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ORIGINAL RESEARCH

Money Gone Up in Smoke: The Tobacco Use and Malnutrition Nexus in Bangladesh

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Abstract

BACKGROUND The tobacco epidemic in Bangladesh is pervasive. Expenditures on tobacco may reduce money available for food in a country with a high malnutrition rate.

OBJECTIVES The aims of the study are to quantify the opportunity costs of tobacco expenditure in terms of nutrition (ie, food energy) forgone and the potential improvements in the household level food-energy status if the money spent on tobacco were diverted for food consumption.

METHOD We analyzed data from the 2010 Bangladesh Household Income and Expenditure Survey, a nationally representative survey conducted among 12,240 households. We present 2 analytical scenarios: (1) the lower-bound gain scenario entailing money spent on tobacco partially diverted to acquiring food according to households' food consumption share in total expenditures; and (2) the upper-bound gain scenario entailing money spent on tobacco diverted to acquiring food only. Age- and gender-based energy norms were used to identify food-energy deficient households. Data were analyzed by mutually exclusive smoking-only, smokeless-only, and dual-tobacco user households.

FINDINGS On average, a smoking-only household could gain 269-497 kilocalories (kcal) daily under the lower-bound and upper-bound scenarios, respectively. The potential energy gains for smokeless-only and dual-tobacco user households ranged from 148-268 kcal and 508-924 kcal, respectively. Under these lower- and upper-bound estimates, the percentage of smoking-only user households that are malnourished declined significantly from the baseline rate of 38% to 33% and 29%, respectively. For the smokeless-only and dual-tobacco user households, there were 2-3 and 6-9 percentage point drops in the malnutrition prevalence rates. The tobacco expenditure shift could translate to an additional 4.6-7.7 million food-energy malnourished persons meeting their caloric requirements.

CONCLUSIONS The findings suggest that tobacco use reduction could facilitate concomitant improvements in population-level nutrition status and may inform the development and refinement of tobacco prevention and control efforts in Bangladesh.

KEY WORDS tobacco use, malnutrition, Bangladesh, opportunity costs of tobacco expenditures, household income and expenditure survey

Conflict of Interest: The authors declare that there is no conflict of interest.

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INTRODUCTION

Nearly half of the adults aged 15 years and older (43%, 41 million persons) in Bangladesh, 58% of men and 29% of women, use tobacco in smoking or smokeless form.[1] The majority of the smokers are men, with 28.3% using manufactured cigarettes and 21.4% using bidis.[1] In addition, smokeless tobacco use is high among both genders: 26.4% of men and 27.9% of women use smokeless tobacco.[1] At the same time, according to the Food and Agriculture Organization of the United Nations (FAO), during 2010-2012, 17.3% (26.5 million persons) of the total population in Bangladesh was malnourished.[2] Alleviation of malnutrition is an important policy goal and public health challenge in Bangladesh.[3-5]

The adverse health and economic consequences of tobacco use are compounded by the global challenges of alleviating poverty and malnutrition. Published reports on the nexus between tobacco use and nutrition have found that households divert a significant amount of scarce income to tobacco products,[6-10] crowding out expenditure on basic needs, such as food, health, and education.[8,11-13] This diversion of funds, in turn, exacerbates the effects of poverty, including the nutritional status of children.[14-19] An earlier study by Efroymson et al[6] reported that the average male cigarette smoker in Bangladesh spent more than twice as much on cigarettes as the per capita expenditure on clothing, housing, health, and education combined; that a typical poor smoker could add more than 500 calories to the diet of 1 or 2 children by eliminating his or her daily tobacco expenditure; and that an estimated 10.5 million malnourished people could have an adequate diet if money on tobacco were spent on food instead.[6]

Bangladesh ratified the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) in 2004 and has been implementing various provisions of the WHO FCTC and the best practices offered in the WHO MPOWER package.[20-25] The post-2015 Sustainable Development Goals include targets to address poverty, poor nutrition, and health, including strengthening the implementation of the WHO FCTC.[26] As the global call for the tobacco "end-game" strategy is gaining momentum,[27] analysis of the links between tobacco use reduction and potential improvements in the nutritional status of the population may inform and propel tobacco use prevention and control initiatives.

This paper uses the most recent data in Bangladesh to quantify the opportunity costs of tobacco expenditure in terms of nutrition (ie, food energy) forgone and the potential improvements in the household level food-energy status if the money spent on tobacco were diverted for food consumption.

Data Source. We used the most recent nationally representative Bangladesh Household Income and Expenditure Survey (HIES) 2010 from the Bangladesh Bureau of Statistics (BBS). The HIES is the major source of socioeconomic information at the household level in Bangladesh and is widely used for estimation of poverty and its correlates in Bangladesh, as well as for compilation of national accounts of the household sectors, and provides the weights for computation of the Current Price Index (CPI). It is one of the main data sources for preparation of the Poverty Reduction Strategy (PRS) and Five Year Plan (FYP); it is also used for monitoring the progress of poverty reduction and the Millennium Development Goals (MDGs) indicators. Details about the HIES methodology and survey design are published elsewhere.[28,29] The 2010 HIES consists of 12,240 households (7840 rural and 4400 urban). The consumption module of the HIES survey records household food quantities consumed and money spent on those for 14 days. The data for 14 days' food expenditure was collected over 7 visits with a 2-day recall for each visit.[28,29] Additionally, consumption of some weekly food items (eg, various spices, betel leaf, and chew goods) was collected for 2 weeks. The questionnaire included a comprehensive list of foods, including items consumed in Bangladesh, which can be broadly categorized as follows: cereals and their products; legumes, beans, and related products; fish and fish products; eggs, meat, poultry, and their products; vegetables and leafy vegetables; milk and dairy products; sugar, molasses, and desserts; oil and fats; fruits; beverages and other drinks; and miscellaneous food.

Expenditures on tobacco and tobacco products, including cigarettes, tobacco leaf, bidis, and gul, were recorded in the daily food consumption section, whereas some other smokeless products (eg, betel leaf and chew goods) were recorded in the weekly food consumption section of the questionnaire. These tobacco products were grouped into smoking and smokeless categories. The consumption module also recorded comprehensive expenditure data on monthly and yearly nonfood items, such as clothing; housing; education; health,

life-style, and hygiene; energy; transport and communication; entertainment; and miscellaneous.

METHOD

Analysis. A single household was used as the primary unit of analysis for this study. A household was considered to have a tobacco user if it recorded any expenditure on tobacco. We denote x_i and y_i as daily household expenditure on food and tobacco, respectively, for the i^{th} household ($i = 1, 2,\ldots, n$); where $x_i > 0$ for all households, $y_i = 0$ for tobacco nonuser households, and $y_i > 0$ for tobacco user households. The analyses were conducted separately for the following mutually exclusive categories of tobacco use in households: smoking-only, smokeless-only, and dual-tobacco (smoking and smokeless) user households. Therefore, y_i included expenditures on smoking-only, smokeless-only, and dual-tobacco use by the respective household groups. Households consumed j food items ($j = 1, 2,\ldots, m$), which were further grouped into k broader categories ($k = 1, 2,\ldots, l$). The function, $f(.)$, which mapped from j to k, recorded the relationship between a j^{th} food item to a food category in k.

Household Food-Energy Acquisition. We calculated the daily food energy acquired by households in kilocalories (kcal) using the food-energy conversion factor (kcal/100 g) and edible portion coefficients for the respective food items.[30] We used the food-energy conversion factors provided in the 2010 HIES dataset by the Bangladesh Bureau of Statistics. Data on edible portions, which was calculated as the edible portion of the total food as purchased, were obtained from the existing literature on the food composition table for Bangladesh.[30,31] The metric quantities (grams) were multiplied by the edible portion (a ratio between 0 and 1) and the energy conversion factors:

$$E_{ij} = \left(Q_{ij} \times \eth_j \times \frac{\varnothing_j}{100}\right)$$

where E_{ij} is the daily food-energy acquisition by i^{th} household from j^{th} food item; Q_{ij} denotes quantity (grams) of j^{th} food item consumed by i^{th} household; $\varnothing_j$ denotes the food energy (kcal) per 100 g, and $\eth_j \in (0, 1)$ denotes the edible portion for j^{th} food item. The food-item level energy values were added up across all categories acquired by each household to arrive at the total daily household food-energy acquisition, E_i:

$$E_i = \sum_j E_{ij}$$

The food energy acquired by i^{th} household from k broad food categories can be derived as

$$E_{ik} = \sum_{for\ \ all\ \ j\ \ such\ \ that\ \ f(j)=k} E_{ij}$$

so that

$$E_i = \sum_j E_{ij} = \sum_k E_{ik} = \sum_k \sum_{for\ \ all\ \ j\ \ such\ \ that\ \ f(j)=\ k} E_{ij}$$

Food Quantity and Food Energy Per Unit of Money Spent. For each household, we calculated the quantity (grams) of food obtained per unit of money (ie, Bangladesh taka) spent on all food (q_i), and on each k broad food categories (q_{ik}), as

$$q_i = \frac{\sum_k Q_{ik}}{\sum_k x_{ik}} = \frac{\sum_j Q_{ij}}{\sum_j x_{ij}}$$

$$q_{ik} = \frac{Q_{ik}}{x_{ik}}$$

where Q_{ik} is total quantity of k^{th} food category acquired daily by i^{th} household and x_{ik} is total expenditure on k^{th} food category by i^{th} household.

Similarly, energy (kcal) acquired per unit of money spent on all food (ε_i) and on each k broad categories (ε_{ik}) were estimated as

$$\varepsilon_i = \frac{\sum_k E_{ik}}{\sum_k x_{ik}} = \frac{\sum_j E_{ij}}{\sum_j x_{ij}}$$

$$\varepsilon_{ik} = \frac{E_{ik}}{x_{ik}}$$

The estimates of quantity (q_{ik}) and food energy (ε_{ik}) acquired per unit of money spent allowed estimating the opportunity costs of tobacco expenditure (y_i) in terms of quantity of food forgone (φ_{ik}) and kcal forgone (ϑ_{ik}) with respect to each broad category of food:

(a) Household's opportunity costs of tobacco expenditure in terms of food quantity forgone:

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$$\varphi_{ik} = (q_{ik} \times y_i)$$

(b) Household's opportunity costs of tobacco expenditure in terms of food energy forgone:

$$\vartheta_{ik} = (\varepsilon_{ik} \times y_i)$$

Food-Energy Deficient Households. We identified food-energy deficient (ie, calorie-malnourished) households using age- and gender-specific calorie requirement norms. Traditionally, a single per capita calorie norm for the entire population is used to determine the prevalence of malnutrition (ie, food-energy deficiency). In Bangladesh, 3 caloric norms are widely used: intake of 2122 kcals, 1805 kcals, and 1600 kcals per person per day to estimate the prevalence of absolute, hard-core, and hard-ultra poverty, respectively.[28] However, use of a single calorie norm does not take into account differences in household composition and the fact that caloric requirements for households of the same size may differ depending on the members' ages, genders, and type of physical work done (eg, light, moderate, or heavy activity).[30,32] For instance, a 2-member household consisting of 2 adults will have different total caloric requirement per day than a household with 1 adult and 1 child. To account for these variations in household composition, we used age- and gender-based daily caloric requirements for light activities recommended jointly by FAO, WHO, and United Nations University.[30,32] Use of the "light" activity level is recommended as a normative standard for all populations.[30] For example, a household that does not consume enough food over the reference period to meet the energy requirements of all of its members for basal metabolic function and light activity is considered food-energy deficient. Appendix Table 1 provides the recommended daily caloric intakes for light activity, by age and gender. We used these values for each household and assigned caloric requirements based on the household composition.

The daily average food-energy acquisitions (E_i) were compared with the assigned calorie norm (e_i) for each household. A household was defined as energy deficient if the total kcal acquired per day was less than the recommended caloric intake for that household:

$$E_i < e_i$$

where e_i represents the FAO, WHO, and United Nations University recommended age- and gender-based daily caloric acquisition for i^{th} household.[30,32]

The percentage of households that were calorie malnourished (P_0), and the food-energy gap (P_1) measuring the extent to which malnourished households fell below the recommended calorie norm as a proportion of the calorie norm, can be expressed as

$$P_0 = \frac{H}{N}$$

$$P_1 = \left| \frac{1}{N} \sum_{i=1}^{H} \left(\frac{e_i - E_i}{e_i} \right) \right|$$

Here, H denotes the total number of food-energy deficient households in total N households. In estimating the food-energy gap (P_1) measure, expressed in absolute percentage values, the households acquiring food energy above the recommended level were considered to have zero energy gaps.[33]

Food-Energy Scenarios. We generated the baseline estimates of daily food energy acquired by households and compared the result with 2 additional analytical scenarios. The baseline estimates represented the daily food energy acquired as reported during the survey, expressed as E_i earlier. The upper-bound scenario entailed the daily food energy acquired by households when the total money spent on tobacco was diverted to food consumption only, expressed here as E_i^{ub}:

$$E_i^{ub} = E_i + (\varepsilon_i \times y_i)$$

The lower-bound scenario estimated the daily food energy acquired when money spent on tobacco was partially diverted to acquiring food according to households' food consumption share in total expenditure, expressed here as E_i^{lb}:

$$E_i^{lb} = E_i + (\varepsilon_i \times y_i \times f_i)$$

Here, f_i denotes the proportion of food expenditure in total expenditure (including food and nonfood items). In the upper-bound scenario, although the households increased caloric intake by shifting their entire money spent on tobacco toward acquiring foods, they preserved their food consumption patterns. The lower-bound scenario assumed that households shifted a portion of the money spent on tobacco toward acquiring food and shifted the remaining portion of the money spent on tobacco toward other nonfood essentials,

so that a household's food consumption pattern, as well as the food and nonfood expenditure ratio, remained unchanged. The daily food-energy acquired by households, the percentage of food-energy deficient households (P_0), and the food-energy gap (P_1) under the baseline, upper-bound, and lower-bound scenarios were then compared.

All estimates were derived applying relevant weights to take into account the complex survey design. The results are presented for the mutually exclusive smoking-only, smokeless-only, and dual-tobacco user households.

RESULTS

Tobacco Use. Overall, 71.5% of households reported spending money on tobacco. Of the 12,240 households surveyed, 17.3% (n = 2061) spent money on smoking-only, 26.8% (n = 3284) on smokeless-only, and 27.4% (n = 3348) on dual-tobacco (smoking and smokeless) use. Daily expenditures on tobacco were 9.1, 4.5, and 15.2 Bangladesh taka for the smoking-only, smokeless-only, and dual-tobacco user households, respectively.

Food and Tobacco Consumption Patterns. Table 1 shows the distribution (high to low) of total food and tobacco expenditures. On average, for smoking-only tobacco user households, the tobacco expenditure was 5.3% of the total spent for food and tobacco and was higher than several food categories, including oil and fat (4.9%), fruits (3.5%), legumes and beans (2.7%), miscellaneous (2.7%), beverage (2.5%), milk (2.3%), sugar (1.8%), and eggs (1.7%). For the smokeless-only tobacco user households, the tobacco expenditure was 2.9% of the total food and tobacco expenditure and was higher than the expenditures for legumes and beans (2.6%), milk (2.6%), beverage (2.1%), sugar (1.9%), and eggs (1.6%). The highest tobacco expenditure share (7.5%) was observed for dual-tobacco user households and was higher than expenditures for meat (5.8%), oil and fat (4.2%), fruits (3.1%), miscellaneous (2.9%), beverage (2.7%), legumes and beans (2.3%), milk (2.3%), sugar (1.8%), and eggs (1.3%).

Daily Food Quantity (Grams) Lost. The average amount of a particular food category that a household would potentially be able to purchase with the money spent daily on tobacco was calculated. Figure 1 shows that smoking-only tobacco user households could buy any 1 of the following quantities: vegetable (540 g), cereal (243 g), fruit (243 g), milk (225 g), legumes and beans (111 g), oil and fat (101 g), fish (77 g), eggs (72 g), or meat (50 g). However, the opportunity cost of daily tobacco expenditure in terms of food quantity forgone was substantially higher for the dual-tobacco user households. A dual-tobacco user household, on average, could purchase any 1 of the following food quantities: vegetable (951 g), cereals (431 g), fruits (424 g), milk (372 g), legumes and beans (207 g), oil and fat (168 g), fish (132 g), eggs (124 g), or meat (87 g).

Table 1. Percent Distribution of Total Food and Tobacco Expenditures, Bangladesh, 2010

	Percentage of Expenditures (95% confidence interval)		
	Smoking-Only Tobacco User Households (n = 2061)	Smokeless-Only Tobacco User Households (n = 3284)	Dual-Tobacco (Smoking and Smokeless) User Households (n = 3348)
Cereals	42.7 (41.7-43.7)	43.4 (42.6-44.3)	43.7 (42.9-44.5)
Fish	12.7 (12.2-13.1)	13.6 (13.1-14.0)	12.8 (12.4-13.1)
Vegetables	10.5 (10.2-10.7)	10.6 (10.4-10.8)	9.8 (9.6-10.0)
Meat	6.9 (6.1-7.6)	7.3 (6.6-8.0)	5.8 (5.2-6.3)
Tobacco	5.3 (5.0-5.5)	2.9 (2.7-3.1)	7.5 (7.1-7.9)
Oil and fat	4.9 (4.8-5.1)	4.9 (4.7-5.0)	4.2 (4.1-4.3)
Fruits	3.5 (3.1-3.9)	3.5 (3.2-3.8)	3.1 (2.7-3.4)
Legumes and beans	2.7 (2.6-2.8)	2.6 (2.4-2.7)	2.3 (2.4-2.4)
Miscellaneous	2.7 (2.5-2.8)	3.1 (3.0-3.2)	2.9 (2.8-3.0)
Beverage	2.5 (2.3-2.7)	2.1 (1.9-2.3)	2.7 (2.5-2.9)
Milk	2.3 (2.0-2.5)	2.6 (2.4-2.8)	2.3 (2.2-2.5)
Sugar	1.8 (1.6-2.0)	1.9 (1.7-2.0)	1.8 (1.6-1.9)
Eggs	1.7 (1.6-1.8)	1.6 (1.5-1.7)	1.3 (1.2-1.4)
Total	100%	100%	100%

Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

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Daily Food Energy (kcal) Lost. The opportunity cost of daily tobacco expenditure in terms of food quantity forgone was converted into daily food energy (kcal) potentially lost. Figure 2 shows the opportunity costs, by different food categories, if all resources could be diverted to that particular category. For instance, if the money spent on tobacco were used to purchase cereals, the smoking-only, smokeless-only, and dual-tobacco user households could potentially gain 857, 437, and 1,512 kcals of food energy daily, respectively.

Potential Caloric Gains. Two analytical scenarios were examined: (1) the upper-bound gain scenario entailing money spent on tobacco diverted to acquiring food only; and (2) the lower-bound gain scenario entailing a portion of money spent on tobacco diverted to acquiring food according to households' food consumption share in total expenditures. Table 2 (columns 2, 4, and 6) presents the averages of daily food-energy acquisitions under the baseline, lower-bound, and upper-bound scenarios for the mutually exclusive smoking-only, smokeless-only, and dual-tobacco user households, respectively. The total daily food-energy gains under lower-bound and upper-bound scenarios compared with the baseline estimates are shown for the 3 types of tobacco-user households in columns 3, 5, and 7, respectively. For instance, for the smoking-only tobacco user households, the average daily food-energy intakes were 9599, 9868, and 10,096 kcals under the baseline, lower-bound, and upper-bound scenarios, implying that compared with the baseline estimates the daily food-energy gains were 269 and 497 kcals per household in the lower-bound and upper-bound scenarios, respectively. The potential food-energy gains for smokeless-only and dual-tobacco user households ranged from 148-268 kcals and 508-924 kcal under lower-bound and upper-bound scenarios, respectively.

Estimated Improvements on Prevalence of Caloric Malnutrition. Table 3 shows the percentage of food-energy deficient households, along with their average food-energy gap compared with the energy recommendations, for each scenario and household

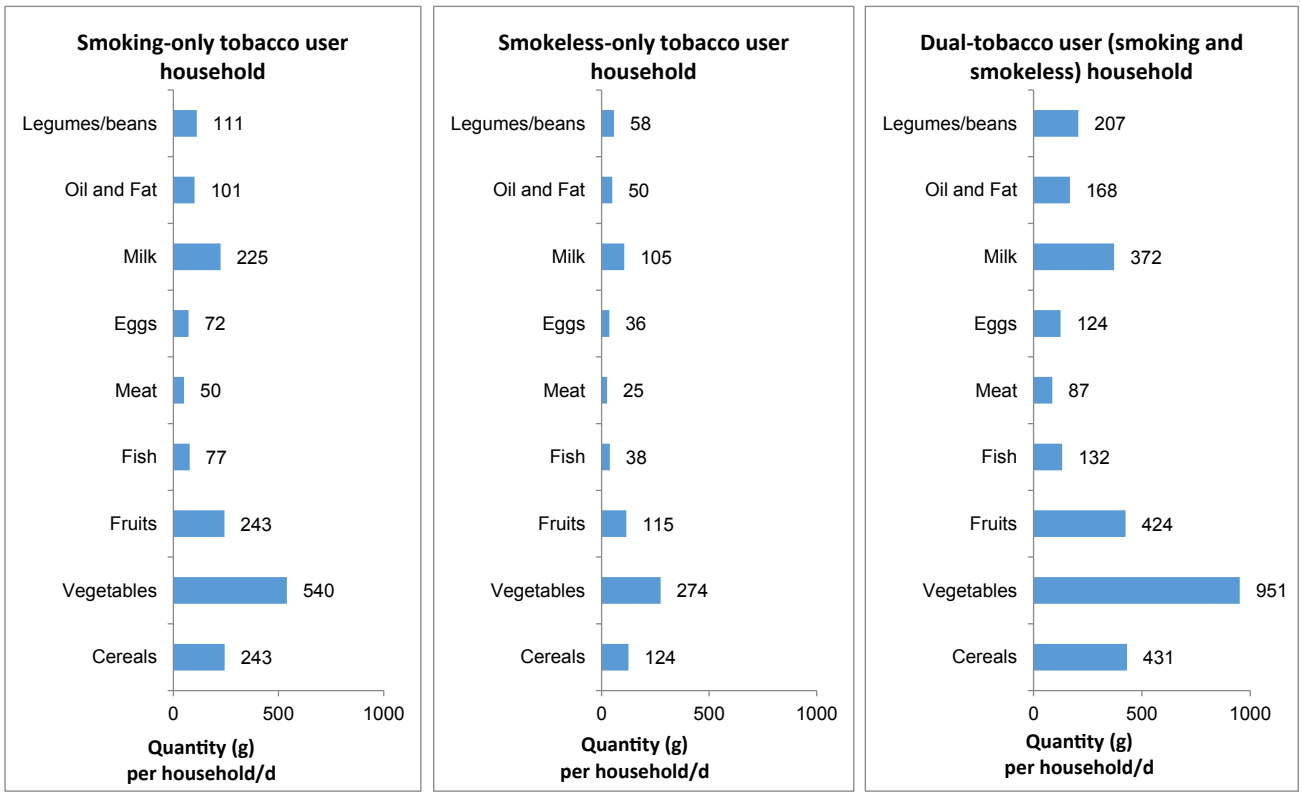

Figure 1. Opportunity cost of daily tobacco expenditure (grams of food per day per household). Quantity metrics are all in equivalent grams. Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

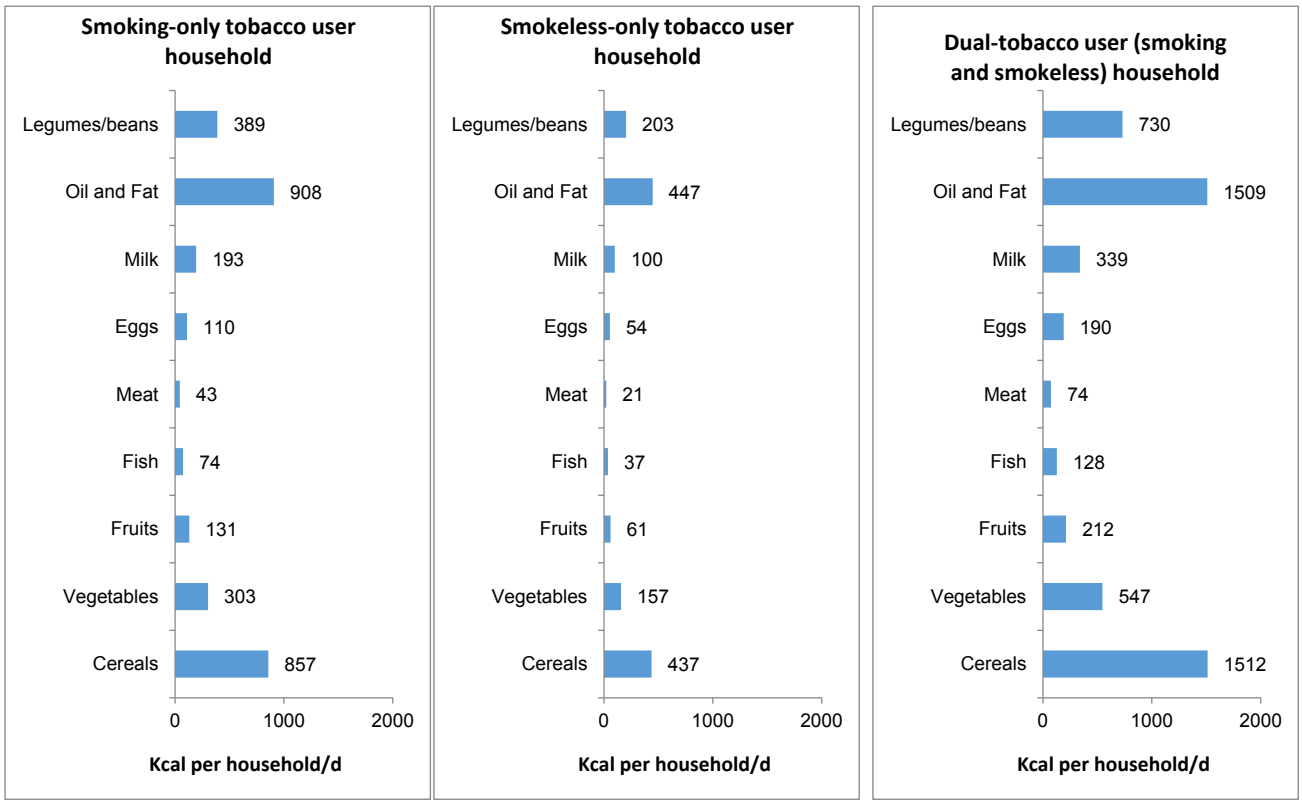

Figure 2. Opportunity cost of daily tobacco expenditure in terms of food energy (kilocalories) forgone. Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

tobacco-use category. The prevalence of food-energy deficient households among the smoking-only households dropped by 5-9 percentage points (38% to 33% and 29%) under the lower-bound and upper-bound estimates, respectively. This indicated that nearly 1.24-2.26 million additional people in 0.28-0.51 million smoking-only tobacco user households could potentially obtain adequate food energy, respectively (Table 4). For smokeless-only and dual-tobacco user households, there were

Table 2. Potential Calorie Gain Under Lower-Bound and Upper-Bound Scenarios (kilocalories/household/day)

	Smoking-Only Tobacco User Households		Smokeless-Only Tobacco User Households		Dual-Tobacco (Smoking and Smokeless) User Households	
	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Total Daily Calorie Acquisition (mean, 95% CI)	Total Daily Calorie Gain (mean, 95% CI)	Total Daily Calorie Acquisition (mean, 95% CI)	Total Daily Calorie Gain (mean, 95% CI)	Total Daily Calorie Acquisition (mean, 95% CI)	Total Daily Calorie Gain (mean, 95% CI)
Baseline estimate	9599 (9372-9825)	—	10,121 (9889-10,352)	—	11,677 (11,398-11,955)	—
Lower-bound scenario	9868 (9639-10,096)	269 (257-281)	10,269 (10,036-10,502)	148 (138-159)	12,185 (11,894-12,474)	508 (470-545)
Upper-bound scenario	10,096 (9866-10,324)	497 (473-520)	10,389 (10,155-100623)	268 (248-288)	12,601 (12294-12,908)	924 (834-1014)

CI, confidence interval.
Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

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Table 3. Percentage of Food-Energy Deficient Households and Food-Energy Gap Under 3 Scenarios

	Smoking-Tobacco User Households		Smokeless-Tobacco User Households		Dual-Tobacco User (Smoking and Smokeless) Households	
	P_0 (% Food-Energy Deficient)	P_1 Food-Energy Gap (%)	P_0 (% Food-Energy Deficient)	P_1 Food-Energy Gap (%)	P_0 (% Food-Energy Deficient)	P_1 Food-Energy Gap (%)
Baseline	37.8 (35.1-40.5)	6.0 (5.4-6.7)	33.8 (31.7-35.9)	5.9 (5.4-6.4)	31.8 (29.5-34.1)	5.1 (4.5-5.6)
Lower-bound scenario	32.9 (30.4-35.4)	5.1 (4.5-5.7)	31.6 (29.6-33.6)	5.4 (5.0-5.9)	26.2 (24.1-28.4)	4.0 (3.5-4.4)
Upper-bound scenario	28.8 (26.4-31.2)	4.4 (3.9-4.9)	30.5 (28.5-32.5)	5.1 (4.6-5.6)	22.8 (20.8-24.8)	3.3 (2.9-3.7)

Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

drops of 2-3 and 6-9 percentage points in the food-energy deficiency prevalence rates, respectively, which translates to 0.8-1.2 million persons in smokeless-only and 2.5-4.2 million persons in dual-tobacco user food-energy deficient households would have adequate food under the lower-bound and upper-bound scenarios, respectively (Table 4). In total, the estimated number of food-energy deficient people who would be able to meet their caloric requirements because of diverting tobacco expenditure toward food would be 4.6 million and 7.7 million under the lower-bound and upper-bound scenarios, respectively (Table 4).

In addition to the predicted reductions in the prevalence of malnutrition in this population, reductions were observed in the household-level food-energy gaps (P_1). Table 3 shows that in the baseline estimate the malnourished smoking-only households, on average, were 6.0% below the recommended food-energy norm. Under the lower-bound and upper-bound scenarios, this gap dropped to 5.1% and 4.4%, respectively, indicating that the remaining malnourished households would move closer to the recommended caloric intake. Similar patterns were observed for smokeless-only and dual-tobacco user households.

DISCUSSION

Poorer households are at greater risk of severe malnutrition, and spending limited household income on tobacco, rather than on food or other critical basic necessities, may potentially exacerbate this risk. The population in Bangladesh, particularly children and women, suffer from high levels of malnutrition, evidenced by the high prevalence of low

Table 4. Number of Food-Energy Deficient Households and Population Under Baseline, Lower-Bound, and Upper-Bound Scenarios

	Smoking-Only User Households		Smokeless-Only User Households		Dual-Tobacco User Households		Total Tobacco User Households*	
	No. of Energy-Deficient Households	Difference From the Baseline Estimate†	No. of Energy-Deficient Households	Difference From the Baseline Estimate†	No. of Energy-Deficient Households	Difference From the Baseline Estimate†	No. of Energy-Deficient Households	Difference From the Baseline Estimate†
Baseline estimates								
No. of households	2,154,248	—	2,910,683	—	2,782,558	—	7,847,489	—
No. of population	9,981,411	—	14,699,141	—	15,326,472	—	40,007,024	—
Lower-bound scenario								
No. of households	1,873,339	280,909	2,720,780	189,903	2,297,571	484,987	6,891,690	955,799
No. of population	8,741,247	1,240,164	13,861,217	837,924	12,824,410	2,502,062	35,426,874	4,580,150
Upper-bound scenario								
No. of households	1,641,492	512,756	2,623,436	287,247	1,994,956	787,602	6,259,884	1,587,605
No. of population	7,717,560	2,263,851	13,461,450	1,237,691	11,163,700	4,162,772	32,342,709	7,664,315

* Estimates are only for households where tobacco is used.
† Values indicate the number of households and population that were food-energy deficient in the baseline estimate that would no longer be food-energy deficient in the lower-bound and/or upper-bound scenarios.
Source: Authors' calculation using Household Income and Expenditure Survey (HIES) 2010.

birth weight, undernutrition (underweight, stunting, and wasting), and micronutrient deficiencies, including vitamin A, iodine, and iron deficiencies.[34] The nexus between tobacco and poverty presents a unique opportunity for public health researchers and policy makers to address tobacco cessation as an essential tool for tackling malnutrition and effectively improving health and well-being.

The findings from this study provide initial evidence that tobacco expenditure represents a significant portion of the total household expenditure among tobacco user households in Bangladesh, entailing large opportunity costs in terms of food quantity and food energy forgone. On average, a smoking-only household in Bangladesh could gain 269 to 497 kcals/day under the lower-bound and upper-bound scenarios, respectively. The potential energy gains for smokeless-only and dual-tobacco (smoking and smokeless) user households are 148-268 kcals/day and 508-924 kcals/day, respectively. Under these estimates, which represent the reallocation of funds spent on tobacco to food, the percentage of smoking-only tobacco user households that are currently malnourished would be reduced substantially from the baseline rate of 38% to 33% (lower-bound) or 29% (upper-bound). We observed similar patterns for smokeless-only and dual-tobacco user households. These estimates suggest that the tobacco expenditure shift could translate to meeting the caloric requirements of an additional 4.6-7.7 million people, a meaningful step toward reducing current malnutrition burden in Bangladesh.

These results should be viewed in relation to some limitations of this study. The lower-bound and upper-bound food-energy gain scenarios serve as analytical assessments of the assumption that a household would spend part or all of their tobacco expenditure on food consumption, preserving the existing household-level food consumption pattern. However, most of the studies investigating the crowding-out effects of tobacco expenditures assert that tobacco money crowds out expenditures on food and other basic needs.[8,11-13] Behavioral changes associated with individuals' quitting tobacco use and their effects on household consumption patterns would be important to understand, and future studies are needed to address these issues. Further research on households' responses to having increased money because of individual household members' quitting tobacco use could inform better study design. The intrahousehold food distribution, or how food distribution among the members of the households differs across households, was beyond the scope of the study. Additionally, for this study we assumed that relative prices for the food items would remain stable after changes in spending from tobacco to food. Furthermore, the implication of reduced tobacco consumption and concomitant increases in the consumption of other commodities on government tax revenue, the long-run health benefits of reducing tobacco use, better food consumption choices among those who quit using tobacco, and the potential for redirecting tobacco expenditures toward human capital investments, such as health and education, were beyond the scope of the present analysis.

Nonetheless, this study describes the potential tradeoff between tobacco expenditure, food energy, and malnutrition status at the household level. Our findings suggest that addressing the issue of tobacco and malnutrition together could enhance tobacco prevention and control efforts in developing countries. Crucially, tobacco control could potentially offer a quick and sustainable route to achieving the goal of eradicating extreme poverty and hunger. These findings suggest that reduction in tobacco use could facilitate improvements in population-level nutrition status and could inform the development and refinement of tobacco prevention and control efforts in Bangladesh.

Disclaimer. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, National Institutes of Health, and University of Dhaka.

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APPENDIX

Appendix Table 1. Recommended Daily Caloric Intake for Light Activities, By Age and Sex

Male		Female	
Age Group (y)	Kilocalories per Day for Light Activities	Age Group (y)	Kilocalories per Day for Light Activities
Boys		Girls	
Infants and Young Children			
<1	650	<1	600
1-2	950	1-2	850
2-3	1125	2-3	1050
3-4	1250	3-4	1150
4-5	1350	4-5	1250
5-6	1475	5-6	1325
Older Children and Adolescents			
6-7	1350	6-7	1225
7-8	1450	7-8	1325
8-9	1550	8-9	1450
9-10	1675	9-10	1575
10-11	1825	10-11	1700
11-12	2000	11-12	1825
12-13	2175	12-13	1925
13-14	2350	13-14	2025
14-15	2550	14-15	2075
15-16	2700	15-16	2125
16-17	2825	16-17	2125
17-18	2900	17-18	2125
Adults			
18-30	2550	18-30	2025
30-60	2500	30-60	1980
>60	2075	>60	1775

The values for infants are the mean of the 12 monthly values reported in Food and Agriculture Organization of the United Nations, World Health Organization, and United Nations University,[32] Table 3.2. The values for older children and adolescents are taken from Tables 4.5 and 4.6. The values for adults are derived from Tables 5.4-5.9 using the midpoint of the physical activity level value ranges given in Table 5.3 and the second interpolation method given on page 40. The values for adults assume a weight of 65 kg for men and a weight of 55 kg for women. All values are rounded to the nearest 25 kcal.[30,32]
Source: Smith & Subandoro,[30] Appendix 8: Recommended Daily Caloric Intakes from the 2001 Expert Consultation.