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## Respiratory Illnesses in Women and Children from Ghana: Problem Identification and Intervention

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**Respiratory Illnesses in Women and Children from Ghana:  
Problem Identification and Intervention**

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**Abstract**

Rural communities in the upper east region of Ghana currently cook with traditional coal pots that produce increased levels of smoke resulting in rapid fuel consumption, increased air pollution, and high levels of respiratory illness in the women and children who use them. New stoves have been developed that remain similar to the traditional ones in use but are designed to provide a variety of benefits such as lowering the cost of fuel, reducing air pollution, and decreasing rates of respiratory illness in women and children. The purpose of this research study was to identify why women have not begun using the new stoves, plan an appropriate educational intervention in response to the problem identification, and evaluate the effectiveness of the educational intervention and implementation. Pre- and post-survey responses were collected initially for problem identification and then again for the purpose of evaluating the effectiveness of the educational intervention. The data analysis indicated that participants intend to alter most cooking habits related to increased smoke exposure and associated health risks following the intervention. The results of the surveys not only accumulated new data about cooking habits in the upper east region of rural Ghana, but also strongly suggested that the educational intervention was effective. Results will be utilized going forward to assess the effectiveness of educational interventions and to provide the groundwork for later research studies including short-term and long-term evaluation following the distribution of the alternative cookstoves to women in Ghana. Such research may include but is not limited to additional follow-up surveys or evaluations of decreased air pollution, fuel consumption, and respiratory illness.

## Introduction

Rural families in developing countries currently utilize high risk cooking methods that predispose women and children to high rates of respiratory illnesses (WHO, 2022). While those who can afford it may use propane stoves, those who cannot often use charcoal or wood burning pots, and some may even use a wood fire built on the ground. It is traditional practice for women to stay in the house doing tasks such as cooking and taking care of the children throughout the day, while many women even strap young children to their backs while they cook (Oluwole, 2012). While traditional coal pots have been used for years, there has been an abundance of research done in developing countries such as Ghana and India showing that these stoves are linked to an increase in the rate of fuel consumption, high levels of household air pollution, and elevated rates of respiratory illnesses in women and children (Burwen, 2022, Oluwole, 2012 and Vliet, 2013). Studies show that smoke inhalation combined with poor ventilation leads to a variety of health conditions including asthma, chronic obstructive pulmonary disease, respiratory infections, cancers, and over three million premature deaths reported annually (Anenberg, 2013 and Surinder, 2020).

In response to these issues, several companies have developed low-cost innovative cooking stoves that are similar in use to the traditional coal pots. These stoves are designed to release less smoke into the air using a ceramic liner or insulator (Akolgo, 2017). A ceramic liner sits above the fuel source, which then absorbs and transfers the heat to what lies on top of the stove, while simultaneously reducing the amount of fuel used and smoke produced (Gyapa, 2011). This design would lead to more efficient fuel use, ultimately lowering the costs of materials for families. In addition, there would be a decrease in air pollution and a reduction in smoke-related health issues including respiratory illness in women and children (Burwen, 2022).

While some regions in different countries have already started to use these stoves due to the benefits, others have not. In one example, Southern Ghana has an abundance of ceramic stove distributors, but rural areas near Bolgatanga have few to none (Gyapa, 2011). The question that now presents itself is: why have some regions not yet switched to these improved cookstoves? The purpose of the completed research study was to determine why families have not switched stoves and to provide an appropriate educational intervention in response to the problem identification. After an educational intervention regarding the dangers of smoke inhalation and the advantages to safe cooking techniques was implemented, the effectiveness of the intervention was re-evaluated to determine if women were more likely to use alternative cooking measures. Current research will lay the groundwork for stoves to be distributed and for research concerning the short-term and long-term effects of alternative cooking methods to be further investigated.

## **Literature Review**

According to the World Health Organization, in 2022, about one-third of the world's population used cooking methods that subjected them to the release of dangerous toxins and pollutants (WHO, 2022). This air pollution was attributed to over 3.2 million deaths in 2020 along with a large number of associated cases of lower respiratory infections, lung cancer, heart disease, strokes, and chronic obstructive pulmonary disease (WHO, 2022 and Xiao, 2012). The instances of unclean cooking methods that are associated with varying respiratory illnesses and numerous deaths were found to be predominantly located in developing countries, specifically in rural communities (Bruce, 2000). The majority of household air pollution has been dubbed the result of unclean cooking methods contributed to by a variety of factors. Some of these factors

include the type of cookstove being used, whether cooking is being done indoors or outdoors, and the type of fuel being used (Balmes, 2019). In many developing countries cooking is done on open fires or using traditional cookstoves that do little to nothing to minimize or redirect smoke production, resulting in direct smoke exposure. Additionally, with traditional coal pots, cooking can either be done outside or inside the home. Typically, women in developing countries cook inside their homes, however, their homes often have poor ventilation resulting in increased smoke exposure to not only those cooking but the rest of those living in the home as well, especially the children who they are typically responsible for watching (Oluwole, 2012 and Ezzati, 2005). Outside stoves, while typically providing better ventilation, still impose a risk concerning the levels of exposure to potentially dangerous pollutants deriving from the fuel sources used (Smith, 2002). Most often, charcoal, coal, wood, or other biomass sources are the fuel sources available and therefore used (Capistrano, 2017). These fuel sources can create smoke as they are burned, releasing pollutants and small harmful particles into the air, that when inhaled can gradually cause an inflammatory response in the lungs, ultimately resulting in lung damage and illness.

The aforementioned effects of these cooking methods on rural communities and developing countries have drawn the attention of leading health organizations across the world, resulting in increasing research on the topic (WHO, 2022). A study in India has denoted that using biomass as fuel has caused over two million deaths per year globally in relation to the carbon monoxide, particulate matter, and other harmful particles produced (Prasad, 2012 and Duflo, 2008). China has found a high instance of lung cancer incidences and related deaths in rural towns, women, and those who use inefficient cook stoves (Xiao, 2012). In rural Honduras, a link was found between increasing exposure to household smoke and increases in systolic

blood pressure (Young, 2018). This would support the claim of polluted cooking methods resulting in hypertension, increased stroke incidence, and consequently, other blood pressure-related conditions. In an alternative Indian study, in rural Orissa, a correlation was found between the use of traditional cookstoves and symptoms of respiratory illness within 30 days of associated smoke exposure (Duflo, 2008). The relationship found was even more prevalent in children than adults, signifying the effects of polluted and unventilated cooking on everyone in the household, not just those doing the cooking. In addition to this potential evidence, there is a strong correspondence of data describing the relationship between COPD in women and asthma and increased respiratory infections in children who are around traditional cookstoves (Torres-Duque, 2007 and Kumar, 2015). There have also been adverse effects noted in pregnancy outcomes and including decreased birth weights, cardiac abnormalities, and increased mortality rates in infants (Alexander, 2018 and Kametas, 2002). These studies emphasize the detrimental effects of unclean cooking methods and emphasize just how prevalent this issue is on a global scale.

Approximately 50% of the population in developing countries is exposed to high levels of cooking air pollution daily (Bruce, 2000). The World Health Organization predicts that by 2030, without significant improvements and major changes, over 2 billion people will still be suffering the consequences of cooking with unsafe measures (WHO, 2022). There have been various proposals to combat this global crisis including different guidelines and policies, however perhaps one of the most promising objectives is the development of new and improved cook stoves (Phillip, 2023). There have been various designs and names for the new and improved cookstoves, as efforts have been dedicated to amending the issue globally, but the advantages to them typically remain the same; reducing the amount of fuel used, decreasing

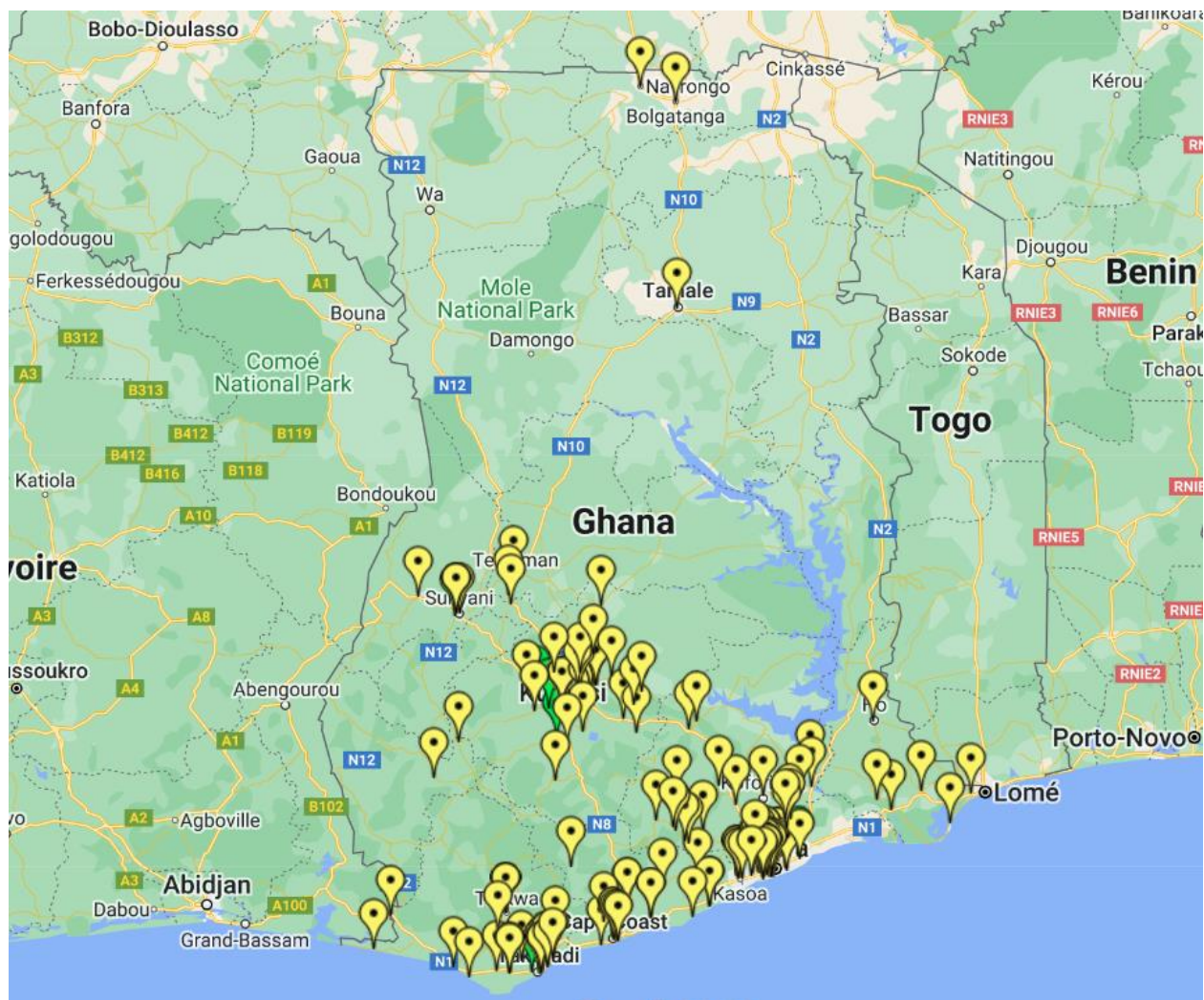


cooking time, and lessening the amount of smoke produced (Reid 1986, Phillip, 2023, and Muneer, 2003). The new stoves are generally similar to the traditional cookstoves in terms of structure and use but consist of an innovative design featuring a ceramic liner that cuts down on smoke production by up to 80% (Urmee, 2014). Less smoke production would lead to decreased exposure to harmful particles and decreased respiratory inflammation and would therefore theoretically diminish the devastating outcomes and illnesses that have been proven to be associated with traditional coal pots. These advantages not only reduce the quantity of damaging particles people are exposed to but also cut down on the costs of cooking since less fuel is being used (Akoglo, 2017). Some of the innovative new stoves can reportedly reduce fuel usage by up to 50% (Gyapa, 2011). These new and improved cookstoves have been trialed, distributed, and become more commonly used in various communities located in countries such as India, Kenya, Rwanda, Bangladesh, and more (Rosenbaum, 2015, Tigabu, 2017, and Lewis, 2015).

Despite the improved cookstoves becoming adopted in various areas of the world, Sub-Saharan Africa was among the regions remaining deficient in the movement for reduced air pollution with 923 million people still without access to improved cooking methods in 2020 (WHO, 2022). It is common in Africa for cooking to be done inside unventilated homes, for infants to be strapped to their mother's backs, and for children to be around the stoves when cooking, exposing women and children to increased levels of polluted air (Oluwole. 2012). Consequently, there is a clear need identified for new and improved cookstoves to become more prevalent in Sub-Saharan Africa.

This study focuses mainly on the previously mentioned need for these cookstoves in rural communities in Sub-Saharan Africa. The rural communities selected were villages located near Bolgatanga, Ghana with no new cookstoves. The upper east region of Ghana was selected,

because this is the poorest region of the country and therefore it is the region with the fewest number of people who have access to improved fuel options (World Bank, 2020). The main new and improved cookstoves that are predominantly located in this region of the world are named the Gyapa Fuel-Efficient Cookstoves (Gyapa, 2011). A distribution map, illustrating the allocation of the Gyapa retailers across Ghana is shown below.



*Image showing the distribution of Gyapa Fuel Efficient Stove Retailers (Yellow) and Producers (Green) across Ghana (Gyapa, 2011).*

From the distribution map, it is evident that the stoves are predominantly sold in southern Ghana, with very few retailers located in northern parts of Ghana, closer to Bolgatanga, and none in the rural villages surrounding Bolgatanga. Questions such as the following arise: why are there currently no new stoves in this area and what interventions would be required to facilitate a change in this pattern?

There could be many different factors contributing to there being no stoves in the area, such as them not being sold in the area, being too expensive, the perception that they are not as good as traditional coal pots, or that there is no difference between them and the traditional pots (Derby, 2015, Lewis, 2015 and Urmee, 2014). It is also possible that there is an educational deficit regarding knowledge of the new stoves and the health risks of traditional methods. Several studies have found educational interventions and demonstrations of the new ceramic cookstove effective measures in increasing awareness regarding the subject and encouraging changes in cooking practices (Lewis, 2015, Walker, 2022, Noonan, 2020, and Nagib, 2023). These studies suggest that an educational approach would be effective in not only increasing awareness surrounding the health risks of current rural cooking habits, but also in potentially altering these dangerous methods and promoting the use of ceramic cookstoves.

## **Methods**

To begin, a literature review was conducted to provide ample background knowledge on both the traditional and newer cookstoves available using scholarly databases such as google scholar, and the University of Arkansas library databases such as PubMed. The focus was on primary peer-reviewed articles, denoting respiratory illnesses related to cooking methods in Ghana and other rural communities. Research criteria included articles discussing respiratory

illness in developing countries and rural communities, those mentioning the more efficient cookstoves that have been made and their implications, and the distribution of the improved cookstoves across the world. The literature review excluded articles with studies located in areas highly saturated with propane stoves or those who did not cook with wood, biomass, or charcoal. Once enough data had been collected to form a strong foundation, a proposal was drafted to submit for IRB approval.

After IRB approval was attained, the initial surveys were then formulated, focusing on current cooking methods, and establishing a baseline for the participants' knowledge regarding the dangers of traditional cooking methods. The preliminary surveys also acted as an essential method in determining why participants have not already begun to use alternative stoves. The questions included a variety of topics encompassing the presence of respiratory signs and symptoms, current cooking methods, and existing knowledge of alternative cooking measures. Next, an educational intervention was planned. The educational intervention was composed of a short presentation to groups of participants that denoted basic anatomy, the effect of smoke on the lungs, health effects, and methods to reduce smoke exposure. The educational intervention was accompanied by a visual aid in the form of a flyer, depicting the basic anatomy of the respiratory system and lungs before versus after long-term smoke inhalation. Finally, the presentation included a demonstration of how to use the Gyapa Fuel Efficient Cookstoves. Following the educational intervention, a secondary survey was drafted to evaluate the effectiveness of the intervention. The post-survey consisted of questions that evaluated participants' intentions of changing previously identified high-risk cooking behaviors following the information learned during the intervention.

Once the components of the study were finalized, research subjects were recruited to participate. Knowledge of the recruitment for the study was spread by word of mouth among those in the community. Inclusion criteria for participation included women currently residing in the rural villages surrounding Bolgatanga who are primarily in charge of cooking within their households. Exclusion criteria for this study excluded those outside of upper east region of Ghana or in areas heavily saturated with improved cookstoves. The research subjects were recruited on an entirely voluntary basis with the incentive of receiving a Gyapa Fuel Efficient Cookstove at the conclusion of the study in exchange for their participation. Participants included 118 women from the upper east region of Ghana in the rural villages such as Bolgatanga, Veaa, Zaare, Bongo, and Zebilla where there are currently no new stoves. The initial surveys were individually read and translated to each participant by two local community health nurses who were familiar with the local dialect. The local nurses were recruited to assist with the study in order to minimize language barriers and to develop consistency throughout the study. For the purpose of maintaining confidentiality, no names were used on the pre- and post-surveys when collecting data. Participants were then split up into groups of roughly 30 women at a time where the educational intervention consisting of the respiratory disease information, the respiratory anatomy and smoke inhalation pamphlet, and the Gyapa stove demonstration, was then presented to them. Finally, the post-surveys were translated and read to each participant to assess the effectiveness of the educational intervention. Once the answers to the pre- and post-surveys were recorded, the data was then returned to the researcher. At the conclusion of the study, participants were provided with an incentive for their participation in the form of an improved ceramic Gyapa cookstove.

After collecting the surveys, the data was analyzed. The results were interpreted using quantitative and qualitative statistical analysis in correspondence to the questions asked. Then the analysis was used to indicate and identify any statistically significant trends or correlations among responses. The goal was to compare the pre- and post-surveys to determine if the educational intervention resulted in any statistically significant changes indicating whether women would be willing to alter specific high-risk behaviors or switch to alternative stoves following the intervention.

## **Results**

The sample consisted of 118 women from rural villages in the upper east region of Ghana, where there are no new stoves. During the study, 118 pre-surveys and 112 post-surveys were collected. The discrepancy in survey numbers may be accounted for by a variety of reasons, which will be discussed further on in detail. Questions 1 through 7 on the initial survey and all 5 of the follow-up survey questions used a Likert scale ranging from numbers 1 to 10. The Likert scale assigns each number a meaning signifying a range of disagreement or agreement with the corresponding question or statement. In this study, 1 was assigned the meaning of “no”, 5 and 6 were assigned “maybe”, and 10 was assigned “yes”. A 10-point Likert scale was chosen instead of a 5-point Likert scale to provide a greater range of opinion and variance, more accurately showing a distribution pattern, and reducing the likelihood that alternative statistical analysis options would reflect insignificance. The eighth and final question on the pre-survey was a qualitative question, allowing participants to choose an answer or to answer open-endedly. Every question from the pre- and post-surveys was individually analyzed, initially for distribution pattern, and then by mean, median, and mode. For the majority of questions, the distribution pattern was significant enough that any additional discussion of the rest of the analytical

processes would either be repetitive or not statistically significant. For this reason, only the distribution pattern will be shown for any results that meet the criterion of having greater than 50% of the sample fall into one extreme category, otherwise characterized as an answer of either 1 or 10. If the question has a distribution that does not meet the criterion previously identified, then the additional analysis will be shown and discussed. The data analysis for each question is shown and discussed below.

### Pre-Survey Questions

**Figure 1.1.**

*Pre-Survey Question 1: I cook with coal or wood every day.*

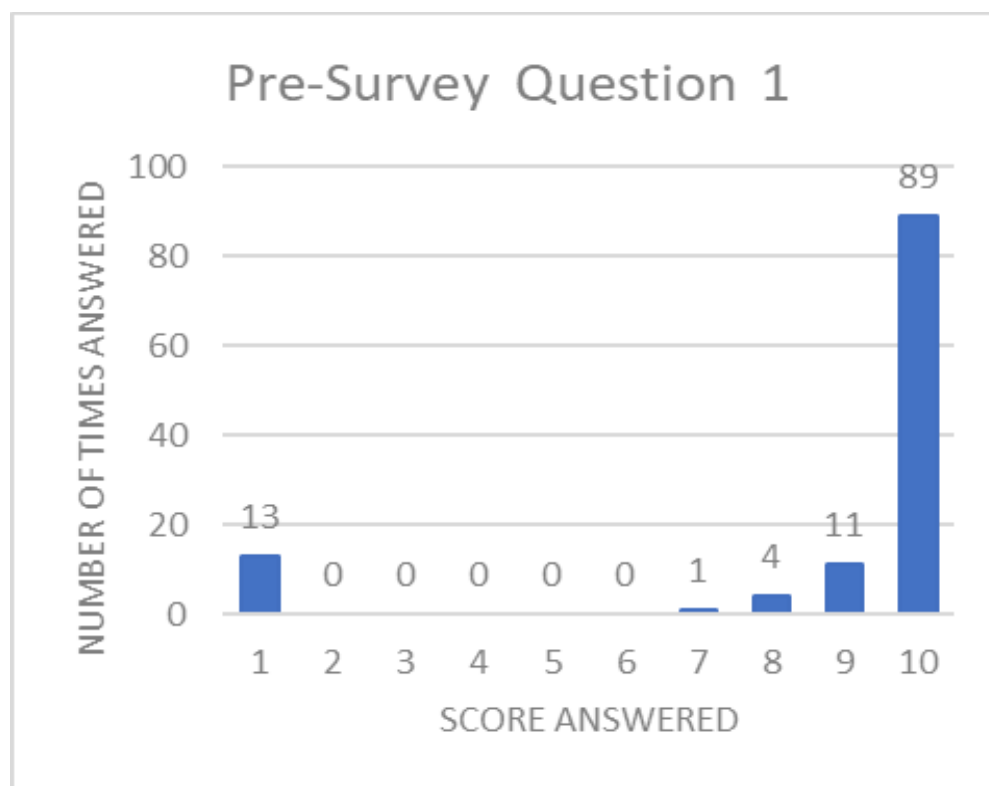


Figure 1.1 determines how often the women cook with wood or coal. 89 out of the sample of 118, or 75.4% of the sample, answered 10, otherwise signifying “yes” to this question.

13 women indicated “no” or “1”, however several had reportedly commented that they used fuel instead of wood or coal. While they did not specify what exact fuel was used, one can assume they are most likely referring to propane, since that is the only other fuel option widely available in this region of Ghana. The rest of the answers fell in the category between “yes” and “maybe” or 7-9. There is a strong distribution illustrating the fact that most women in the sample cook with wood or coal nearly every day.

**Figure 1.2.**

*Pre-Survey Question 2: I cook inside with coal or wood every day.*

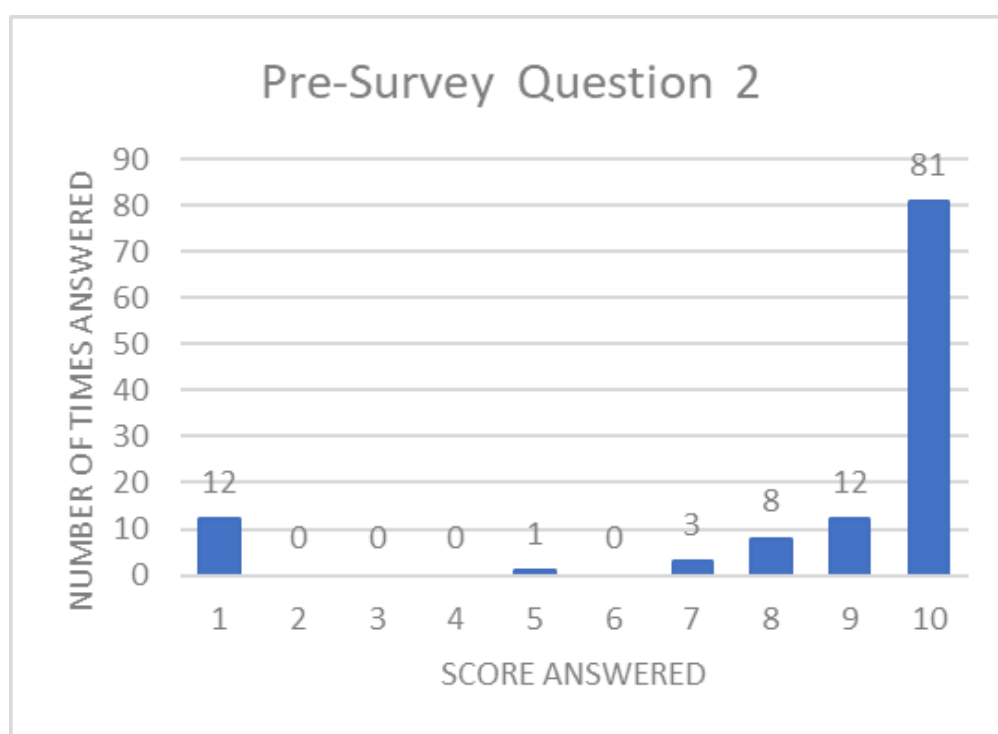


Figure 1.2 aims to determine how often the women who answered “yes” to the previous question are cooking inside. 117 answers were collected to this question, with 1 left blank on the survey. 12 indicated “no” or that they do not cooked inside, 1 indicated “maybe”, and 81, or 69.2% of the sample, answered “yes”, or that they cook inside. The other 23 women suggested



that they cook inside most of the time. Once again, the distribution is strongly skewed towards the right, showing that most of the sample size always or almost always cooks inside.

**Figure 1.3.**

*Pre-Survey Question 3: I cough or wheeze during or after cooking.*

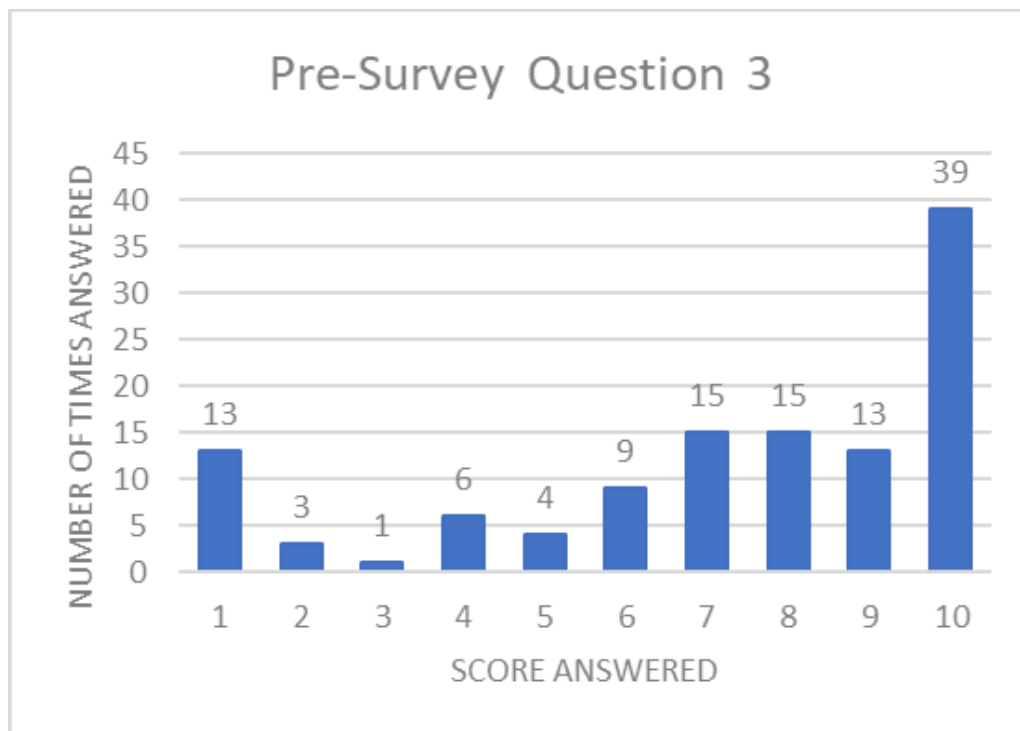


Figure 1.3 determines how many participants cough or wheeze during or after cooking. The results are slightly more varied with 13 answering “no”, 10 answering between “no” and “maybe”, 13 answering “maybe”, 43 answering between “maybe” and “yes”, and 39 answering “yes”. While the distribution is more spread out, it is still skewed toward women experiencing respiratory symptoms while cooking. However, because 50% of women did not answer on the extreme end of the scale, further analysis will be used. The mean was 7.2, the mode was 10, and the median was 8. All of these statistics agree that while answers vary slightly, it is more

common for the women to experience respiratory symptoms than not after being around smoke from cooking.

**Figure 1.4.**

*Pre-Survey Question 4: My children are close to the smoke when I cook.*

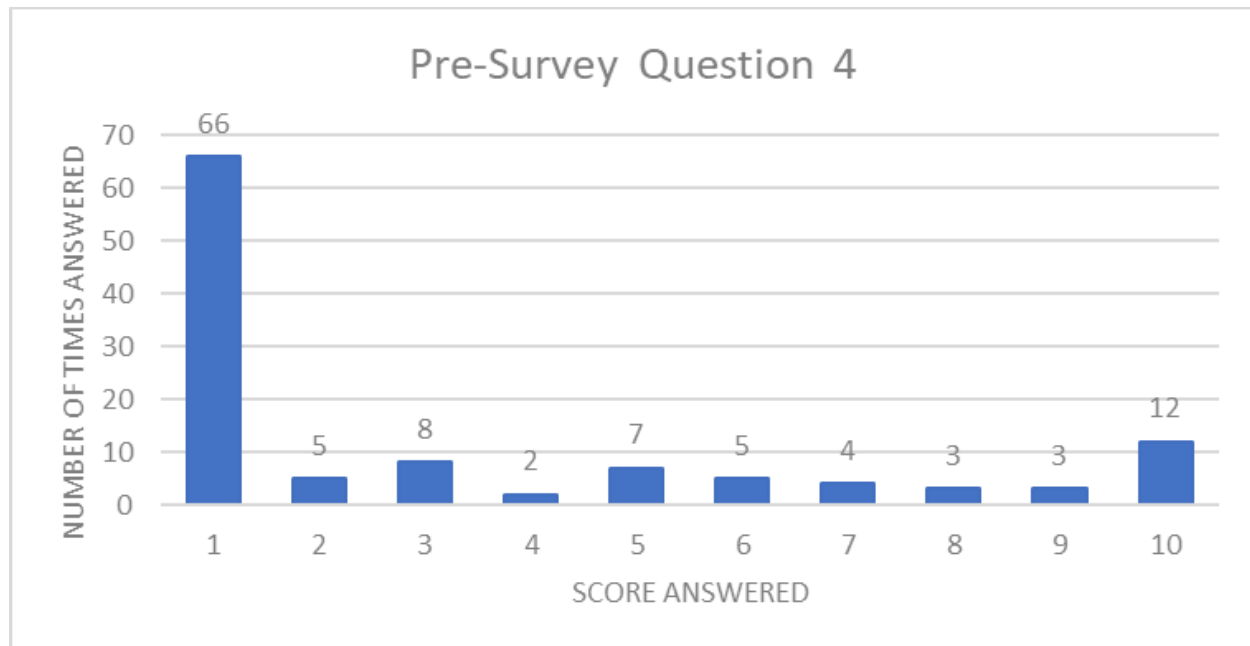


Figure 1.4 asks if the participants' children are close to the smoke when they cook. 66 answered "no", 12 answered "yes", and the other 37 answers were varied between various points of the scale. 3 women did not have any children and therefore did not provide an answer to this question. While there is slightly more variation in answers to this question compared to some others, over half, or 57.4%, of the sample size answered "1" or "no" to this survey question. The distribution of answers in this figure shows that for the most part, the children are not typically around smoke while cooking.

**Figure 1.5.**

*Pre-Survey Question 5: My children cough and wheeze if they are close to me when cooking.*

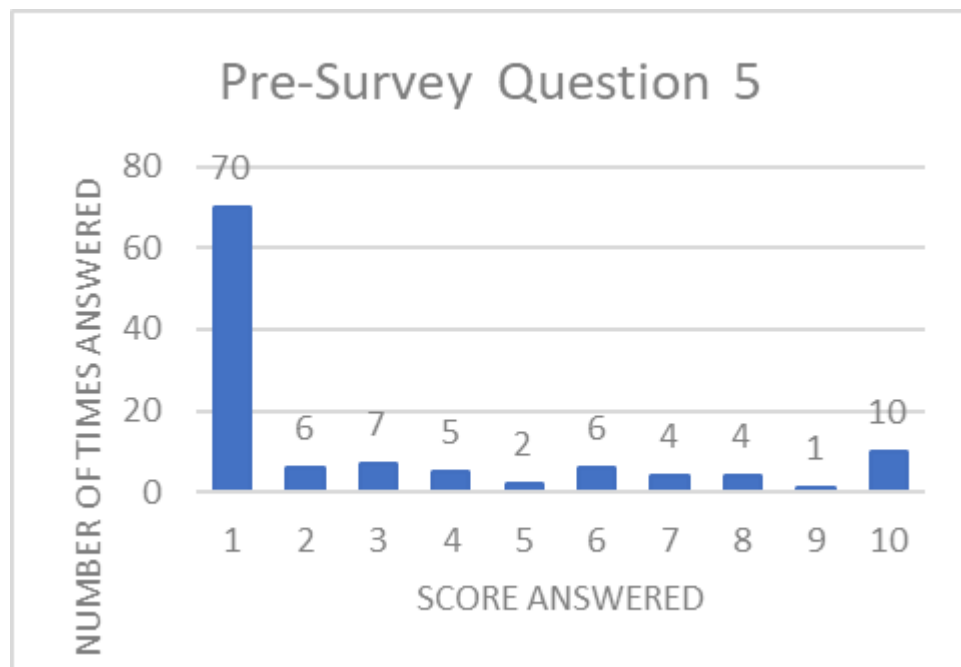


Figure 1.5 asks how often their children cough or wheeze if they are close by when cooking. The spread on this figure looks similar to Figure 1.4 with 70 (60.9%) answering “no”, 10 answering “yes”, and the other 35 answers varied along the scale. Once again, 3 participants did not qualify to answer this question since they do not have children. The graph is once again skewed towards “1” or “no”, indicating that the majority of children do not cough or wheeze during or after being exposed to the smoke from cooking. However, in relation to Figure 1.4, the lack of respiratory symptoms shows some correlation to the fact that children are not exposed to the smoke from cooking in the first place.

**Figure 1.6.**

*Pre-Survey Question 6: I know that breathing smoke can make you sick.*

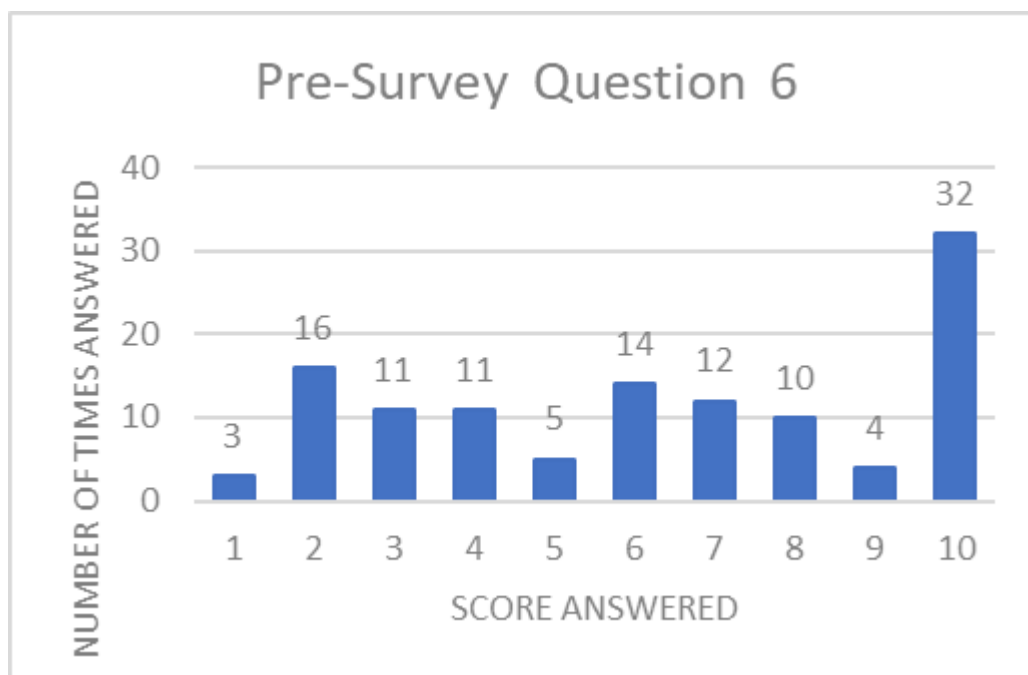


Figure 1.6 asks participants if they know the dangers of smoke inhalation. This question had varied answers, but the most common answer was “yes” or “10” with 32 answers out of the sample size of 118. Other than that, 3 answered “no” or “1”, 38 answered between “no” and “maybe” or “2-4”, 19 answered “maybe” or “5-6”, and 26 answered between “maybe” and “yes” or “7-9”. Less than 50% of the sample answered with either “1” or “10”, so the rest of the analysis is presented. Question 6 had a mean of 6.3, a mode of 10, and a median of 6. The mean and median do not indicate a statistically significant opinion, suggesting the average answer was “maybe”. However, the mode indicates the most commonly answered number was “yes”, with 28.6% of the sample choosing this answer. Because of the results from the distribution pattern and the analysis, it is not possible to have a strong consensus. Results were varied, but much of the population is between maybe knowing and strongly knowing about the dangers of smoke inhalation, indicating that many are at least partially aware of the dangers.

**Figure 1.7.**

*Pre-Survey Question 7: I have heard that there is a ceramic pot that doesn't make much smoke.*

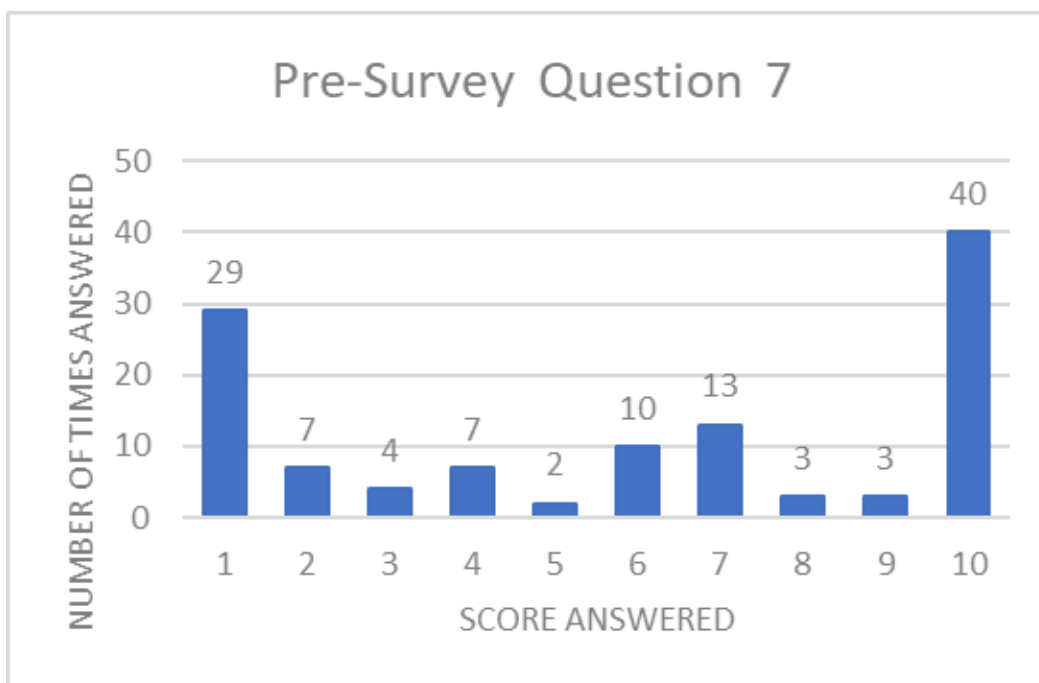
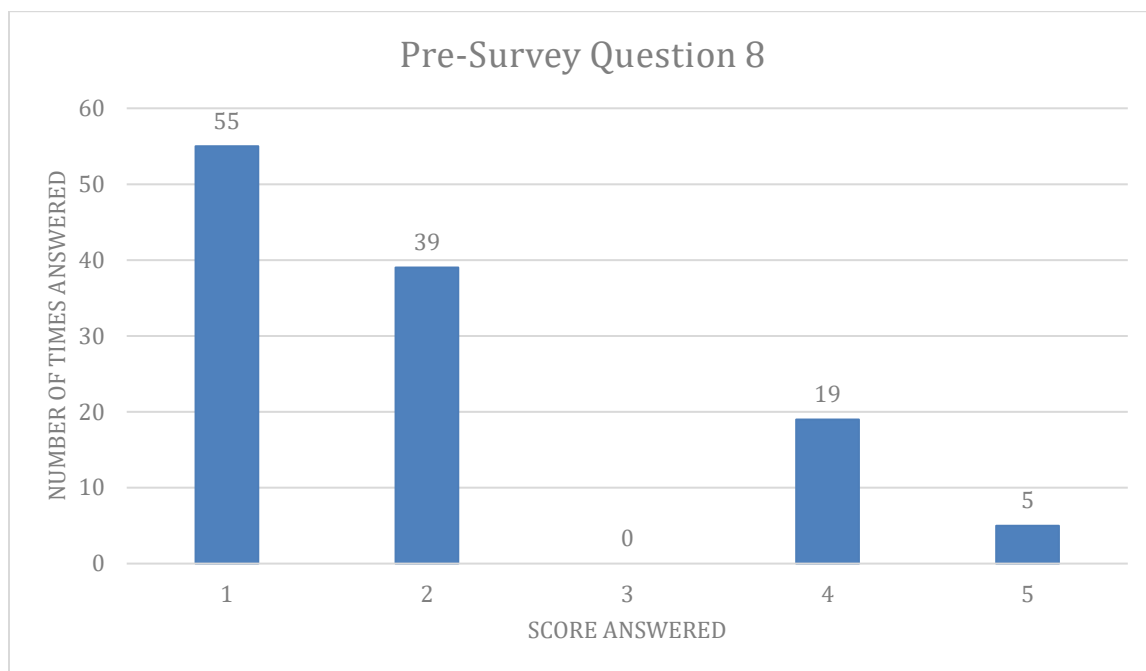


Figure 1.7 illustrates whether participants have heard that there are ceramic stoves that don't make as much smoke or not. The distribution showed that participants seemed to have a relatively strong split response with 29 answering "no", 40 answering "yes", and the rest being varied within the middle. Because neither "no" or "yes" received over 50% of the distribution, further analysis is as follows. The mean was 5.9, the median was 6.5, and the mode was 10. 10 was the most common answer, indicating that many of the women are already knowledgeable about the new ceramic stoves. With the sample being strongly split between both 1 and 10, the mean and median most likely do not give an accurate representation of the data. From the results, it appears that most of the sample have at least heard of the new stoves but may not have much knowledge of them. On the other hand, there is still a decent presence of answers saying they have not ever heard about them with 25.9% of answers being "no".

**Figure 1.8.**

*Pre-Survey Question 8: Circle all that apply. I do not use a ceramic pot because:*



*Note.* The numbers correspond to the following answers: 1- They are not in Bolgatanga, 2-They are too expensive, 3- It is not a good stove, 4- It is no different than any other pot, 5- Other reasons: Please list

Figure 1.8 was a qualitative analysis question, assessing the reason that participants did not own a ceramic pot. For this question, each person was allowed to select multiple answers out of several provided, or to provide their own answer under “other”. The reason with the highest number of answers, was “they are not in Bolgatanga” with 69 answers, closely followed by “they are too expensive” with 50 answers. The reason “it is no different than any other pot” acquired 28 answers and “it is not a good stove” had no selections. 9 people chose “other reasons”, and many listed that “traditional stoves cook faster and better” or that ceramic pots are “difficult to use”.

Post-Survey Questions**Figure 2.1.**

*Post-Survey Question 1: I learned a lot from this program.*

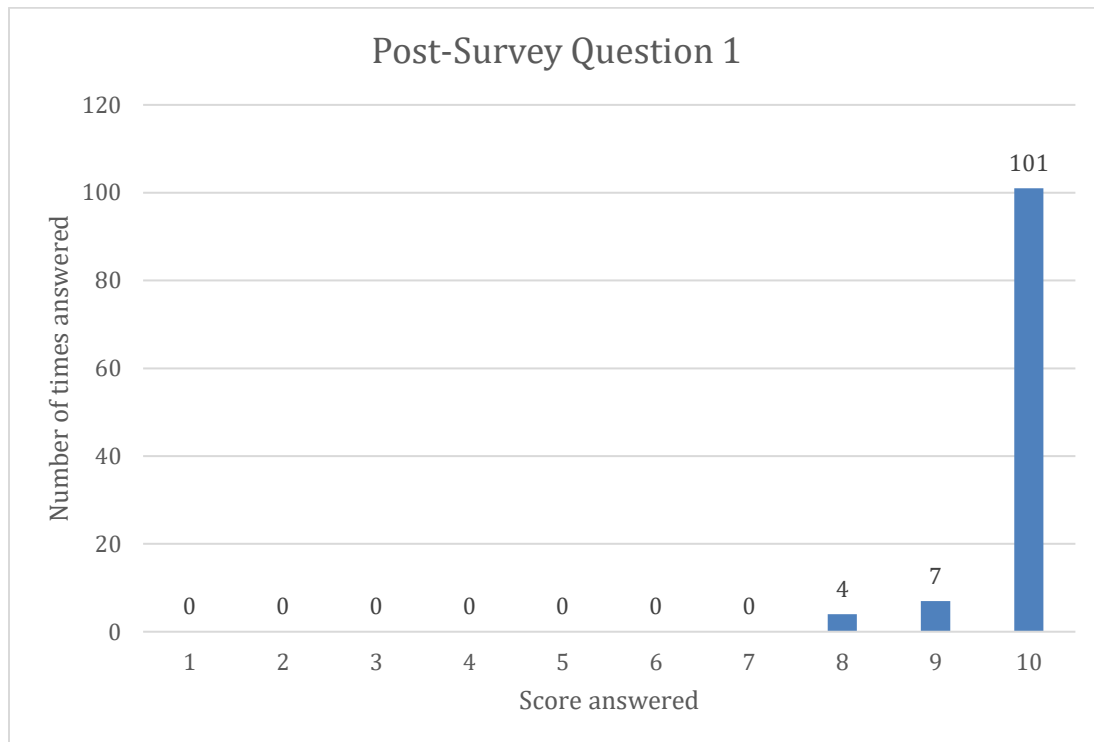


Figure 2.1 begins to address the effectiveness of the planned intervention by gauging how much participants learned from the program. 101 people (90.2%) answered “10”, otherwise signifying “yes”, and the rest of the sample answered “8” or “9”, which is also towards the higher end of the spectrum. The post-survey only included a sample size of 112 answers, so this includes all answers from the sample. The consensus on this question was fairly unanimous, with the entire sample size indicating that they learned from the educational intervention.

**Figure 2.2.**

*Post-Survey Question 2: I intend to use a ceramic pot if I have one available.*

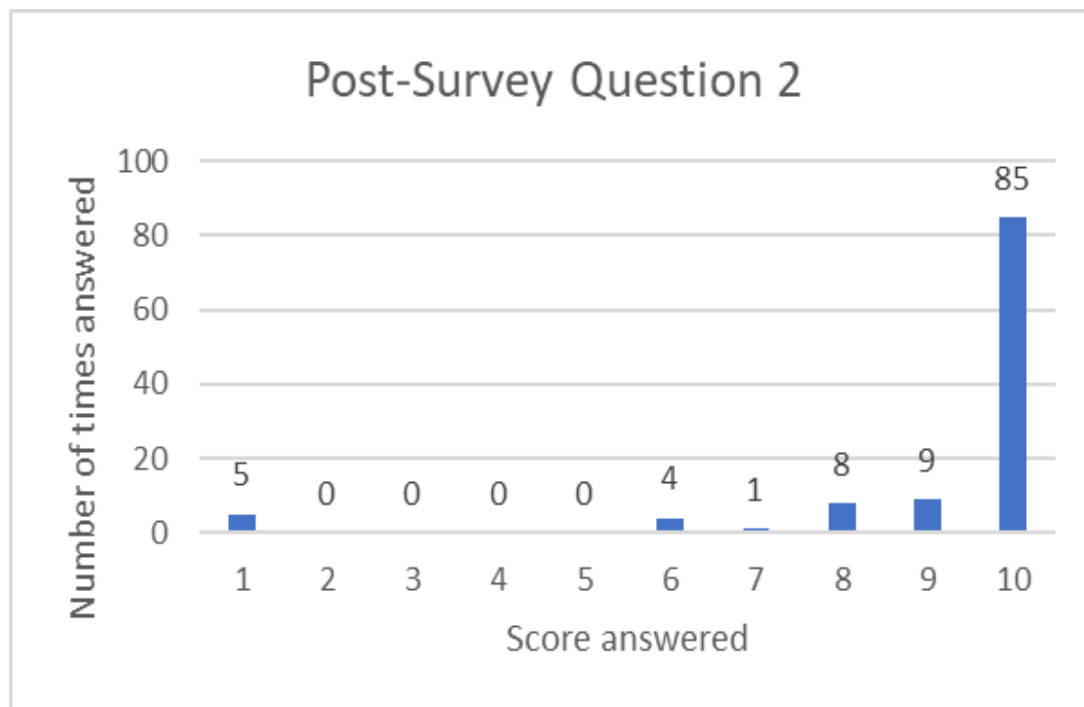


Figure 2.2 assesses the number of women from the sample who intend to use a ceramic stove if they have one available following the educational intervention. This is another way of indicating whether the educational intervention was effective since a major goal of the study was to promote changes in dangerous cooking practices such as traditional cookstoves. 5 reported “no” or “1”, 4 reported “maybe” or “6”, 17 reported between “maybe” and “yes” or “8 or 9”, and 85 (75.9%) reported “yes” or “10”. According to the distribution data, most of the women in the sample indicated that they would use a ceramic stove if they had one available.



**Figure 2.3.**

*Post-Survey Question 3: I intend to continue cooking inside.*

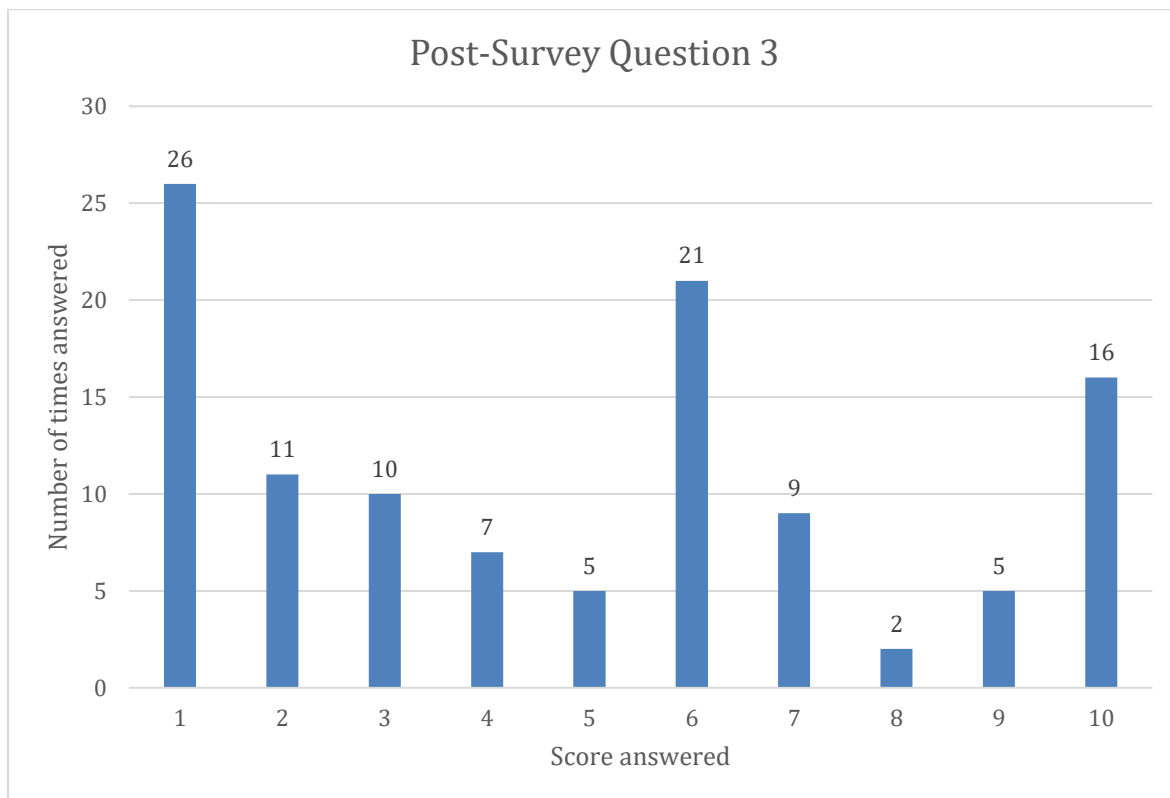


Figure 2.3 asks participants whether or not they intend to continue cooking inside. The distribution of this sample is varied. 26 answered “no”, 28 answered between “no” and “maybe”, 26 answered “maybe”, 16 answered between “maybe” and “yes”, and 16 answered “yes”. Further analysis is presented since the results did not meet the distribution criteria. The mean was 4.8, the median was 5, and the mode was 1. The mean, median, and mode all seem to reflect the same as the pattern of distribution. For the most part, the graph is evenly distributed and slightly skewed to the left, with most answers being varied between “never”, “maybe”, and “yes”.

**Figure 2.4.**

*Post-Survey Question 4: I understand the risks of cooking with wood or coal.*

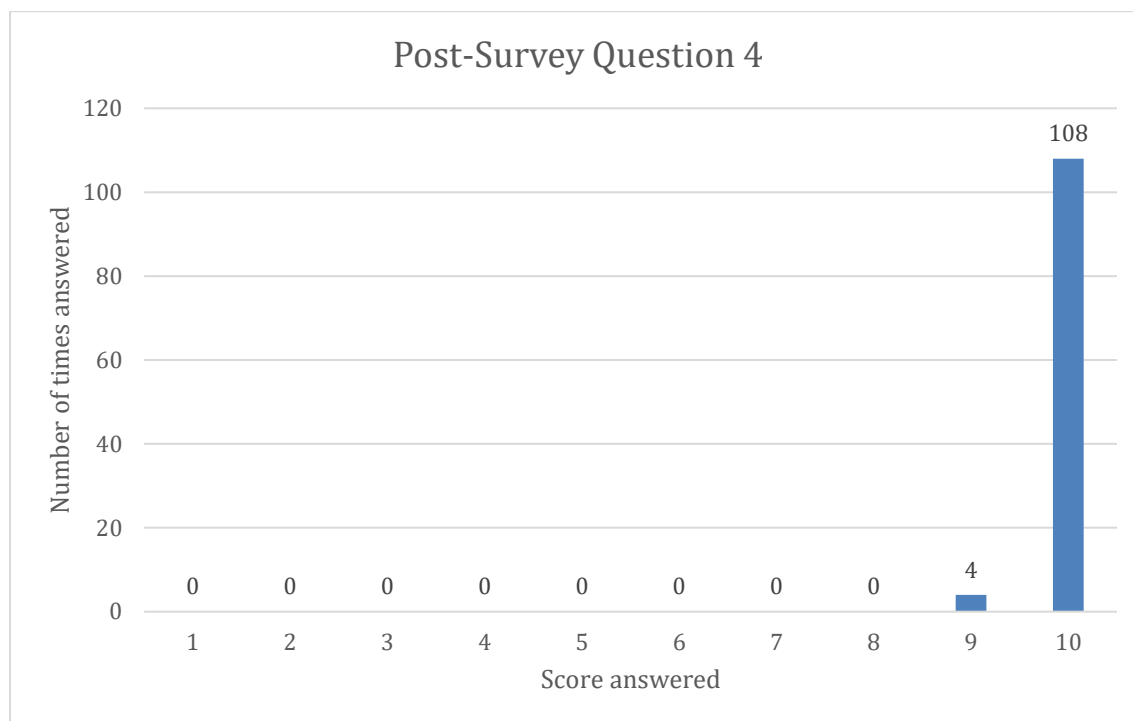


Figure 2.4 identifies if the study population understands the risks of cooking with wood or coal following the study. Again, there is almost a unanimous response with 108 participants (96.4%) responding with “10” or “yes” and 4 responding with “9”. There are no other answers besides these, which signifies that the distribution pattern is entirely skewed toward the entire sample size understanding the risks of cooking with wood or coal.

**Figure 2.5.**

*Post-Survey Question 5: Do you intend to try to keep your children away from smoke?*

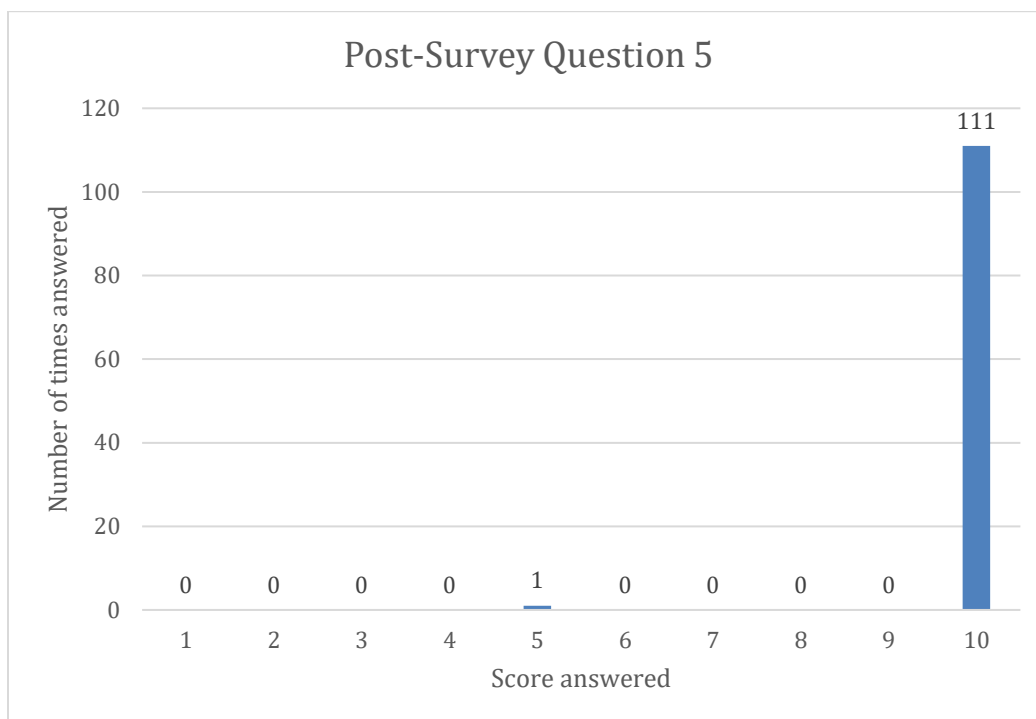


Figure 2.5 asks participants if they intend to keep their children away from smoke following the educational intervention. 111 women (99.1%) answered “10” or “yes” and 1 answered “5” or “maybe”. All besides one outlier has indicated that they plan to keep their children away from smoke while cooking during the post-study survey.

## Discussion

The sample size of 118 was large enough that it should provide an accurate general representation of the selected population including women in rural villages near Bolgatanga where there are no new stoves, while accounting for individual variance. For the most part, the data collected was significantly skewed in one direction or another, indicating strong support for a specific answer to many of the questions. If there was not a clear strong response from the

sample, then further data analysis was shown and analyzed. The pre- and post-surveys from the study provide ample data to allow for inferences to be made about the demographics of the population and the effectiveness of the educational intervention.

The initial survey was created with the purpose of identifying preliminary cooking habits and knowledge. The data collection consisted of 118 responses to 8 questions, 7 of those containing a 1-10 Likert Scale, and one containing a qualitative analysis. The results of the initial survey provided strong support for the purpose of the study and the educational intervention. It indicated that most of women cook with wood or coal and cook inside, which are two of the major components of smoke exposure that puts the population at risk for respiratory illness. As a result, most of the women cough or wheeze most of the time after being around smoke from cooking. While some women had heard about a stove that produces less smoke and are at least somewhat aware of the dangers of smoke inhalation, there was still a potential knowledge deficit identified since the answers to these questions tended to be more varied. The data collected agrees with the initial compilation of evidenced-based practice literature and sets a substantial precedent for an educational intervention, justifying the basis of the study. On the other hand, two questions involved in the data collection opposed the standards found within the literature review. While the review suggested that children were often exposed to smoke from cooking and developed similar respiratory symptoms, the results of the study contradicted this belief. Several comments were left on surveys collected that suggested “children play outside” nearly all the time. Predominantly, children near rural Bolgatanga are not around smoke while cooking and do not experience associated respiratory symptoms. The eighth and final question on the pre-survey assessed the reasons women did not use a ceramic cookstove with the top reasons being that “they are not in Bolgatanga” and that “they are too expensive”, two things this study also

intended to address with the incentive of a ceramic cookstove for participating. The other answers to this question such as “it is no different than any other stove”, “it is difficult to use”, and “traditional coal pots cook faster and better” were also included and addressed during the educational intervention and demonstration.

The post-survey intended to assess the effectiveness of the educational intervention and had a total of 112 responses. The discrepancy between the number of pre- and post- surveys is unclear but could be accounted for by a variety of reasons. It is possible several participants did not complete the study for some reason, or that they failed to fill out the post- survey following the educational intervention. Since this study was done remotely with physical paper surveys, it is also a possibility that several of the surveys were lost in transition or left behind. Even without the additional 6 post- surveys, almost all the results were either nearly unanimous or strongly skewed toward one answer or another. The majority of women indicated that they learned a lot from the program, they would use a ceramic cookstove if they had one available, they understand the risks of cooking with wood and coal, and that they intend to keep their children away from smoke. The only question with varying results was the one asking if women intend to continue cooking inside. Most answers indicated between “no” and “maybe” which while improved from the pre-survey, was not as significant of a difference as other answers. While there is no specific reason identified, this may be because weather conditions are not always optimal to cook outside or that it is more convenient to cook inside. For the most part the differences between pre-survey cooking intentions and post-survey results are drastic with clear intentions to apply cooking methods that reduce smoke exposure, indicating that the educational intervention and participation incentive were highly effective.

While results indicate a successful implementation, the variables, obstacles, and additional factors must also be addressed and contemplated. This study was conducted remotely in a different country with a foreign language. The targeted women involved in the study did not speak or read English, presenting a communication barrier. The language spoken involves a specific dialect that does not translate well consistently when using an automated translation system such as that on a computer. For this reason, each survey was individually read and translated by two Ghanaian community health nurses, who speak both, English and the local dialect. This raises the concern of reliability and consistency when conducting the interviews, which is why each translator was provided with a scripted educational intervention and specific questions on the surveys to fill out. Additionally, while the Likert scale produced strong results, it is often not the assessment tool of choice when conducting statistical analysis because of its strong likelihood to produce varying results that conclude with answers averaging out to null results following analysis. However, due to the nature of the study being remote in a country with an alternative language, this scale was chosen to limit the potential variables and misinterpretations. When choosing a 1-10 Likert scale, the problem arose that there were not enough words in the local dialect to convey the translation accurately. To address this, the ranges of the scale were assigned the correlating meaning of “no”, “maybe”, and “yes” and participants were asked to gauge where they fell within the scale. Because of these reasons, it is possible that the answers associated with the pre- and post- surveys are more strongly skewed because of the various barriers regarding translation. After further consideration, an alternative scale such as the visual analog scale may have provided greater range for participants to gauge where they fell while also accommodating the language barrier. There is also the issue with the remote aspect of this research. While specific directions and scripts were given, without someone being there to

supervise the extent of the project, there is no way of knowing what other confounding variables could have possibly been introduced. Ideally in future studies, the researcher will be present to facilitate and oversee the extent of the study. Despite the potential variables surrounding this project, precautionary steps were taken to minimize confounding factors when possible and the overall results of the study appeared to be relatively consistent throughout.

## **Conclusion**

The purpose of this research project was to focus on rural villages near Bolgatanga with no new ceramic cook stoves and to provide an appropriate educational intervention in response to the problem identification. The findings of this study included collecting data on what current cooking practices were, evaluating current knowledge, determining why participants did not currently use a ceramic cook stove, and assessing the effectiveness of the planned educational intervention. Various relevant data was collected that can help similar villages in other areas that also have no new cook stoves. Overall, results suggested the educational intervention was extremely successful in increasing knowledge of smoke related health risks and changing almost all intentions of cooking habits that are associated with the aforementioned health risks.

The results of this study can be used in future studies for a variety of reasons. The various pre- and post-survey information can be used to create more appropriate educational interventions going forward and can provide additional data about the cooking methods and habits of rural villages near Bolgatanga. For instance, future interventions may want to focus more on the dangers of cooking inside poorly ventilated homes and less on the health risks to children. This study may also serve as an indicator of the usefulness of educational interventions in terms of changing behavior, since participants almost unanimously showed intentions to

change the riskiest cooking behaviors following the study. Survey responses may also indicate a need for additional solutions and improvements to the ceramic stoves, since several participants reported that they did not use a ceramic pot because there are none in Bolgatanga, they are too expensive, or they do not cook as fast or as well as traditional coal pots. This identified need may help indicate what improvements can be made to make the stoves more accessible in various rural communities. Overall, the survey information provides a variety of data and indicates the potential effectiveness of using educational interventions in future scenarios that are similar to the one in this study.

This study also sets the precedent for future studies to continue to follow participants going forward. Future studies may take place as soon as six months later and may continue to develop as time goes on. Short term and long-term studies may be done on cooking habits, respiratory illness, the performance and satisfaction with ceramic stoves, variations in cooking based on demographics, and the lasting effectiveness of the educational intervention. Studies could also assess the effectiveness of the completed research project by following whether participants continue to exemplify a change in cooking habits and if they continue to use the ceramic stoves given to them or not. Various research projects may particularly concentrate on identifying what factors result in the deviation from healthy practices and what additional educational needs may need to be addressed. They also may track trends in respiratory illness and signs and symptoms in women and children over time as they continue to use the new and improved cook stoves. Research such as this will allow future researchers to determine if improved stoves are efficient in decreasing respiratory illness and death, and therefore an effective solution to the crisis that rural communities and developing countries are currently facing.



## Apparatus

### Pre-Survey



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Survey for women who cook in Bolgatanga, Ghana    1=no    5-6= maybe    10=yes

1. I cook with coal or wood everyday:

1    2    3    4    5    6    7    8    9    10

2. I cook inside with coal or wood everyday:

1    2    3    4    5    6    7    8    9    10

3. I cough or wheeze during or after cooking:

1    2    3    4    5    6    7    8    9    10

4. My children are close to the smoke when I cook:

1    2    3    4    5    6    7    8    9    10

5. My children cough and wheeze if they are close to me when cooking:

1    2    3    4    5    6    7    8    9    10

6. I know that breathing smoke can make you sick:

1    2    3    4    5    6    7    8    9    10

7. I have heard that there is a ceramic pot that doesn't make much smoke:

1    2    3    4    5    6    7    8    9    10

8. Circle all that apply

I do not use a ceramic coal pot because:

They are not in Bolgatanga

They are too expensive

It is not a good stove

It is no different than any other coal pot

Other Reasons:

## Educational Intervention- Presentation Outline

### Basic Anatomy

- During inhalation, air travels into the nose and mouth, down the trachea, through small passageways called bronchi, and into the lungs. The lungs consist of different lobes, which contain small sacs called alveoli. Alveoli are where oxygen and carbon dioxide exchange takes place.

### How Smoke Harms the Lungs

- Smoke contains fine particles and toxic chemicals, which can enter the lungs and bloodstream. The toxic particles can cause inflammation and interfere with the exchange and transportation of oxygen. This can lead to the health issues listed below.

### Long-Term Consequences

- Long-term consequences include premature death, asthma, increased respiratory infections, chronic obstructive pulmonary disease (COPD), ischemic heart disease, stroke, and lung cancer.
- In 2019, over 3.2 million people died from illnesses associated with smoke inhalation.

### Reducing Exposure to Smoke (Why and How)

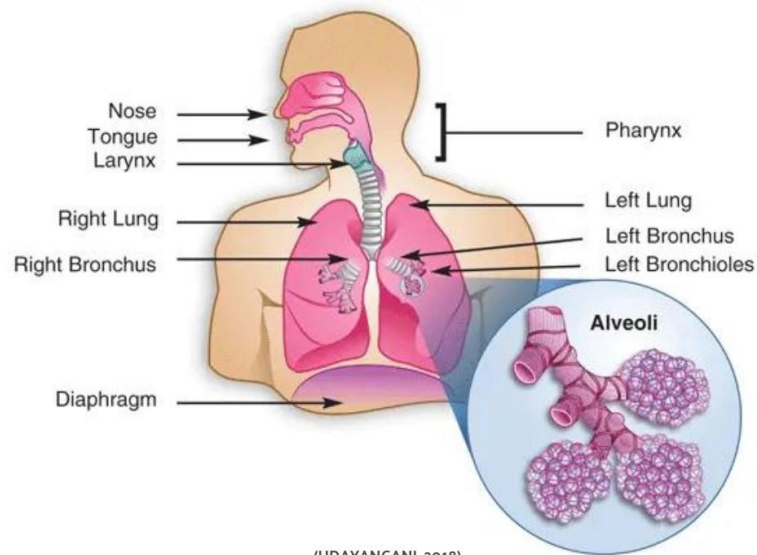
- In order to reduce illness related to smoke inhalation, it is best to minimize your exposure to smoke. Some ways to do this are by cooking outside instead of inside in order to provide better ventilation, keeping children away from the cookstove when possible, and using more efficient cookstoves that use a ceramic liner instead.

### How to Use the New Cookstove

- The nurses in Bolgatanga will demonstrate how to use the new cookstoves.
- Instead of a simple piece of tin molded to hold charcoal or wood, there is a ceramic insert for the pans/pots to sit on, and the ceramic transfers the heat. The wood and coal go into the bottom of the stove under the ceramic piece instead of on top.
- The way the stove is made reduces the amount of smoke and uses less coal or wood.

## Educational Intervention- Flyer

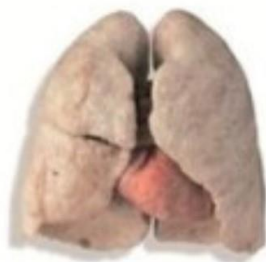
# BASIC ANATOMY



(UDAYANGANI, 2018).

# LUNGS AND SMOKE

## NORMAL LUNGS



## SMOKE-AFFECTED LUNGS



(CANSAs, 2013).

## Post-Survey



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## Cooking Questionnaire

Circle the response from the participant after the program is given to improve cooking practices:

1. I learned a lot from this program: 1=no 5-6= maybe 10= yes

1    2    3    4    5    6    7    8    9    10

2. I intend to use a ceramic pot if I have one available:

1    2    3    4    5    6    7    8    9    10

3. I intend to continue cooking inside:

1    2    3    4    5    6    7    8    9    10

4. I understand the risks cooking with wood or coal:

1    2    3    4    5    6    7    8    9    10

5. Do you intend to try to keep your children away from smoke?

1    2    3    4    5    6    7    8    9    10

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