC Health Services Research*, 17(1), 94.
- Rahman, M. M., Gilmour, S., Saito, E., Sultana, P., & Shibuya, K. (2013). Health-related financial catastrophe, inequality and chronic illness in Bangladesh. *PLoS One*, 8(2), e56873.
- Saksena, P., Hsu, J., & Evans, D. B. (2014). Financial risk protection and universal health coverage: Evidence and measurement challenges. *PLoS Medicine*, 11(9), e1001701.
- Wagstaff, A., & van Doorslaer, E. (2003). Catastrophe and impoverishment in paying for health care: With applications to Vietnam 1993–98. *Health Economics*, 12(11), 921–934.
- Wagstaff, A., Flores, G., Hsu, J., Smitz, M. F., Chepynoga, K., Buisman, L. R., ... Eozenou, P. (2017a). Progress on catastrophic health spending in 133 countries: A retrospective observational study. *The Lancet Global Health*.
- Wagstaff, A., Flores, G., Smitz, M. F., Hsu, J., Chepynoga, K., & Eozenou, P. (2017b). Progress on impoverishing health spending in 122 countries: A retrospective observational study. *The Lancet Global Health*.
- World Bank (2011). *Bangladesh – Household income and expenditure survey: Key findings and results 2010* Washington DC: World Bank.
- World Health Organization (2011a). *Global status report on noncommunicable diseases 2010* Geneva: World Health Organization.
- World Health Organization (2011b). *Bangladesh NCD risk factor survey 2010 fact sheet* Bangladesh: World Health Organization.
- World Health Organization (2014). *Global status report on noncommunicable diseases 2014* Geneva: World Health Organization.
- World Health Organization (2017). *The updated appendix 3 of the WHO global NCD action plan 2013–2020* Geneva: World Health Organization.
- Xu, K. (2005). *Distribution of health payments and catastrophic expenditures methodology*. Geneva: World Health Organization.