CHARACTERIZING THE RELATIONSHIP BETWEEN SOCIAL DETERMINANTS AND ENVIRONMENTAL RISKS TO HEALTH IN RURAL GUJARAT, INDIA

by

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DEDICATION

I dedicate this thesis to my wife, Karen and my children Daniel, Samuel and Ellie. To you I give my sincerest expression of love and appreciation for the inspiration and drive to continually improve our lives.

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ABSTRACT

Characterizing the Relationship between Social Determinants and Environmental Risks to Health in Rural Gujarat, India

Maj Ryan Jung, MSPH, 2017

Thesis directed by: Colonel Edwin K. Burkett, Associate Professor, Department of Preventive Medicine and Biostatistics, Global Health Division.

Socioeconomic status (SES) has been identified as the fundamental cause of health disparities impacting health outcomes and access to healthcare. About 24% of the Global Burden of Disease (GBD) was attributed to modifiable environmental risk factors such as pollution of water, sanitation and air. These environmental health (EH) problems are more vulnerable in developing countries than in developed countries because of a lack of regulations and primitive systems for environmental control. The purpose of this study is to analyze the relationship between SES and EH conditions in rural villages in Gujarat, India. This study represents a secondary analysis using data collected through the SEVAK project. Descriptive statistics were used to understand the basic characteristics of the respondents and inferential statistics were used to examine the relationship between SES (education and employment) and EH (toilet, drinking water, cooking fuel) by calculating the chi-square value, the Spearman Rank Coefficient (SRC),

and the Odds Ratio (OR). A model was developed to predict the EH conditions according to the level of SES using logistic regression.

A total of 36,809 individuals completed the interviews between December 2010 and October 2016. Gender distribution was 51.7% for males and 48.3% for females. The vast majority of males (75.9%) were self-employed and the majority of females (80.8%) were homemakers. The proportion of people who had treated water was 76.2% for males and 74.7% for females. The proportion of people who own a toilet was 44.1% for males and 43.7% for females. 80.9% for males and 71.6% for female used the improved cooking fuel. Among the EH conditions, possession of the toilet was found to be most affected by individual SES (p-value <0.01, SRC = 0.256). Interaction analysis indicated college education and employment for wages created the greatest synergy. The regression model represented that the higher the SES of the female, the better the preference for the environment (e.g. toilet (male/female): OR=12/31). The results of this study will help local residents improve their health by allowing more effective interventions at each stage of SES and preventing diseases caused by environmental risks.

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CHAPTER 1: INTRODUCTION

BACKGROUND

Health is essential to enhance humans' productive life and happiness. The Universal Declaration of Human Rights acknowledged that health is the fundamental right granted to each human being(20). However, social inequities exist ubiquitously in all human societies and lead to heath disparity in different social groups. On a global level, health disparities widely exist among countries ranging from low-income to high income. In order to reduce health disparities adequately, personal and financial resources and suitable assistance must be distributed to peoples in countries that cannot afford to promote health themselves. To evaluate health disparities worldwide, the Global Burden of Disease (GBD) provides a tool to quantify and estimate of health risks. GBD is the collective measure of combined mortality and disability reports of major diseases, injuries and risk factors and is represented by using the concept of the disability-adjusted-life-year (DALY). WHO utilizes measures of the GBD and DALY to determine the impact of environmental risks to health(59).

According to the latest estimate from the World Health Organization (WHO), about 24% of GBD was attributed to modifiable environmental risk factors such as pollution of water, soil and air(59). The WHO defines the environmental risks to health as "all the physical, chemical and biological factors external to a person, and all related behaviors but excluding those natural environments that cannot reasonably be modified"(18). In this respect, healthier environments can significantly contribute to a reduction in GBD, and successful environmental management can play a major role in reducing health disparities. Accordingly, creating and maintaining healthy environments

should be a priority of primary prevention. As quantitative evidence has increased showing relationship between health and environment, many cost-effective interventions have been developed to reduce the environmental burden of death and disease. To be most effective and sustainable these interventions need to be designed and implemented holistically by considering social factors determined by the local circumstances and environment(49).

Social determinants of health include the broader circumstances in which people are born, grow, live, and the wider set of systems determining the conditions of daily life. These determinants are affected by the distribution of money, education, power and resources at global, national and local levels(56). Consequently, the social determinants of health influence people's exposure to environmental risks and health behavior; they are often the root causes of illness and are a key to understanding health disparities. The WHO identified these social determinants as a critical component of the post-2015 sustainable development global agenda and addressed the importance of integrated approaches to reduce health inequities(27). Among various social determinants, socioeconomic status (SES) has been identified as the fundamental cause of health disparities impacting health outcomes and access to healthcare(54).

Environmental risk factors and SES are interrelated(60). Improved SES can mediate exposure to environmental risk factors such as working conditions, housing, water, sanitation, and healthy lifestyles. In other words, the change in SES could modify the impact of environmental risks to different degrees. Thus, a systematic approach will improve our understanding that social determinants play a major role in the health status of populations, as well as in the design and implementation of interventions (39; 52).

Environmental health problems are more serious in developing countries than in developed countries (43). People in developing countries are at greater risk of exposure to environmental health issues caused by the lack of regulations and primitive systems for environmental control. Among the various environmental health problems, the lack of clean household water, poor sanitation and indoor air quality are the top priority issues in developing countries(5).

Diseases from untreated water and poor sanitation account for an average of 6-7% of annual deaths in developing countries (53). Most diseases are caused by pathogen contained in human or animal feces. Poor sanitation provides a pathway for these pathogens to contaminate groundwater and soil. Water-borne and food-borne diseases are mostly associated with diarrhea and fatal to children who experience severe dehydration (38). Diseases caused by indoor air quality are mainly caused by solid cooking fuel used for food in the kitchen. Combustion process of these fuels generates CO or particulate matters (PM) introduced into the lungs, and leads to the deteriorated function of the respiratory tract (61). These diseases caused by the conditions of environmental health can be reduced considerably by changing the social determinants of the individual and the externally formed physical conditions (57).

LITERATURE REVIEW

A review of the literature showed that few studies have examined the relationship between SES and environmental risks to health at a community level in a low-income country. As shown in Table 1, only a small number of studies have presented the positive association between SES and environmental risks to health. However, these studies focused on developed countries, and few were conducted in developing nations (35; 36;

41; 44; 45). Results from developed countries cannot be generalized to the developing nations because the causes of health inequities are different (57). In developed countries the systems and resources to care for environmental risks are universal so that SES may have a significant influence on the risk factors; however in developing countries uneven access to services could be a more critical consideration to improve Environmental Health (EH) disparities.

Table 1. Literature review for the impact of SES on environmental risks to health.

Year	Author	SES	EH				Country
			DW	Air	IAQ	Toilet	
2003	S.Hales	X	X				New Zealand
2008	Briggs	X		X			England
2011	Vinyals	X	X				Spain
2013	Hajat	X		X			USA
2015	Fecht	X		X			England/Netherland

* **SES** (Socioeconomic status), **EH** (Environmental Health), **DW** (Drinking Water), **IAQ** (Indoor Air Quality)

One report, based on the Joint Monitoring Program (JMP), highlighted the inequalities of wealth and education to drinking water and sanitation in developing countries (25). However, the JMP database had substantial limitations because it led to large discrepancies by utilizing nationally representative household surveys based on certain populations, which excluded marginal settlements, and was based on linear regressions rather than the results of the recent surveys(33). Hence, the findings may not provide an adequate explanation regarding the association between SES and environmental risks to health at the community level in developing countries.

As the civilian and military global health interventions expand to rural communities, better understanding of the relationship between SES and environmental risks to health will be crucial to developing cost-effective and effective interventions. This project will examine selected social determinants and environmental risks to health in the rural community of Gujarat, India. Results from this study may support community workers and policy makers in designing appropriate interventions to minimize environmental risks and ultimately enhance community health in rural regions of India.

HYPOTHESIS & SPECIFIC AIMS

Hypothesis: Education, income and employment will influence people's exposure to environmental risks to health in the rural communities of Gujarat, India.

Specific Aim #1: Describe demographic characteristics of selected social determinants of health (income, education, employment) and the environmental risks to health (drinking water, toilet, cooking) in the state of Gujarat, India.

Specific Aim #2: Determine the impact of income, education and employment on environmental risks to health for individuals in rural communities in Gujarat, India.

Specific Aim #3: Develop a multivariable model to examine the independent effect of income/education/employment on environmental risks to health.

GLOBAL HEALTH RELEVANCE

This study will determine how education and employment contributes to environmental risks to health in Gujarat, India and create a better understanding of the relationship between these two variables. This understanding could lead to direct and indirect impacts. The direct impact is to enhance appropriate preventions that promote

community health and sustainability in rural communities in India and would be beneficial to local community workers or policy makers of a public health center in India. The characterization of the relationship between social determinants and environmental risks to health in developing countries could enhance policy development in global health at the strategic level as the indirect impact.

CHAPTER 3: METHOD

SEVAK PROJECT

The research project used data obtained from the SEVAK project (Sanitation and Health Education in Village Communities through Improved Awareness and Knowledge of Prevention/Management of Disease and Health Promotion project)(50). This project has been ongoing for six years in the state of Gujarat, which is ranked the 11th fastest growing state among all 28 states in India. The purpose of the SEVAK project was to focus on primary and secondary health education and access to care for rural Indians; individuals are screened for diabetes, obesity, and hypertension by trained community health educators called Sevaks, and provided lifestyle modification education. The Sevaks were trained in chronic disease risk factors, lifestyle modification and data collection techniques by a multidisciplinary team of local and US health professional for six weeks. All Sevaks were citizens hired from the local communities in which they lived and selected if they had an interest in community health issues and had a high school degree or college level education. Sevaks use door-to-door visitations to reach individuals and families, and conduct face-to-face interviews (using a standardized survey questionnaire in the local language) to elicit information on their EH settings, behavioral risk factors, and chronic diseases. These Sevaks become the single point of contact for the healthcare of all villagers by forming liaisons with the community health clinic, district hospital, and the private practitioners(16).

STUDY DESIGN AND DATA EXTRACTION

This research project is a secondary analysis of data collected by the SEVAK survey. The collection period was from December 2010 to Jun 2016. The state of Gujarat consists of 26 districts, each of which is comprised of several villages, with populations of 1500-2000. In each district, the villages with the lowest income level were selected as survey subjects, and a total of 26 villages were surveyed. Educated SEVAKs visited these villages and conducted surveys via face-to-face interview on the entire population of the villages over 18 years of age. The questionnaire contains more than 60 questions and items such as income, occupation, education field and environmental risk were extracted.

STUDY POPULATION AND SIZE

In this study, the rural communities are defined as villages with a low population density located outside the city or town (4). They are poorly equipped with medical facilities and delivery systems to promote and protect the health of the residents. In addition, education opportunities and information are limited, so residents' level of knowledge for EH and hygiene is relatively low compared to people in large cities. A total of 36,809 participants from 26 villages completed the questionnaire by Sevak interview. The survey response rate exceeded 95% of the participants who were requested to participate in the study. The high response rate is due to the trust of the community stakeholder and members for member of the study team and their village Sevak. The sample size was sufficiently large to provide a reliable measure of the association between social determinants and environmental risks to health so the power of the test was calculated to be above 99%.

STUDY VARIABLES

All data were obtained from the SEVAK project PI and Co-PI (Drs. Misra and Patel). Data for the project are compiled by the project data manager and "de-identified" data were obtained for the secondary analysis. All of the variables used in this study were examined at the individual level. In order to investigate the differences between women and men, the analysis was conducted separately. The variables related to SES were income, employment and education in the questionnaire. However, income data had not been well collected because of low response rate for various reasons (e.g. reluctance to share information, etc). Therefore, only education and employment were considered as determinants of SES for the analysis.

As shown in Table 2, the extracted data were classified into independent variables and dependent variables for this study. The levels of education were divided into four categories as follows: Those who have not received formal education, those who have received elementary education, those who have graduated from high school, or those who have received education of college and above. Employment was divided into four categories by grouping the seven occupations surveyed. They were homemaker, self-employed (including farmers), and people who were employed for wages. Finally, the students, those who are unable to work, and the retirees were categorized by "others".

Dependent variables for environmental risks to health were drinking water, toilet, and cooking fuel. Each variable was categorized into binary responses. The drinking water was categorized into treated water obtained through chlorination or reverse osmosis (RO) processes and untreated water acquired directly from the water source without any purifying or disinfection processes. Toilet was classified whether a respondent had their

own private toilet or not. Cooking fuels used in the kitchen were divided into firewood and improved fuels such as gas, kerosene, or mixed fuels.

Table 2. Determination of categorical variables from the existing data.

Variables		Category	Collected data
Independent	Gender	Male	Male
		Female	Female
	Education	No education	g (no formal education)
		Elementary	a (primary)
		High school	c (secondary), d (higher secondary)
		College and above	d (some college), e (college graduate), f (post graduate), h (Technical edu)
	Employment	Others	STUDENT, RET, UW (unable to work)
		Homemaker	HW
		Self-Employed	SE. OW (Farmer)
		Employed for wage	EW
Dependent	Drinking water	Yes	RO, VT (Village tank), VT/RO
		No	Others
	Toilet ownership	Yes	Y
		No	N
	Cooking Fuel	Improved (G, K, etc)	Gas, Kerosene, Stove, Combined (ex. F/G, G/S, etc)
		Firewood	F, F.V to OS-No, F.V to OS-Yes

IRB AND DATA AGREEMENT

The SEVAK project started after an internal IRB committee reviewed and approved the research ethics. This study was a secondary analysis using de-identified

data obtained through the SEVAK project. Therefore, according to Chapter 5 of the USU Human Research Decision Chart (HRDC)(17), this study was suitable for exemption. However, IRB application was made through the eIRB system and the USU IRB office approved the final exemption based on the attached SEVAK IRB certificate and attached documents. After this IRB approval, the data was provided and the study started.

STATISTICAL ANALYSIS

All statistical analyses were performed using the SPSS 22 program and the independent and dependent variables were coded appropriately and the results were obtained.

Descriptive statistics

These statistics were used to understand the basic characteristics of the respondents in the survey. This analysis simplifies large amounts of data by comparing the frequency and proportion of the variables, and provides a general understanding of SES and environmental risks in rural communities.

Inferential statistics

This analysis determined the association and correlation between SES and environmental risks to health. First, a chi-square test was used to confirm the existence of a significant association between two categorical variables. Each of these variables had two or more categories depending on the way of classification. This test examined the association by comparing the observed frequency or the proportion in each category. Second, correlation analysis was performed to measure the strength and direction of the linear relationship between two variables. While the Pearson correlation coefficients are

used for the continuous variables, the Spearman Rank Order correlation coefficient represents the relationship between the categorical variables. Therefore, Spearman's correlation coefficient was used to analyze whether the correlation was positive or negative

Development of Logistic Regression Model

Logistic regression was used to develop a model that can understand and predict how each of the SES factors affected the environmental risk to health. There were two reasons for doing logistic regression modeling. The first reason was to measure the effect of one independent variable on the EH condition when controlling other variables affecting the EH condition. The second reason was to measure the extent and significance of the interaction between independent variables on EH conditions.

Table 3. Three logistic regression models.

Model	Equation
1 (Unadjusted)	$\log\left(\frac{P}{1-P}\right) = \alpha + \beta_1 X_1$
2 (Adjusted)	$\log\left(\frac{P}{1-P}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$
3 (Adjusted+ interaction)	$\log\left(\frac{P}{1-P}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_1 X_2 + \beta_5 X_1 X_3 + \beta_6 X_2 X_3$
Notion	P = Probability of having good EH conditions α = Constant $\beta_{1/2/3/4/5/6}$ = Coefficients X_1 = Gender, X_2=Education, X_3=Employment

As shown in Table 3, the final model was developed through three steps. The first model was the simplest model that did not adjust confounding factors considering the influence of only one variable. The second model was to see how three independent variables affected EH conditions by adjusting confounding factors that are independent of each other. The last model was created by adding interaction terms to the second model.

Model development

The final outcome obtained from the model is an Odds ratio (OR). The OR indicates the degree of difference in the EH conditions of respondents in different SES groups as compared with the EH conditions of respondents in an arbitrarily set baseline group. From this ratio, the degree of environmental risk to health can be measured for each group.

In case of Model 1 and Model 2, OR can be obtained by exponential of the β coefficient of each variable. In other words, it can be obtained directly from the results of the SPSS program. However, the OR of Model 3 can be obtained by additional calculations with the variables obtained from the output.

Odds ratio calculation

Model 3 takes into account the interrelated independent variables. In this model, only two-way interaction is considered. Three-way interaction could be considered, but it was excluded from this study because the model becomes more complex and eventually a saturated model.

A model considering two-way interaction is obtained by adding the product of two independent variables to model 2. The variable X_1 for gender is divided into two

categories (Yes / No) and the variable for education X_2 is divided into four categories (NE, Elm, High, College). Finally, the employment variable X_3 has three categories (H, SE and EW). Therefore, a total of 11 (1 * 3 + 1 * 2 + 2 * 3) interactions can be obtained by excluding the categories specified by baseline in the number of 26 cases (2 * 4 + 2 * 3 + 3 * 4) do. The OR is calculated by adding the β coefficients of interaction terms and variables to 0 or 1 according to the SES combination. To describe this in more detail, three variables are divided into two categories in order to obtain OR. The model 3 equation is as follows:

$$\log\left(\frac{P}{1-P}\right) = \alpha + \beta_1(Gender) + \beta_2(Education) + \beta_3(Employment) + \beta_4(Gender * Education) + \beta_5(Gender * Employment) + \beta_6(Education * Employment)$$

Table 4. Calculation of $\log\left(\frac{P}{1-P}\right)$ according to the different combination of gender, education and employment.

	Gender	**Education**	**Employment**	$\log\left(\frac{P}{1-P}\right)$
1	Male (0)	No education (0)	Homemaker (0)	α
2			SE or EW (1)	$\alpha+\beta_3$
3		Elem, High or college (1)	Homemaker (0)	$\alpha+\beta_2$
4			SE or EW (1)	$\alpha+\beta_2+\beta_3+\beta_6$
5	Female (1)	No education (0)	Homemaker (0)	$\alpha+\beta_1$
6			SE or EW (1)	$\alpha+\beta_1+\beta_3+\beta_5$
7		Elem, High or college (1)	Homemaker (0)	$\alpha+\beta_1+\beta_2+\beta_4$
8			SE or EW (1)	$\alpha+\beta_1+\beta_2+\beta_3+\beta_4+\beta_5+\beta_6$

Males, no education and homemaker were coded as “0”, which was a baseline category for each variable. In Education and Employment, the categories other than the baseline category were integrated into one and then coded as “1”. Table 4 shows the calculated value of log (P / 1-P) according to each gender and SES combination by coding “0” or “1”.

When people are in the group of baseline category which is male, no education and homemaker, log odds and odds ratio are

$$\text{Log odds} = \log\left(\frac{P}{1-P}\right) = \alpha$$

$$\text{Odds ratio} = \exp(\alpha)$$

So, the probability of outcome is obtained as follows.

$$\frac{\exp(\alpha)}{1+\exp(\alpha)}$$

β_1, β_2, and β_3 are interpreted as follows.

- β_1 : the log-odds ratio comparing males and females amongst people who were not educated and homemakers.
- B_2 : the log-odds ratio comparing higher level of education and no education amongst male homemakers.
- β_3: the log-odds ratio comparing SE or EW and homemaker amongst males with no education.

To understand what the interaction term coefficients β_4, β_5, β_6 mean in this model, eq(1) is rearranged as follows.

$$\log\left(\frac{P}{1-P}\right) = \alpha + (\beta_1 + \beta_4 Education + \beta_5 Employment)(\boldsymbol{Gender}) + (\beta_2 + \beta_6 Employment)(\boldsymbol{Education}) + \beta_3(\boldsymbol{Employment})$$

This is like a multivariate regression model where gender, education, and employment are used as predictors. In regards to terms including β_4, β_5, β_6, the following explanation can be made.

- $(\beta_1 + \beta_4 Education + \beta_5 Employment)$: the log-odds ratio for males vs. females
- $(\beta_2 + \beta_6 Employment)$: the log-odds ratio for elementary, high school or college above vs. no education.

Finally, the interpretation of β_4, β_5, and β_6 is

- β_4 : In homemakers, difference between the log-odds ratio of females vs. males with elementary, high or college (and above) and the log-odds ratio of females vs. males with no education.
- β_5 : In no education group, the difference between the log-odds ratio of females of males in the SE or EW groups and the log-odds of females vs. males in a group with homemakers.

β_4 , β_5 , and β_6 are the modification of effect for each two-way interaction. So, one example of interpretation in Table 4 is

$$\text{Odds ratio} = \left(\frac{Male,\ College\ \&\ EW}{Male,\ no\ education\ \&\ Homemaker}\right) = \frac{\exp(\alpha + \beta 2 + \beta 3 + \beta 6)}{\exp(\alpha)}$$

$$= \exp(\beta 2 + \beta 3 + \beta 6)$$

Or, another interpretation can be made by subtracting two values in Table 4

By subtracting 1st equation from 2nd equation in Table 4

- β_3 : The log-odds ratio between group of male, no education and homemaker and group of male, no education and SE or EW.

By subtracting 8st equation from 7th equation in Table 4

- $\beta_5 + \beta_6$: The log-odds ratio between SE or EW and homemakers amongst female and elem/high/college education.

Analyses of interaction

The interaction is determined as three types; additive, multiplicative and synergistic. Two equations are defined to determine these interactions with the computed ORs.

A natural way to assess interaction is to measure the extent to which the effects of both factors outweigh the sum or multiplication of each individual effect. It was defined as the departure of additivity and departure of multiplicativity in the i*j contingency Table as follows(62).

- DA = Departure of additivity = $O_{ij}-O_{i0}-O_{0j}+O_{00}$
- DM = Departure of multiplicativity = $O_{ij}/(O_{i0}*O_{0j})$

From above definition, the following interpretations are obtained.

- DA > 0 : positively additive interaction (super-additive), DA<0: negatively interaction (sub-additive)
- DM > 1 : positively multiplicative, DM<1: negatively multiplicative
- DA or DM = 0 : No interaction
- DA>>0 and DA>>1 : Synergistic interaction

CHAPTER 4: RESULTS

SPECIFIC AIM #1: DESCRIPTIVE STATISTICS

In order to fulfill the first specific aim, descriptive statistics were performed to figure out observed differences from the data collected before performing more complex analyses. This analysis provides the first step to understand the relationship between variables. That is, this section seeks to identify the characteristics of respondents through frequency and proportions related to gender, education and employment status, and EH conditions.

Table 5 shows the frequency and proportion of the independent variables (education and employment) and dependent variables (toilet, drinking water and cooking fuel) according to gender. A total of 36,809 individuals completed the interviews between December 2010 and October 2016. Gender distribution was 51.7% for males and 48.3% for females. There were missing data for each variable, but the number of missing variables was less than 3% for a large number of respondents. Hence, missing variables was not an issue because the impact was negligible. The observed characteristics are presented in Figure 1-5.

Figure 1 shows the difference in education level distribution between males and females. 27.2% of males and 38.9% of females did not receive formal education. 40.1% of males and 38.2% of females received elementary education. The proportion of high school graduates was 28.2% for males and 20.1% for females. Finally, the proportion of respondents completed education of college and above was 4.4% and 2.8% for males and females, respectively.

Table 5. Frequency and proportion of education, employment and EH conditions by gender

	Gender				Total	
	Male		Female			
	#	%	#	%	#	%
Education						
No education	5148	27%	6861	38.9%	12009	32.9%
Elementary	7581	40%	6734	38.2%	14315	39.2%
High school	5335	28%	3550	20.1%	8885	24.3%
College and above	841	4%	487	2.8%	1328	3.6%
Subtotal	18905	100%	17632	100.0%	36537	100.0%
Employment						
Others	1341	7%	857	4.9%	2198	6.0%
Homemaker	923	5%	14247	80.8%	15170	41.5%
Self-employed	14335	76%	1479	8.4%	15814	43.3%
Employed for wage	2280	12%	1051	6.0%	3331	9.1%
Subtotal	18879	100%	17634	100.0%	36513	100.0%
Drinking water						
Treated	14504	76.2%	13266	75%	27770	75.4%
Untreated	4540	23.8%	4499	25%	9039	24.6%
Subtotal	19044	100%	17765	100%	36809	100%
Toilet						
Yes	8393	44.1%	7767	44%	16160	43.9%
No	10651	55.9%	9998	56%	20649	56.1%
Subtotal	19044	100%	17765	100%	36809	100%
Cooking fuel						
Improved	15407	80.9%	12727	72%	28134	76.4%
Firewood	3637	19.1%	5038	28%	8675	23.6%
Subtotal	19044	100%	17765	100%	36809	100%

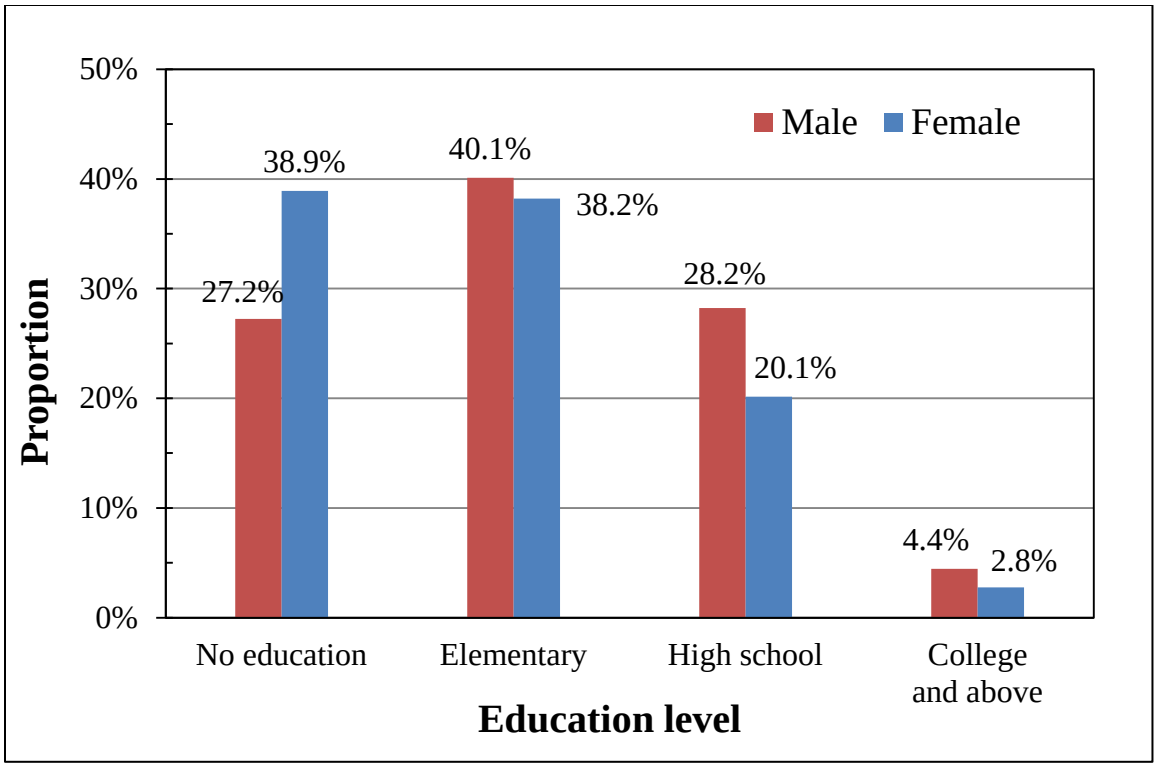

Figure 1. Proportion of different educational levels for males and females.

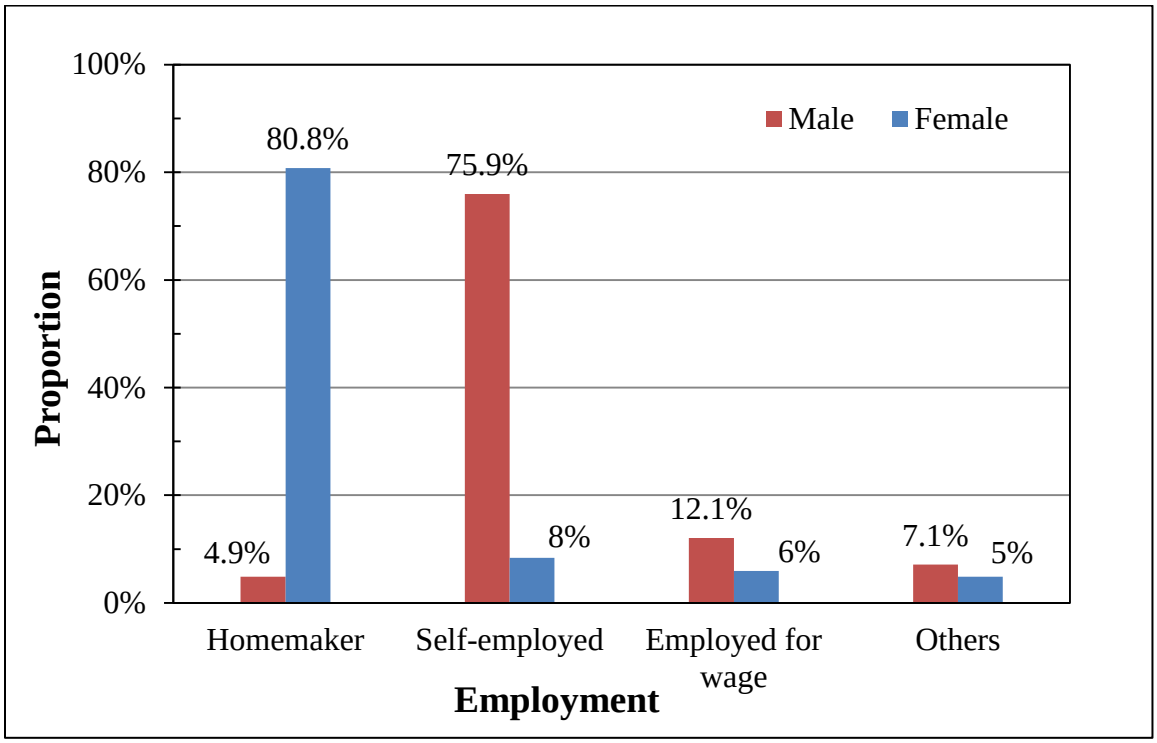

Figure 2. Proportion of employment status for males and females.

The proportion of people who received elementary education was the highest in males, while the proportion of people who did not experience formal education was greatest.in females.

Figure 2 shows a clear difference between males and females when comparing participants' occupational distribution. The vast majority of males (75.9%) were self-employed and the majority of females (80.8%) were homemakers. 4.9% of males were working as homemakers, and 7% were in “others” groups, including students, retirees, and those unable to work. The proportion of people who employed for wages was 12.1% for males, twice as high as for females

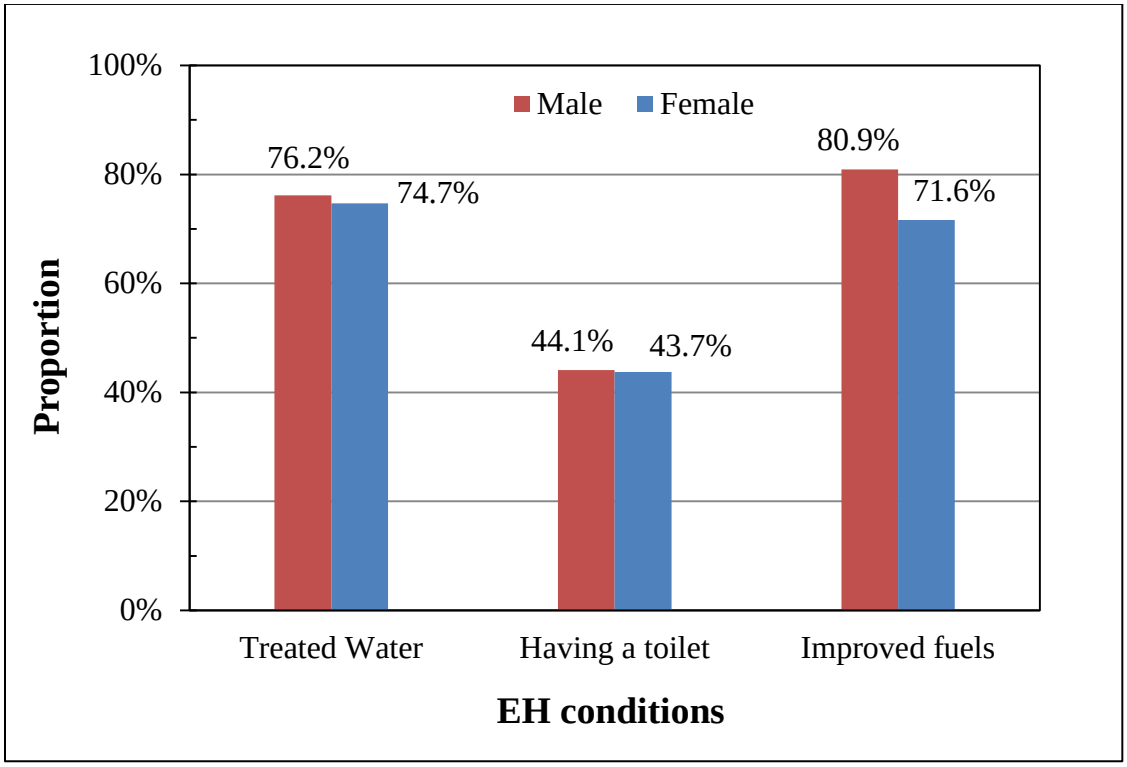

Figure 3. Proportion of positive EH conditions (Drinking water, Toilet ownership and Cooking fuel) for males and females.

In Figure 3, the bar graph compares the EH conditions that males and females use or have. The numbers on the graph indicate the proportion of respondents who answered with positive conditions in terms of drinking water, toilet, and cooking fuel. The proportion of people who had treated water was 76.2% for males and 74.7% for females. The proportion of people who own a toilet also shows only a slight difference of 0.4% between males and females. Cooking fuel shows a big difference of 9.3%, 80.9% for males and 71.6% for females. It has been shown that males are cooking using improved fuels such as gas or kerosene instead of firewood.

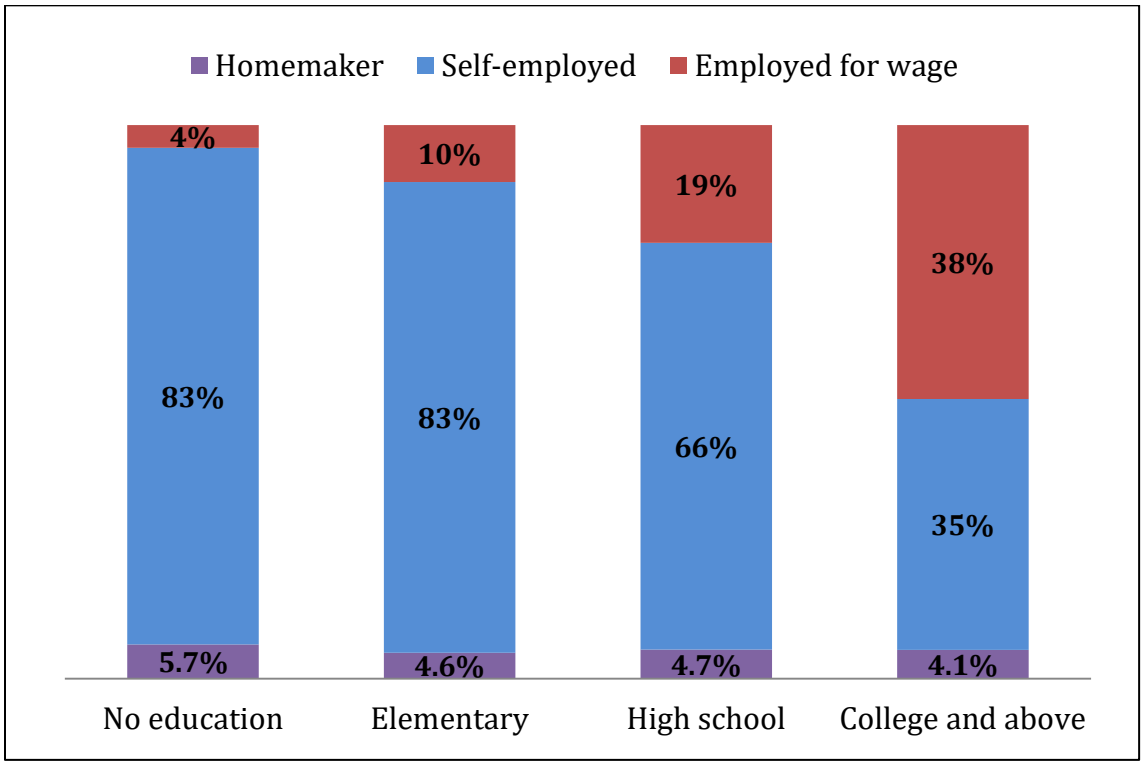

Figure 4. The relationship between education level and employment status (Males)

In order to easily distinguish between the level of education and the employment of residents in rural communities, a 100% stack column was used. Students and retirees

belonging to "others" were heterogeneous and difficult to interpret as characteristics of a unified profession. Hence, except for the respondents categorized as "others," only the other three employment conditions were represented in this graph. Figure 4 shows employment variation by education level in males. The sum of occupations in each of the four education categories was 100%. (100% was not available here because it excludes "others").

Among non-formal educated people, the proportion of self-employed was the highest at 83%. This rate was substantially reduced as the level of education increased. In the end, only 40% of those who received college education were self-employed. This tendency was the opposite in a group of people receiving wages. As can be seen in the Figure 4, the percentage of people who received wages among uneducated people was 4%, but it increased with the level of education, accounting for 38% of college graduates

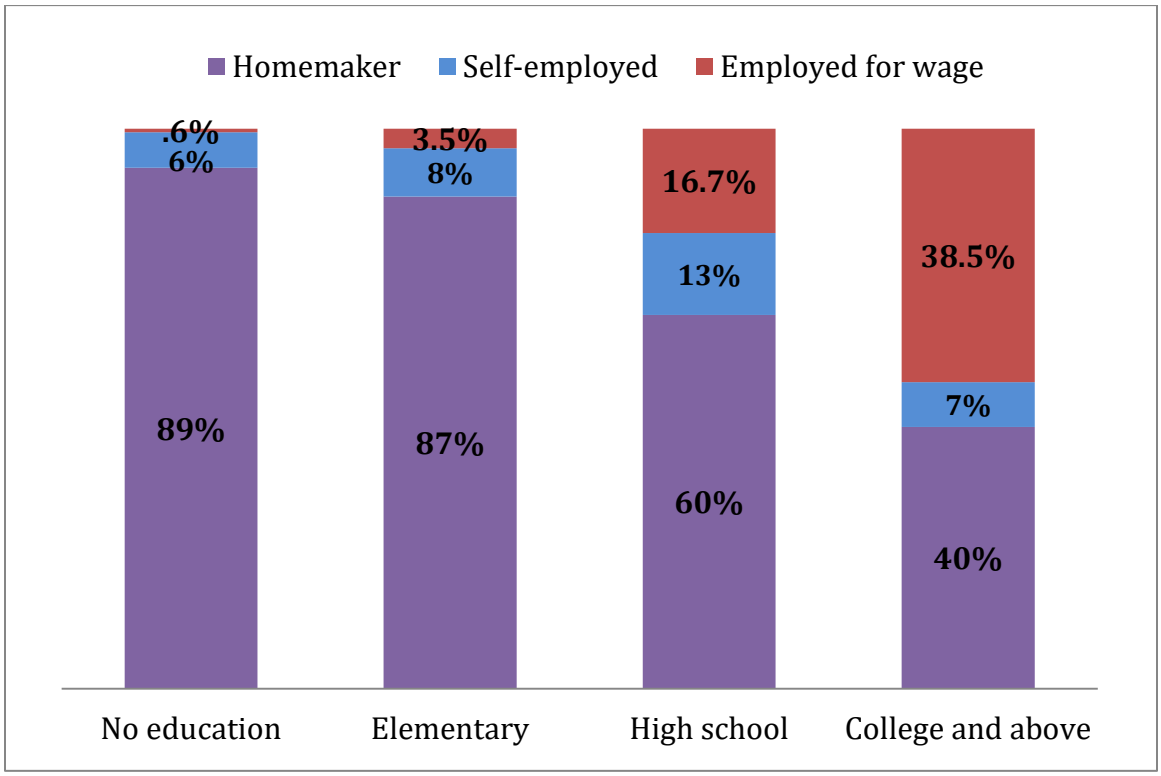

Figure 5. The relationship between education level and employment (Females)

In Figure 5, females tend to be different from males. Of the uneducated respondents, 84% were homemakers and the proportion of them decreased to nearly half, with an increase in educational opportunities. Like males, the proportion of jobs receiving wages increased as educational level was higher. However, the proportion of self-employed people remained somewhat fluctuating between 6-13%, despite the rising level of education.

SPECIFIC AIM #2: ASSOCIATION AND CORRELATION

The second goal is to identify associations and correlations between independent (gender, education and employment) and dependent (toilet, drinking water and cooking fuel) variables. The association indicates whether the independent variables, education and employment, are related to the dependent variable, which is an environmental condition, but it does not indicate how the relationship is specifically associated. Correlation, on the other hand, determines whether two independent and dependent variables are proportional or inversely proportional to each other through a positive and negative linear relationship between two variables. The chi-squared test was used to confirm the association and the Spearman rank coefficient was used to understand the correlation.

As shown in Table 6, the significance level of association between education and employment and toilet, drinking water and cooking fuel was $P < 0.01$, showing significant relationships. This means that education and employment affect EH conditions. The correlation Table shows that SRC of education and toilet ownership has a proportional relationship of 0.256; other relationships are statistically positive but relatively weak.

Table 6. Association (Chi-square test) and correlation (Spearman rank coefficients)

		Toilet	Drinking water	Cooking fuel
Association (Chi-square test)	Education	P <0.01	P <0.01	P <0.01
	Employment	P <0.01	P <0.01	P <0.01
Correlation (Spearman rank Co)	Education	r= 0.256	r=0.101	r=0.049
	Employment	r= -0.103	r= 0.077	r=0.161

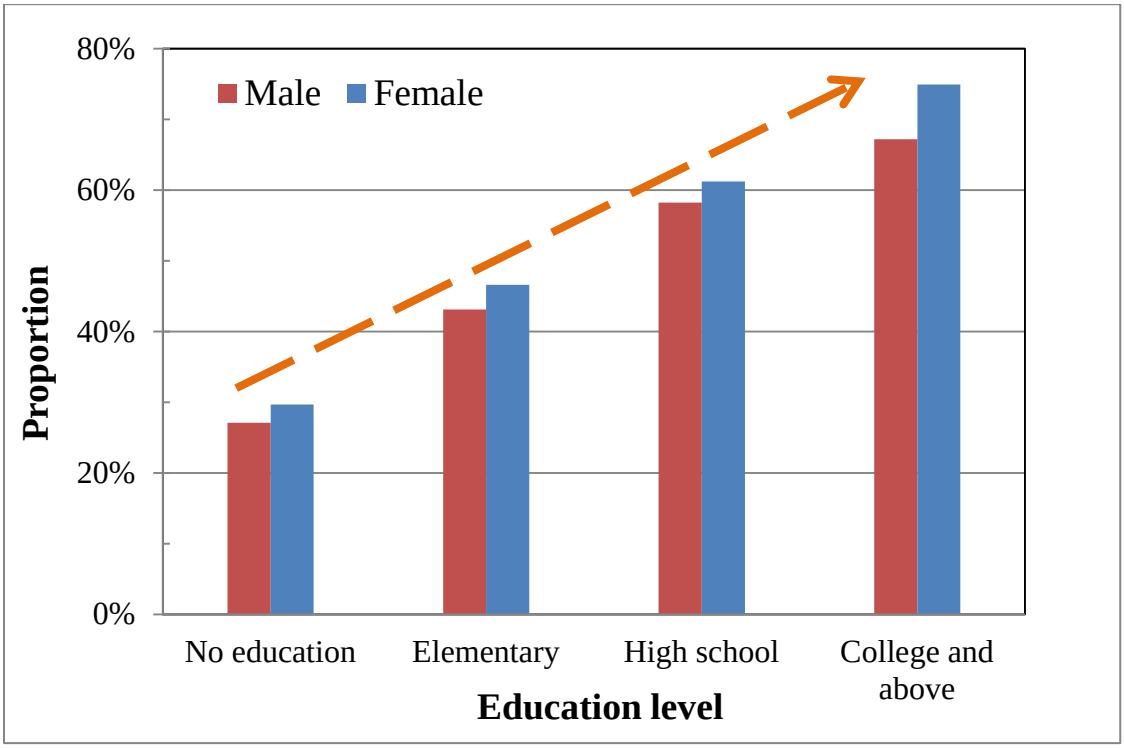

Figure 6. The positive correlation between educational level and toilet ownership

Figure 6 provides a visual representation of the correlation between education and toilet ownership identified in Table 6. The graph clearly shows that as the level of

education increases, the possession of the toilet increased and it indicated a proportional correlation. Both males and females show that the higher the level of education, the greater the proportion of toilet ownership.

SPECIFIC AIM #3: MODEL DEVELOPMENT

A logistic regression model was developed for each of the dependent variables, toilet, drinking water, and cooking fuel. Since the development process of the three models is similar, the model for the toilet was selected here to describe the details how the final outcomes were obtained from the beginning. For the drinking water and cooking fuel, only the final results were interpreted. All of the intermediate results are found in the Appendix A-D.

The impact of education and employment on toilet ownership

Model 1 & 2

Model 1 shows a simple relationship between one independent variable and the possession of the toilet. That is, Model 1 describes the individual effects on toilet ownership without controlling other factors and provides an unadjusted OR. After controlling all the independent variables, the adjusted OR was obtained from Model 2. If there is a significant discrepancy between the unadjusted OR and the adjusted OR by controlling confounding factors, it indicates the need for an interaction model. Table 7 shows that as the level of education increases and the employment status improves, the OR increases.

In addition, there was a difference in OR between the two models, indicating that there was an interaction between gender, education, and employment. Hosmer and Lemeshow fitness tests for Model 2 show that the value of p in Model 2 was less than

0.01. This means that Model 2 is not suitable as a model for predicting the possession of a toilet. Thus, a third model including interaction was developed.

Table 7. Odds ratios of toilet ownership obtained from Model 1 and 2

Variables		**Model 1**		**Model 2**	
		Odds ratio (95% CI)	**p value**	**Odds ratio (95% CI)**	**p value**
Gender	Male	Ref		Ref	
	Female	0.99 (0.95,1.03)	<0.01	1.57 (1.46,1.7)	<0.01
Education	No education	Ref		Ref	
	Elementary	2.03 (1.93,2.14)	<0.01	2.12 (2.01,2.24)	<0.01
	High school	3.69 (3.48,3.91)	<0.01	3.67 (3.45,3.91)	<0.01
	College and above	5.85 (5.16,6.62)	<0.01	4.87 (4.22,5.61)	<0.01
Employment	Homemaker	Ref		Ref	
	Self-employed	1.12 (1.07, 1.17)	<0.01	1.41 (1.3,1.53)	<0.01
	Employed for wage	2.82 (2.61,3.05)	<0.01	2.27 (2.05,2.5)	<0.01
Hosmer & Lemeshow test			1		<0.01

Model 3

Table 8 shows the results obtained from the SPSS program for model 3. This model shows that the P-value of the Hosmer & Lemshow test was higher than 0.05, so it was suitable as a model for calculating predicted values. Each B coefficient represents the change in logit P by a one-step change in the defined categorical variable and OR is

obtained by exp (B). The variables of education and employment and the coefficients of interaction are interpreted as follows.

- Each education coefficient showed a difference between education level and reference category (no education), but only for males and homemaker.
- Each employment coefficient showed a difference between the employment status and the basic category of homemaker, but only for males with no formal education.
- The coefficients for each interaction period (gender * education, gender * employment and gender * employment) indicate how the effect of employment differs according to the level of education compared to the magnitude of the employment effect of uneducated males.

As can be seen in Table 8, the two-way interactions between gender, education, and employment were statistically significant, with a P value <0.01, which meant a significant impact on the model. If the interaction is not taken into consideration, the odds ratio directly seen in Table 8 can be interpreted in the case where one variable is fixed. For example, a male homemaker educated through high-school was 3.63 times more likely to have a toilet than a male homemaker without formal education. However, when the interaction is considered, the odds ratio should be obtained from a separate calculation through the combination of the variable and the B coefficient as shown in the Methods section. According to constant and B coefficients in Table 8, the following equation was obtained.

Table 8. Variables in the equation for Model 3 (Toilet ownership)

Variables	Model 3				
	B	**Wald**	**df**	**OR (95% CI)**	**P value**
Gender					
Male	Ref				
Female	0.19	3.4	1	1.21 (0.99, 1.47)	0.06
Education		131.7	3		<0.01
No education	Ref				
Elementary	0.51	22.5	1	1.67 (1.35, 2.07)	<0.01
High school	1.29	125.3	1	3.63 (2.89, 4.54)	<0.01
College and above	0.64	7.2	1	1.90 (1.19, 3.05)	0.07
Employment		6.5	2		0.04
Homemaker	Ref				
Self-employed	0.05	0.3	1	1.05 (0.86, 1.29)	0.61
Employed for wage	-0.38	4.1	1	0.68 (0.47, 0.99)	0.04
Education * Gender		14.7	3		<0.01
Elem by Female	0.20	3.4	1	1.22 (0.99, 1.5)	0.07
High school by Female	-0.05	0.2	1	0.95 (0.76, 1.18)	0.66
College by Female	0.61	7.4	1	1.85 (1.19, 2.88)	<0.01
Employment * Gender	Ref	11.9	2		<0.01
Self-employed by female	0.31	11.4	1	1.37 (1.14, 1.64)	<0.01
EW by Female	0.12	1.0	1	1.12 (0.89, 1.41)	0.32
Education * Employment		94.9	6		<0.01
Elem by Self-employed	0.21	3.7	1	1.23 (1.00, 1.52)	0.05
Elem by EW	1.36	46.6	1	3.89 (2.63, 5.75)	<0.01
High school by Self-employed	0.07	0.4	1	1.07 (0.86, 1.35)	0.53
High school by EW	0.84	18.2	1	2.33 (1.58, 3.43)	<0.01
College by Self-employed	0.60	5.5	1	1.82 (1.1, 3.00)	0.02
College by EW	2.25	61.2	1	9.51 (5.41, 16.71)	<0.01
Constant	-1.123	123.3	1	0.33	<0.01
Hosmer & Lemeshow test					0.88

$$\log\left(\frac{P}{1-P}\right) = LO = -1.123 + 0.19\left(Gen_{fem}\right) + 0.51(Edu_{elem}) + 1.29\left(Edu_{high}\right)$$
$$+ 0.64(Edu_{col}) + 0.05(Emp_{SE}) - 0.38(Emp_{EW})$$
$$+ 0.2\left(Edu_{elem} * Gen_{fem}\right) - 0.05\left(Edu_{high} * Gen_{fem}\right)$$
$$+ 0.61\left(Edu_{col} * Gen_{fem}\right) + 0.31\left(Emp_{SE} * Gen_{fem}\right)$$
$$+ 0.12\left(Emp_{EW} * Gen_{fem}\right) + 0.21(Edu_{elem} * Emp_{SE})$$
$$+ 1.36(Edu_{elem} * Emp_{EW}) + 0.07\left(Edu_{high} * Emp_{SE}\right)$$
$$+ 0.84\left(Edu_{high} * Emp_{EW}\right) + 0.6(Edu_{col} * Emp_{SE})$$
$$+ 2.25(Edu_{col} * Emp_{EW})$$

In the above model, variables were coded as 0 or 1 in the combinations generated according to the categories of gender, education, and employment. Table 9 shows the values of log-OR and OR obtained from the input coding according to the combination of the three variables.

Figure 7 shows the OR obtained by coding 0 or 1 along the SES, which was a combination of the categories of variables in Table 9. Regardless of gender, those who were educated in the same employment status were more likely to own a toilet than those who did not. Self-employed males and those who were homemaker's showed a tendency to an increased OR compared to those with high school education, but slightly less than those who received college education. Males employed for wages are 12.3 times more likely to have toilet than those in the baseline category (male homemaker with no education). Female homemakers did not differ greatly between high school and college

Table.9. Coding combination for odds ratio of toilet ownership

Group			X_1		X_2				X_3			B-α	OR
			Male	Female	**No edu**	Elem	High.	Col.	**H**	SE	EW		
Male	No edu	H	**0**	0	**0**	0	0	0	**0**	0	0	0.00	1.00
		SE	**0**	0	**0**	0	0	0	**0**	1	0	0.05	1.05
		EW	**0**	0	**0**	0	0	0	**0**	0	1	-0.38	0.68
	Elm	H	**0**	0	**0**	1	0	0	**0**	0	0	0.52	1.67
		SE	**0**	0	**0**	1	0	0	**0**	1	0	0.77	2.16
		EW	**0**	0	**0**	1	0	0	**0**	0	1	1.49	4.45
	High	H	**0**	0	**0**	0	1	0	**0**	0	0	1.29	3.63
		SE	**0**	0	**0**	0	1	0	**0**	1	0	1.41	4.10
		EW	**0**	0	**0**	0	1	0	**0**	0	1	1.75	5.75
	Col.	H	**0**	0	**0**	0	0	1	**0**	0	0	0.64	1.90
		SE	**0**	0	**0**	0	0	1	**0**	1	0	1.29	3.64
		EW	**0**	0	**0**	0	0	1	**0**	0	1	2.51	12.34
Female	No edu.	H	**0**	1	**0**	0	0	0	**0**	0	0	0.19	1.21
		SE	**0**	1	**0**	0	0	0	**0**	1	0	0.55	1.74
		EW	**0**	1	**0**	0	0	0	**0**	0	1	-0.08	0.93
	Elem.	H	**0**	1	**0**	1	0	0	**0**	0	0	0.90	2.46
		SE	**0**	1	**0**	1	0	0	**0**	1	0	1.47	4.34
		EW	**0**	1	**0**	1	0	0	**0**	0	1	1.99	7.34
	High	H	**0**	1	**0**	0	1	0	**0**	0	0	1.48	4.38
		SE	**0**	1	**0**	0	1	0	**0**	1	0	1.91	6.77
		EW	**0**	1	**0**	0	1	0	**0**	0	1	2.06	7.81
	Col	H	**0**	1	**0**	0	0	1	**0**	0	0	1.45	4.25
		SE	**0**	1	**0**	0	0	1	**0**	1	0	2.41	11.12
		EW	**0**	1	**0**	0	0	1	**0**	0	1	3.43	30.97

educated people. However, as self-employed and wage-earning females have become more educated, the possession of toilets has increased. In particular, females who graduated from college and employed for wages were 31 times more likely to own a toilet than the baseline category.

The effect of joining education and employment was calculated in Table 10. In the case of the male self-employed group, the interaction of education on employment has been additive up to high school, but the college and above shows a multiplicative or synergistic effect. In the case of wage workers, the effect of education on employment was synergistic, showing that the synergies with college education were particularly significant. The synergistic effect of education and employment on females was much greater than that of males.

Table 10. Interaction of education levels and employment status on toilet ownership

		Self-employed		Employed for wage	
		Additivity	Multiplicativity	Additivity	Multiplicativity
Male	Elementary	0.44	1.23	3.10	3.92
	High school	0.42	1.08	2.44	2.33
	College and above	1.69	1.82	10.76	9.55
Female	Elementary	1.12	1.23	3.26	3.88
	High school	1.54	1.07	2.07	2.32
	College and above	5.24	1.82	21.31	9.48

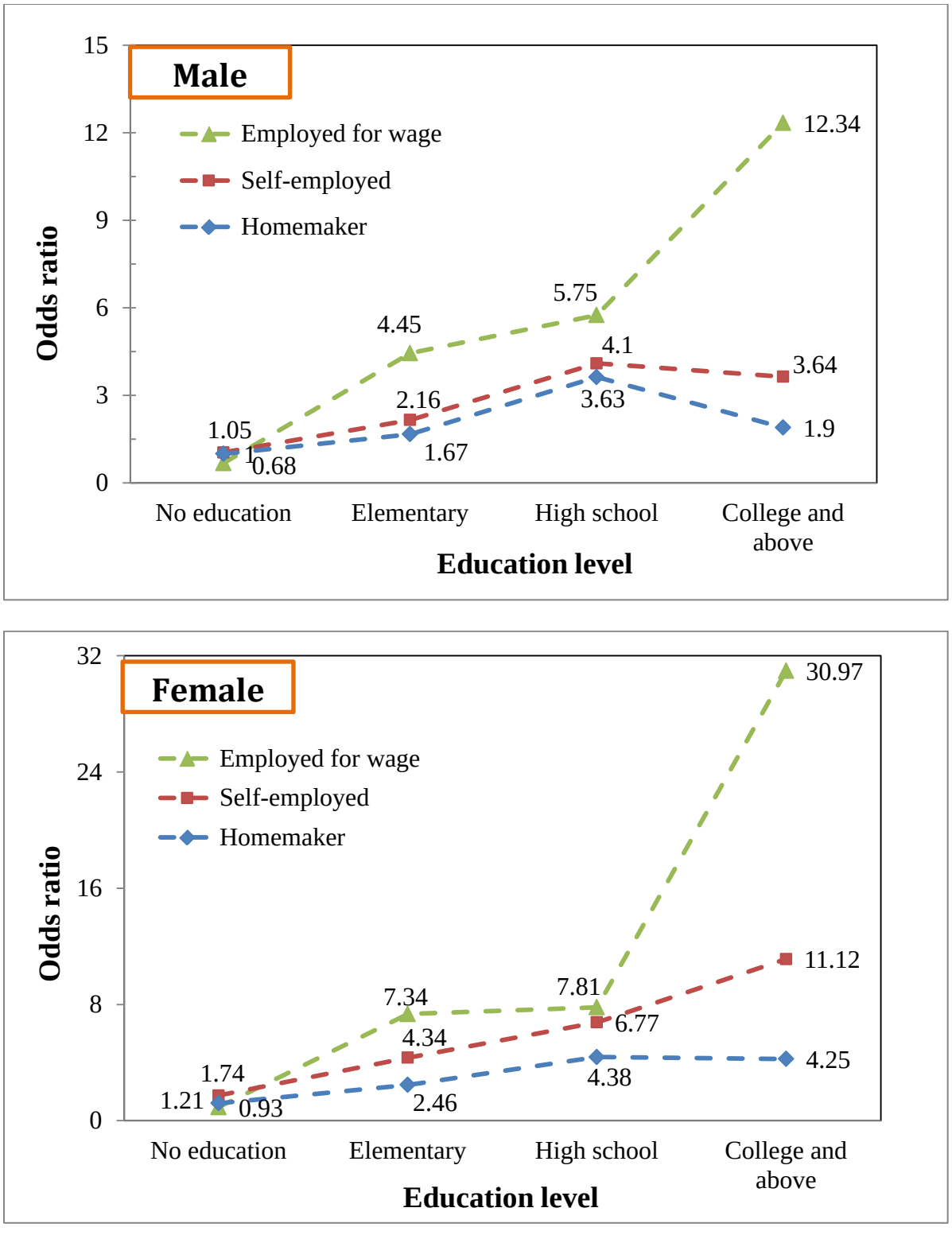

Figure 7. Odds ratio according to employment status vs education level for toilet (Baseline = male+no education+homemaker) – Top (Male), Bottom (Female)

The impact of education and employment on drinking water

Figure 8 shows the impact of education levels and employment status on having treated or untreated drinking water. There were similar trends among the three different occupations regardless of gender. Both male and female homemakers and those who were self-employed showed little change in the OR as the level of education increased. In other words, the effect of education did not influence the selection of drinking water. Among the employed for wage, the effect of education was significant, and males who had completed high school and college education were more likely to have access to a treated drinking water source for ORs of 8.5 times and 6.1 times more than the standard category, respectively. For females, those who completed high school and college education were 16 times and 11 times more likely to have treated drinking water access than the baseline category, respectively.

Table 11 shows the effect of education and employment interaction on drinking water. In both male and female homemakers and self-employed groups, the synergy effect from interaction with education was not significant. However, in the group of people employed for wages, the additive effects for males and females were 10.8 and 21, respectively and it indicated that there were significant synergic effect between education and employment.

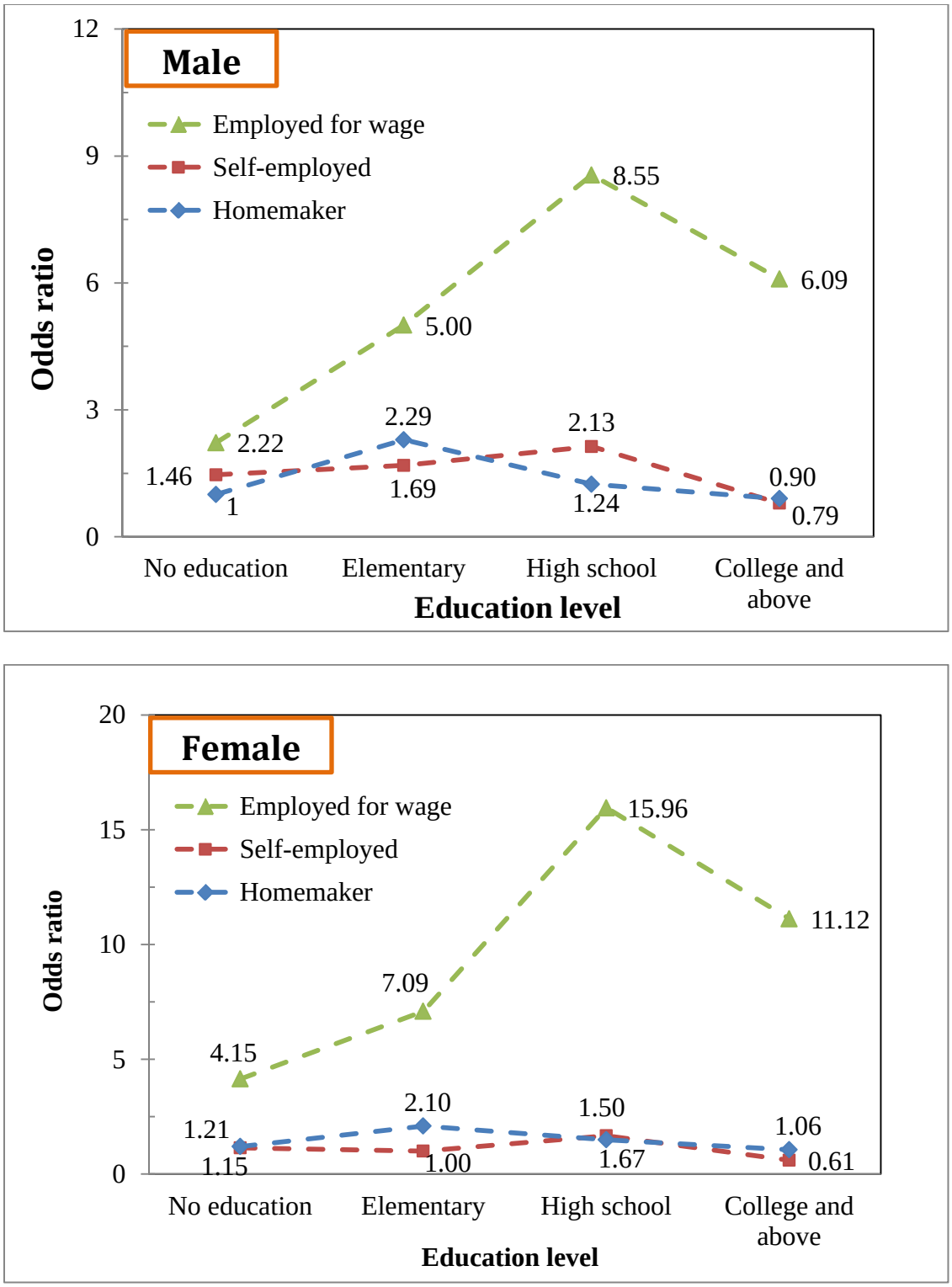

Figure 8. Odds ratio according to employment status vs education level for drinking water (Baseline = male+no education+homemaker) – Top (Male), Bottom (Female)

Table 11. Interaction of education levels and employment status on drinking water

		Self-employed		Employed for wage	
		Additivity	Multiplicativity	Additivity	Multiplicativity
Male	Elementary	-1.07	0.50	1.49	0.98
	High school	0.43	1.17	6.09	3.10
	College and above	-0.57	0.60	3.97	3.04
Female	Elementary	-0.85	0.50	0.70	0.99
	High school	0.20	1.18	8.52	3.11
	College and above	-0.32	0.60	4.88	3.05

The impact of education and employment on cooking fuel

Figure 9 shows the impact of education and employment on the selection of a clean burning cooking fuel. Regardless of gender, there was a similar trend among the three professions. Both homemakers and self-employed males and females showed little or no change as the level of education increased. In other words, the effect of education in the two occupational groups did not have a significant effect on the choice of cooking fuel.

The education effect of wage workers was relatively larger than that of the other two occupation categories, and males who had completed high school education and college education were more likely to choose the cleaner burning cooking fuel at ratios 3.5 times and 2.1 times higher than the baseline category, respectively. For females, those who completed high school and college education were 10.2 times and 5.2 times more likely to use improved cooking fuel than the baseline category, respectively.

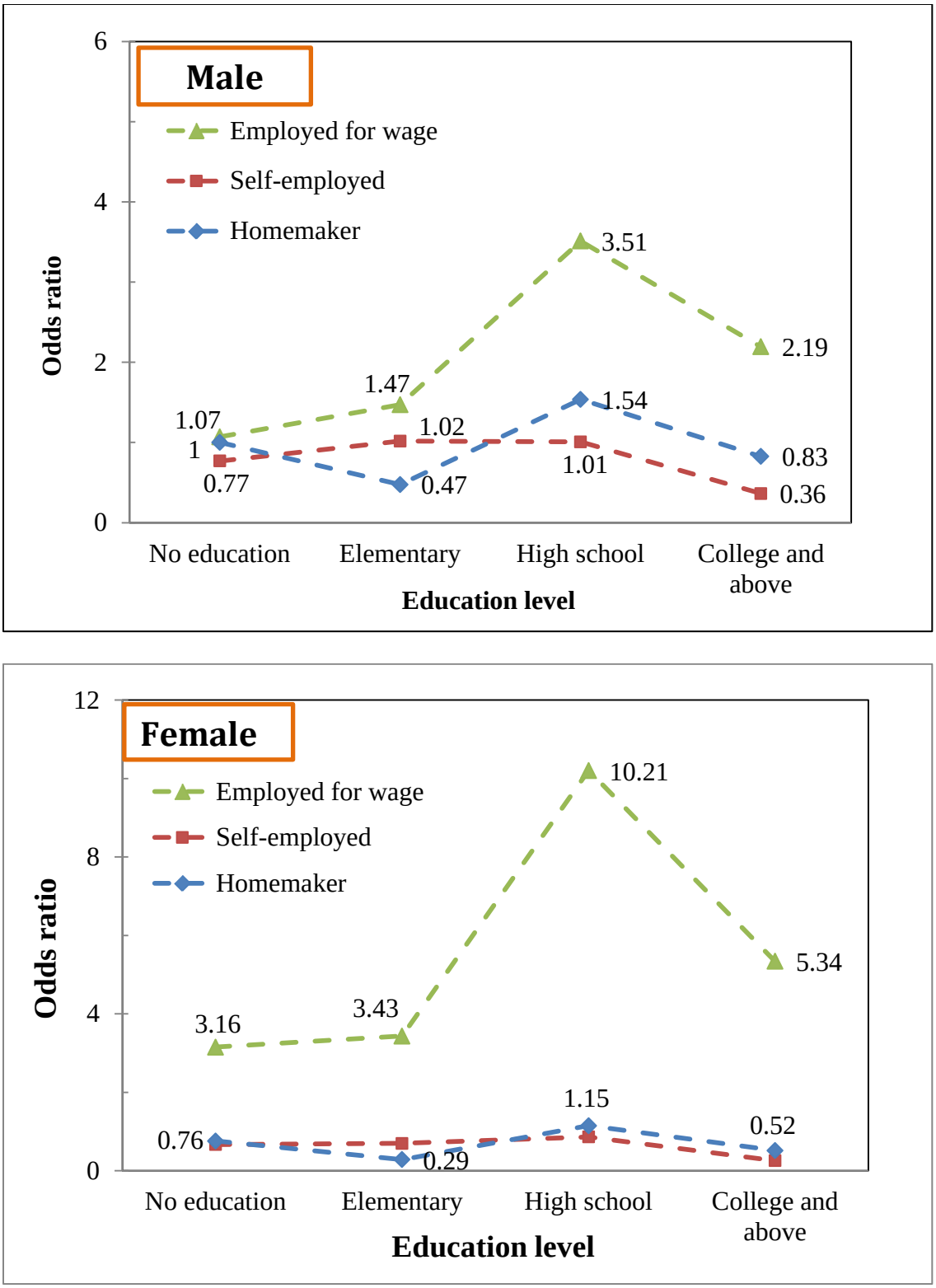

Figure 9. Odds ratio according to employment status vs education level for cooking fuel (Baseline = male+no education+homemaker) – Top (Male), Bottom (Female)

Table 12 shows the interaction effects of education and employment on the type of cooking fuel. Both males and females in the homemakers' and self-employed groups did not have much synergy effect with education. However, the highest additive value for males and females in the wage worker group were 1.9 and 7.1, respectively, indicating synergy effect.

Table 12. Interaction of education levels and employment status on cooking fuel.

		Self-employed		Employed for wage	
		Additivity	Multiplicativity	Additivity	Multiplicativity
Male	Elementary	0.77	2.78	0.93	2.90
	High school	-0.30	0.85	1.90	2.14
	College and above	-0.23	0.57	1.30	2.48
Female	Elementary	0.96	3.67	1.20	3.82
	High school	0.25	1.12	7.11	2.81
	College and above	-0.17	0.75	2.88	3.27

CHAPTER 5: DISCUSSION

Environmental hazards are affected by physical and social factors. 57.4% of the population of Gujarat live in rural areas and the remaining 42.6% live in urban areas (2). Due to the undeveloped infrastructure, people can be vulnerable to environmental risks. This infrastructure is considered as a physical factor, which provides poor water quality to residents, improper sewerage systems, and inadequate medical services due to scarce transportation capabilities. Among social factors, literacy and formal education play an important role in disseminating knowledge about EH(24). According to the 2011 census (2), the literacy of Gujarat is 78.3%, which is higher than the national average of 71%. Comparing gender, male and female literacy are 87.2% and 70%, respectively, indicating that males are more educated than females. In our sample, the proportion of males and females educated until high school was 32% and 23%. Differences in education levels by gender may be the result of various complex factors. First, there may be a lack of educational opportunities due to discrimination against women. Indeed, India's Global Gender Gap Index (GGGI) is ranked 114th out of 142 countries (7), indicating that there is a serious gap between men and women. Second, because of the religion and caste system, educational opportunities may be given unequally. The decline in education due to these inequalities may not only weaken the health of women, but may also lead to increased crime.

In employment, males and females showed distinct differences as well. Most of the males were self-employed (76%), while most of the females were homemakers (81%). Female job participation rate was 14%, which was lower than the average national rate of 25.6%(3). This difference may be due to the low level of education of women in rural

areas, but it may be due to the fact that the opportunity to participate in a job or their willingness to participate is lower than in larger cities.

The measure of environmental risk, which was found in drinking water, the possession of the toilet, and the type of cooking fuel, showed that men and women were exposed to a similar level of risks. The reason why the difference between men and women was not so large can be attributed to data collection. Because surveys were conducted by household for adults over 18 years of age, the same environmental conditions may be shared regardless of their individual educational level and employment status. Thus, the statistics of the whole sample show that the proportions of men and women were similar.

In both men and women, education and employment status are interrelated. For males, the proportion of wage earners increased self-employed as the level of education increased. As the level of education increases, women also have more opportunities for self-employment or wage-earning jobs other than homemaker. Since there is no information on income for self-employed and wage workers, it is difficult to distinguish which jobs are more profitable. However, given that the higher education level is proportional to the wage workers, it can be inferred that the better the education, the more favorable the wage-earning profession (46).

SES has a different effect on EH conditions. The different levels of education and employment status were found to be most closely related to possession of the toilet. Both male and female groups with three different employment status showed a greater likelihood of possession of the toilet as education increased. This shows that individual SES has a direct impact on toilet ownership(42). However, the choice of drinking water

and cooking fuel did not show as much variation as toilet ownership when education increased for both the homemaker and self-employed groups for both males and females. This may be because the choice of drinking water and cooking fuel is not an issue of individual choice but of the infrastructure or services provided in the geographical location of the respondents. Residents in rural communities may have difficulty in obtaining personal drinking water. Therefore, they have no choice but to rely on the community infrastructure for their supply (40). If the village processes and stores drinking water, people living in the area can benefit from the same services regardless of their SES. In the case of improved cooking fuel, gas or kerosene, they cannot be self-produced and must be supplied by local public services. If local service is not available, the user must visit and purchase or order and receive delivery. Therefore, these services can only benefit if they live in the area where they are available (48).

An interesting finding is that education is synergistic in a group of people receiving wages. This may be due to people in this group tend to migrate to a good area, sharing information about areas that are better served. In addition, it may be because there is better infrastructure for supplying drinking water and cooking fuel to the places where commuting is relatively easy.

In toilet ownership, there are many possible explanations for the greatest impact of wage-earning occupations, along with university education. Those with college education can benefit from several experiences that increase their likelihood of using a toilet (32). First, during college education, people may experience the use and convenience of public toilets and have learned the importance of owning a toilet after graduation. Second, the higher the level of education, the more shameful it may be

perceived to take an outdoor bowel movement (open defecation). Third, they may understand and attempt to circumvent the adverse effects of open defecation on the environment. Finally, people may have learned and applied the toilet habits they have observed in developed countries in the process of expanding their diverse experience and knowledge at college.

Those who were employed for wage may also have received several benefits compared to homemaker and self-employed. First, there is a high possibility that a workplace for multiple employees has a toilet. Therefore, people will become accustomed to using the toilet and apply the convenience to their homes. Secondly, people may naturally use the toilet as workplace etiquette in the process of working together.

As females increased their education, they were more likely than males to change to better EH conditions in regards to toilets, drinking water, and cooking fuel. Men do not pay much attention to health until their condition is severe. On the other hand, women use information to respond more aggressively to environmental health than men. They are more concerned with environmental health issues than men and have more responsibility to cope with the risk perceptions they are facing (37).

India is lagging behind in many countries in the area of EH. Most cities and villages in India are characterized by population density, congestion, inadequate water supply, and inadequate human waste, wastewater and solid waste treatment facilities. Most of the problems in this country lead to people's health, destruction of livelihoods, and weakening overall development potential due to incomplete circumstances. EH is still a ignored problem in India (58). In order to improve the EH of the community, the

government should have strong institutional support and regulations. Based on these regulations and policies, local public health officials should develop appropriate interventions considering social determinants.

This study has several limitations as follows. First, the effects of age were not considered in this study. Dependents over 18 years old may have complied with the EH condition regardless of their SES because the conditions of EH are determined by the decision of the head of the household. Also, the impact of SES may be relatively weak in older people who do not want to change their familiar lifestyle. Second, this is an individual survey, not a family unit. Therefore, it may have been decided according to the SES of the head, regardless of the SES of the individual family member. Third, income level, an important element of SES, was not considered. It can predict income in the state of education and employment, but it may not necessarily be proportional. Finally, the geographical characteristics in which respondents reside are not considered. Depending on the geographical characteristics, the physical infrastructure may vary, which may have had a significant impact on the respondent's EH conditions.

Based on the results of this study, the following study was proposed. The risk analysis of EH by geographical location will help to provide appropriate EH conditions by understanding regional imbalances. By analyzing the effect of age on the EH condition, it is possible to develop an intervention considering the multifaceted aspects by classifying the EH risk levels for each generation.

CHAPTER 6: CONCLUSIONS

This study was to analyze the relationship between SES and EH in rural villages. The level of education and employment status have influenced the choice of toilet ownership, drinking water, and cooking fuel, showing closest relevance to ownership of the toilet. While the possession of the toilet has changed dramatically according to individual SES, the choice of drinking water and cooking fuel was less so as shown to be more influenced by the infrastructure of the village. College education and wage-employment have produced the greatest synergy in determining EH conditions. The results of this study will help to promote the health of the local residents by guiding more effective intervention at each level of SES and will help to prevent disease caused by environmental risks in this rural setting in India.

APPENDIX A: MODEL 1 & 2 FOR DRINKING WATER AND COOKING FUEL

Drinking Waters

Variables		Model 1		Model 2	
		OR (95% CI)	p value	OR (95% CI)	p value
Gender	Male	Ref		Ref	
	Female	0.92 (0.88,0.97)	<0.01	1.01 (0.92,1.11)	0.84
Education	No education	Ref		Ref	
	Elementary	1.47 (1.39,1.55)	<0.01	1.42 (1.34,1.5)	<0.01
	High school	2.02 (1.89,2.16)	<0.01	1.75 (1.63,1.88)	<0.01
	College and above	1.43 (1.25,1.63)	<0.01	0.83 (0.71,0.97)	0.02
Employment	Homemaker	Ref		Ref	
	Self-employed	1.01 (0.96, 1.07)	<0.01	0.96 (0.88,1.05)	0.41
	Employed for wage	4.43 (3.88,5.06)	<0.01	3.95 (3.39,4,59)	<0.01
Hosmer & Lemeshow test			1		<0.01

Cooking Fuel

Variables		Model 1		Model 2	
		OR (95% CI)	p value	OR (95% CI)	p value
Gender	Male	Ref		Ref	
	Female	0.6 (0.57,0.63)	<0.01	0.84 (0.77,0.92)	<0.01
Education	No education	Ref		Ref	
	Elementary	0.71 (0.67,0.75)	<0.01	0.64 (0.6,0.68)	<0.01
	High school	1.62 (3.48,3.91)	<0.01	1.28 (1.18,1.38)	<0.01
	College and above	1.02 (5.16,6.62)	<0.01	0.59 (0.5,0.69)	<0.01
Employment	Homemaker	Ref		Ref	
	Self-employed	1.69 (1.6, 1.78)	<0.01	1.44 (1.31,1.58)	<0.01
	Employed for wage	5.02 (4.42,5.71)	<0.01	4.39 (3.8,5.08)	<0.01
Hosmer & Lemeshow test			1		<0.01

APPENDIX B: MODEL 3 FOR DRINKING WATER

Variables	Model 3				
	B	**Wald**	**df**	**OR (95% CI)**	**p value**
Gender					
Male	Ref				
Female	0.19	3.6	1	1.21 (0.99, 1.46)	0.06
Education		62.1	3		<0.01
No education	Ref				
Elementary	0.83	53.9	1	2.29 (1.84, 2.86)	<0.01
High school	0.22	3.0	1	1.24 (0.97, 1.59)	0.08
College and above	-0.10	0.2	1	0.90 (0.55, 1.47)	0.68
Employment		22.3	2		<0.01
Homemaker	Ref				
Self-employed	0.38	14.8	1	1.46 (1.21, 1.78)	<0.01
Employed for wage	0.80	17.5	1	2.22 (1.53, 3.23)	<0.01
Education * Gender		37.1	3		<0.01
Elem by Female	-0.27	6.2	1	0.76 (0.61, 0.94)	0.01
High school by Female	0.45	13.1	1	1.56 (1.23, 1.99)	<0.01
College by Female	-0.02	0.0	1	0.98 (0.61, 1.57)	0.93
Employment * Gender	Ref	33.8	2		<0.01
Self-employed by female	-0.43	19.1	1	0.65 (0.54, 0.79)	<0.01
EW by Female	0.44	5.2	1	1.55 (.106, 2.25)	0.02
Education * Employment		105.3	6		<0.01
Elem by Self-employed	-0.69	38.1	1	0.50 (0.4, 0.63)	<0.01
Elem by EW	-0.02	0.0	1	0.98 (0.64, 1.52)	0.94
High school by Self-employed	0.16	1.7	1	1.17 (0.92, 1.5)	0.20
High school by EW	1.13	23.9	1	3.10 (1.97, 4.87)	<0.01
College by Self-employed	-0.51	3.9	1	0.60 (0.36, 1.00)	0.05
College by EW	1.11	12.2	1	3.04 (1.63, 5.66)	<0.01
Constant	0.55	32.2	1	1.74	<0.01
Hosmer & Lemeshow test					0.29

APPENDIX C: MODEL 3 FOR COOKING FUEL

Variables	Model 3				
	B	**Wald**	**df**	**OR (95% CI)**	**p value**
Gender					
Male	Ref				
Female	-0.28	5.9	1	0.76 (0.61,0.95)	0.01
Education		92.2	3		<0.01
No education	Ref				
Elementary	-0.75	38.4	1	0.47 (0.38, 0.6)	<0.01
High school	0.43	9.3	1	1.54 (1.17, 2.03)	<0.01
College and above	-0.19	0.5	1	0.83 (0.48, 1.41)	0.48
Employment		8.1	2		0.02
Homemaker	Ref				
Self-employed	-0.26	5.3	1	0.77 (0.62, 0.96)	0.02
Employed for wage	0.07	0.1	1	1.07 (0.71, 1.61)	0.75
Education * Gender		5.2	3		0.16
Elem by Female	-0.23	3.9	1	0.79 (0.63, 1.00)	0.05
High school by Female	-0.01	0.0	1	0.99 (0.76, 1.28)	0.91
College by Female	-0.19	0.6	1	0.83 (0.5, 1.37)	0.46
Employment * Gender		45.9	2		<0.01
Self-employed by female	0.13	1.6	1	1.14 (0.93, 1.41)	0.2
EW by Female	1.36	44.9	1	3.89 (2.61, 5.78)	<0.01
Education * Employment		172.3	6		<0.01
Elem by Self-employed	1.02	74.3	1	2.78 (2.21, 3.51)	<0.01
Elem by EW	1.06	21.2	1	2.90 (1.84, 4.56)	<0.01
High school by Self-employed	-0.16	1.3	1	0.85 (0.65, 1.12)	0.25
High school by EW	0.76	9.3	1	2.14 (1.31, 3.48)	<0.01
College by Self-employed	-0.56	4.1	1	0.57 (0.33, 0.98)	0.04
College by EW	0.92	7.2	1	2.50 (1.28, 4.87)	0.01
Constant	1.444	164.77	1	4.24	<0.01
Hosmer & Lemeshow test					0.49

APPENDIX D: ORS FOR EH CONDITIONS (COMBINED)

Group			Odds Ratio		
			Toilet	Drinking water	Cooking fuel
Male	No education	Homemaker	1.00	1.00	1.00
		Self-employed	1.05	1.46	0.77
		Employed for wage	0.68	2.22	1.07
	Elementary	Homemaker	1.67	2.29	0.47
		Self-employed	2.16	1.69	1.02
		Employed for wage	4.45	5.00	1.47
	High school	Homemaker	3.63	1.24	1.54
		Self-employed	4.10	2.13	1.01
		Employed for wage	5.75	8.55	3.51
	College and above	Homemaker	1.90	0.90	0.83
		Self-employed	3.64	0.79	0.36
		Employed for wage	12.34	6.09	2.19
Female	No education	Homemaker	1.21	1.21	0.76
		Self-employed	1.74	1.15	0.67
		Employed for wage	0.93	4.15	3.16
	Elementary	Homemaker	2.46	2.10	0.29
		Self-employed	4.34	1.00	0.70
		Employed for wage	7.34	7.09	3.43
	High school	Homemaker	4.38	1.50	1.17
		Self-employed	6.77	1.67	0.88
		Employed for wage	7.81	15.96	10.36
	College and above	Homemaker	4.25	1.06	0.52
		Self-employed	11.12	0.61	0.26
		Employed for wage	30.97	11.12	5.34

APPENDIX E: HEALTH CONTEXT COUNTRY ANALYSIS (INDIA)

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South Asia - India

I. THE COUNTRY CONTEXT

HISTORY

The Indus Valley civilization, one of the world's oldest, flourished during the 3rd and 2nd millennia B.C. and extended into northwestern India. Aryan tribes from the northwest infiltrated the Indian subcontinent about 1500 B.C.; their merger with the earlier Dravidian inhabitants created the classical Indian culture. The Maurya Empire of the 4th and 3rd centuries B.C. - which reached its zenith under ASHOKA - united much of South Asia. The Golden Age ushered in by the Gupta dynasty (4th to 6th centuries A.D.) saw a flowering of Indian science, art, and culture. Islam spread across the subcontinent over a period of 700 years. In the 10th and 11th centuries, Turks and Afghans invaded India and established the Delhi Sultanate. In the early 16th century, the Emperor BABUR established the Mughal Dynasty, which ruled India for more than three centuries. European explorers began establishing footholds in India during the 16th century.

By the 19th century, Great Britain had become the dominant political power on the subcontinent. The British Indian Army played a vital role in both World Wars. Years of nonviolent resistance to British rule, led by Mohandas GANDHI and Jawaharlal NEHRU, eventually resulted in Indian independence, which was granted in 1947. Large-scale communal violence took place before and after the subcontinent partition into two separate states - India and Pakistan. The neighboring nations have fought three wars since independence, the last of which was in 1971 and resulted in East Pakistan becoming the separate nation of Bangladesh. India's nuclear weapons tests in 1998 emboldened Pakistan to conduct its own tests that same year. In November 2008, terrorists originating from Pakistan conducted a series of coordinated attacks in Mumbai, India's financial capital. Despite pressing problems such as significant overpopulation, environmental degradation, extensive poverty, and widespread corruption, economic growth following the launch of economic reforms in 1991 and a massive youthful population are driving India's emergence as a regional and global power (31).

GEOPOLITICS

1. Location: Located in the south of the Asia, India is between Burma and Pakistan by bordering the Arabian Sea and the Bay of Bengal.

2. Size: India is slightly more than one-third the size of the U.S, comprising a total is of about 3.3M km^2 (land area: 3M km^2 and water area: 0.3M km^2). It ranks 7^{th} biggest country in the world. Its land borders are 13,888 km and its coastline is 7,000 km (227 mi). Border countries are Bangladesh (4,142 km), Bhutan (659 km), and Burma (1,468km), China (2,659) , Nepal (1,7770 km) and Pakistan (3,190km) (31).

3. Disputed territories: India neighbors with six countries and occupies a strategically important position in South Asia and continuous border disputes have strained India’s relations with its neighbors (31).

- China: The two major disputes are Aksai chin which is the westernmost, and McMahon line which is the easternmost. Aksai Chin is controlled and administered by part of the China, Xinjiang. But, India claims Aksai chin as part of the state of Jammu and Kashmir and region of Ladakh based on an instrument of accession signed in 1947. McMahon line was agreed by British and Tibet in 1914, but China disputed the legal status. Even China and India initiated a security and foreign policy dialogue in 2005, unresolved territorial disputes continue.

- Pakistan: The Kashmir conflict has been the main issue that caused four wars between 1947 and 1991. India claims the entire erstwhile princely state of Jammu and Kashmir based on an instrument of accession signed in 1947, while Pakistan claims the region based on its majority of Muslim population.

4. U.S. relations: Strategic and economic partnership has been developed to increase the importance of the bilateral relationship. Both countries shared interests in enhancing security, global health security and economic cooperation via trade and connectivity. The U.S. supports India in maintaining stability and developing the defense partnership via military sales and joint research. The U.S.-India Strategic and Commercial Dialogue agreed in 2015 strengthen partnership in the area of energy, climate change, education and counterterrorism (28).

ECONOMY

India ranks as the country with 4th largest GDP (PPP, $7.965 trillion) in the world. However, the overpopulation degrades to the poor country which ranks 158th out of 229 countries for GDP per capita (PPP, $6200). 49% of the work force is in agriculture, but services accounting for 31% of the work force drive major economic growth accounting for nearly two-thirds of India's output with less than one-third of its labor force. India has capitalized on its large educated English-speaking population to become a major exporter of information technology services, business outsourcing services, and software workers.

India is developing into an open-market economy, yet traces of its past autarkic policies remain. Economic liberalization measures, including industrial deregulation, privatization of state-owned enterprises, and reduced controls on foreign trade and investment, began in the early 1990s and served to accelerate the country's growth, which averaged under 7% per year from 1997 to 2011. India's economic growth began slowing in 2011 because of a decline in investment caused by high interest rates, rising inflation, and investor pessimism about the government's commitment to further economic reforms and about slow world growth. Rising macroeconomic imbalances in India and improving economic conditions in Western countries led investors to shift capital away from India, prompting a sharp depreciation of the rupee.

Growth rebounded in 2014 and 2015, with both years exceeding 7%. Investors' perceptions of India improved in early 2014, due to a reduction of the current account deficit and expectations of post-election economic reform, resulting in a surge of inbound capital flows and stabilization of the rupee. Since the election, economic reforms have

focused on administrative and governance changes largely because the ruling party remains a minority in India's upper house of Parliament, which must approve most bills. Despite a high growth rate compared to the rest of the world, in 2015, India's government-owned banks faced mounting bad debt, resulting in low credit growth and restrained economic growth (31).

SECURITY

1. Armed Forces Overview: The Indian Armed Forces consist of approximately 1.3M active personnel (Army, Navy, Air Force, and Coast Guard). It is composed of voluntary military members starting at 16-18 years old. Woman may join as an officer and will be allowed in all combat roles from 2016. Military expenditure was 2.4% of GDP in 2015(9)

2. Threats: India has disputed with China and Pakistan. China is developing ports and infrastructure projects in Pakistan and other neighboring countries. Energy- starved India is looking for the stable energy source and making an effort to protect Indian Ocean Region from China. Level of internal violence in India is high due to wealth gaps and the religion issue between Hindu and Muslim groups (51).

ENVIRONMENT

1. Natural Resources (55):

- Soil: A large proportion of well-watered fertile lands. In the alluvial soil, abundant crops are wheat, rice, maize, sugarcane and jute. In the black soil, Andhra Pradesh and Tamil Nadu are grown.
- Mineral: Quite rich in minerals such as iron, coal, mineral oil, manganese, etc.
- Livestock: Good production of goat, sheep, poultry, cattle, buffalo, etc.
- Fisheries: Increasing fishing production.
- Horticulture: Diverse conditions produce a large number of crops such as vegetables, fruits, flower, medical and aromatic plant, mushroom, etc.

2. Climate:

India experiences variety of climates ranging from tropical in the south to temperate and alpine in the Himalayan north. The elevated areas receive sustained snowfall during winters. The Himalayas and the Thar Desert strongly influence the climate of the country. The Himalayas work as a barrier to the frigid katabatic winds, which blow down from Central Asia. The Tropic of Cancer passes through the middle of the country and this makes its climate more tropical. India is a big tropical country and is famous for its diverse climatic features. The climates of India are divided into four different groups; Tropical wet (humid), Tropical dry, Sub-tropical humid climate and mountain climate (47).

INFRASTRUCTURE

1. Transportation(31)

Airports: total 346 (Airports with runways: 253, Airports with unpaved runways: 93)
Railways: 68,525 km

Roadways: 4,699,024 km total
- 96,214 (national highways and expressways),
- 147,800 (state highways)
- 4,455,010 (other roads)

Waterways: 14,500 km total
- 5,200 km (major rivers)
- 485 km (canals)

2. Communication:
Telephone - fixed lines: 2 subscriptions/100 inhabitants
Mobile cellular: 76 subscriptions/100 inhabitants
Internet use: 19.2% population (2014 est.)

II. SOCIOCULTURAL BACKGROUND

DEMOGRAPHIC PROFILE

1. Population Size: 1,251,695,584
2. Distribution(31):
Sex ratio: 1.08 male/female
Urban: 32.7%
Rural: 67.3%

3. Annual Population Growth: 1.22% (2015 est)
4. Birth rate: 19.55/1,000 (2015 est)
5. Death rate: 7.32/1,000 (2015 est)

6. Population Age Structure:
0–14 yrs: 28.8%
15–24 yrs: 18.06%
25-54 yrs: 40.75%
55-64 yrs: 7.16%
65 yrs & over: 5.95%
Median age: 27.3 years (2015 est.)

7. Total Fertility Rate: 2.48 children born/woman (2015 est)

8. Net Migration Rate: -0.04migrant(s)/1,000 population (2015 est)

SOCIAL STRUCTURE

1. Ethnic/religious Groups:
- Indo-Aryan 72%, Dravidian 25%, Mongoloid and other 3% (2000)
- Hindu 79.8%, Muslim 14.2%, Christian 2.3%, Sikh 1.7%, other and unspecified 2% (2011 est.)

2. Social Class System:
- India's caste system is the oldest form of social stratification in the world.

- Originally four caste groups: Brahmines (priests), Kshatriyas (rulers), Vaishyas (merchants or farmers) and Shundras (artisans or servants)
- The system was abolished in 1947, but the reality is that ideals and perceptions remain throughout different Indian societies.
- As the economic growth of India increases, the boundaries of class system are becoming vague.

3. Gender Parity:

- Gender Inequality Index (UNDP, 2014) is 127 out of 152 countries. Gender inequalities are common, with men having higher social status and increased access to education and health services
- Lack of women nurses and physicians; girls are not likely to discuss sexual reproductive health or domestic violence with male nurses and physicians
- 65.46% of adult women are literate, compared to 82.14% of men
- Seats held by women in national parliaments: 12% (2015 est.)

4. Labor Force Participation:

- 27% of female population ages 15+

CULTURE

1. Language:

- Spoken by Hindi (41%), Bengali (8.1%), Telugu (7.2%), Marathi (7%), Tamil (5.9%) other 10 languages.
- English is the most important language for national, political and commercial communication as a result of the British colony.
- There are hundreds of dialects within the traditional language of India, with Dravidian and Indo-Iravian being the two most common.
- Most people are multilingual and are familiar with many dialects within the Indian language.

2. Communication Style:

- People seldom use “no” or negative word. They don’t want to disappoint the person they are talking to, so instead they will say things such as, “it is unavailable” in order to avoid negative forms of words.
- Due to the respect held for elders, when meeting a group of people the elder is greeted first.
- When leaving, they always say goodbye to each person individually.
- There are also a lot of boundaries set between men and women, and in more traditional cultures there aren’t handshakes between men and women.

3. Individualism or collectivism

- Society with both collectivism and individualism : Intermediate score of 48
- Collectivist side: Group identity, group consensus, and loyalty to group are emphasized
- Individualist side: dominant in the area of religion because the Hindus believe in a cycle of death and rebirth.

4. High Power Distance:

- India has high score of 77 which indicate hierarchy and a top-down structure in society and organizations.
- Honors referent powers and perceives a clear delineation between superiors and subordinates and between young and the old
- Expects obedience in team members
- Expects obedience, respect and loyalty to superiors and those in power[i]

5. Uncertainty Avoidance

- India has the score of 40 that shows a medium low preference for avoiding uncertainty
- Traditionally very patient by having the high tolerance for the unexpected things.
- Prefer to established rolls and routines rather than innovation or change.

6. Masculinity

- India has the score of 56 that shows a Masculine society.
- Acknowledged visual display of success, power and achievements

7. Long Term orientation

- India has the intermediate score of 51.
- The concept of "Karma" drives religious and philosophical views.

III. HEALTH CULTURE

HEALTH BELIEFS AND EXPLANATORY MODELS OF ILLNESS

- Traditional Indian system called as "Ayurvedic Medicine"
- Focuses on the delicate balance among physical, mental and spiritual status.
- Illness is believed to be from the imbalance of the bodily humors.

HEALTH PRACTICES AND HEALTH SEEKING BEHAVIOR

- While western biomedical medicine has become widely available, traditional medicine remains prominent in India, especially among those living in rural areas and by people with lower income, and is supported by the government.
- Treatment for illness mostly involves changes in diet, herbal remedies, massage, application of oil to key areas and rest.
- Public health is a major concern of every state government because of the continuing incidence of epidemic diseases, high rates of infant mortality, and the need for family planning (usually sterilization) to control the growth of the population.
- Indians avoid western medicine because they fear blood draws, x-rays, and surgery. They believe blood is not replaced and can weaken their bodies. Western medicine may sometimes complement traditional healing methods, but often will be used as a last resort because their side effects are not well understood by Indian patients.

HEALTH IMPLICATIONS OF CULTURAL PRACTICE

1. Stigmatization

- Due to social and cultural non-acceptance of same-sex relationship, those living with HIV/AIDS suffer from stigma and discrimination from their family and communities and impede millions from accessing prevention and treatment services.
- Mental illness is commonly denied and feared because its attribution to immoral causes. Families often go to great lengths to hide a disturbed family member and if they are discovered, great shame is brought to the family.

2. Traditional Healers

- The access to western healthcare system is unevenly distributed in India. In rural area, Ayurveda still plays a role to provide the traditional treatment. Government is making an effort to integrate the traditional and western medicines.

IV. DETERMINANTS OF HEALTH

POPULATION HEALTH PROFILE

1. Life Expectancy at Birth(19):
Total population: 68.13 years
Male: 66.97yearsFemale: 69.42 years (2015 est.)

2. Mortality Rates(19):
Infant mortality rate (per 1,000 live births): 41.81
Maternal mortality ratio (per 100,000 live births): 174

3. Country Disease Profile(29)

Burden of Disease

- Top 10 leading causes of death:
  1. Ischaemic Heart Disease
  2. Stroke
  3. Chronic Obstructive Pulmonary
  4. Diarrhoeal diseases
  5. Lower Respiratory infection
  6. Preterm birth complications
  7. Tuberculosis
  8. Self-harm
  9. Falls
  10. Road Injury

DALYs:

- Top 3 causes of DALYs were Maternal/neonatal/nutritional, cardiovascular disease/diabetes and other NCDs.

- Top 3 risk factors that account for disease burden: tobacco use, blood pressure and blood glucose.
- Leading risk factors for under-5 disease burden was malnutrition and infections

SOCIAL DETERMINANTS OF HEALTH

1. Poverty

An estimated 21.25 percent of the Indian population lives on less than US$1.90 per day. The country is home to one-quarter of all undernourished people worldwide. Any global impact on hunger requires progress in food and nutrition security in India. India ranks 130th out of 188 countries in the 2015 UNDP Human Development Index and 80 out of 104 countries in the Global Hunger Index. While per capita income in India has more than tripled in the last two decades, the minimum dietary intake fell during the same period. Levels of inequality and social exclusion are very high. The bottom 10 percent of the population accounts for only 3.6 percent of the total consumption expenditure and the top 10 percent accounts for 31 percent - the gap between rich and poor has increased during the period of high economic growth (15).

- India ranks 4th in GDP (PPP) per country out of 230 and 158th in GDP (PPP) per capita out of 229.
- 29.8% population below poverty line
- Rural poverty rate was 25.7%
- Urban poverty rate was 13.7%
- Income shared by lowest 20% is 8.5%.

2. Employment:

- Total unemployment is 7.1% (0.4% female)

3. Education

- Literacy rate over 15yrs old is 71.2% (male:81.3% vs female 60.6%)
- Education expenditure of GDP is 3.8%
- Primary and secondary enrollment:

4. Crime

Total violent crimes are 11.6% to the total IPC(14).

PUBLIC HEALTH CONCERNS

1. Water and Sanitation (25)

93% Indians have access to improved drinking water sources:
Urban: 97%
Rural: 91%

36% Indians have access to improved sanitation facilities
Urban: 60%
Rural: 25%

2. Food Security and Nutrition(6; 15)

- Home to one-quarter of all undernourished people worldwide
- Achieved the significant growth for agricultural production and varieties.
- Regarding food security, the access to food is more challengeable than the food production.
- The immediate concerns are food distribution system and agricultural trade policy
- It's time to focus on dietary quality and diversity rather than the quantity of food production.
- Micronutrient deficiencies, especially iron, vitamin A and iodine are a major health concern especially among children and pregnant women.

V. HEALTH SYSTEMS

LEADERSHIP AND GOVERNANCE

- The Ministry of Health and Family Welfare leads to the health systems in India. The goal of national health policy is universal access to good-quality health care services without financial hardship.
- Central government is responsible for international treaties, national disease control, and family planning programs. State government plays a role with respect to organizing and delivering health services to their population.
- Private insurance has a limited role (<5% of total expenditure) to provide substitute coverage for the upper class urban population (13; 34).

FINANCING

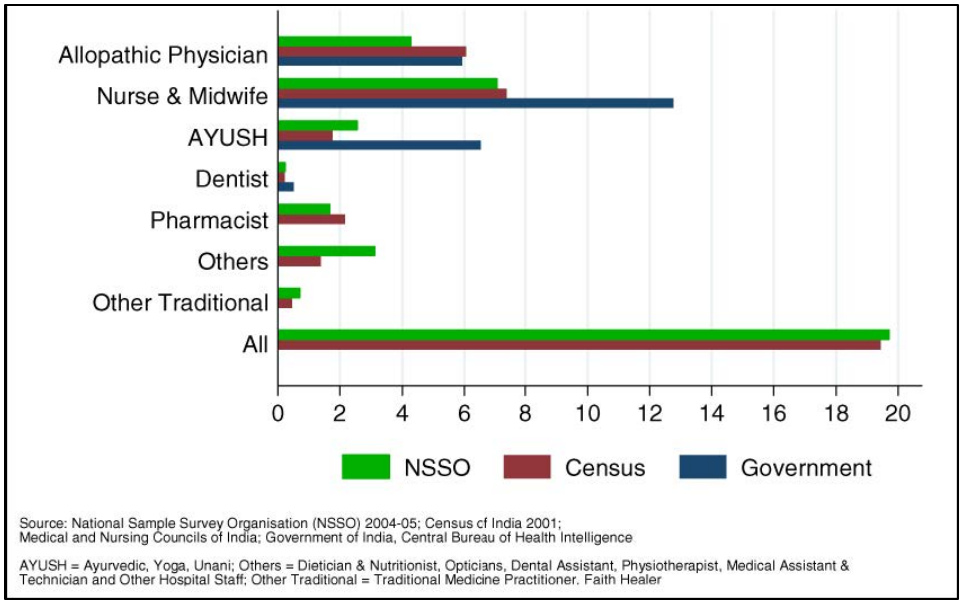
- Total Health Expenditure per capita: $75
- General government expenditure on health (% of THE): 30.04
- General government expenditure (% of government expenditure):5.05
- Out-of-pocket expenditures as % of private expenditure on health: 89.21
- Pre-paid plans as % of private expenditure on health: 2.54
- Domestic funding: 99%, the household is spending 62% of health care (8; 10).

HEALTH SERVICE DELIVERY

- Primary facilities include: sub-centers for a population of 3000 to 5000; primary health centers for 20,000 to30,000 people; community health centers, which serve as referral centers for every four PHCs covering 80,000 to 12,000.
- Sub-centers: 148,3366, PHCs: 24,049, CHCs; 4,833(2013 est)
- Availability of staff in these centers is a major concern (11; 34).

HEALTH WORKFORCE

- Health workers per 10,000: 19
- 0.7 physicians/1,000 population
- 1 nurse/1,000 population
- Number of health workers per 10,000 population



- 381 medical colleges and 49,668 medical graduates(12; 63)

MEDICAL PRODUCTS, VACCINES, AND TECHNOLOGIES

- In 2011 the Ministry of Health in India published the National List of Essential Medicines of India (NLEMI 2011) revised from the last version in 2003 (22).
- All public health facilities have experienced lack of essential medicines and supplies due to procurement and distribution problems, low regulation capacity and weak enforcement of the law
- Average availability of 14 selected essential medicines: 20.5 (public), 75.4 (private)
- Average consumer price ratio of 14 selected essential medicines: No public info, 1.8 (private)(21)

HEALTH INFORMATION SYSTEM

- 2015 Demographic and Health Survey is published (26).
- MOH has a country website for health statistics, with latest reports and data available to the general public, including National database for health workers and facilities (30).
- Birth registration: 80%, Death registration: 67 % (23)

VI. CROSS-CULTURAL HEALTH COMMUNICATION

- Common method of communication is verbal language and total literacy level for adults is 62.8%.
- People do not feel comfortable to talk about skin color, castes, and cows.
- Many Indians prefer to use herbal remedies to cure illness and relieve pain.

- Pregnancy is considered a “hot state”, meaning “a time of increased body heat”. It is believed that one should not ‘over-heat’ with ‘hot foods’ such as meat, eggs, nuts, herbs and spices (1).
- Communication is often indirect with questions posed in vague terms, or no response if the answer is a negative. It is best to ask open-ended questions.

VII. CONCLUSION

Over the last few decades India has achieved remarkable economic growth, creating the fourth largest GDP in the world. In response to this development, the U.S. has built a supportive bilateral relationship with India, the U.S.-India Strategic and Commercial Dialogue signed in 2015. Crucial to President Obama’s commitment to ‘rebalance to Asia,’ India is strategically located, neighboring six countries in South Asia. India, however, is faced with external threats such as territorial disputes with China and Pakistan, and internal challenges such as poverty, human rights and infrastructure development. In this respect, the U.S can provide a strong strategic partnership that results in economic and military development.

India faces many health-related issues. The greatest concerns are high infant and maternal mortalities, 42 per 1,000 child births and 176 per 100,000 live births, respectively. These values remain high in comparison to other BRICS countries. Another concern is the treatment of females; India ranked 122nd among 168 countries in the gender equality index. A third issue is the environmental risks to health. Specifically, open defecation is the most significant sanitation concern and requires interventions at governmental and community levels. The final concern is the government’s low fiscal contributions to public health, resulting in an unevenly distributed healthcare delivery and increased of out-of-pocket payments by individuals.

The U.S. military can support India, as one of America’s strategic partners, by providing military assistance and by developing effective interventions for the global health challenges described above. India would best benefit from interventions that include:

1. Creation of a strong military health partnership with India’s Armed Forces.
2. Developing the project for a Military-Civilian partnership to expand the area of impact.
3. Improve environmental health, both by addressing the physical conditions that pose risks to human health and by providing environmental health education.
4. Promote human rights.
5. Encouraging India to increase governmental expenditure on public health, particularly healthcare infrastructure and increasing the number of healthcare professionals.
6. Applying specific interventions with consideration to local cultures.

India has great potential to increase its growth by using its powerful economy, vast human resources and geographic proximity to other countries. However, India could underestimate the importance of public health in their focus on macroeconomic development. It is very important that India balance development with public health, including healthcare as a human right. In order to achieve this goal, policy makers and global health partners need to ensure that interventions are appropriate, sustainable, and feasible.

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