BERKELEY AIR MONITORING GROUP

protecting health and climate

Effects on gender-related outcomes after the introduction of improved cookstoves in rural Zambia

January 2020

Prepared for C-Quest Capital by Berkeley Air Monitoring Group

Co-funded by the Foundation Future of the Carbon Market.

Stiftung ZUKUNFT DES KOHLENSTOFFMARKTES

Table of Contents

Report Authors

Primary Author
Kirstie Jagoe, Berkeley Air Monitoring Group

Associate Authors
Dana Charron, Berkeley Air Monitoring Group
Sam Delapena, Berkeley Air Monitoring Group
Madeleine Rossanese, Berkeley Air Monitoring Group

Gender Expertise
Joni Seager, Bentley University, MA

Field team

Eco Consultancy and Research
Francis Waweru, Project Manager
Michael Soko, Coordinator
Tamara Soko, Moderator
Zachariah Kumwenda, Team Leader

Interviewing team
Tafwa Mutonga
Renny Dube
Mike Nyau
Simon Nkhoma
Timothy Nyirenda
Philip Mbwewe
Emma Sakala

Financial Support

This report has been co-funded by the Foundation Future of the Carbon Market.

Acknowledgements

The study concept was developed by C-Quest Capital to inform and underpin the development of its Drudgery Reduction methodology in collaboration with VERRA's SDVista. The methodology is to independently quantify and verify time savings for women and girls in adopting efficient cookstoves and switching to readily available sustainable crop residues and small diameter sticks and twigs. Community Markets for Conservation (COMACO) staff provided training and oversight for the installation of the cookstoves and construction of new half-walled kitchens, designed to reduce exposure to smoke by women cooks and other family members.

We would like to thank the participants who welcomed us into their homes and gave us their precious time to tell their stories.

Key Results

The aim of this study was to measure and understand any changes in time use patterns and perceived levels of drudgery after the installation of a TLC-CQC stove in rural Zambia. While the focus was on the main cook, the study design also allowed us to explore effects and changes in all household members.

The data showed evidence of a significant reduction in the self-reported time spent cooking, cleaning the kitchen area, as well as collecting and preparing fuelwood.

Cooks reported to be spending an average of an hour less per day actively cooking, since the installation of the TLC-CQC stove. The participants described multiple pathways through which the TLC-CQC saved varying amounts of time, including the ability to simultaneously cook two dishes, faster cooking of food, and a shift of cooking responsibilities to other household members.

Self-reported time spent collecting fuel showed a reduction in 4 hours per week after installation of the TLC-CQC stove. The main cook was the person who was mostly responsible for the collection of fuel wood in all households, meaning she experienced most of the time burden from these activities, and also consequently, the time savings from the new technology.

Most women reported to spend any saved time resting and sleeping. Very few women reported to use the extra time by engaging in extra income generating activities.

It is well recognised that the perception of 'drudgery' is context specific and can be extremely challenging to define and measure. The exploration and measure of drudgery in this study, was achieved by applying multiple questions that probed about perceived hard work, levels of effort and enjoyment, together with an all-encompassing question that asked about tasks that were ‘very hard work, either physically or mentally, was time consuming, repetitive, AND unavoidable’. This technique aimed to identify cross-cutting recurring themes that would illustrate the ‘drudgerous’ tasks.

The majority of women believed they had ‘drudgerous’ activities in their everyday life. The most frequency reported drudgerous tasks at baseline were working on the land and fuelwood collection. Fuelwood collection was seen as drudgerous by nearly 40% of the participants before the introduction of the TLC-CQC stove, falling to less than 5% afterwards. Although not frequently cited as a drudgerous task at baseline, cooking was not viewed as drudgerous by any participants after installation of the stove, and was, in fact, the activity people reported to enjoy most at both baseline and follow-up.

Even with the significant reduction in time spent collecting fuelwood after installation of the TLC-CQC the women still spent a considerable amount of time engaged in tasks perceived as drudgerous. These drudgerous hours were mostly spent tending the field/gardens, which could possibly have been an effect exacerbated by the planting season coinciding with the follow-up study.

1 Introduction

This study aims to document the initial impacts after the installation of the more efficient wood burning TLC-CQC cookstove on time use patterns in households using a traditional three stone fire. The key research questions are:

- Has the introduction of the TLC-CQC stove changed the amount of time spent by any household members on fuel collection, fuel preparation, cooking, and/or kitchen maintenance? If so, whose time use has changed, why, and in what way?
- If time is saved by the introduction of the TLC-CQC stove, what is the time saved used for?
- Has the quality of the time spent on collecting fuel or cooking related tasks changed? If so, what is the nature of and cause for this change?
- What, if any, impact does the TLC-CQC stove have on tasks that household members have identified as drudgery?
- Secondarily, as the TLC-CQC stove allows for the use of smaller pieces of wood to cook the regular meals, is there evidence of households changing the type and source of the cooking fuel from larger diameter trees logged from forests or agricultural landscapes to smaller diameter fuel, such as twigs, shrubs, or crop residues, sourced from their own farms, agroforestry projects, or woodlots? If so, what is the nature and extent of this?

The results and learning from this study will be used to develop a framework to measure impact of an improved cookstove on the metric “household drudgery hours” as part of the new Sustainable Development Verified Impact Standard (SDVISta).

2 Study population

Households were selected from two rural communities in the Chipata district in eastern Zambia (Figure 1a). Household selection was conducted in collaboration with the CQC-sponsored stove dissemination team, drawing from a pool of pre-qualified households who had already committed to having the TLC-CQC stove installed in their homes (Figure 1b). A screening survey was applied to identify participants who predominately use wood fuel for cooking and collect at least half of their own fuel throughout the year (see Annex A for a copy of the selection survey).

Figure 1: a) Map showing the selected study site in Zambia (left) and b) The TLC-CQC Stove (right)

3 Study Design

The impact that a new cooking technology can have on time use and quality is often complex. Therefore, to better understand, and as much as is possible, to measure this impact, a mixed methods approach was implemented as part of the before and after study design.

An explanatory sequential mixed-method design was used to collect data. Before the installation of the TLC-CQC stove, qualitative data collected during a focus group discussion (FGD) was used to guide and inform the development of a quantitative baseline survey. One FGD with female cooks was conducted at baseline. After the installation of the TLC-CQC stove, a second quantitative survey was conducted, and qualitative data from two FGDs conducted three weeks thereafter was used to explore and interpret the quantitative findings. One FGD was conducted with male participants, and one with female participants. Final versions of the FGD guide and baseline survey are provided in the annex document.

3.1 Sample size and timing

Data was collected from a total of 75 households during May and June 2019. The follow up survey was carried out in October 2019, with the post-intervention FGDs implemented in November 2019. The TLC-CQC stoves were installed in study homes between July and September 2019, giving all households at least 4 weeks to become accustomed to the new technology. The households that were the last to receive their stoves were interviewed at the end of the data collection period, in order to maximize the time between receipt of the stove and the interview.

Although not an inclusion requirement, the participants were encouraged to build a covered ventilated kitchen area before installation of the TLC-CQC stove. All participants made the recommended changes to their cooking area.

3.2 Analysis

3.2.1 Quantitative data

After cleaning the files for incorrect, missing, or inconsistent entries, the research team used Microsoft Excel and SPSS (IBM Version 23) to analyze the quantitative data.

3.2.2 Qualitative data

The audio data from FGDs was transcribed verbatim and translated into English by two people who were present at the group discussions. Thematic analysis was then used (Braun & Clarke, 2006) to synthesize and interpret transcripts. Analysis was carried out using Nvivo 12 qualitative analysis software (QSR International, 2018). The transcripts were initially reviewed by two researchers, and a provisional coding frame was created based on the research questions and themes in the FGD guide. Nvivo codes were added as unanticipated themes were introduced by the participants. Coding frames were continually refined by the analysts to avoid duplication. A final synthesis and interpretation of the data was conducted to explore and understand similarities and differences within the dataset and to ensure that the emerging themes were voiced by multiple participants and not just raised repeatedly by one person.

4 Results

4.1 Demographic characteristics of the study population

A total of 75 households were recruited to the study in May 2019 and were retained throughout the study. The main participant was defined as the person who did 'most of the cooking' for the household. Although male primary cooks were eligible to take part, all participants were women. The majority of participants were married, most had not completed their elementary education, and they had an average age of 38. The average household size was 6, which is slightly higher than the 2015 national average for Zambian rural households, standing at 5.2.[1]

[1] Central Statistical Office. (November 2016). 2015 Living Conditions Monitoring Survey Report (Zambia). Retrieved from Central Statistical Office, Republic of Zambia, World Bank Group. Available at: https://www.zamstats.gov.zm/phocadownload/Living_Conditions/2015%20Living%20Conditions%20Monitoring%20Survey%20Report.pdf

Table 1: Demographic characteristics of the study population, showing percentages and sample sizes, with standard deviations where noted.

Characteristic	% (n)
Married	81% (61)
Completed elementary education or more	36% (27)
Paid work outside the home	15% (11)
Income generating activities from the home	73% (55)
Characteristic	**Mean (SD)**
Average age	38 (15)
Average household size	6 (2)

Although only 15% (n=11) of the participants had paid work outside the home at the time of the baseline, over 73% (n=55) conducted income-generating activities from within the home. The primary source of income in most households (n=70, 93%) was from selling home-grown produce. Figure 2 shows the primary income earners in the homes at baseline. None of the married women were the primary income earner in the home.

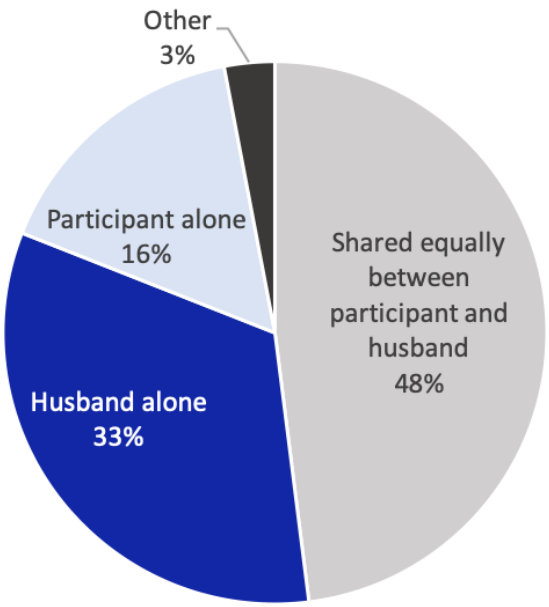


Figure 2: Primary income earners in participating households (n=75)

Sleep deprivation did not seem to be an issue in this community; the average time spent asleep per night at baseline was 9 hours and 31 minutes (SD 56 minutes). Figure 3 shows the methods the participants use to tell the time, notably almost half used the rise and setting of the sun.

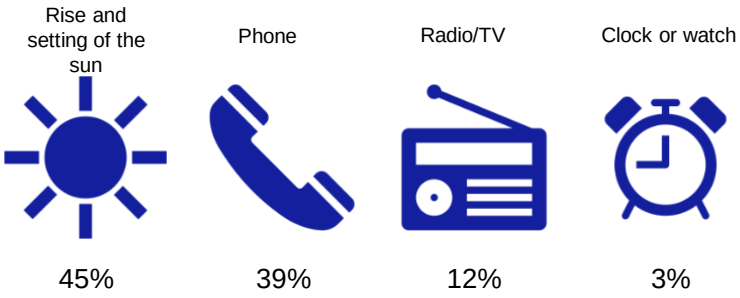


Figure 3: Methods participants use to tell time (n=75)

4.2 Time spent cooking

The participant was asked about household stoves currently used at least once per week at both baseline and follow-up. As per selection criteria, the primary stove in all households at baseline was a traditional wood stove, mostly three stone fires. Secondary stove use was reported in only 10% (n=8) of homes and simultaneous use of the primary and secondary stoves was not a common practice.

At the follow-up, all participants reported their primary stove to be the TLC-CQC stove. 17% (n=13) reported using a secondary cooking device, mostly three-stone fires, on average once per week (with a median range of 1-7 times per week), to brew beer and heating bathing water.

"…. when it comes to bathing water, I like putting on the three-stone because the TLC needs a lot of tending meaning I will be close to the stove instead of doing other things so that is why I put the bathing water on the three stone, which does not need a lot of tending…." Survey

"The only task that I cannot complete on my TLC stove is brewing beer because it is done using a big drum or pot which is usually heavy and can damage my TLC, and I brew beer twice a week and I normally use the three-stone fire." Survey

All participants perceived that they spent either a bit less (67% n=50) or a lot less (33% n=25) time cooking since the installation of the TLC-CQC stove. They also all perceived to spend either a bit less (75% n=56) or a lot less (25% n=19) time cleaning the cooking utensils and kitchen, attributing this to a reduced amount of smoke and soot.

In order to explore cooking time and multitasking habits, the surveyors asked the cooks about the amount of time spent lighting the stove, preparing food, and cooking food for each meal, both before and after TLC-CQC stove installation. Similar questions were asked for preparing snacks, heating water for bathing, and brewing beer. The participants were then asked what proportion of time they leave the stove unattended while cooking, when neither food nor fire

needs attention, again on a per meal basis. Table 2 shows that participants reported the stove to be alight for just over an hour less per day after the installation of the TLC-CQC stove, and this decrease translated into approximately an hour less per day actively cooking next to the stove.

Table 2: Time spent cooking and cleaning before and after installation of TLC-CQC stove.

Description	Average daily amount (SD)			P value-paired t-test
	Baseline	Follow-Up	Difference	
Length of time participants report that food or drink is being cooked or re-heated on a typical day. This also includes the time taken to light the stove and any food preparation that is not conducted while the food is cooking and the time taken to heat water for bathing and brewing beer, if the activity is carried out.	3 hours 43 mins. (SD 1 hour 11 mins)	2 hours 37 mins. (SD 43 mins)	1 hour 6 mins. (SD 1 hour 12 mins)	<0.001
Length of time the cook spends actively cooking next to the stove/fire, actively preparing and tending the food and/or stove/fire.	3 hours 9 mins. (SD 1 hour, 6 mins)	2 hours 8 mins. (SD 41 mins)	1 hour 1 min. (SD 1 hour, 12 mins)	<0.001
Average time spent washing pots and cleaning the kitchen area.	1 hour, 3 mins (SD 36 mins).	23 mins (SD 15 mins).	40 mins (SD 42 mins).	<0.001

The participants consistently reported not being able to leave the TLC-CQC stove unattended as much as they were able to with the traditional stove, due to its requirement for more frequent tending and a higher possibility of burning the food, due to the faster cooking speed. However, this experience was not reflected in the reported cooking times, which showed that at baseline, participants actively cooked for almost 85% of the time the stove was alight but only 81% of the time at follow-up.

"I now leave my stove unattended a bit less, because the TLC cooks very fast, and I fear my food being burnt, so I have to be there and observe the cooking. Also, if the TLC is left unattended, it can go off as the firewood gets finished in the combustion chamber, hence I have to slot in some firewood to keep the fire burning." Survey

"Now in the TLC stove you cannot put a pot and go fetch water, No! when you go to fetch water you find the food is burnt and previously we were just tending to the fire and you go out to fetch water but with the TLC it can happen, this is the change which I have seen.." Female FGD

Note: It is unlikely that the participants knew the term 'combustion chamber' and we anticipate that this was a clarification added during translation.

The participants reported that their cooking time was reduced after the installation of the TLC-CQC stove due to the technical features of the TLC-CQC cookstove, which allowed for simultaneous cooking of two dishes and faster cooking with a higher heat flame protected from the wind.

"The stove is a two-burner stove, so I cook two meals at a time, making me spend less time cooking. Wind does not blow the fire away because the TLC keeps the fire inside it, hence having enough heat for cooking." Survey

"Meals are cooked within a short period of time because now […] you can come from the field and everyone is tired, you just light up two plates […] and it will be cooked at the same time." Female FGD

Another pathway through which the cooks reported reducing the time they spent cooking since the installation of the TLC-CQC stove was by shifting of some of the cooking responsibilities to other family members. At baseline, just under half of the participants (41% n=31) reported that people helped them with some aspect of the cooking: food preparation; tending the fire; and/or cleaning up afterwards. The assistance most often came from the participants daughter (58% n=18) or other female relatives (23% n=7), and they were reported to have helped three days or less per week. On average, the helpers cooked 3.3 hours (SD 1.9) per week alongside the main cook, and 2.3 hours (SD 2.7) per week alone.

Male involvement in the cooking process was rare. Only six participants regularly got help from the men in the household. 21% (n=16) reported that their husbands did cook but only when the woman was sick or travelled away from the village. Overall, there is a strong reoccurring belief that men cannot cook, as they are very busy, but also that they should not cook due to deeply ingrained local customs. The participants describe how it is embarrassing or even disrespectful for men to cook. Ultimately, in a family setting, cooking is the wife's role, one which she accepts without question.

All quotes below are from the baseline survey:

"He says he doesn't know how to cook. He hasn't helped me before, even when I go out for a day, he will wait for me to be back in order to cook for him."

"This is because he is a man and can't cook, since it's the duty of the woman to cook, and he married me so that I can cook for him, and when he doesn't help, I don't take an offence".

"He doesn't accept to help her cook because he believes the man does not cook, and it is embarrassing for a man to cook in villagers' view."

"My husband cannot cook because I am there as a wife to help him. According to traditional custom, a married man is not supposed to cook; it is disrespectful for a man to cook when he is married."

After the installation of the TLC-CQC stove, 53% (n=40) of participants reported that other people within the home had become more involved in cooking. 60% (n=24) of these participants reported that an adult male member of the household had increased their involvement in cooking since receiving the TLC-CQC stove. In the FGD, the men described spending more time cooking when women were away or otherwise engaged. Many of the men who reported cooking also reported that the new enclosed kitchen encouraged them to overcome any stigma. This is discussed further in section 4.3.2.

"My husband now is more involved in cooking. He cooks his own meals when my daughter and I are not around. He is able to cook nshima and relish, and this happened because he is happy to be in an enclosed place while cooking. This is because, in the past, he was scared of being laughed at that he was doing a woman's job." Survey

"My sons are now more involved because the TLC stove is easier to light than the three stone." Survey

"Now [my husband] helps me, when I am bathing my child, and if I leave something on the stove, he finishes cooking" Female FGD

"Previously my sons …were refusing because they were afraid of being laughed at by the girls, and now they do like the TLC stove, and they are involved in cooking more." Female FGD

In general, however, when assistance was given, it continued to come mainly from the participants daughter (45% n=25) or other female relatives (14% n=9). The FGD revealed that an increase in perceived safety, as well as the children's interest in using the stove, increased children's involvement in cooking. These 'helpers' usually assisted three days or less per week. However, the average time they cooked alongside the main cook decreased to 1.9 hours (SD

1.0) and the time they spent cooking on their own increased slightly to 2.9 hours (SD 2.2) per week.

4.3 Time spent collecting fuel

Table 3 below shows the changes in fuelwood collecting patterns after installation of the TLC-CQC stove. There was a significant shift towards collecting fuelwood with a diameter less than 5 cm from within the village boundaries, compared to baseline when the majority of households reported to collect fuelwood measuring between 5-10 cm in diameter from outside the village boundaries.

Table 3: Fuelwood collection patterns before and after installation of the TLC-CQC stove.

	Baseline (n=74)	Follow-up (n=74)
% collecting all wood **within the village boundary**	19%	88%
% collecting only **dead wood from the ground**	78%	86%
% collecting wood **larger than 10cm diameter**	11%	1%
% collecting wood **with a diameter between 5-10 cm**	73%	13%
% collecting wood **with a diameter less than 5 cm**	15%	76%
% collecting **leaves, twigs, maize cobs**	1%	9%

No households purchased any fuel for use on their stove at baseline. At follow-up, only two homes purchased a portion of their fuelwood. As per selection criteria, all homes used wood for cooking, with occasional supplementation with maize cobs at both baseline and follow up.

In 96% of the homes (n=72) at baseline, the female cook was the only person who regularly collected the fuelwood. Male contribution to the task of fuel collection occurred in only one home. At follow-up, 40% (n=30) of participants reported that other household members had become responsible for fuelwood collection since the installation of the TLC-CQC stove. In all but one case, both adult and younger children in the household had become more involved in collecting fuel.

"Because the size of the sticks is small and easy to carry, my son is able to collect them when he is coming from the field." Survey

*"[*My daughter*] is now involved in firewood collection because the firewood we are using now is very small in size, it does not need her to use a lot of energy to carry and also do a lot of walking in search of the woodfuel."* Survey

The FGD revealed that the husbands were now more involved in fuel collection but were never reported to be the main procurer for the household.

"My husband now can even pick some sticks on the road as he is coming home so that we can use it for cooking" Female FGD

At baseline, the majority of women (96%, n=72) walked to the source of wood collection, spending an average of 284 minutes (SD 197) per week on this task, including travel time, which accounted for just over 40% of the dedicated collection time (120 mins, SD 85 mins). 19% (n=10) combined fuel collection with trips for other tasks.

99% (n=74) of participants perceived that they spent less time collecting wood after the installation of the TLC-CQC stove (a lot less 62% n=45; a bit less 37% n=27). The reported time spent collecting wood was 59 minutes (SD 61) per week (p=<0.001 paired t-test) (see Figure 4). There was no significant difference between the reported time spent collecting fuelwood by women who reported receiving help and those who collected alone.

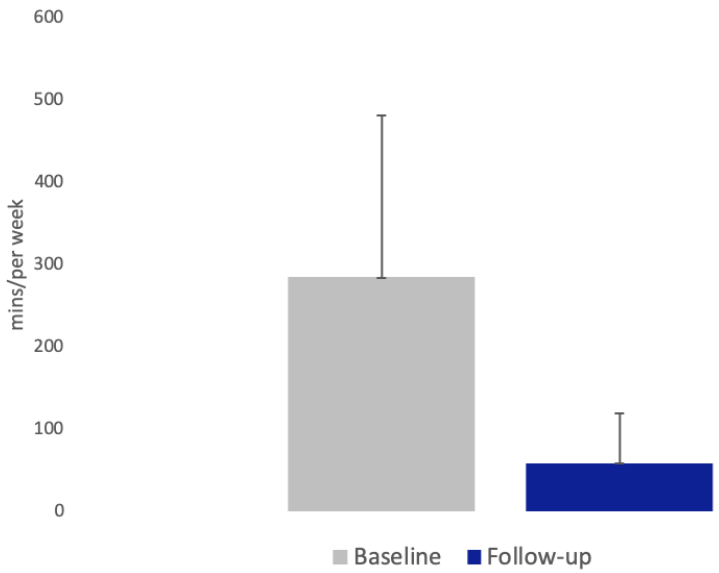


Figure 4: Reported time spent collecting fuelwood before and after installation of the TLC-CQC stove.

The proportion of the collection time spent traveling to the source of the fuelwood also reduced to just under 30% (17 mins SD 8 mins). Facilitated by the requirement for smaller size fuel, just under half (49% n=37) of all participants now combine the collection of fuelwood fuel with carrying out other tasks, such as collecting water and working in the field.

"Since the wood is of small size, I can carry some in my hands when coming from collecting water. I carry a bucket of water on my head and sticks wood in my hands." Survey

"I now collect wood when I come from the field because the firewood needed by the TLC is small and easy to carry." Survey

"When you are taking a walk, you can pick some sticks as if you are just playing with them but instead you are going to cook at home with them." Male FGD

"Now you just go around or behind the house, you pick sticks and use them for cooking and within a short time everything is ready unlike before." Female FGD

4.4 Time spent preparing fuelwood

The percentage of participants who reported carrying out some level of fuel preparation after bringing the wood back to their homes, such as chopping or stacking, increased slightly from 87% (n=68) at baseline to 97% (n=73) after the installation of the TLC-CQC stove. However, the overall average time spent preparing wood fuel fell from 55 minutes per week (SD 43) to 40 minutes per week (SD 60).

At baseline, it was reported that fuel preparation was overwhelmingly carried out by the women alone. After installation of the TLC-CQC stove, 40% (n=29) of households carrying out some preparation of wood fuel reported that someone other than the participant had taken over the chore. One quarter of the new fuel preparers were male household members.

"Because the firewood, which is used in this cook stove, is very easy to stack even at the back of the TLC stove it can be stacked so that they don't get soaked by the rains" Male FGD

4.5 How saved time was used

At baseline, the participants were asked, "If you had more time available, how would you spend it"? The most frequent response was sleeping/resting (72% n=54), followed by going to the

church/temple (n=20, 27%). Only 9% (n=7) expressed a desire to take up more income generating activities if they had extra time. Once saved time became a reality for the participants, they were asked what they had done with the extra time available. In line with their aspirations, the most frequent use of the saved time was to rest and sleep. Attending social gatherings was the next most common use of saved time (see figure 5 below).

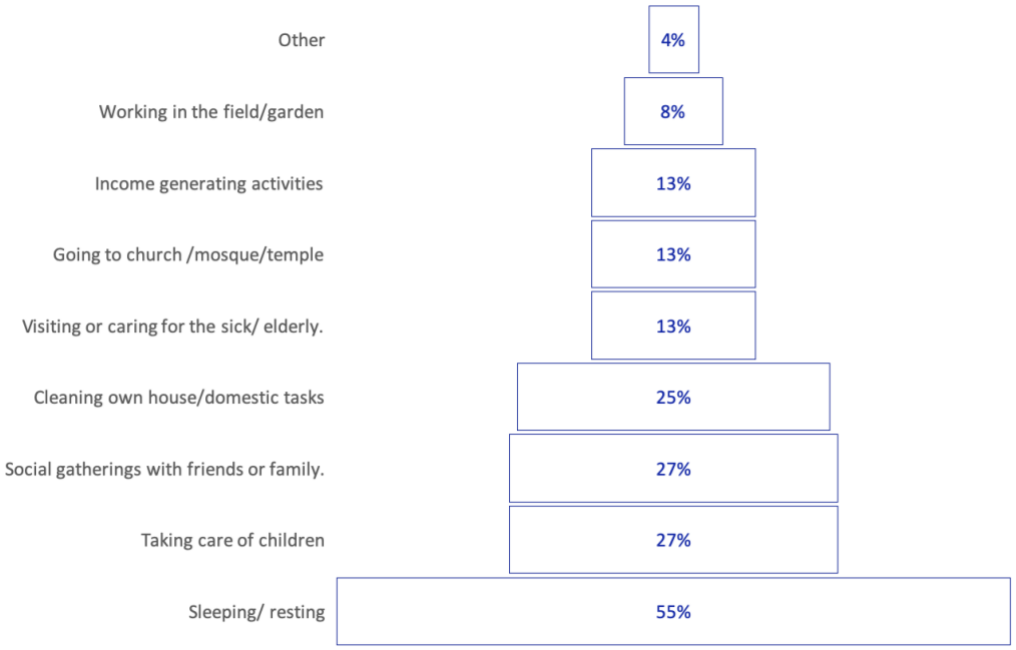


Figure 5: How participants reported to spend any time saved since installation of the TLC-CQC stove

The use of any free time made available by the installation of the TLC-CQC stove was discussed in both the male and female FGDs. The men recognize that the stove allowed the women to have more free time and frequently use it to rest, which most of them perceived to be a positive development for the household. The women reported feeling rested and enjoying the time to socialise, as well as expressing satisfaction with having cleaner homes and better fed children. They reported that having more time to complete their daily tasks reduced their stress.

"The change is there, previously we were getting big logs of firewood but now we are using smaller ones, and within a short time, food is cooked, and now the women have rest." Male FGD

"Now our women are finding rest because they no longer walk long distances to the hills to go and fetch big, heavy logs of firewood […] now with the coming of the TLC stove, firewood can be carried even in our hands, I have seen women are resting now." Male FGD

"The time which we have now, it's a privilege to go and visit the neighbors and have a chat and share ideas with that time." Female FGD

4.6 Perceptions of drudgery and time quality

Participants reported feeling a high level of autonomy on how they could spend their time at baseline; 95% (n=71) agreed or strongly agreed with the statement, 'I have the choice to spend my time in any way I wish.' This sentiment was unchanged at follow-up.

To provide a broad understanding of the perceived time burden in their lives, the participants were asked to give their perception of how busy they were on a scale of 1-5, both at baseline and then again at follow-up. The left end of the scale presented the green smiling face with the number "1" and was captioned, "very relaxed with plenty of free time", while 5 was described as, "I'm extremely busy and never have enough free time". The results show that at baseline, around half of the participants (50% n= 37) thought their lives were very or extremely busy, with only two people reporting to be 'relaxed with plenty of time' (Figure 6). There was a definitive shift in the responses given during the follow up survey, with only 15% (n=11) thinking their lives were very busy, with no one reporting that it was extremely busy.

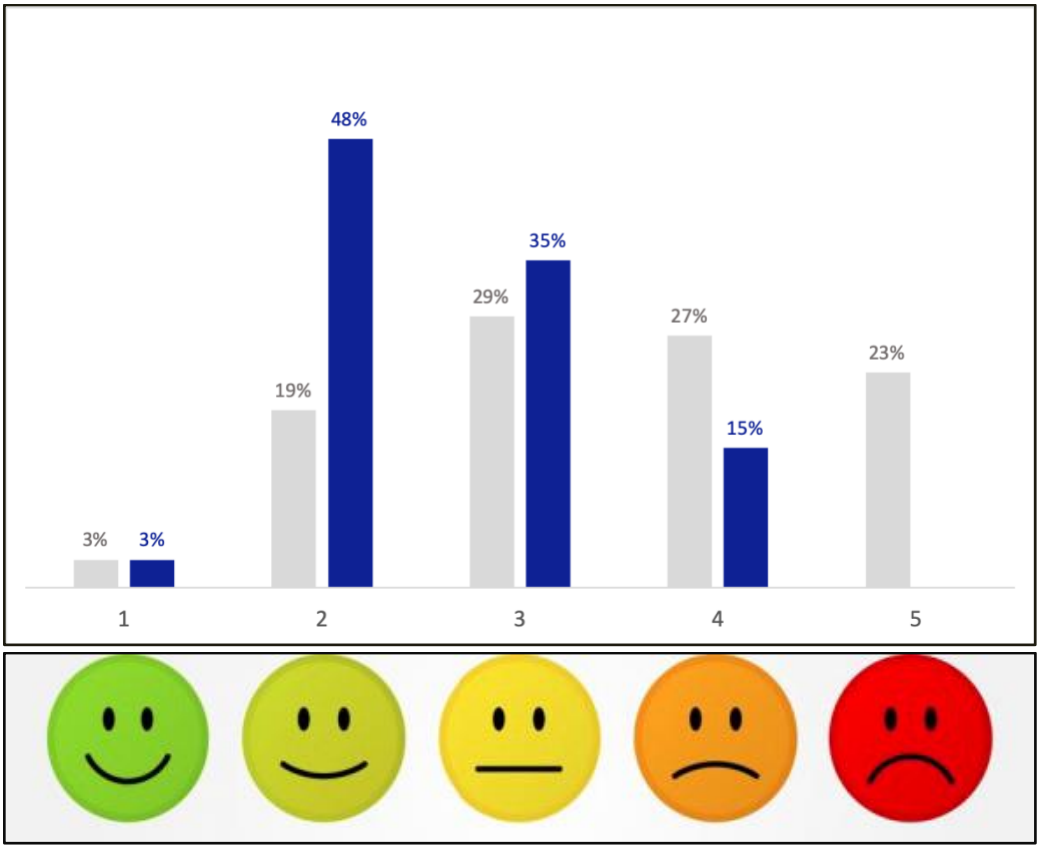


Figure 6: Participants responses to five options presented on a scale regarding how busy they felt their time was, where 1 represents, "very relaxed with plenty of free time", and 5 represents, "I'm extremely busy and never have enough free time". Gray shaded is baseline data, blue is follow-up.

A graphic depicting tasks that require an increasing level of effort, from light effort to extreme exertion (see Figure 7), was used to characterize the participants' perceptions of the amount of effort they direct towards certain tasks. They were asked to point to the picture that most closely represented the amount of effort spent on each of three tasks: cooking, collecting fuelwood, and processing collected wood into fuel before and after receiving the TLC-CQC stove. The average (median) baseline level of perceived drudgery for cooking was 3 (range 1-5), fuelwood collection was 4 (range 2-5), and fuel preparation was also 4 (range 1-5).

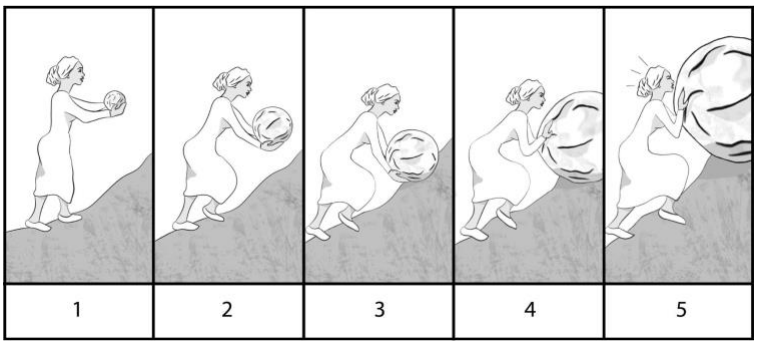
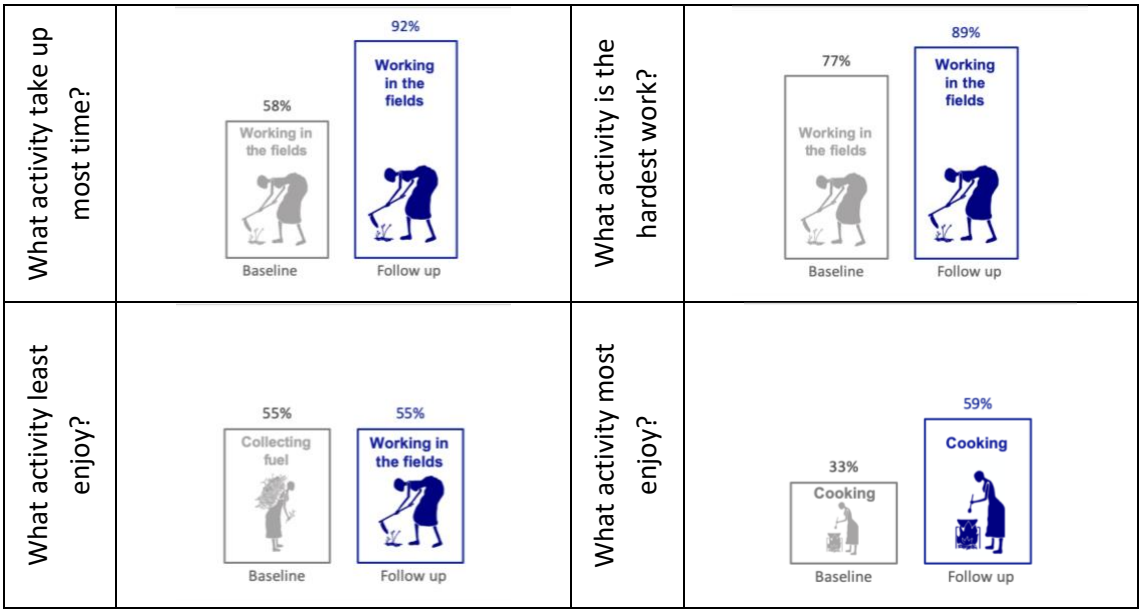


Figure 7: Visual aid shown to study participants when asked to report their level of perceived drudgery for various tasks. The leftmost graphic, level 1, indicates the lowest perceived drudgery, up to the rightmost graphic, level 5, indicating the highest level of perceived drudgery associated with a given task.

A change of 2 or more in the perceived levels of effort was deemed to reflect a real change between the baseline case and the post-intervention status. Based on this criterion,

- 37% (n=28) experienced a decrease in the level of effort associated with cooking after receiving the TLC-CQC stove;
- 56% (n=42) experienced reduced effort associated with fuelwood collection;
- 57% (n=43) had a decrease in the level of effort associated with fuel preparation.

To explore for further changes in perceptions of drudgery and time quality related to their household tasks, participants were asked a series of questions about which tasks they enjoyed, which took up most of their time, and which they found to be the hardest work both before and after receiving the TLC-CQC stove. The top results at both baseline and follow-up are presented in Figure 8 below.



Note: Where more than one answer was allowed, the participants were asked to order the responses in importance to them. In these cases, the first response was taken.

Figure 8: Participants' responses when asked which tasks take up most of their time, which tasks they find the hardest work, which tasks they enjoy the least, and which they enjoy the most.

Working in the fields was the activity that took up most of the women's time and was the hardest work at both baseline and follow-up. By the follow-up survey, fuelwood collecting was no longer the top choice for "least enjoyable'; working in the fields replaced this category.

Quotes below are from the survey:

"I don't enjoy working in the fields because making ridges with a hoe is hard work and waking up early every day to do farming is not enjoyable. I don't enjoy working in the garden because watering is done every day and where we get water from is far and it makes me too tired when I finish watering."

"I find working in the field the hardest because of the distance between the source of the water and where the garden is. One uses a lot of energy to carry the water cans. One also spends a lot of time weeding and digging, since I don't use animals to do this task."

Cooking was reported to be the most enjoyed activity at both data collection points, but by a significantly higher proportion at follow-up. The women who reported to enjoy cooking the most seemed to derive this enjoyment from knowing that they were providing nourishment to themselves and their families, giving them the energy required to complete their daily tasks.

"I enjoy cooking because my family needs to eat a fully cooked meal and now, I do spend a lot less time." Survey

"With the coming of the TLC, I enjoy cooking because I am now able to cook two meals at the same time because the TLC is two burner stove, so even if am very hungry, I am able to cook very fast, eat, and have the energy to do other tasks such as sweeping." Survey

To explore which tasks the women might consider to be drudgerous, the participants were asked if they had "any regular household-related activities that are very hard work, either physically or mentally, time consuming, repetitive, AND unavoidable?" At baseline, 91% (n=68) reported they had activities with these characteristics, rising slightly to 99% (n=74) at follow-up. Figure 9 shows which tasks these were at both time points. It can be seen that at baseline, nearly 40% of participants viewed fuel collection to be one of these drugerous activities, but by follow-up, the percentage of participants who viewed fuel procurement as a drudgerous task had fallen considerably to 3% (n=2). Cooking was no longer seen as a drudgerous task by any of the women after the installation of the TLC-CQC stove. The total reported amount of time spent engaged in drugerous tasks increased from 17 (SD 9.4) at baseline to 31 (SD 12.7) hours (p=<0.001), possibly due to the timing of the follow-up survey during the planting season.

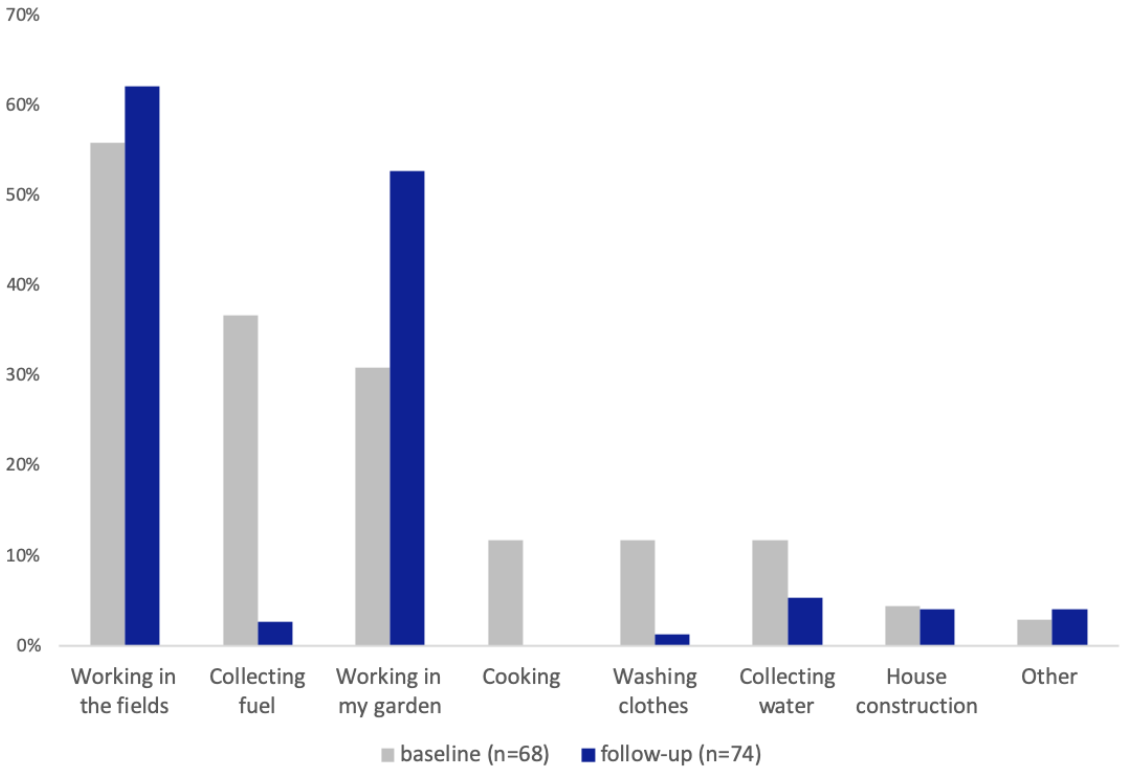


Figure 9: Participants' responses when asked which of their tasks could be described as very hard work, either physically or mentally, time consuming, repetitive, AND unavoidable. More than one response allowed.

4.3.2 Changes in perceived quality of the time spent cooking

At baseline, the participants most frequently reported to cook either in a building separate from the main house (45%, n=34) or in an uncovered outdoor area, such as a courtyard (23%, n=17). Nearly half of the participants usually cooked alone (45%, n=34), and 60% (n=45) described their cooking area as unpleasant. Perceptions of cooking space atmosphere were very much related to location, with those who cooked in the courtyard area unanimously describing the space as unpleasant.

"It's unpleasant because I cook from outside which is windy, dusty, and goats are everywhere. These usually tamper with the food. The sun also burns me as I am cooking." Survey- participant with a courtyard cooking area.

"It is pleasant because it is well covered and is well ventilated." Survey- participant with an indoor kitchen

After installation of the stove and construction of the new kitchen area, the proportion of participants who reported cooking alone had dropped to 35% (n= 26), and 99% (n=74) described their kitchen as a pleasant place to be when cooking. The women described how other adults now choose to join them in their cooking space because they experience less smoke in the kitchen area. They also described how the reduced smoke makes them feel more comfortable bringing their children into the kitchen.

"My husband now sits in the kitchen especially in the evening as I am cooking, we chat as well, and this was not happening before. Now, it is happening because there is less smoke in the kitchen, and it is well ventilated." Survey

"Before the installation of the TLC, I was unable to bring my baby near the three stone because there was a lot of smoke…….now I can do the cooking while carrying my baby at the back because in the newly built kitchen there is good ventilation and the TLC produces less amount of smoke." Survey

Discussions during the FGD revealed that the construction of the kitchen area yielded several positive impacts including:

- Increased ventilation and airflow in the cooking area, creating a less smoky environment;
- Shelter from the weather (sun, wind, and rain) allowing for cooking in all conditions;
- A cleaner, more comfortable designated cooking space where the participant, her family, and friends were happier to spend their time; and
- An enclosed private area allowing men to cook without being seen.

"[After building the kitchen] I felt good; now there is a great difference, because when we were cooking from outside, dust was getting into the food being prepared." Male FGD

"[After building the kitchen] I felt good because previously my wife was cooking outside in the sun." Male FGD

"Since the coming of the TLC stove, even me as a man, I can cook because cooking now is done in a closed place." Male FGD

"The change is good because now there is fresh air, which comes in through the spaces between the roof and the walls of the kitchen. There is also no smoke, and now I don't cough." Female FGD

"There is a great change because now my husband cooks. Previously he was not able because he was afraid of being laughed at by people in the community while cooking in the open place, but now he cooks when I am not around in the kitchen." Female FGD

4.3.2 Changes in perceived quality of the time spent collecting and preparing wood fuel

At baseline, the participants were asked if they liked anything about collecting fuelwood and were requested to explain further why they did or did not like it. The majority, 87% (n=65), stated that they did not like anything about collecting fuelwood. There was an overwhelming feeling that the task is very tiresome and time consuming, as well as being detrimental to health and exposing them to various safety hazards.

"I don't enjoy collecting wood fuel because of the distance between going to the hills and back home. It's also difficult because I carry the wood fuel on my head, which makes me to have headaches." Survey

"It is too involving, meaning it takes much of my time, and it is tiresome, so I do not like anything about it." Survey

The minority who did report to like some aspects of fuelwood collection pointed to the wild fruit they could pick while completing the task, as well as the sense of satisfaction associated with acquiring a household necessity.

*"I love collecting [*fuelwood*] because it's my main fuel and helps me in cooking."* Survey

"… at this time of the year, there is availability of wild fruits …which we eat as we collect fuel." Survey

Nearly all participants (91% n=68) reported they perceived risks and dangers associated with collecting fuelwood. The most frequently described risks were snakes, bees, and wild dogs. A few women described the risk of slipping and falling, particularly in the wet season. Physical attack seemed to be a rare occurrence. The women use several mechanisms to avoid these actual and perceived risks, including collecting fuel in groups, changing the location of their procurement, and walking more slowly.

"Snakes and wild animals pose the most dangers associated with firewood collection. This gets worse in the rainy season when the vegetation thrives; we avoid this by collecting firewood in areas that do not have thick vegetation." Survey

"Risks are there: falling when climbing the hill; during the rainy season snakes also hide in thick bushes making it dangerous to go through bushes during this time." Survey

---

There was a similarly prevalent perception of long-term health impacts associated with fuel collection (91% n=68). The word cloud in Figure 10 shows the responses given when participants were asked about long-term health risks associated with fuelwood collection. All words in the open response are included and the size of each word indicates its relative frequency.

Figure 10: Long term health risks associated with fuel wood collection.

The reduction of risk and adverse health impacts derived from travelling shorter distances, carrying smaller loads, and chopping less wood fuel was a reoccurring theme raised during the FGD.

"The change is there because now our women don't complain "I have broken my leg or have hurt myself when collecting fuel"... firewood is just within the village boundaries and anything which they can pick in the village is able to cook meals. But previously when they go to the hills, if not careful, they were hurting themselves, and it was taking long for them to heal." Male FGD

"Now the firewood is prolonged and very easy to cut and stack, and I don't use an axe to prepare the firewood. Labor has lessened, and I don't have body pains caused when chopping the firewood." Female FGD

In order to explore the possibility that firewood collection, though arduous, was also an important socializing and networking opportunity, the participants were asked if there were any negative aspects related to spending less time collecting fuelwood; 96% (n=72) reported that there were no negative aspects associated with spending less time collecting wood fuel.

5 Discussion

The aim of this study was to measure and understand any changes in time use patterns and perceived levels of drudgery after the installation of a TLC-CQC stove in rural Zambia. While the focus was on the main cook, the study design also allowed us to explore effects and changes in all household members.

Time Use Patterns

The data showed evidence of a significant reduction in the self-reported time spent cooking and cleaning the kitchen area, as well as collecting and preparing fuelwood. Cooks reported spending an average of an hour less per day actively cooking since the installation of the TLC-CQC stove. The participants described multiple pathways through which the TLC-CQC saved varying amounts of time, including the ability to simultaneously cook two dishes, faster cooking of food, and a shift of cooking responsibilities to other household members. This shift was catalysed by the perceived enhanced ease of use and safety of the TLC stove. The kitchen that was built alongside the TLC-CQC stove installation in all homes also provided privacy that allowed men to take up more cooking responsibilities without fear of scrutiny from neighbours, who might perceive cooking to be demeaning for men.

Post intervention, the quantitative data showed a significant reduction in the time spent collecting fuel (4 hours less per week). The main cook was the person who was mostly responsible for the collection of fuel wood in all households, meaning she experienced most of the time burden from these activities, and also consequently, the time savings from the new technology. Further exploration revealed that this reduction was driven by the fact that the TLC-CQC stove is able to produce the necessary cooking energy from smaller size fuelwood, which can be found more locally, removing the need to walk long distances. The lighter fuel loads and ability to collect fuel nearer to home meant that fuel collection was now able to be carried out during other activities, such as collecting water or travelling back from working in the fields. Also, these tasks were now able to be performed by unsupervised younger household members. There is evidence that fuelwood collection can be a source of group solidarity and friendship for women, who may benefit from having the time with other women and away from the restrictions of home (Khandelwal et al., 2017).[2] However, very few women in this study group perceived any aspects of fuelwood collection positively, and there was no evidence to suggest

[2] Khandelwal, Meena, et al. 2017. "Why have improved cook-stove initiatives in India failed?" World Development 92: 13-27. https://www.sciencedirect.com/science/article/abs/pii/S0305750X15309566

that the significant reduction in time spent collecting fuel had any negative effects on the women.

When taking into account the self-reported reductions in time spent cooking and cleaning the kitchen area, as well as collecting and preparing fuelwood, the primary cook in the household saved on average 2 hours and fifteen minutes per day. Most women reported spending this time resting and sleeping. There are some income generating activities available to the women in these communities, mostly associated with growing and selling produce, however very few women reported using the extra time to engage in extra income generating activities.

These reductions in self-reported time spent cooking and collection fuelwood are consistent with other similar studies carried out in sub-Saharan Africa. Jagoe (2020)[3] found an average reduction in self-reported time spent cooking of an hour less per day and just over 4 hours reduction in time spent collecting fuelwood, 4 weeks after study participants received one or two wood-burning rocket stoves in rural Kenya. Similar self-reported findings were also shown by Cundale (2017)[4] in Malawi.

Drudgery

The study also aimed to explore the concept of drudgery in the study communities to better understand if the women perceived any of their daily tasks to be drudgerous and if so, what impacts the TLC-CQC stove had on these.

It is well recognised that the perception of 'drudgery' is context specific and can be extremely challenging to define and measure. Extrinsic framing of the concept with pre-conceived ideas can lead to unrepresentative, misleading data. In order to understand if the study participants perceived any of their activities to be ‘drudgerous’, we set out to explore and measure ‘drudgery’ using intrinsic and qualitative approaches. Data from FGD showed that the local language did not have one regularly used word or phrase that could fully capture the concept. The exploration and measure of drudgery in this study, therefore, was achieved by applying multiple questions that probed about perceived hard work, levels of effort and enjoyment, together with an all-encompassing question that asked about tasks that were ‘very hard work, either physically or mentally, was time consuming, repetitive, AND unavoidable’. This technique aimed to identify cross-cutting recurring themes that would illustrate the ‘drudgerous’ tasks.

[3] Jagoe K., Rossanese M., Charron D., Rouse J., Waweru F., Waruguru M., Delapena S., Piedrahita R., Livingston K., Ipe J. Sharing the burden: Shifts in family time use, agency and gender dynamics after introduction of new cookstoves in rural Kenya. Energy Research & Social Science 64 (2020) 101413

[4] K. Cundale, R. Thomas, J.K. Malava, D. Havens, K. Mortimer, L. Conteh, A health intervention or a kitchen appliance? Household costs and benefits of a cleaner burning biomass-fuelled cookstove in Malawi, Soc. Sci. Med. 183 (2017) 1–10 https://doi.org/10.1016/j.socscimed.2017.04.017.

Using this approach, it emerged that the majority of women believed they had activities in their everyday life that they would describe as unenjoyable, very hard work (either physically or mentally), time consuming, repetitive, AND unavoidable. The negatively perceived activities that were repeatedly reported at baseline were working on the land and fuelwood collection. Fuelwood collection was seen as drudgerous by nearly 40% of the participants before the introduction of the TLC-CQC stove, falling to less than 5% afterwards. Although not frequently cited as a drudgeous task at baseline, cooking was not viewed as drudgerous by any participants after installation of the stove, and was, in fact, the activity people reported to enjoy most at both baseline and follow-up, citing a satisfaction gained from knowing their families were nourished and healthy.

Even with the significant reduction in time spent collecting fuelwood, however, the women still spent a considerable amount of time engaged in tasks perceived as drudgerous. In many cases, the reported time spent engaged in these types of tasks had increased during the follow-up survey period. These drudgerous hours were mostly spent tending the field/gardens, which could possibly have been an effect exacerbated by the planting season coinciding with the follow-up study. The post-intervention FGD suggested that this amount of time spent engaged on the land was normal for the time of year, and prior to the installation of the TLC-CQC, the women would have had to complete the necessary farming tasks as well as the fuelwood collection, compounding the drudgery. Without a control group, it is difficult to measure and understand the nature of this change with a high level of confidence. However, these findings suggest that to make a significant impact on women's drudgery, all significant sources of drudgery in the participants' daily life need to be identified, measured and, if possible, addressed.

Gender roles

Although the data suggests that men became more involved in cooking and fuelwood collection after the installation of the TLC-CQC stove, overall the gender roles changed very little, which is not unexpected given that entrenched customs and beliefs are unlikely to shift significantly within a short time frame. It appears from this data that men will engage more in fuelwood collection when it becomes an easier task that can be combined with other work, and/or they will carry out some cooking, as long as they cannot be seen. This finding suggests that if the task is easy and convenient, they will do it on an *ad hoc* basis, without permanently taking on the full responsibility and/or burden for its completion. Other studies have also shown that men's involvement in roles traditionally seen as 'women's' work increases when it is made less physically tiring through transportation or other technical interventions.[5]

Study Strengths, Limitations and Recommendations for Future Research

A strength of this study was the mixed methods approach, which allowed the information from the quantitative survey data to be corroborated and augmented by the qualitative data. Further it is a strength that this research, commissioned by a private development company, was

[5] UNEP 2016. Global Gender and Environment Outlook. UN Environment, Nairobi, Kenya.

conducted at all, showcasing the importance of understanding the intended and unintended effects and impacts of energy interventions on the daily lives of recipient households.

One limitation of this study is the lack of a control group. The before-after design did provide a robust basis for attributing changes in time use and quality to the intervention, however a control group would have allowed for the control and understanding of the influences of confounding factors, such as seasonal changes. A further design limitation was the short study timeline, which did not allow for the measurement of the effects of the TLC-CQC stove over the course of all seasons, or as the technology and kitchen configuration changes aged. A follow-up assessment at 12 or 24 months would provide valuable evidence of the staying power of gender co-benefits of efficient cookstove installations.

Another limitation of this study is the likely influence of social desirability bias on these results. Although it is impossible to know of the exact nature and extent of its effects, the likelihood of social desirability is higher in a setting where a stove (or any intervention) is given freely with the possibility of more benefits to come. In this case, the stove installers were well known to the participants and regularly present in the community.

Sensor-based usage measurements are the gold-standard approach for ground truthing self-reported impacts of more efficient cookstoves and are strongly recommended for this type of study. Prior studies have found that the use of new cooking technologies is often overreported by the recipients relative to the objective sensor data.[6] If usage is overreported, then it is likely that participants may also be overstating positive impacts of the intervention, and having sensor-based data can allow researchers to probe more deeply into these inconsistencies. Sensor-based usage data does have limitations, of course, as it cannot confirm that active cooking is happening while the stove is lit, identify who is doing the cooking, or inform on what the type of cooking is being conducted (water boiling, reheating food, or making full meals etc.).

Collecting reliable and representative time use data in communities that use the sun to tell time and may conceptualize time differently to more industrialized cultures presents several challenges.[7] Accurate recall and expression of tasks in terms of minutes and hours is sometimes not possible. We recognised and considered these issues when designing data collection tools that explored participants' perceptions as well as quantification of time. In a study such as this, it is therefore important to consider not just the numerical results, but also to give equal weight

6 Thomas, E. A., Barstow, C. K., Abadie Rosa, G., Majorin, F., & Clasen, T. F. (2013). Use of remotely reporting electronic sensors for assessing use of water filters and cookstoves in Rwanda. *Environmental Science & Technology*. https://doi.org/10.1021/es403412x

7 Seymour G, Malapit HJ, Quisumbing AR. 2017. Measuring time use in development settings. Policy Research Working Paper No. 8147. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/443201500384614625/Measuring-time-use-in-development-settings

the more qualitative findings. Further work is still needed to find more accurate, cost effective and reproducible methods to accurately measure complex time use patterns in communities like these.