environments

MDPI

Article

Traditional Biomass Energy Use Among Women Street Coffee Vendors: Access and Health Implications in Bahir Dar City, Ethiopia

Yilikal Muche Engida, Binyam Afewerk Demena * and Salomey Gyamfi Afrifa

International Institute of Social Studies, Erasmus University Rotterdam, Kortenaerkade 12, 2518 AX The Hague, The Netherlands; yilikalm2000@gmail.com (Y.M.E.); gyamfiafrifa@iss.nl (S.G.A.)
* Correspondence: demena@iss.nl

Abstract: Biomass energy is a significant yet often overlooked energy source in many developing nations, particularly in households where it is utilized in highly inefficient ways. This inefficiency stems from the direct combustion of wood, charcoal, leaves, agricultural residues, and animal dung for cooking purposes. A substantial portion of the Ethiopian population relies on traditional biomass energy, a dependence influenced by socioeconomic factors and residential location. In this study, we focus on traditional coffee vendors operating on the streets of Bahir Dar who utilize traditional biomass for coffee preparation. We aim to investigate the accessibility and health implications of traditional biomass utilization among these women coffee vendors. We employed a mixed-methods research approach with a concurrent research design to achieve our objectives. Data were analyzed quantitatively through descriptive statistics and qualitatively through thematic analysis. Both the descriptive and textual data indicate that women traditional coffee vendors (WTCVs) rely on traditional biomass energy because customers expect the ceremonies to be performed using it, as it holds significant traditional and cultural value. While traditional biomass energy is relatively accessible, the vendors' limited income often restricts their ability to secure it consistently. Consequently, their dependence on traditional biomass, combined with poor working conditions, negatively impacts their respiratory health and heightens the risk of burns and injuries.

Keywords: traditional biomass; traditional coffee vendors; access; health effects

Academic Editor: Brian D. Fath

Received: 2 December 2024
Revised: 10 January 2025
Accepted: 17 January 2025
Published: 21 January 2025

Citation: Engida, Y.M.; Demena, B.A.; Afrifa, S.G. Traditional Biomass Energy Use Among Women Street Coffee Vendors: Access and Health Implications in Bahir Dar City, Ethiopia. *Environments* **2025**, *12*, 34. https://doi.org/10.3390/environments12020034

1. Introduction

Coffee brewing in Ethiopia is unique in many ways and is deeply rooted in tradition and ritual. Before the ceremony begins, the dining area undergoes a series of pre-ritual preparations. Coffee cups and snacks are carefully arranged on a table, and the floor is adorned with freshly cut grass. Pleasant incense is burned to purify the room, adding to the sensory ambiance. The duration of the ceremony varies depending on the occasion. Holiday ceremonies are typically much longer than the daily personal rituals, while vendors often adjust the length according to their schedules. In Ethiopia, drinking coffee is an incomparable sensory experience. Women preparing the coffee wear traditional clothing, adding to the cultural richness of the event. The process begins with the washing and roasting of the beans on a Mitad, a traditional iron pan. Once the beans have been roasted, they are brought to guests to inhale the aroma, an essential part of the Ethiopian coffee experience that engages all the senses. Figure 1 shows the traditional coffee ceremony.

Figure 1. Traditional coffee ceremony and biomass energy utilization. Source: Photo from fieldwork, 2022.

Although biomass energy is widely used in most developing countries, it remains an important yet often overlooked energy source. Currently, 14% of the world's population relies on biomass, primarily for household use, but it is frequently utilized in highly inefficient ways. The widespread use of inefficient cookstoves leads to a significant loss of biomass energy. The overuse of biomass creates another related problem: indoor pollution and unnecessary greenhouse gas (GHG) emissions [1]. Traditional biomass is the poorest energy in the world [2], typically involving the direct combustion of wood, charcoal, leaves, agricultural residues, and animal dung for cooking and lighting [3]. As a result, many developing countries use biomass as the main source of energy, mainly in Africa. However, biomass can also be used efficiently through Modern Biomass Fuels (MBFs), which are produced by converting biomass into liquid and gaseous fuels, such as ethanol, biogas, and producer gas. Stoves for modern biomass fuels are carefully designed and built and easy to operate. MBFs have a high conversion efficiency of 30–40% and promote a clean cooking environment by significantly reducing indoor pollutants and greenhouse gas emissions [2].

Access to energy in Ethiopia is closely linked to socioeconomic issues. According to [3], energy is one of the most important factors in Ethiopia's economic growth and social development. In this context, the Ethiopian People's Revolutionary Democratic Front (EPRDF) added that in some places, access to biomass fuels has been severely reduced throughout the country. The reduced availability of woody biomass has significant implications for development and society. About 92% of Ethiopians rely on biomass for energy. This energy is mainly used for baking and cooking in the household. As a result, the amount of energy consumed in the household is much greater than that used for other purposes [3].

The urban population growth rate of Ethiopia is 4.8%, and by 2050, the population is expected to be 205 million [4]. Ethiopia's total annual bioenergy resources are projected to be 153.4 million tons. Of this total, woody biomass will account for 73% (wood 69% and charcoal 4%), while animal dung (14%) and residue (13%) will be second and third [5]. Due to their poorer socioeconomic status, traditional coffee vendors in Ethiopia, especially in Bahir Dar city, are victims of inefficient use of biomass energy. Although urban families in Ethiopia use less harmful fuels and technologies, they still rely mainly on traditional biomass, represented by 38% firewood and 30% charcoal. Clean fuels and technologies are utilized in about a quarter of households in large cities, with about 23% cooking with electricity and 1% using liquefied petroleum gas (LPG). However, charcoal remains a daily staple for cooking and coffee ceremonies in nearly every urban household. It is also

frequently used for heating, particularly during the rainy season [6]. The improper use of biomass energy impacts not only women but also children. For instance, factors such as malnutrition, cooking with charcoal, carrying a child on the back while cooking, and living in crowded conditions have all been identified as risk factors for pneumonia in children under the age of five. Pneumonia is characterized by symptoms such as coughing, rapid breathing, and severe signs like chest retractions and stridor [7].

While several studies have shown the effects of traditional biomass energy use among women in Ethiopia, most of this research has been focused at the household level. There are few empirical investigations into the socioeconomic and health implications of biomass use in the informal sectors. Specifically, very little is known about women traditional coffee vendors (WTVCs) and their use of biomass energy, although they represent a substantial percentage of the emerging informal sector in Ethiopia. Given their significant contribution to the informal sector, this study aims to provide empirical evidence by exploring how access to traditional biomass energy has negative health implications on women traditional coffee makers in Bahir Dar city, Ethiopia.

Accordingly, this study seeks to explore the following key research questions: How do women traditional coffee vendors access traditional biomass energy and what is its economic influence on them? What are the health effects of using this energy on these vendors? In addressing these questions, this paper provides an important empirical contribution from an African perspective, thus contributing to the sparse literature on the impact of traditional biomass on the economy and the health of WTCVs in Ethiopia. Secondly, by focusing on the health implications of using biomass, this paper provides empirical evidence to support policies that will help address health-related challenges associated with the use of traditional biomass and improve access to health-friendly energy for cooking. Since the outdoor health effects of the direct combustion of traditional biomass have negative consequences on vendors' economics, it will be of interest to researchers to support a more environmentally sustainable cooking facility. Thirdly, the results of the study contribute to policymaking by providing empirical evidence to support cross-cutting policies that will propel the achievement of the United Nations Sustainable Development Goal (SDG) 7 (Affordable and Clean Energy), Target 1 (access to affordable, reliable and modern energy services), specifically to ensure the development of evidence-based policies that help improve access to safe, affordable, reliable, sustainable, and modern energy.

The remainder of the paper is organized as follows: Section 2 outlines the theoretical framework, establishing the foundational concepts and theories that guide the study. This section highlights relevant literature and key theoretical perspectives that inform the analysis. Section 3 details the study methodology, describing the research design, data collection techniques, and analytical approaches employed. This section aims to provide clarity and transparency regarding the procedures used to ensure the validity and reliability of the findings. Section 4 presents the results and discussion, integrating the study's findings with existing literature and theoretical insights. This section critically examines the results, highlighting their significance, implications, and potential limitations within the broader context of the study. Finally, Section 5 concludes the paper, summarizing the key findings and their relevance. This section also discusses the broader implications for policy and practice and offers suggestions for future research directions to build on the insights gained from this study.

2. Theoretical Framework

2.1. Theory of Access

"Access" depends on a variety of characteristics, including constellations of methods, relationships, and procedures that, in combination with a "bundle of rights", enable

multiple actors to derive benefits from resources [8]. In some cases, different individuals and institutions have varying degrees of access to and decision-making power over resources. Some individuals control resources, while others only have access [9].

The United Nations SDG 7(1) states that universal access to affordable, reliable, and modern energy services is both a prerequisite and a driver for improving the lives and working conditions of everyone in the world [10]. Lack of access to modern energy is a barrier to achieving many other SDGs, especially for the poorest and most vulnerable communities. Access to modern energy lifts people out of poverty and improves their wealth, health, security, well-being, and educational and entrepreneurial prospects; it also promotes gender equality and social, economic, and political equity [11]. Regarding why some benefit from others, ref. [12] stated that different political and economic situations alter the conditions of access and, thus, the specific individuals or groups that can best benefit from a set of resources.

Access to energy and health is directly related to the fact that modern and health-friendly energy improves health, while poor (traditional biomass) energy is detrimental to the user's health. In this context, electrification has the potential to improve health in low- and middle-income countries in multiple ways. According to [13], electric lighting and cooking appliances are expected to reduce indoor air pollution and respiratory illness by reducing the demand for wood, charcoal, and kerosene. Similarly, improved access to media through television, radio, and the Internet (i.e., through the use of electricity) can also provide health information to influence health behaviors. In addition, access to electricity in healthcare facilities enables the use of essential medical equipment and improved sanitation and safety [14].

2.2. Access to and Health Effects of Utilizing Traditional Biomass Energy

People in Ethiopia, both urban and rural, rely heavily on traditional biomass fuels such as wood, dung, leaves, twigs, charcoal, and others. Burning biomass releases carbon monoxide, hydrocarbons, and particulate matter into the atmosphere. The health of the fireplace is also affected by smoke from combustion [15]. The health effects of biomass energy are determined by two parameters: first, the number of pollutants that vary throughout the day depending on the use (combustion or smoldering), type of stove and fuel, and the effectiveness of a ventilation system or chimney; second, the time that is spent in a contaminated environment [16].

Biomass is among the sources of local and regional air pollution that can cause illness and death. The use of solid fuels for cooking, heating, and lighting in homes is a significant contribution to indoor air pollution [17]. According to [18], indoor air pollution from biomass cooking kills about 2 million people worldwide each year from pneumonia, chronic lung disease, and lung cancer, with poor countries accounting for 99% of these deaths. According to the organizations, women account for 60% of adult mortality in poor countries, including less developed countries and sub-Saharan Africa. After 9 years, ref. [19] reported that about 4 million people died prematurely from diseases caused by domestic air pollution due to improper cooking habits, including polluting stoves and solid fuels.

2.3. Energy Ladder and Stacking Model

The concept of the energy ladder addresses differences in energy use behavior among families of different economic classes (Figure 2). According to the neoclassical consumer, households gradually switch to more sophisticated energy sources as income rises. In contrast to poorer households, who use wood and crop waste, wealthier households use electricity and petroleum products [20]. The basic assumption is that households have a variety of energy supply options that can be ranked in ascending order of technical

complexity. Electricity is at the top of the list, while firewood, manure, and crop waste are at the bottom. Assuming that the household's economic situation improves, it will move up the energy ladder and use more sophisticated energy sources. If the household's economic situation deteriorates, whether due to a loss of income or an increase in fuel prices, the household is more likely to "go down" the energy ladder and use less complex energy sources. Consequently, the energy ladder is a simplified extension of economic consumption theory: as income increases (decreases), families not only buy more (less) of the same goods but also migrate to higher (lower) value items [20]. Based on the energy ladder model, ref. [21] reports on the shift to a different fuel in three stages. The first stage is characterized by a complete dependence on the use of traditional biomass energy. Second, families are expected to switch to "transitional fuels" such as kerosene, coal, and charcoal in response to rising incomes, urbanization, and biomass scarcity. Finally, households switch to LPG, natural gas, or electricity for cooking.

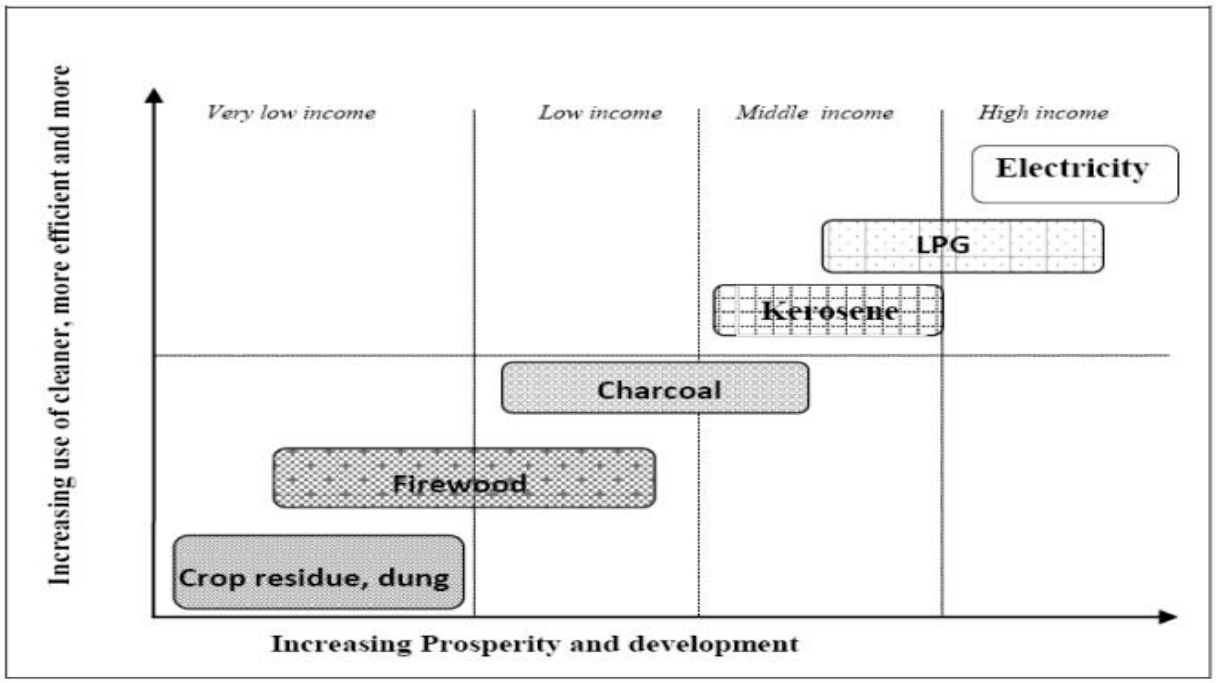


Figure 2. Energy ladder and stacking model. Note: The shift from traditional to modern energy sources carries significant health implications. Greater reliance on traditional energy sources correlates with more severe negative health effects, symbolized by darker shades, in the lower half of the figure. Conversely, as the adoption of modern energy sources increases, these health impacts are significantly reduced, represented by lighter shades appearing progressively in the upper half of the figure. Source: adopted from [22].

In contrast to the energy ladder model, the energy stack model assumes that family behavior in choosing an energy source and the transition process, especially in developing countries, does not necessarily follow a unidirectional, straight-line movement from one energy source to another. This model assumes that families vary their energy portfolio and use "different fuels" regardless of changes in income levels, rather than switching completely from traditional biomass energy to modern fuels [23]. The fundamental reason households use "multiple fuels" is to save energy and benefit from the complementarities between traditional and modern fuels [24,25]. The energy stacking model views household energy transition as a protracted process resulting from the complex interplay of economic, technological, and social elements, rather than a single-income, unilateral fuel switch [23].

3. Materials and Methods

3.1. Description of the Study Area

The study area is in the city of Bahir Dar, one of the largest cities in Ethiopia. It is located at the center of the Amhara National Regional State and borders the southern part of Lake Tana. The urban area of Bahir Dar covers a radius of 25 km around the city center. Bahir Dar city is in the heart of the metropolitan region. Its exact coordinates are 11°37′ north latitude and 37°25′ east longitude. The distance from Addis Ababa is 550 km by road via Bure and 460 km via Motta, while the flight time is 55 min. The urban area lies between 1650 and 2100 m above sea level. The average altitude of Bahir Dar ranges from 1786 m above sea level (near the sea coast) to 1886 m above sea level. See Figure 3 for the map of Bahir Dar city.

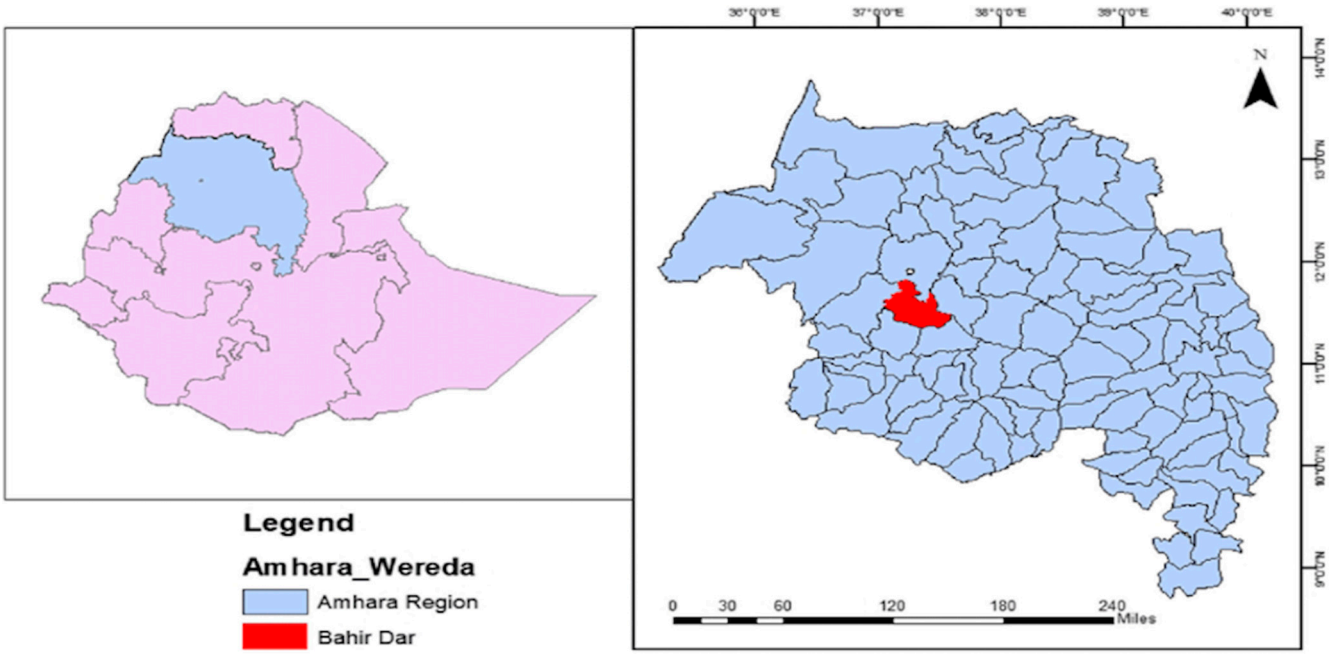


Figure 3. Map of Bahir Dar city [26].

3.2. Research Methods

This research is grounded in a pragmatic philosophical worldview. Pragmatism is flexible and not confined to a single system of philosophy; instead, it draws on both qualitative and quantitative approaches [27]. Embracing this pragmatic perspective, we employed a mixed-methods design. Among the various mixed-methods designs, we selected the convergent approach, which allows for qualitative and quantitative data collection to occur simultaneously, with integration taking place during the interpretation stage. Using the two approaches in a single research work has two advantages, "*one to gain an in-depth perspective and the other to generalize to a population*" [27] (219).

As quoted by [28], Cochran (1963) suggested the most commonly used formula for a questionnaire survey study's sample size determination when the population is large, and a representative sample is needed to analyze proportion.

The formula is as in Equation (1):

$$\text{no} = \frac{Z^2\, Pq}{e^2} \quad (1)$$

where no = number of samples required.

Z = the value of the desired confidence level or confidence interval (95% = 1.96).

e = the desired level of margin of error or precision.

P = estimated variability or proportion of an attribute in the population (50% = 0.5).

$q = 1 - P$

Consequently, when examining the expected criterion, the researcher used a 95% confidence level (Z = 1.96), the highest population variability (50%), and a margin of error/precision of 5%.

Therefore, based on the formula in Equation (1),

$$\frac{(1.96)^2\,(0.5(1-0.5))}{(0.06)^2} = \frac{3.8416 \times 0.5 \times 0.5}{0.0036} = 266.77 = 267 \quad (2)$$

For the selection of 267 samples, the city was stratified into six sub-cities (Dagemawi Menilik, Tana, Fasilo, Gishe Abay, Belay Zeleke, and Atse Tewodros). Then, the 267 samples were divided into each sub-city (267/6 = 45). Finally, the individual samples were selected by systematic sampling from the main streets of each sub-city. The sample selection started from one side of the street and was conducted based on the given interval. The sample size in each street was designed as follows: Tana (Gudo Bahir Street, 80 traditional coffee vendors (TCV), through 2 intervals), Belay Zeleke (Belay Zeleke Street, 120 TCV, through 3 intervals), Atse Tewodros (Beg Tera Street, 87 TCV, through 2 intervals), Gish Abay (Cherka Ckerk street, 95 TCV, through 2 intervals), Fasilo (Aba Fasio Street, 115 TCV, through 3 intervals), and Dagemawi Menilik (Mulualm street, 150 TCV, through 3 intervals).

For non-probability sampling (qualitative), the samples did not have an equal chance of being included in the research. Instead, the individuals whom the researcher believed provided relevant information were selected. Thus, a purposive sample was drawn from the non-probability sampling to select participants based on the criteria. Accordingly, those who had been working as traditional coffee vendors for more than one month were selected. The number of group discussants and interviewee participants was determined by data saturation.

Both primary and secondary sources were used for this research. Primary sources for collecting primary data include survey respondents, interviewees, and participants in focus group discussions. On the other hand, secondary sources, such as books, journals, and annual reports related to the study, were used to obtain secondary data. Concerning secondary data, ref. [29] suggested that someone else collects and analyzes written sources, allowing for the interpretation or registration of primary data.

Questionnaires, interviews, and focus group discussions (FGD) were the data collection tools used to collect primary data. The questionnaire contained both closed and open-ended questions that were used to prepare and collect primary data from respondents. The questionnaire was designed to collect information on the variables that drive traditional coffee vendors to use biomass energy, as well as its health effects. The interviews were classified into individual and focus groups. They were conducted in Amharic, as this is the medium of communication for the interviewees and discussants in the field, with an active assistant who took notes and received appropriate instructions to coordinate the protocols. The researcher acted primarily as a moderator during the discussions. All discussants had equal opportunity to contribute their ideas. After each interview, the notes were summarized, and important and relevant points were noted to help the researcher reformulate the interview questions.

Both quantitative and qualitative data analysis methods were used in this study, and it was found that a combination of data analysis methods is essential for this research. In quantitative data analysis, empirical and numerical data are tabulated, analyzed, and summarized to characterize or generalize the population based on samples. Consequently, descriptive and inferential statistics are used to analyze quantitative data. After data

collection was completed, data were coded, revised, and entered into SPSS (Statistical Package for Social Science) version 23 and then analyzed descriptively. Regarding the qualitative analysis, thematic data analysis was applied. The main goal of the analysis was to identify themes from the collected data. While the general themes were determined before the analysis, the specific categories and themes to be explored were not determined in advance. The data collected were explained in detail in the guiding and probing questions about access to energy among traditional coffee vendors.

4. Results and Discussions

4.1. Socio-Demographic Characteristics of the Respondents

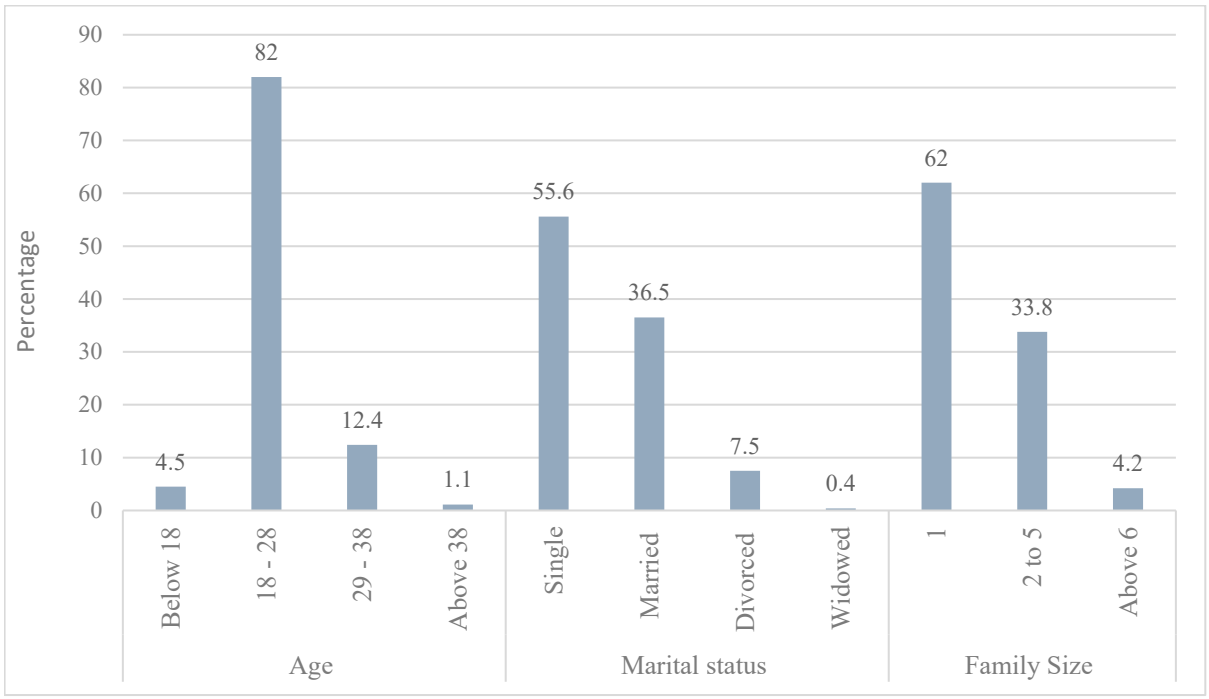
Figure 4A presents the socio-demographic characteristics of the respondents, including age, marital status, and family size. In terms of age distribution, the percentages are as follows: 82% were between 18 and 28 years old, 12.4% were between 29 and 38 years old, 4.5% were below 18, and only 1.1% were above 38. This indicates that the majority of traditional coffee sellers in this informal sector are young adults, specifically those aged 18 to 28. Conversely, older age groups are less represented. The data suggest that women aged 18–28 face high unemployment rates and rely on biomass for coffee preparation.

Regarding marital status, 55.6% of respondents were single, 36.5% were married, 7.5% were divorced, and 0.4% were widowed. Despite the predominance of the 18–28 age group, most respondents (55.6%) were single. However, 36.5% were married, indicating that their livelihoods depend on selling coffee. Family size data show that 62% of respondents live in households with 2–5 members, 33.8% live alone, and 4.2% have households with more than six members. These figures suggest that respondents either live with family or share housing to manage the challenges of urban life.

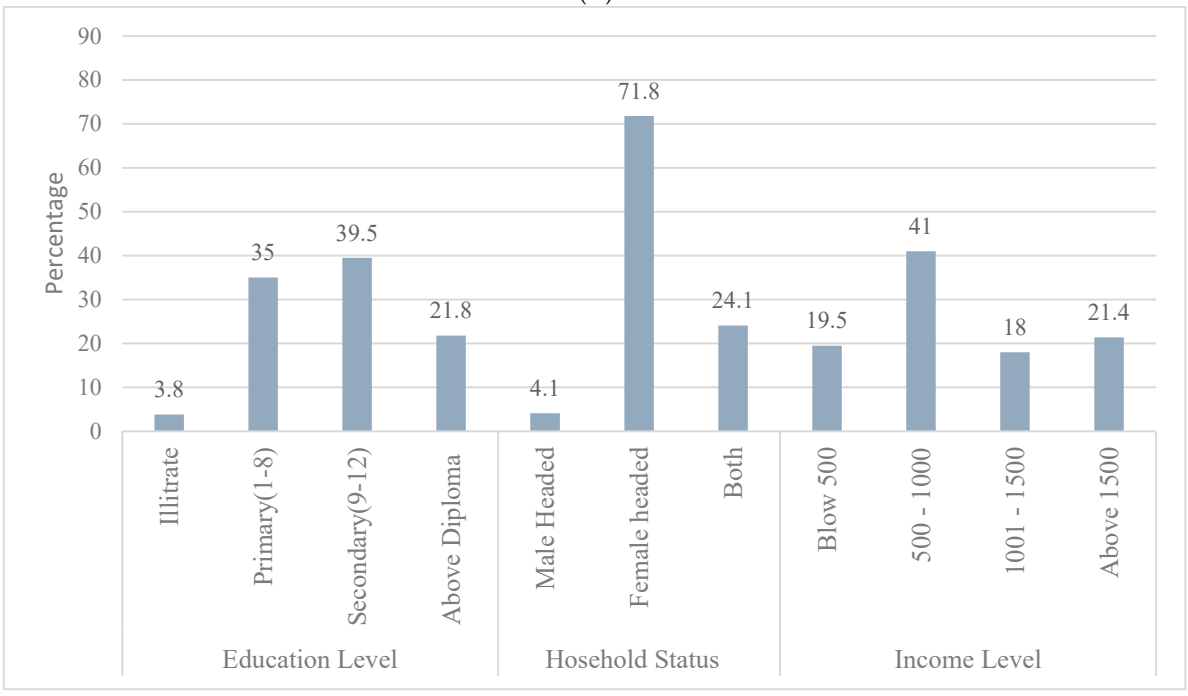
Figure 4B gives the socio-demographic characteristics of the respondents related to educational level, household status, and income level. The educational background of respondents offers valuable insights into their involvement in traditional street coffee preparation in Bahir Dar city. Analysis reveals that 39.5% have completed secondary education (grades 9–12), 35% have attended primary school (grades 1–8), 21.8% hold a diploma or higher, and 3.8% are illiterate. These data suggest that a significant portion of those involved in coffee preparation have at least a high school education, while only a small percentage are illiterate.

Regarding household status, 71.8% of respondents are heads of female-headed households, 4.1% are heads of male-headed households, and 24.1% have both a male and female head of household. This indicates that respondents are more likely to live alone or with a female partner, which aligns with their predominantly single marital status. The prevalence of female-headed households is positively correlated with the number of single or unmarried women living independently.

In terms of monthly income (Ethiopian birr), 41% of respondents earn between ETB 500 and ETB 1000, 21.4% earn above ETB 1500, 19.5% earn below ETB 500, and 18% earn between ETB 1001 and ETB 1500. The majority, 41%, fall into the ETB 500–1000 income bracket, which influences their consumption of biomass energy. However, a notable portion (19.5%) earns less than ETB 500, indicating that income from street coffee preparation in Bahir Dar often does not exceed this lower threshold. Regarding this, ref. [16] stated that the most important clues have always been the type of fuel used and people's involvement in preparing meals. Indoor air pollution is much worse in areas where the average household income is less than USD 1 per day.



(**A**)



(**B**)

Figure 4. (**A**). Socio-demographic characteristics of the respondents representing age, marital status, and family size. (**B**). Socio-demographic characteristics of the respondents related to educational level, household status, and income level. Source: Own survey, 2022.

4.2. Working Conditions and Traditional Biomass Energy Utilization

In most cases, the type and location of work also determine what type of energy women should use. In some places, some women traditionally prepare coffee in front of their own houses. These women use electricity to prepare the coffee, although electricity is not used for burning incense; rather, it is easier and more proper to use charcoal. As for the workplace, one of the participants said, "As you can see, we work outside. We do not have any other option. I would like to use electricity without changing the traditional

ceremony". The focus group discussant added that it is possible to make coffee with electricity without changing the ceremony that people like to see. Participants think that the fresh grass spread on the ground and the incense make the ceremony beautiful. Even though WTCVs want to use healthier and safer energy, the interests of the customers, who enjoy the traditional ceremony, and their place of work determine the traditional use of biomass energy, specifically charcoal. In accordance with this study, ref. [30] confirmed that consumption habits determine the energy consumption patterns of consumers. This means that consumption habits spread from generation to generation through tradition. In this context, the traditional Ethiopian coffee ceremony is one that is lovingly and colorfully passed down from generation to generation. Figure 1, in Section 1, illustrates the working conditions of traditional coffee vendors.

4.3. Biomass Energy Access and Economic Influence of Women Traditional Coffee Vendors

Ethiopian women traditional coffee vendors use traditional biomass energy to prepare coffee on city streets, including in Bahir Dar, the study area. Therefore, they use different types of traditional biomass energy, mainly charcoal. Their access to traditional biomass energy for coffee preparation depends on several factors, mainly income. Income determines the ability to afford to purchase biomass energy sources to make traditional street coffee. Participants stated that charcoal is the main energy source. as it is easy to access; however, the capability to afford it is determined by the price level.

The coffee vendors buy the charcoal from their customers. This is because, according to the respondents of the study, there are many charcoal sellers in the city who are constantly trying to secure their business. Most of the time, the coffee vendors call their customers to bring charcoal to the place where they work. Regarding this, a traditional coffee vendor in the sub-city of X said that

> "*I use charcoal to make coffee. I have customers who bring charcoal to me. Whenever I want, I call them, and they bring it to me*".

In addition, sometimes, coffee vendors buy charcoal from stores and unions when their respective customers are not available. Occasionally, farmers also sell charcoal to women traditional coffee vendors. Similar ideas have also been raised, e.g., that they can contact their constant customers (biomass sellers) to buy. Thus, the data collected through both the FGD and the interviewee confirmed that the accessibility (availability) of charcoal is not a difficulty, but the level of affordability matters.

The research also mentioned many things about access to and affordability of sustainable and healthy energy. As mentioned elsewhere in the study, coffee vendors' access depends on their ability to afford the price. Since they use traditional biomass, especially charcoal, they consume a lot of energy. Consequently, their consumption is different from that of households. Thus, coffee vendors are forced to spend money to buy energy from traditional biomass sources. Their affordability is affected by their income level. This is because access to energy is not guaranteed if one is not able to afford it. According to [10], access is described as "*access as the ability to benefit from things, including material objects, persons, institutions, and symbols*". Related to this, ref. [31] stated that the reason the majority of Ethiopians use biomass is because of a lack of access to clean modern energy, high poverty, and technological disadvantages. The energy ladder model is also aligned with the idea [20] that as households' income situation improves, they will move up the energy ladder; the model also implies that the lower income level also leads to a lower capability to access more expensive fuels. Similarly, ref. [32] stated that traditional consumption habits also determine the consumption patterns.

4.4. Health Effects of Biomass Energy Use on WTCVs

Due to their access to energy, low economic capability, and working conditions, women traditional coffee vendors experience health impacts from biomass energy use. This research focuses on respiratory health effects and fire-related burns.

4.4.1. Respiratory-Related Health Effects

Figure 5 presents a summary of the respiratory-related health effects of utilizing traditional biomass energy. Respiratory health issues are closely linked to lung and breathing problems caused by the direct combustion of biomass in traditional coffee preparation. According to the descriptive analysis, 53.4% (142) of respondents reported experiencing coughing, while 44.6% (124) did not. This indicates that a majority of women traditional coffee vendors are exposed to smoke from traditional biomass energy. Similarly, 66.2% (176) of respondents suffer from nose irritation, compared to 33.8% (90) who do not. In line with this, ref. [33] showed that indoor air pollution from biomass use causes about 36% of respiratory infections and 22% of chronic respiratory diseases.

The analysis of respiratory-related breathing capacity indicates that WTCVs had impacted breathing capacity due to biomass use. The understanding of society towards how coffee should be prepared has a direct correlation with the health effects because the dependence on charcoal for incense causes breathing-related health effects. Specifically, 74.1% (197) of women reported no shortness of breath, while 25.9% (69) experienced shortness of breath. Pneumonia affects 62% of respondents, and asthma impacts 69.5%, while 38% and 30.5% are unaffected, respectively. Additionally, 78.2% do not experience lung cancer, whereas 21.1% do.

Sociological and socioeconomic factors are also determinant factors for the health risks to vendors. For example, regarding items of household status, women-headed households are the majority (71.8) in the business. This means that these women are exposed to the respiratory health effects mentioned above. Economic factors also determined whether women used relatively healthy fuels or less combustion. As a result, the health effects are greater for the less economically privileged than for the moderate group.

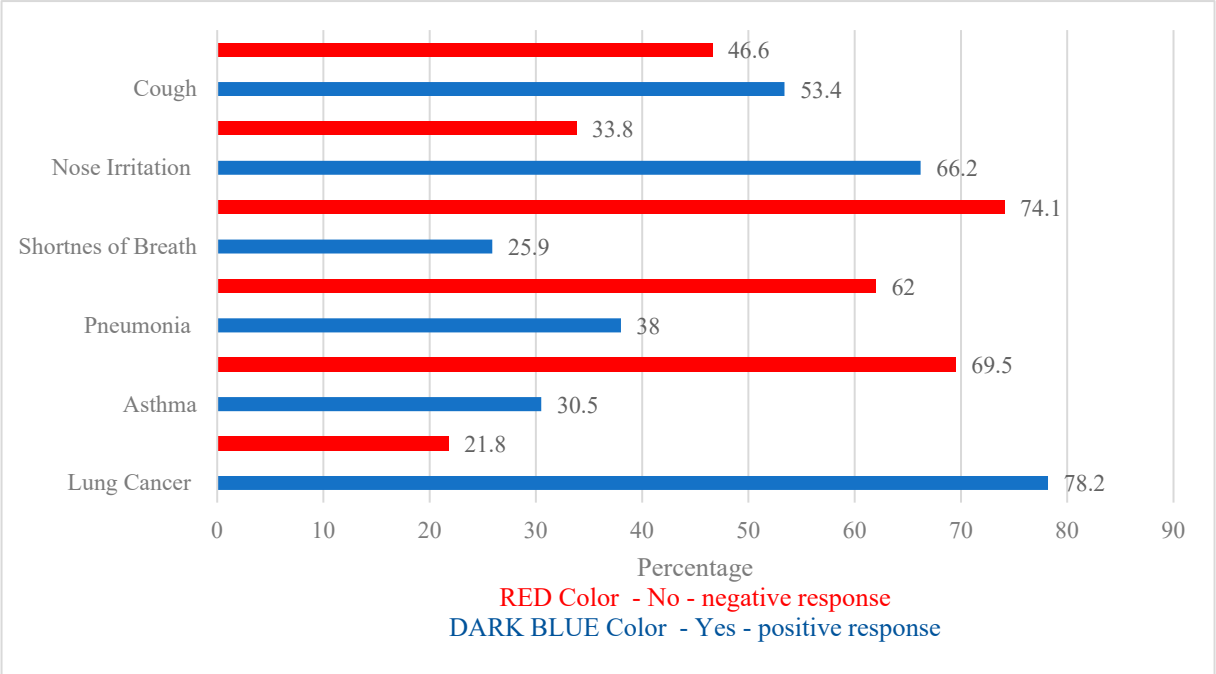


Figure 5. Percentage distribution of the respiratory-related health effects of utilizing traditional biomass energy. Source: Own survey, 2022.

Regarding the health effects, evidence from the study [33] shows that unsustainable resource collection and inefficient energy conversion technologies exacerbate these health effects. Compatibly, ref. [18] added that approximately 2 million people globally die each year from pneumonia, chronic lung disease, and lung cancer, with 99% of these deaths occurring in developing countries.

4.4.2. Fire-Related Burns

The use of biomass energy also has physical implications. Even when women use a locally made improved cookstove, they can be victims of charcoal fire incidents. According to [34] for instance, the use of traditional biomass energy, including firewood and charcoal, alongside an increased reliance on kerosene, is likely to raise the incidence of skin burns while simultaneously exacerbating environmental issues through heightened air pollution, thereby contributing to a broader range of associated health risks. Figure 6 gives a summary of fire-related burns due to utilizing traditional biomass energy. The statistical descriptive analysis shows that the majority of traditional coffee sellers (71.4%) have suffered burns, while only 28.6% of women have not. Since they are in business, they are exposed to open fire when they try to start fires. Another major problem is the eyes: 75.2% of the respondents have problems with their eyes, while 24.8% do not. This is because they use their breath to fire the charcoal. Lastly, the majority of respondents (97%) reported no additional health effects from utilizing traditional biomass energy, while a small minority (3%) experienced other health impacts not previously mentioned. Similar to respiratory health issues, their socio-economic status influences the physical harm they experience, as economic capability determines the type of stove they can afford and the quality of biomass (charcoal) they use. Specifically, less advanced stoves expose them to more open flames, while lower-quality charcoal requires more effort to burn, further increasing health risks.

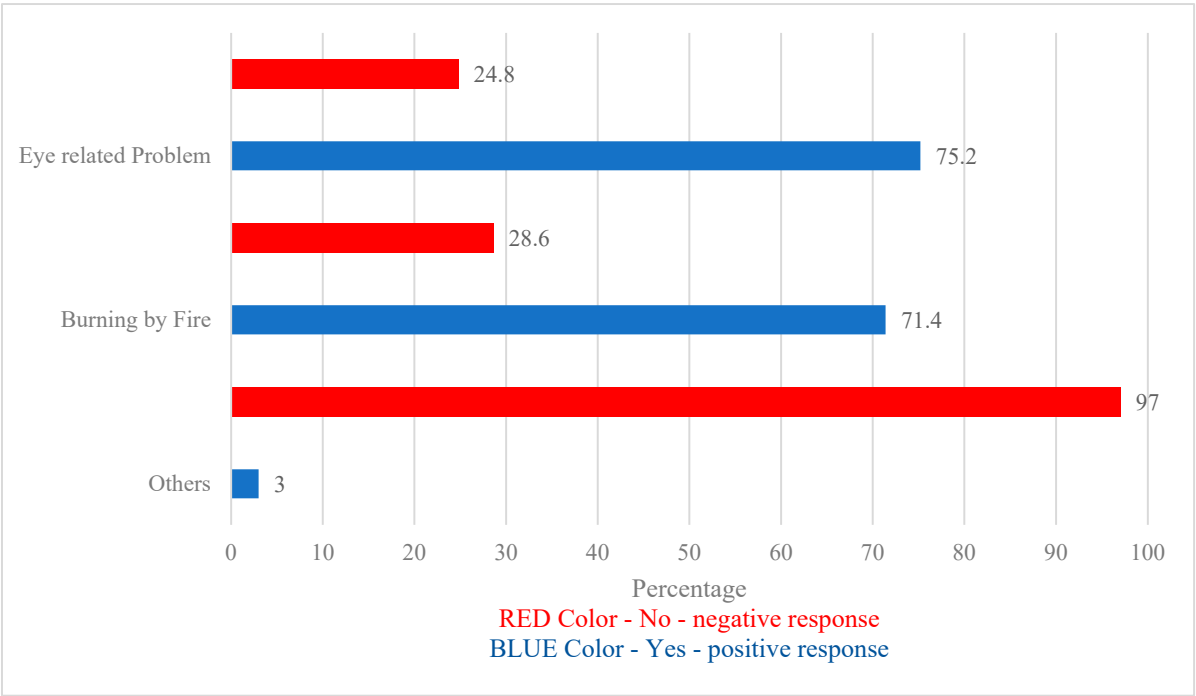


Figure 6. Percentage distribution of the fire-related burns of utilizing traditional biomass energy. Source: Own survey, 2022.

4.5. Limitations

As the research topic is a new and unaddressed problem, finding research on the discussion in the study area, specifically the study site, was challenging. Even though biomass

has been researched with regard to other issues and target groups, women traditional coffee vendors' biomass utilization was untouched. Despite it not having a significant impact on the findings, it is worth noting that the questionnaire from one respondent was not collected.

5. Conclusions

Biomass energy is widely used in rural areas and low-income urban households across developing countries. However, its direct combustion poses significant health risks, particularly for women, who are typically responsible for household tasks. While numerous studies have explored the effects of traditional biomass energy use among women in Ethiopia, most of these studies focus on the household level. Few empirical investigations have examined the socioeconomic and health implications of biomass use in the informal sector. In particular, limited research has been conducted on WTCVs despite their significant presence in Ethiopia's emerging informal sector. Given their crucial role in this sector, this study seeks to provide empirical evidence by examining how access to traditional biomass energy negatively impacts the health of women traditional coffee vendors in Bahir Dar city, Ethiopia.

To achieve this, we employed a mixed-methods research approach with a concurrent research design. The data were analyzed using both quantitative and qualitative methods. Quantitative analysis was conducted through descriptive statistics to summarize and interpret numerical data, providing an overview of patterns and trends. Qualitative analysis was performed using thematic analysis, which involved identifying, analyzing, and interpreting key themes and patterns in the qualitative data to gain deeper insights into the experiences and perspectives of the participants.

In the context of this study, women who traditionally sell coffee rely on biomass energy, primarily charcoal. This informal business is rapidly expanding, as many unemployed women turn to it as a last resort for their livelihood. Although many of those involved are young adults, a significant number depend on selling coffee to sustain themselves. Despite the cultural importance of the traditional Ethiopian coffee ceremony, which continues to dictate the use of biomass, the health risks associated with charcoal usage are significant. A considerable portion of WTCVs suffer from respiratory and fire-related burns, including coughing, nose irritation, burns, and eye problems, as a result of constant exposure to smoke and open fire.

The study also underscores the economic pressures these women face, with many earning low incomes, further restricting their access to healthier energy options. The findings suggest an urgent need for policies that promote affordable, clean energy solutions to improve the health and well-being of these women while maintaining the cultural integrity of the coffee ceremony. The findings indicate that the health of WTCVs should be addressed as a cross-cutting policy issue to support sustainable development. To advance the United Nations SDG 7(1), both governmental and non-governmental organizations within the city administration must develop policies that improve access to safe and healthy energy. The identification of appropriate solutions should be aligned with the specific challenges at hand. Given that the outdoor health impacts of traditional biomass energy use are relatively new and insufficiently addressed in current policies, programs, and projects, it is crucial that these issues be incorporated. In light of the concerning rise in the number of WTCVs in Bahir Dar city, development practitioners focused on sustainable energy and health should prioritize the inclusion of outdoor health impacts from traditional biomass use in their policy agendas. Sustainable interventions can help reduce health risks and support the livelihoods of women working in this informal sector. For future studies, incorporating an experimental design to predict the factors could provide further valuable insights and strengthen the research approach.

Author Contributions: Y.M.E.: Conceptualization, Data collection, Empirical analysis, Writing—original draft, Writing—Review and editing. B.A.D.: Conceptualization, Supervision, Empirical analysis, Writing—Review and editing. S.G.A.: Conceptualization, Writing—Review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Adamu, M. Biomass Energy Usage in Developing Countries: An Overview of The Domestic Sector. In *Bio-Carbon Opportunities in Eastern & Southern Africa*; UNDP: New York, NY, USA, 2009; Volume 2004, p. 86.
2. Organisation for Economic Co-operation and Development. *International Energy Agency. World Energy Outlook*; OECD/IEA: Paris, France, 2009.
3. Karekezi, S.; Lata, K.; Coelho, S.T. Traditional biomass energy: Improving its use and moving to modern energy use. In *Renewable Energy—A Global Review of Technologies, Policies and Markets*; Routledge: London, UK, 2006; Volume 1, pp. 231–261.
4. Ethiopian People's Revolutionary Democratic Front (EPRDF). *Ethiopian National Energy Policy (second draft)*; Ethiopian People's Revolutionary Democratic Front (EPRDF): Addis Ababa, Ethiopia, 2013. Available online: https://www.academia.edu/22807122/Fina_Energy_policy_draft (accessed on 29 April 2022).
5. The World Bank. *World Development Indicator: Population Estimates and Projections*; World Bank: Washington, DC, USA, 2021. Available online: https://databank.worldbank.org/source/population-estimates-and-projections (accessed on 27 April 2022).
6. Tiruye, G.A.; Besha, A.T.; Mekonnen, Y.S.; Benti, N.E.; Gebreslase, G.A.; Tufa, R.A. Opportunities and challenges of renewable energy production in Ethiopia. *Sustainability* **2021**, *13*, 10381. [CrossRef]
7. Beyene, G.E.; Kumie, E.; Edwards, R.; Troncoso, K. *Opportunities for Transition to Clean Household Energy in Ethiopia: Application of the Household Energy Assessment Rapid Tool (HEART)*; World Health Organization: Geneva, Switzerland, 2018. Available online: https://iris.who.int/bitstream/handle/10665/311280/9789241514491-eng.pdf?sequence=1 (accessed on 10 May 2024).
8. Fekadu, G.A.; Terefe, M.W.; Alemie, G.A. Prevalence of pneumonia among under-five children in Este Town and the surrounding rural Kebeles, Northwest Ethiopia: A community-based cross-sectional study. *Sci. J. Public Health* **2014**, *2*, 150–155. [CrossRef]
9. Mutea, E.; Rist, S.; Jacobi, J. Applying the theory of access to food security among smallholder family farmers around North-West Mount Kenya. *Sustainability* **2020**, *12*, 1751. [CrossRef]
10. Ribot, J.C.; Peluso, N.L. A theory of access. *Rural Sociol.* **2003**, *68*, 153–181. [CrossRef]
11. United Nations. *Theme Report on Energy Transition: Towards the Achievement of SDG 7 and Net-Zero Emissions*; United Nations: New York, NY, USA, 2021. Available online: https://www.greenpolicyplatform.org/research/theme-report-energy-transition-towards-achievement-sdg-7-and-net-zero-emissions (accessed on 15 December 2024).
12. Miller, P.; Gordon, C.; Burchell, G. *The Foucault Effect: Studies in Governmentality*; University of Chicago Press: Chicago, IL, USA, 1991.
13. Lee, K.; Miguel, E.; Wolfram, C. *Electrification and Economic Development: A Microeconomic Perspective*; Center for Effective Global Action: Berkeley, CA, USA, 2017.
14. Irwin, B.R.; Hoxha, K.; Grépin, K.A. Conceptualising the effect of access to electricity on health in low and middle-income countries: A systematic review. *Glob. Public Health* **2020**, *15*, 452–473. [CrossRef] [PubMed]
15. Geremew, K.; Gedefaw, M.; Dagnew, Z.; Jara, D. Current level and correlates of traditional cooking energy sources utilization in urban settings in the context of climate change and health, Northwest Ethiopia: A case of Debre Markos Town. *BioMed Res. Int.* **2014**, *2014*, 572473. [CrossRef] [PubMed]
16. World Health Organization. *Indoor Air Pollution: National Burden of Disease Estimate*; World Health Organization: Geneva, Switzerland, 2007. Available online: https://iris.who.int/bitstream/handle/10665/69651/WHO_SDE_PHE_07.01_eng.pdf?sequence=1 (accessed on 30 May 2022).
17. Duflo, E.; Greenstone, M.; Hanna, R. Indoor air pollution, health and economic well-being. *Surv. Perspect. Integr. Environ. Soc.* **2008**, *1*, 6–16. [CrossRef]
18. United Nations Development Programme. *The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa*; United Nations Development Programme: New York, NY, USA, 2009. Available online: https://cleancooking.org/wp-content/uploads/2021/07/32-1.pdf (accessed on 15 September 2022).
19. World Health Organization. *Household Air Pollution and Health*; World Health Organization: Geneva, Switzerland, 2018. Available online: https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health (accessed on 20 May 2022).

20. Hosier, R.H.; Dowd, J. Household fuel choice in Zimbabwe: An empirical test of the energy ladder hypothesis. *Resour. Energy* **1987**, *9*, 347–361. [CrossRef]
21. Leach, G. The energy transitions. *Energy Policy* **1992**, *20*, 116–123. [CrossRef]
22. World Health Organization. *Fuel for Life: Household Energy and Health*; World Health Organization: Geneva, Switzerland, 2006. Available online: https://www.who.int/publications/i/item/9789241563161 (accessed on 31 August 2024).
23. Masera, O.; Saatkamp, B.D.; Kammen, D.M. From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. *World Dev.* **2000**, *28*, 2083–2103. [CrossRef]
24. Kebede, B.; Bekele, A.; Kedir, E. Can the urban poor afford modern energy? The case of Ethiopia. *Energy Policy* **2002**, *30*, 1029–1045. [CrossRef]
25. Nansaior, A.; Patanothai, A.; Rambo, A.T.; Simaraks, S. Climbing the energy ladder or diversifying energy sources? The continuing importance of household use of biomass energy in urbanizing communities in Northeast Thailand. *Biomass Bioenergy* **2011**, *35*, 4180–4188. [CrossRef]
26. Neela, S.; Fanta, S.W. Injera (An ethnic, traditional staple food of Ethiopia): A review on traditional practice to scientific developments. *J. Ethn. Foods* **2020**, *7*, 32. [CrossRef]
27. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approach*; Sage Publications: Thousand Oaks, CA, USA, 2017.
28. Amugune, B.K. Sample size determination and sampling techniques. In *Mental Health Workshop*; Maanzoni: Athi River, Kenya, 2014; Volume 15.
29. Kothari, C.R. *Research Methodology: Methods and Techniques*; New Age International: Mumbai, India, 2004.
30. Mekonnen, A.; Köhlin, G. Determinants of Household Fuel Choice in Major Cities in Ethiopia, Working Papers in Economics 399. University of Gothenburg, Department of Economics. 2009. Available online: https://ideas.repec.org/p/hhs/gunwpe/0399.html (accessed on 31 August 2024).
31. Guta, D.D. Assessment of biomass fuel resource potential and utilization in Ethiopia: Sourcing strategies for renewable energies. *Int. J. Renew. Energy Res.* **2012**, *2*, 131–139.
32. United Nations Environment Program (UNEP). *Global Environment Outlook Yearbook 2006*; United Nations Environment Program: Nairobi, Kenya, 29 August 2007. Available online: https://www.unep.org/resources/year-books (accessed on 29 August 2024).
33. Birol, F. *World Energy Outlook 2007: China and India Insights*; MP3 file 1; Council on Foreign Relations, Inside CFR Events Podcast: New York, NY, USA, 2007; pp. 2–17.
34. Wagner, N.; Rieger, M.; Bedi, A.S.; Vermeulen, J.; Demena, B.A. The impact of off-grid solar home systems in Kenya on energy consumption and expenditures. *Energy Econ.* **2021**, *99*, 105314. [CrossRef]