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Exposure to household tobacco smoke and risk of cancer morbidity and mortality: Analysis of data from the Afghanistan Demographic and Health Survey 2015

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ABSTRACT

Active and secondhand tobacco exposures are major causes of cancer. Cancer prevention efforts are particularly relevant in resource-constrained settings in which significant barriers to early detection and cancer treatments contribute to poor outcomes. We assess the associations between exposure to household tobacco smoke and cancer morbidity and mortality. We used household data from Afghanistan Demographic and Health Survey, which was a national cross-sectional survey that applied a two-stage stratified random sampling technique in 2015 and 2016. We performed regression analysis to estimate associations between exposure to household tobacco smoke and cancer morbidity and mortality at the household level. Exposure to household tobacco smoke was significantly associated with household reports of a history of any cancer (Adjusted Odds Ratio (AOR): 1.90; 95% Confidence Interval (CI): 1.44, 2.51), breast cancer (1.59; 1.00, 2.55), lung cancer (2.88; 1.58, 5.27), and liver cancer (2.56; 1.10, 5.96), compared to households with no tobacco smoke exposure. These associations persisted after controlling for household location, wealth index, type of cooking fuel used in house, and location of food preparation. Households in a rural location experienced significantly higher mortality of any cancer (4.40; 95% CI: 1.57, 12.38), breast cancer (2.91; 1.02, 8.25), and liver cancer (3.91; 1.29, 11.89) vs. those in an urban location. Exposure to household tobacco smoke is a risk factor for cancer morbidity in Afghanistan. Strategies to implement comprehensive smoking cessation and smoke free housing policies are urgently needed as primary cancer prevention strategy in Afghanistan and comparable resource-constrained settings.

1. Introduction

In 2015, cancer was the second-leading cause of death worldwide, with an estimated 8.7 million cancer-related deaths worldwide (Fitzmaurice et al., 2017). Tobacco smoke is a human carcinogen and the leading cause of preventable cancer-related death. Tobacco use is responsible for more than six million deaths annually in the world, of which more than one million deaths are due to involuntary exposure to secondhand smoke (Dockery and Trichopoulos, 1997), including cancers in nonsmokers (Cumberbatch et al., 2016; Glantz and Johnson, 2014; Hori et al., 2016; The Office of Environmental Health Hazard Assessment, 1997; US Department of Health Human Services, 2014).

Recent scientific innovations in cancer management have significantly increased the life expectancies of cancer patients in the developed world (Lowy and Collins, 2016); however, in developing countries, lack of access to affordable therapies remains a significant barrier to cancer patients (Horton and Gauvreau, 2015). Low education status, low levels of medical knowledge and cancer awareness, and lack of available supports are common factors that also contribute to disproportionately high mortality rates among cancer patients in developing countries (Coleman, 2014; Stringhini et al., 2012). The development of cost-effective cancer control strategies in resource-constrained settings must prioritize primary prevention strategies in high-risk populations in order to achieve maximum reductions in the

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burden of cancers affecting the population.

The Afghanistan government started its Basic Package of Health Services (BPHS) to promote free universal health coverage at the primary health care level across the country in 2000, but, access to quality health care has not increased for rural, disabled, and minority populations (Trani et al., 2017). Of note, BPHS did not cover non-communicable diseases, including cancer which is important for cancer prevention efforts (Acerra et al., 2009).

The WHO Framework Convention on Tobacco Control (FCTC) was ratified by 181 countries prior to October 2018. WHO FCTC Article 8 titled "Guidelines on Exposure to Tobacco Smoke" obligates parties to protect bystanders from secondhand smoke. Afghanistan ratified WHO FCTC in 2005 and in 2015 enacted a national law requiring smoke-free environments. The law pertains to indoor public places and workplaces but not to private vehicles and homes. However, in 2017, the WHO rated implementation of this policy as only "moderate" (World Health Organization, 2015, 2017). This study assesses associations between self-reported cancer morbidity and mortality exposure to indoor tobacco smoke in households in Afghanistan.

2. Methods

2.1. Study design

The Afghanistan Demographic and Health Survey (DHS) was conducted by the Central Statistics Organization and the Ministry of Public Health between 2015 and 2016 with financial support from the United States Agency for International Development (USAID) and technical support from the ICF International and the United Nations Children's Fund. This nationally representative cross-sectional survey of households in Afghanistan was designed to provide up-to-date estimates of basic health indicators.

The DHS employed a two-stage stratified random sampling technique which covered all 34 provinces of Afghanistan. In the first stage, census enumeration areas (clusters) were selected from both urban and rural areas. In the second stage, households were selected within selected clusters. Equal numbers of households were selected from each cluster (27 households per cluster) using a probability sample. Participants included married women and men, aged 15–49 years, who were permanent residents of Afghanistan. Following sample selection, a total 25,741 households were selected for participation, of which 24,941were occupied during the survey and 24,395 were interviewed from 956 unique clusters. Trained enumerators collected data using face-to-face interviews conducted in the Dari and Pashto languages. Household data was self-reported by the household head or other capable adult member of the household.

The survey protocol was approved by the institutional review board of the ICF International and by the Ministry of Public Health of Afghanistan. A de-identified dataset for this secondary analysis were provided by ICF International, with approval by the USAID DHS program.

2.2. Variables

2.2.1. Cancer morbidity and mortality

Cancer morbidity data were collected by using the following questions: (1) has any member of this household been diagnosed with cancer? (Yes or No); and (2) what type of cancer has been diagnosed? (Any cancer: Yes or No; breast: Yes or No; lung: Yes or No; liver: Yes or No; duodenal: Yes or No; cervical: Yes or No; other cancer: Yes or No; don't know: Yes or No). Morbidity was defined as the presence of any history of cancer for any member of the household and as such represents a cumulative prevalence of cancer at the time of the interview without reference to a time frame during which it occurred. Cancer mortality data were collected only when the respondent reported cancer morbidity in the household, using the following questions: (1) has any member of this household died due to cancer in the last three years? (Yes or No); and (2) what type of cancer caused the death of your household member(s) in the last three years? (Any cancer: Yes or No; breast: Yes or No; lung: Yes or No; liver: Yes or No; duodenal: Yes or No; cervical: Yes or No; other cancer: Yes or No; don't know: Yes or No). Different types of cancer (breast, cervical, duodenal, liver, lung) and "other cancer" was combined for "Any cancer," excluding "don't know" for both mortality and morbidity.

2.2.2. Covariates

Frequency of exposure to household tobacco smoke by any household member inside the house was categorized as never, daily, weekly, monthly, or less than monthly. This variable captured active smoking as well as secondhand smoke exposure; however, the survey questions did not distinguish between these two different routes of exposure. We combined all households reporting weekly or monthly smoke exposures, regardless of frequency due to small sample sizes in each of these categories, with a combined category henceforth referred to as "exposed." A small number of households in which smoke exposure was reported as occurring less than once a month (0.5% of total) were excluded from the analysis. Daily vs. never household smoke exposure was tested as a sensitivity analysis (Supplemental Table S1 (morbidity) and S2 (mortality)).

We included location of the household (urban vs. rural), household wealth index, type of cooking fuel used in the household (solid: coal, lignite, charcoal, wood, straw/shrubs/grass, agricultural crop, animal dung vs. non-solid: electricity, LPG, natural gas, biogas, kerosene), location of food preparation in the household (outdoor vs. in the house vs. in a separate building vs. other people do not cook food in the household) and number of family members in the household as covariates. Household wealth index was based upon the DHS analysis of the number and kinds of consumer goods owned (e.g., television, bicycle, or car) and housing characteristics (e.g., source of drinking water, toilet facilities, and flooring materials), using scores derived from a principal component analysis. It was divided in quintiles from poorest to richest for analysis. Fuel sources including coal/lignite, charcoal, wood, straw/shrubs/grass, agricultural crop waste and dung cakes were categorized as solid. Fuel sources including electricity, liquid petroleum gas, natural gas, and biogas were categorized as non-solid.

2.3. Statistical analyses

We compared the different types of cancer morbidity and mortality by household characteristics. We calculated weighted estimates of household characteristics stratified by cancer morbidity and mortality.

We used logistic regression accounting for the two-stage survey design, with data weighted according to the cluster sampling design of the surveys. Primary sampling units and strata were employed to ensure that the samples were nationally representative.

We tested for interactions between location of food preparation and cooking fuel used in the house in a logistic regression for cancer morbidity outcomes. The p-values for the interaction for all morbidity outcomes were > 0.087. Including interactions for cancer mortality outcomes induced a structural multicollinearity with variance inflation factors > 14. Therefore, interaction terms were excluded from the analysis for both morbidity and mortality outcomes.

All analyses were performed using the complex survey function of R statistical software (version 3.5.1) (Lumley, 2017). Statistical significance was assigned for p-values ≤ 0.05. Because of very low level of missing data (0.2%), we used listwise deletion.

3. Results

Data from a total of 24,395 households were included in the analysis. Table 1 summarizes descriptive statistics for cancer morbidity, by

Table 1
Cancer morbidity and background variables of household, numbers in parentheses are weighted percentages (N = 24,395), 2015.

Variables	Any cancer		Breast[a]		Cervical		Duodenal		Liver		Lung	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Total[b]	715 (2.8)	23,680 (97.2)	178 (0.6)	24,217 (99.4)	36 (0.1)	24,359 (99.9)	84 (0.5)	24,311 (99.5)	145 (0.5)	24,250 (99.5)	129 (0.5)	24,266 (99.5)
Residence												
Rural	567 (79.3)	17,437 (73.6)	150 (84.3)	17,854 (73.7)	32 (88.9)	17,972 (73.8)	55 (65.5)	17,949 (73.8)	118 (81.4)	17,886 (73.8)	106 (82.2)	17,898 (73.8)
Urban	148 (20.7)	6243 (26.4)	28 (15.7)	6363 (26.3)	4 (11.1)	6387 (26.2)	29 (34.5)	6362 (26.2)	27 (18.6)	6364 (26.2)	23 (17.8)	6368 (26.2)
Wealth index												
Poorest (quintile I)	113 (15.8)	4703 (19.9)	27 (15.2)	4789 (19.8)	4 (11.1)	4812 (19.8)	15 (17.9)	4801 (19.7)	22 (15.2)	4794 (19.8)	28 (21.7)	4788 (19.7)
Poorer (quintile II)	158 (22.1)	5239 (22.1)	35 (19.7)	5362 (22.1)	8 (22.2)	5389 (22.1)	14 (16.7)	5383 (22.1)	37 (25.5)	5360 (22.1)	37 (28.7)	5360 (22.1)
Middle (quintile III)	159 (22.2)	4992 (21.1)	37 (20.8)	5114 (21.1)	9 (25.0)	5142 (21.1)	17 (20.2)	5134 (21.1)	40 (27.6)	5111 (21.1)	22 (17.1)	5129 (21.1)
Richer (quintile IV)	177 (24.8)	4934 (20.8)	55 (30.9)	5056 (20.9)	13 (36.1)	5098 (20.9)	18 (21.4)	5093 (20.9)	26 (17.9)	5085 (21.0)	29 (22.5)	5082 (20.9)
Richest (quintile V)	108 (15.1)	3812 (16.1)	24 (13.5)	3896 (16.1)	2 (5.6)	3918 (16.1)	20 (23.8)	3900 (16.0)	20 (13.8)	3900 (16.1)	13 (10.1)	3907 (16.1)
Type of cooking fuel used												
Solid	524 (73.4)	6579 (27.8)	128 (71.9)	17,467 (72.2)	29 (80.6)	17,566 (72.2)	59 (70.2)	17,536 (72.2)	109 (75.7)	17,486 (72.2)	105 (81.4)	17,490 (72.2)
Non-solid	190 (26.6)	17,071 (72.2)	50 (28.1)	6719 (27.8)	7 (19.4)	6762 (27.8)	25 (29.8)	6744 (27.8)	35 (24.3)	6734 (27.8)	24 (18.6)	6745 (27.8)
Food cooked in the house												
Outdoor	99 (13.8)	3767 (15.9)	16 (9.0)	3850 (15.9)	5 (13.9)	3861 (15.9)	13 (15.5)	3853 (15.8)	26 (17.9)	3840 (15.8)	23 (17.8)	3843 (15.8)
In the house	493 (69.0)	14,306 (60.4)	137 (77.0)	14,662 (60.5)	27 (75.0)	14,772 (60.6)	46 (54.8)	14,753 (60.7)	93 (64.1)	14,706 (60.6)	83 (64.3)	14,716 (60.6)
In a separate building	110 (15.4)	5170 (21.8)	18 (10.1)	5262 (21.7)	4 (11.1)	5276 (21.7)	23 (27.4)	5257 (21.6)	24 (16.6)	5256 (21.7)	18 (14.0)	5262 (21.7)
Other	13 (1.8)	437 (1.8)	7 (3.9)	443 (1.8)	0 (0)	450 (1.8)	2 (2.4)	448 (1.8)	2 (1.4)	448 (1.8)	5 (3.9)	445 (1.8)
Anyone smoke inside the house												
Never	471 (65.9)	18,196 (76.9)	118 (66.3)	18,549 (76.7)	22 (61.1)	18,645 (76.6)	59 (70.2)	18,608 (76.6)	91 (62.8)	18,576 (76.7)	73 (56.6)	18,594 (76.7)
Daily	201 (28.1)	4638 (19.6)	52 (29.2)	4787 (19.8)	11 (30.6)	4828 (19.8)	19 (22.6)	4820 (19.9)	43 (29.7)	4796 (19.8)	47 (36.4)	4792 (19.8)
Weekly	29 (4.1)	558 (2.4)	2 (1.1)	585 (2.4)	2 (5.6)	585 (2.4)	3 (3.6)	584 (2.4)	8 (5.5)	579 (2.4)	7 (5.4)	580 (2.4)
Monthly	9 (1.3)	134 (0.6)	3 (1.7)	140 (0.6)	1 (2.8)	142 (0.6)	3 (3.6)	140 (0.6)	2 (1.4)	141 (0.6)	1 (0.8)	142 (0.6)
Less than once a month	5 (0.7)	122 (0.5)	3 (1.7)	124 (0.5)	0 (0)	127 (0.5)	0 (0)	127 (0.5)	1 (0.7)	126 (0.5)	1 (0.8)	126 (0.5)

[a] Women only.
[b] Row percentage, any cancer included breast, cervical, duodenal, liver, lung and other cancer.

Table 2
Cancer mortality and background variables of household, numbers in parentheses are weighted percentages (N = 711), 2015.

Variables	Any cancer		Breast[a]		Cervical[a]		Duodenal		Liver		Lung	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Total[b]	420 (60.4)	291 (39.6)	118 (16.1)	593 (83.9)	20 (3.3)	691 (96.7)	50 (10.9)	661 (89.1)	92 (13.9)	619 (86.1)	76 (10.1)	635 (89.9)
Residence												
Rural	338 (80.5)	225 (77.3)	98 (83.1)	465 (78.4)	18 (90.0)	545 (78.9)	36 (72.0)	527 (79.7)	71 (77.2)	492 (79.5)	65 (85.5)	498 (78.4)
Urban	82 (19.5)	66 (22.7)	20 (16.9)	128 (21.6)	2 (10.0)	146 (21.1)	14 (28.0)	134 (20.3)	21 (22.8)	127 (20.5)	11 (14.5)	137 (21.6)
Wealth index												
Poorest (quintile I)	71 (16.9)	42 (14.4)	14 (11.9)	99 (16.7)	3 (15.0)	110 (15.9)	10 (20.0)	103 (15.6)	14 (15.2)	99 (16.0)	18 (23.7)	95 (15.0)
Poorer (quintile II)	91 (21.7)	65 (22.3)	29 (24.6)	127 (21.4)	6 (30.0)	150 (21.7)	6 (12.0)	150 (22.7)	17 (18.5)	139 (22.5)	21 (27.6)	135 (21.3)
Middle (quintile III)	96 (22.9)	62 (21.3)	24 (20.3)	134 (22.6)	6 (30.0)	152 (22.0)	12 (24.0)	146 (22.1)	27 (29.3)	131 (21.2)	12 (15.8)	146 (23.0)
Richer (quintile IV)	100 (23.8)	76 (26.1)	36 (30.5)	140 (23.6)	4 (20.0)	172 (24.9)	11 (22.0)	165 (25.0)	17 (18.5)	159 (25.7)	18 (23.7)	158 (24.9)
Richest (quintile V)	62 (14.8)	46 (15.8)	15 (12.7)	93 (15.7)	1 (5.0)	107 (15.5)	11 (22.0)	97 (14.7)	17 (18.5)	91 (14.7)	7 (9.2)	101 (15.9)
Type of cooking fuel used												
Solid	301 (71.8)	221 (75.9)	81 (68.6)	441 (74.5)	15 (75.0)	507 (73.5)	35 (70.0)	487 (73.8)	63 (69.2)	459 (74.2)	62 (81.6)	460 (72.6)
Non-solid	118 (28.2)	70 (24.1)	37 (31.4)	151 (25.5)	5 (25.0)	183 (26.5)	15 (30.0)	173 (26.2)	28 (30.8)	160 (25.8)	14 (18.4)	174 (27.4)
Food cooked in the house												
Outdoor	59 (14.0)	39 (13.4)	9 (7.6)	89 (15.0)	2 (10.0)	96 (13.9)	10 (20.0)	88 (13.3)	18 (19.6)	80 (12.9)	14 (18.4)	84 (13.2)
In the house	283 (67.4)	208 (71.5)	90 (76.3)	401 (67.6)	16 (80.0)	475 (68.7)	23 (46.0)	468 (70.8)	52 (56.5)	439 (70.9)	46 (60.5)	445 (70.1)
In a separate building	67 (16.0)	42 (14.4)	13 (11.0)	96 (16.2)	2 (10.0)	107 (15.5)	16 (32.0)	93 (14.1)	20 (21.7)	89 (14.4)	11 (14.5)	98 (15.4)
Other	11 (2.6)	2 (0.7)	6 (5.1)	7 (1.2)	0	13 (1.9)	1 (2.0)	12 (1.8)	2 (2.2)	11 (1.8)	5 (6.6)	8 (1.3)
Anyone smoke inside the house												
Never	265 (63.1)	203 (69.8)	72 (61.0)	396 (66.8)	12 (60.0)	456 (66.0)	31 (62.0)	437 (66.1)	56 (60.9)	412 (66.6)	42 (55.3)	426 (67.1)
Daily	125 (29.8)	75 (25.8)	39 (33.1)	161 (27.2)	5 (25.0)	195 (28.2)	12 (24.0)	188 (28.4)	30 (32.6)	170 (27.5)	30 (39.5)	170 (26.8)
Weekly	18 (4.3)	11 (3.8)	2 (1.7)	27 (4.6)	2 (10.0)	27 (3.9)	3 (6.0)	26 (3.9)	3 (3.3)	26 (4.2)	4 (5.3)	25 (3.9)
Monthly	8 (1.9)	1 (0.3)	3 (2.5)	6 (1.0)	1 (5.0)	8 (1.2)	3 (6.0)	6 (0.9)	2 (2.2)	7 (1.1)	0	9 (1.4)
Less than once a month	4 (1.0)	1 (0.3)	2 (1.7)	3 (0.5)	0	5 (0.7)	1 (2.0)	4 (0.6)	1 (1.1)	4 (0.6)	0	5 (0.8)

[a] Women only.
[b] Row percentage, any cancer included breast, cervical, duodenal, liver, lung and other cancer.

household characteristics of location, wealth and exposure to smoke. A total of 711 cancer-related deaths were reported, which are summarized in Table 2 according to the same characteristics of the households.

Table 3 summarizes the associations between cancer morbidity and exposure to household tobacco smoke following adjustments for household location, wealth index, type of cooking fuel used in house, and location of food preparation in the household. Morbidity from any cancer (Adjusted Odds Ratio (AOR) 1.90; 95% Confidence Interval (CI) 1.44, 2.51), lung cancer (AOR 2.88; 95% CI 1.58, 5.27), liver cancer (AOR 2.56; 95% CI 1.10, 5.96) and breast cancer (AOR 1.59; 95% CI 1.00, 2.55) were all significantly higher in households with any tobacco smoke exposures compared to households never exposed to tobacco smoke. Morbidity from any cancer (AOR 1.67; 95% CI 1.05, 2.64), breast cancer (AOR 4.03; 95% CI 2.03, 7.99), liver cancer (AOR 2.86; 95% CI 1.14, 7.19), and cervical cancer (AOR 18.88; 95% CI 1.99, 179.18), were significantly higher in rural households, compared to households in urban areas. The point estimate for lung cancer morbidity was higher in rural vs. urban households (AOR 1.19; 95% CI 0.52, 2.72) but not statistically significant. Morbidity from breast cancer was significantly higher in households with an indoor cooking source vs. an outdoor cooking source (AOR 2.49; 95% CI 1.32, 4.70).

Table 4 summarizes associations between cancer mortality and exposure to household tobacco smoke, following adjustments for household location, wealth index, type of cooking fuel, and location of food preparation in the household. Rural household location was associated with significantly increased mortality from any cancer (AOR: 4.40; 95% CI: 1.57, 12.38), breast cancer (AOR 2.91; 95% CI 1.02, 8.25), and liver cancer (AOR 3.91; 95% CI 1.29, 11.89), compared to urban location. However, exposure to household tobacco smoke was not significantly associated with cancer mortality.

A sensitivity analysis using daily vs. never household smoke exposure revealed similar findings for both morbidity and mortality outcomes (Supplemental Table S1 (morbidity) and S2 (mortality)).

4. Discussion

In a large nationally representative sample of Afghanistan's population, we found that exposure to household tobacco smoke is significantly associated with morbidity, but not mortality, from any cancer. Site-specific associations were detected for breast, lung, and liver cancers. These findings are consistent with reports in the existing literature from other settings that cancer morbidity is associated with exposure to tobacco smoke (Cao et al., 2015; Chen et al., 2014; Hori et al., 2016; Macacu et al., 2015; US Department of Health Human Services, 2014; Whiteman and Wilson, 2016). Cancer is common in Afghanistan as in other Middle East and South Asia regions (Fitzmaurice et al., 2017). Prevalence of tobacco smoke is 23.1% in men and 3.3% in women in Afghanistan (Bhatta and Glantz, 2018) compared to the Eastern Mediterranean region prevalence of 25% (World Health Organization, 2016). Pollution and drinking unsafe water are common in these regions which could contribute to cancer incidence (GBD 2017 Risk Factor Collaborators, 2018).

The relationship between household tobacco smoke exposure and breast cancer morbidity in our study (OR 1.59; 95% CI: 1.00, 2.55) was comparable to findings from prior systematic reviews and meta-analyses of active and passive smoking and breast cancer, which report OR's ranging from 1.1 to 1.6 (Cao et al., 2015; Chen et al., 2014; Glantz and Johnson, 2014; Macacu et al., 2015). The association of household tobacco smoke exposure and cervical cancer was similar to previous systematic reviews based on observational epidemiological studies (OR: 1.73; 95% CI: 1.35, 2.21) (Cao et al., 2015); however, statistical significance was not reached in our study (OR: 1.61; 95% CI: 0.67, 3.90). Our study found an association of household tobacco smoke exposure and liver cancer (OR: 2.56; 95% CI: 1.10, 5.96), which is consistent with the 2014 U.S Surgeon General's Report indicating a link between liver cancer and tobacco smoking (US Department of Health Human Services, 2014) and further corroborated by laboratory based research on the effects of secondhand smoke on atherosclerosis and development

Table 3
Associations between cancer morbidity and household smoke exposure, with adjustment for covariates (N = 24,395).

Morbidity	Any cancer		Breast[a]		Cervical[a]		Duodenal		Liver		Lung	
	OR	P-value	OR	P-value	OR	P-value	OR	P-value	OR	P-value	OR	P-value
Unadjusted association												
Smoke inside the house												
Never	1		1		1		1		1		1	
Exposed	2.03 (1.55, 2.65)	< **0.001**	1.75 (1.10, 2.80)	**0.019**	1.83 (0.83, 4.02)	0.134	1.91 (0.77, 4.78)	0.164	2.76 (1.17, 6.53)	**0.021**	3.05 (1.67, 5.57)	**0.000**
Adjusted for residence, wealth index, cooking fuel used in house, food cooked inside house, number of family member												
Smoke inside the house												
Never	1		1		1		1		1		1	
Exposed	1.90 (1.44, 2.51)	< **0.001**	1.59 (1.00, 2.55)	**0.050**	1.61 (0.67, 3.90)	0.290	1.98 (0.80, 4.94)	0.142	2.56 (1.10, 5.96)	**0.029**	2.88 (1.58, 5.27)	**0.000**
Residence												
Urban	1		1		1		1		1		1	
Rural	1.67 (1.05, 2.64)	**0.030**	4.03 (2.03, 7.99)	< **0.001**	18.88 (1.99, 179.18)	**0.010**	0.66 (0.18, 2.45)	0.536	2.86 (1.14, 7.19)	**0.025**	1.19 (0.52, 2.72)	0.675
Wealth index												
Poorest	1		1		1		1		1		1	
Poorer	1.07 (0.65, 1.75)	0.776	1.46 (0.74, 2.85)	0.268	1.95 (0.44, 8.58)	0.374	0.46 (0.12, 1.70)	0.245	1.64 (0.81, 3.25)	0.161	1.65 (0.84, 3.25)	0.146
Middle	1.05 (0.59, 1.86)	0.883	0.98 (0.51, 1.90)	0.954	2.15 (0.48, 9.54)	0.316	0.38 (0.10, 1.51)	0.172	1.90 (0.93, 3.84)	0.077	1.13 (0.45, 2.78)	0.804
Richer	1.14 (0.75, 1.76)	0.523	1.58 (0.80, 3.13)	0.185	4.03 (0.93, 18.48)	0.063	0.52 (0.14, 1.92)	0.333	1.82 (0.81, 4.11)	0.153	0.87 (0.41, 1.86)	0.661
Richest	1.19 (0.53, 2.66)	0.672	1.99 (0.84, 4.69)	0.115	1.46 (0.10, 22.74)	0.788	0.73 (0.15, 3.53)	0.694	1.87 (0.62, 5.65)	0.271	0.74 (0.27, 2.23)	0.587
Cooking fuel used in house												
Non-solid	1		1		1		1		1		1	
Solid	0.75 (0.52, 1.08)	0.123	0.81 (0.43, 1.50)	0.496	0.76 (0.26, 2.17)	0.618	1.15 (0.48, 2.74)	0.752	0.36 (0.15, 0.86)	**0.022**	1.25 (0.61, 2.53)	0.538
Food cooked inside house												
Outdoor	1		1		1		1		1		1	
In the house	1.31 (0.96, 1.79)	0.089	2.49 (1.32, 4.70)	**0.005**	0.76 (0.26, 2.17)	0.605	0.95 (0.43, 2.14)	0.890	0.57 (0.32, 1.01)	0.055	1.38 (0.76, 2.50)	0.293
In a separate building	1.04 (0.61, 1.79)	0.859	1.03 (0.36, 2.88)	0.962	0.44 (0.08, 2.47)	0.349	1.72 (0.48, 6.39)	0.404	0.96 (0.41, 2.22)	0.921	0.64 (0.26, 1.57)	0.326
Other	2.43 (0.98, 6.01)	0.055	12.10 (4.50, 32.52)	< **0.001**	–		1.21 (0.30, 4.91)	0.793	0.57 (0.12, 2.59)	0.471	5.79 (1.04, 32.21)	**0.045**
Number of family members	1.06 (1.02, 1.09)	< **0.001**	1.07 (1.03, 1.10)	< **0.001**	1.08 (0.99, 1.18)	0.088	1.02 (0.94, 1.10)	0.685	1.08 (1.03, 1.13)	**0.002**	1.05 (0.98, 1.13)	0.110
VIF	< 1.3		< 1.4		< 2.3		< 2.9		< 2.4		< 1.8	

Statistically significant P values (< 0.05) are bold.
[a] Women only.

Table 4
Associations between cancer mortality and household smoke exposure, with adjustment for covariates (N = 711).

Mortality	Any cancer		Breast[a]		Cervical[a]		Duodenal		Liver		Lung	
	OR	P-value	OR	P-value	OR	P-value	OR	P-value	OR	P-value	OR	P-value
Unadjusted association												
Smoke inside the house												
Never	1		1		1		1		1		1	
Exposed	1.06 (0.59, 1.91)	0.845	1.18 (0.63, 2.19)	0.592	0.66 (0.25, 1.75)	0.412	0.88 (0.25, 3.19)	0.851	2.05 (0.66, 6.37)	0.214	1.56 (0.71, 3.41)	0.266
Adjusted for residence, wealth index, cooking fuel used in house, food cooked inside house, number of family member												
Smoke inside the house												
Never	1		1		1		1		1		1	
Exposed	1.01 (0.63, 1.63)	0.968	0.93 (0.48, 1.82)	0.900	0.73 (0.25, 1.08)	0.559	1.49 (0.63, 3.50)	0.360	1.74 (0.81, 3.72)	0.154	1.45 (0.75, 2.81)	0.269
Residence												
Urban	1		1		1		1		1		1	
Rural	4.40 (1.57, 12.38)	**0.005**	2.91 (1.02, 8.25)	**0.036**	7.92 (0.51, 12.38)	0.141	1.12 (0.03, 46.24)	0.953	3.91 (1.29, 11.89)	**0.016**	1.23 (0.25, 6.02)	0.802
Wealth index												
Poorest	1		1		1		1		1		1	
Poorer	0.71 (0.31, 1.62)	0.422	2.29 (0.97, 5.37)	0.066	1.89 (0.36, 9.83)	0.450	0.24 (0.05, 1.25)	0.092	1.66 (0.58, 4.74)	0.345	0.82 (0.32, 2.13)	0.690
Middle	0.77 (0.35, 1.68)	0.510	1.33 (0.51, 3.41)	0.587	2.24 (0.34, 14.71)	0.401	0.25 (0.06, 1.02)	0.054	2.34 (0.88, 6.25)	0.090	0.67 (0.21, 2.17)	0.512
Richer	0.61 (0.29, 1.29)	0.192	1.31 (0.50, 3.46)	0.528	2.49 (0.33, 18.98)	0.379	0.30 (0.06, 1.62)	0.163	1.88 (0.51, 6.87)	0.342	0.55 (0.18, 1.68)	0.297
Richest	0.47 (0.14, 1.57)	0.221	1.34 (0.38, 4.60)	0.588	0.68 (0.03, 16.96)	0.811	0.42 (0.01, 26.29)	0.687	2.25 (0.55, 9.15)	0.259	0.28 (0.07, 1.16)	0.080
Cooking fuel used in house												
Non-solid	1		1		1		1		1		1	
Solid	0.39 (0.20, 0.78)	**0.007**	0.60 (0.27, 1.34)	0.242	0.88 (0.22, 3.54)	0.861	1.53 (0.31, 7.56)	0.602	0.32 (0.13, 0.83)	**0.019**	1.10 (0.39, 3.10)	0.860
Food cooked inside house												
Outdoor	1		1		1		1		1		1	
In the house	0.85 (0.46, 1.59)	0.600	2.49 (1.01, 6.14)	**0.040**	0.66 (0.13, 3.27)	0.614	0.34 (0.11, 1.03)	0.058	0.31 (0.13, 0.77)	**0.012**	0.86 (0.36, 2.04)	0.734
In a separate building	1.01 (0.38, 2.72)	0.990	1.10 (0.27, 4.41)	0796	0.35 (0.01, 5.18)	0.447	2.78 (0.61, 12.64)	0.186	0.65 (0.27, 1.53)	0.323	0.48 (0.11, 2.09)	0.330
Other	5.67(1.10, 29.11)	**0.038**	16.72 (5.42, 51.58)	< **0.001**	–		0.19 (0.02, 1.92)	0.162	0.22 (0.03, 1.64)	0.141	4.91 (0.62, 38.71)	0.132
Number of family members	1.01 (0.95, 1.06)	0.821	1.04 (0.98, 1.10)		0.94 (0.79, 1.12)	0.515	0.92 (0.85, 1.00)	0.063	1.04 (0.99, 1.10)	137	1.04 (0.94, 1.15)	0.427
VIF	< 1.3		< 1.4		< 2.2		< 1.6		< 1.6		< 1.6	

Statistically significant P values (< 0.05) are bold.
[a] Women only.

of non-alcoholic fatty liver disease (Yuan et al., 2009). The association of household tobacco smoke exposure and lung cancer morbidity for anyone in the household was higher in our study (OR: 2.88; 95% CI: 1.58, 5.27) than reported in a previous systematic review of individual risk (OR 1.27; 95% CI 1.17, 1.37) (Cao et al., 2015). Moreover, it was higher than the relative risk reported by Cao et al. in a study in Japan (RR 1.28, 95% CI 1.10, 1.48) (Hori et al., 2016).

By contrast, the absence of any significant associations between household tobacco smoke exposure and cancer mortality in this analysis is not consistent with the existing literature. This failure to detect an association between smoke exposure and cancer mortality could be in part due to the limitations of the dataset. First, the unit of analysis was the household and not the individuals exposed in the household. Second, we were unable to determine whether the individuals who developed cancer were current or former smokers vs. passive smokers with secondhand smoke exposure. Finally, we were unable to discern the actual number of morbidity and mortality events in each household unit due to the cancer. Smoking in males and females, duration of exposure, and age are determinants of cancer mortality and morbidity. In addition, universal health coverage, availability and accessibility of healthcare in the country could affect the burden of cancer morbidity and mortality.

Independent of household tobacco smoke exposure, we also found that households from rural areas in Afghanistan were at higher risk of both morbidity and mortality of cancer. Notably, the increased risk of morbidity from breast, liver, and cervical cancers, all of which are considered preventable cancers, in rural areas in Afghanistan could possibly be explained by the lack of health care infrastructure in rural areas and barriers to accessing appropriate screening and early detection services (Stefan, 2015).

Indoor air pollution is the largest environmental health risk to the increased incidence of cancer and other diseases in developing countries (World Health Organization, 2014). For example, the odds of a cancer associated with solid fuel used in homes in South Asia is high (Junaid et al., 2018). Solid fuels, including fuelwood (65%), charcoal (25%) and coal (3%), are commonly used for cooking in Afghanistan, predominantly in rural areas. Animal dung is also used in 85% of rural homes and 15% of urban homes (Asian Development Bank and the Clean Air Initiative for Asian Cities Center, 2006). Risk of lung cancer morbidity and mortality was higher with use of solid cooking fuel; however, we did not find a significant association between solid cooking fuel and morbidity or mortality from lung cancer or other cancers. Morbidity risk of any cancer, breast and lung cancer was higher with preparing food inside the house, however, only breast cancer morbidity was statistically significant.

Of all the cancer prevention approaches that exist, tobacco exposure is perhaps the most important, cost-effective, and preventable risk factor (Forouzanfar et al., 2016). The United Nation's Sustainable Development Goals (SDG 3) aim to reinforce the implementation of the WHO Framework Convention on Tobacco Control (FCTC) in signatory countries by implementing national tobacco control policy (World Health Organization, 2017). Reducing exposure to smoking and secondhand smoke is the major provision of the FCTC. Although Afghanistan ratified the FCTC to develop its smoke free policies (World Health Organization, 2015, 2017), the policies did not clearly specify a complete ban on smoking in workplaces and homes. Moreover, implementation of the policies is poor, without strategies for enforcement or consequences for non-compliance (Oncken et al., 2010). Afghanistan reported minimal cessation policies or programs for treatment of tobacco dependence (World Health Organization, 2017). Our results support the importance and need for raised awareness and effective implementation of policies to enforce smoke free homes, both to provide interventions and incentives to that encourage and facilitate smoking cessation (Callinan et al., 2010; Hopkins et al., 2010) and to protect bystanders from exposure to secondhand smoke.

4.1. Limitations

All of the available information was provided by self-report at the level of the household rather than the level of individuals. Education status of respondent is not available therefore we were unable to include it in the model. Questions related to cervical cancer might be a sensitive issue for a conservative community, which could have contributed to under-reporting of this diagnosis. The accuracy of site specification is more likely to be reliable for cancers that are easily visible, like breast or cervical cancer, rather than for internal cancers like lung, liver and duodenal cancers where in the common absence of pathologic diagnosis assumptions are made as to primary site. In contrast to our findings, the worldwide incidence of duodenal cancer is very low (Fitzmaurice et al., 2017), raising some concern regarding the accuracy of this terminology. Our analysis is based on the English language versions of the questionnaire even though it was administered in a local language. It may be that the term used was translated to “duodenal” may refer to stomach or other upper gastrointestinal track cancers. The number, age, and sex of individuals who were using or exposed to tobacco smoke and who developed a cancer were not collected. As a result, we were unable to draw inferences at the individual level, and we were unable to disaggregate outcomes based upon sex, age, and active vs. secondhand smoke exposures. Because of the small sample sizes in the categories of frequency of exposure (i.e., weekly, monthly) any smoke exposure was categorized as a binary variable (exposed vs. never); as such, no dose-response relationship could be evaluated. The absence of granularity in the dataset regarding the number of cigarettes smoked, the number of smokers in each household, duration of smoke exposure rendered us unable to measure dose response or to test associations of nicotine levels with outcomes. The survey was cross-sectional, and without additional follow-up, we were unable to determine the causal associations between exposure to secondhand smoke in the household and cancer morbidity and mortality. Date of cancer diagnoses and deaths or even the number of individuals within a given household who suffered a specific cancer were not defined. In these data “morbidity” is a self-reported cumulative prevalence at the time of the interview, so we do not know when the cancer occurred or the age of the person at the time of occurrence, which depends on the age of the persons in the household which are unknown (e.g., an 80 year old person could have been told they had cancer 50 years prior). Finally, we were unable to account for potential genetic, biologic, or environmental factors in Afghanistan which may have contributed to the development of incident cancers. This is a secondary data analysis of an existing dataset. We have no ability to validate the responses, and DHS did not provided any information to validate the responses. However, we analyzed agreement between household response (household data) and individual response (male data) of tobacco smoking. We found the high agreement with both responses ($\kappa = 0.7$, $P < 0.001$).

5. Conclusions

This analysis of data from the Afghanistan Demographic and Health Survey represents a first report on the impact of household tobacco exposure in Afghanistan. Our analysis demonstrated that exposure to household tobacco smoke is a risk factor for the development of cancer in Afghanistan, even after controlling for household location, wealth index, cooking fuel used in house, and location of food preparation. Although we were not able to evaluate the effects of dose or primary vs. secondhand exposure due to inherent limitations of the dataset, our findings affirm that any tobacco exposure contributes to adverse outcomes in this setting (National Toxicology Program, 2016; US Department of Health Human Services, 2014).

Despite the limitations of the available data, this analysis serves to raise further questions and opportunities for future studies regarding the prevalence of household tobacco use and impact on Afghanistan's cancer burden. In light of Afghanistan's 2015 enactment of a national

law requiring smoke-free environments, actionable strategies to educate the lay public and implement policies to enforce smoke-free environments are urgently needed. This may be particularly relevant in rural settings in which cancer screening and treatment are not readily available, further underscoring the need for cost-effective cancer prevention strategies.

Contributors

DNB designed the study, performed the analysis, and prepared the manuscript. KVL contributed to study design and preparation of the manuscript. RAH contributed to the manuscript preparation. SG contributed to the analysis and preparation of the manuscript.

Declaration of interests

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

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