



# Adoption of innovative energy efficiency pots to enhance sustained use of clean cooking with gas in resource-poor households in Kenya: Perceptions from participants of a randomized controlled trial

Willah Nabukwangwa<sup>a</sup>, Stephen Clayton<sup>b</sup>, James Mwitari<sup>a</sup>, Arthur Gohole<sup>a</sup>, Elizabeth Muchiri<sup>c</sup>, Dan Pope<sup>b</sup>, Elisa Puzzolo<sup>b,c,\*</sup>

<sup>a</sup> School of Public Health, Amref International University, Nairobi, Kenya

<sup>b</sup> Department of Public Health, Policy and Systems, University of Liverpool, Liverpool, United Kingdom

<sup>c</sup> The Global LPG Partnership (GLPGP), 654 Madison Avenue, New York, United States

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## ABSTRACT

**Background:** Scaling up clean cooking is a priority to address the substantial health burden from exposure to household air pollution resulting from burning of polluting fuels. The costs of cooking equipment and fuel, as well as cooking behaviors, may present barriers to adoption and sustained use of clean cooking. This paper reports novel qualitative findings from a Randomized Controlled Trial (RCT) evaluating the effects of innovative energy-efficient cooking pots on sustained use of LPG for the first time in a low and middle-income setting.

**Method:** Semi-structured interviews (SSIs) were conducted with 22 of 200 cooks (LPG primary users) from an informal settlement in Nairobi, participating in the RCT. Data were analysed through thematic analysis.

**Results:** Reported benefits of the enhanced pots (compared to standard pots), included perceived fuel and time savings and prestige. Findings also indicate participants' willingness to pay for the pots and ways to support their scale.

**Conclusion:** This study highlights the potential for energy-efficient pots in facilitating sustained/exclusive clean cooking with LPG and their ability to meet all cooking needs. This is relevant to informing commercial scalability of energy-efficient cookware in the local Kenyan market.

## Introduction

Over 2.8 billion people worldwide (~900 million in Sub-Saharan Africa (SSA)) are dependent on polluting solid fuels and kerosene for cooking (IEA, 2020). The resulting Household Air Pollution (HAP) is responsible for over 2 million premature deaths globally each year, including 23,000 Kenyans (HEI, 2020) with the highest burden falling on women and children under five. Given this substantial public health burden, the World Health Organization (WHO) (WHO, 2014) recommends rapid transition to cleaner cooking fuels and technologies, and this has also become a policy priority for many countries whose populations rely on polluting fuels (Bruce et al., 2018a; Puzzolo, Cloke, Parikh, Evans, & Pope, 2020; Quinn et al., 2018 Oct; Thoday, Benjamin, Gan, & Puzzolo, 2018 Oct; Van, Richenda, Alex, & Besnik, 2017). Nonetheless, transitioning to cleaner cooking fuels remains challenging, and despite the increased global awareness of the detrimental effects of

polluting fuel usage on health, gender and the environment, the number of polluting fuel users is expected to reach 3.5 billion by 2025 (Stoner et al., 2021).

Efforts to reduce the significant health impacts from HAP, have focused on improved cooking technologies, in particular increasing access to more efficient cookstoves and cleaner cooking fuels, such as liquefied petroleum gas (LPG) (Pillarsetti et al., 2019 Jun; Puzzolo et al., 2019; Puzzolo, Daniel, Debbi, Bruce, & Rehfuess, 2016; Quinn et al., 2021 Dec 1; Sambandam et al., 2015 Mar 1; Thoday et al., 2018 Oct; Williams et al., 2020 Dec). The 2021 World Energy Outlook report projects LPG as the most cost-efficient solution in promoting access to clean cooking, potentially displacing solid fuels in around 40 % of the projected 2.8 billion solid fuel using households by 2030 (IEA, 2021). The Kenyan government set a target of 35 % of households adopting LPG use by 2030 (SE4All, 2016; SE4All Africa Hub. Kenya. <https://www.se4all-africa.org/seforall-in-africa/country-data/kenya/> [Accessed 25

\* Corresponding author at: Department of Public Health, Policy and Systems, University of Liverpool, Liverpool, United Kingdom.

E-mail address: [puzzoloel@liverpool.ac.uk](mailto:puzzoloel@liverpool.ac.uk) (E. Puzzolo).

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May, 2022), which has already seen usage grow from 3.5 % in 2005 (KIHBS, 2013) to 23.9 % in 2019 (KIHBS, 2020; SE4All, 2016). This expansion has been driven by expanding consumer demand, increased supplier competition, and policies such as zero-VAT rating of LPG between 2005 and 2013 and 2016–2021 to facilitate uptake by low-income households. Evidence indicates that the reintroduction of 16 % VAT in July 2021 (Business Daily Press, 2021) has led some poorer households to switch back to more polluting sources of energy or reducing their overall use of LPG (Business Daily Press, 2021; CCA, 2021; Shupler et al., 2022).

The Kenyan LPG market has multiple companies supplying LPG in standardized 3 kg, 6 kg and 13 kg cylinders (GLPGP, n.d.). The most popular cooking set-up is with a 6 kg cylinder using a camping-valve and metal ring on top of the cylinder (popularly referred to as “meko” stove) (GLPGP, n.d.). Affluent households often use 13 kg cylinders connected to double or multi-burner stoves allowing for more exclusive cooking on LPG (Shupler et al., 2021). Potential barriers to LPG adoption in Kenya and more widely, include equipment costs, high recurrent fuel costs, inconsistent supply, safety concerns and difficulties accessing cylinder refills (Puzzolo et al., 2016; Shupler et al., 2021; Shupler et al., 2022). A further potential barrier is the perception that foods that have a longer cooking time (e.g., beans) are more wasteful of expensive LPG, which leads to the use of more polluting traditional stoves and fuels that are perceived as being cheaper and/or less wasteful for slow-cooking. This also leads to fuel/stove ‘stacking’ or multiple stove-and-fuel cooking combinations within the same household (GLPGP, n.d.; CCA, 2021; KIHBS, 2020; Shupler et al., 2021). Achieving sustainable and more exclusive household LPG use is therefore reliant on increasing stable access to more efficient cooking technologies that are also perceived by cooks as not wasting cleaner but more expensive fuel (Pope et al., 2018; Puzzolo et al., 2016; Shupler et al., 2022).

Energy efficiency has often been considered in terms of more efficient cookstoves than the use of more efficient cooking pots. Gas and

electric pressure cookers (EPCs) have been suggested as potentially useful in saving energy, time and costs for foods with a longer cooking duration and have some availability in Kenya and other SSA markets (Hollada et al., 2017; Ronzi et al., 2019; Kweka et al., 2021). However, their limited local availability, high initial costs (KSh 6000–15,000, or USD 53–133) (Atela et al., 2021), and an unreliable electricity supply (Bruce et al., 2018b; Leary et al., 2019), has constrained their wide-scale adoption.

The current study explores the role of enhanced energy-efficient cooking pots in promoting more exclusive use of LPG for clean cooking through time and fuel savings. To the best of our knowledge, this paper is the first study to explore the potential for improved fuel-efficient cooking pots to facilitate clean cooking by use of LPG among low-income earners in LMICs.

Two commercially available cooking pots with innovative fuel-efficient designs were tested in the field: (i) the Turbopot (Fig. 1a) and (ii) the Flare pan (Fig. 1b).

The unique thermo-dynamic properties of the pots result in more efficient energy transfer from the heat source compared to standard cooking pots, with claimed energy efficiency improvements of over 30 % (Kitchenwarenews, 2018; Nguyen, 2014). The pots are made of heavy-duty stainless steel or cast-aluminum with a wide margin to ensure temperature uniformity across surfaces and high heat retention, resulting in energy savings and faster cooking. Both pots included lids designed to fit closely on the pan. Both pots are manufactured and sold in the US at a retail cost of USD 60–150 depending on the size. While they are currently marketed as a high-end ‘niche’ product for high-income settings, discussions with the manufacturers indicated costs might be reduced in new LMIC markets through local manufacturing and reduced finishing.

This paper presents the findings of qualitative research conducted alongside a randomized controlled trial (RCT) designed to investigate the impacts on cooking and fuel use of the fuel-efficient pots under



Fig. 1. Energy efficient intervention pots used by 6 kg LPG study participants.

typical daily use in urban, informal settlements of Nairobi. It also provides novel evidence on importance of harnessing innovative, scalable technology such as enhanced cookware, to promote clean cooking. Impacts in terms of fuel, time and cost saving from cooking daily meals with the enhanced pots were assessed along with cooking behaviors related to use of the pots (e.g. whether the new pots fully replaced or supplemented the use of standard pots and whether they resulted in more sustained use of LPG). The findings presented here highlight the experiences and perceptions of households using the enhanced cookware relative to their normal cooking involving local standard cooking pots (called *Sufuria*). The aim of the research was to understand whether the enhanced pots could be successfully adopted for everyday cooking by Kenyan urban households in resource poor settings.

## Methods

### Study context

This study was conducted in Mukuru kwa Njenga and Mukuru kwa Ruben, two of the eight villages within Mukuru informal settlement in Nairobi, Kenya (Fig. 2). One of the largest informal settlements in Kenya, Mukuru has a population of more than 700,000 inhabitants (Kim, Yoon, & Mutinda, 2019). Like other informal settlements, Mukuru suffers from poor infrastructure, limited access to basic services, and a lack of land tenure for its residents (Joshi et al., 2011). Most families live in one-roomed structures (in some cases corrugated iron shacks) measuring approximately three-by-three meters. The two rapidly growing urban settlements were selected purposively to generate contextual knowledge and understanding on the potential for wider uptake of the enhanced pots (with anticipated greater use of LPG and reduction in fuel stacking) among resource poor households.

### Study design

Qualitative semi-structured interviews (SSIs) were conducted with 22 of the RCT participants which explored the practical use and perceptions of the enhanced pots. Participants were all from the same informal settlement and were recruited purposively among those cooks who had consistently used LPG during the RCT timespan (based on refills data obtained from weekly surveys).

Informed signed consent was obtained from all participants. The study was approved by the AMREF Ethics and Scientific Review Committee and the University of Liverpool's Research Ethics Committee. The Kenya's National Commission for Science, Technology and Innovation

(NACOSTI) granted the research permit in February 2020.

All participants had been trained in using both the enhanced pots and had experience of using them in contrast to their standard *Sufurias* as part of the RCT. The RCT was conducted with two groups of participants in consecutive order: (a) A less-exclusive LPG using group using the smaller 6 kg cylinder with the single on-top burner for primary cooking (*meko* users); (b) intensive LPG users cooking with a 13 kg cylinder and double/multi-burner stove. A key difference between the two groups, shown in our own data and in wider literature, is that the 6 kg *meko* users tend to engage in more fuel stacking than the 13 kg double- or multi-burner stove users who were likely to be more affluent (Shupler et al., 2021). Eligibility criteria for being a participant of the RCT included using LPG as primary/exclusive cooking fuel (with fully working LPG burners) and having a family size of two or more household members.

During the trial, all participants were asked to use their assigned enhanced pots while cooking with LPG and not with any other fuel (e.g. charcoal or kerosene) to avoid damage to the pots. Participants were given mobile phone credit to facilitate text messaging for research and gas refills updates to the project team. Qualitative study participants were further given a token of 500 Ksh (about USD 4.5) each for compensation for their time at the end of the semi-structured interviews.

### Data collection

Data collection for the RCT was carried out from November 2020 to June 2021. The interviews were conducted at two points: March 2021 with the 6 kg *meko* users (at the end of the first RCT phase testing both Flare pans and Turbopots) and June 2021 with 13 kg LPG users (at the end of the second RCT phase, testing Turbopots only). The interviews were conducted by community health workers fully trained and employed by AMREF International University. During the in-depth qualitative methods research training, the research assistants were taken through ethical research and qualitative interviewing techniques with remote training offered by experts from the University of Liverpool.

The interview guide was developed in English and translated into Kiswahili to facilitate a common understanding of the guide before starting data collection. Questions focused on exploring the cooking experience with and without the enhanced pots, including pot attributes, time and perceived fuel usage, as well as the influence of culture and decision making on household energy choices in the study setting. The interview guides were piloted in Mukuru with RCT participants who had not been selected for participation in the qualitative study. The interviews were conducted face-to-face at individuals' home or at a convenient site. All interviews were conducted in Kiswahili or English



Fig. 2. Picture of one of Mukuru's villages.



depending on the participants' preferences and recorded with a digital recorder alongside field notes.

### Data analysis

The recorded interviews were transcribed verbatim and translated into English by a member of the research team, who is fully fluent in both languages and then imported into QSR NVivo 12 for analysis. A thematic framework approach was adopted to classify and organize data into key themes (Braun & Clarke, 2021). Seven members of the research team used an iterative analysis process, three (including the lead analyst) developed the initial thematic framework and later four research team members provided comments which contributed to the development of a tentative thematic framework by the lead analyst. A second iteration of analysis using the frameworks developed by the core program team was conducted. Analysis charts were prepared for each theme and category of participants and used to identify common themes across the whole dataset.

## Results

### Study participants' characteristics and cooking experiences

Interviews were conducted with 22 primary cooks (8 users of meko 6 kg cylinders and 14 users of 13 kg cylinders), all of whom were above 18 years of age. All but two were married females, with the majority having attained a high school level of education (Table 1).

Almost half the participants had families of 4 or fewer members, while the rest ranged between 5 and 7. Most participants reported earning an average income below Ksh 10,000 (USD 83) per month,

**Table 1**  
Socio-demographic characteristics of participants

	6 kg LPG cylinder Users	13 kg LPG cylinder Users
	<i>n</i> = 8	<i>n</i> = 14
<b>Age (years)</b>		
20–39	7	10
Above 40	1	4
<b>Gender</b>		
Female	7	14
Male	1	0
<b>Marital status</b>		
Married	7	12
Not Married (Single, Widowed)	1	1
Divorced/Separated	0	1
<b>Education level</b>		
Primary	1	3
Secondary /High school	7	11
<b>Household monthly income</b>		
Below 10,000 Ksh / Below USD 89	5	6
10,000–19,000 Ksh/ USD 89–170	3	4
20,000–30,000 Ksh/ USD 179–268	0	4
<b>Family size</b>		
Less than 5 people	4	6
Between 5 and 7	4	7
More than 7 people	0	1
<b>Employment of the household head</b>		
Laborer	1	3
Government officer	0	1
Employee in a business	5	5
Owns a business	2	3
Other informal employment	0	2
<b>Secondary cooking fuel used</b>	<i>n</i> = 2	<i>n</i> = 3
Charcoal briquettes/ pellets	1	0
Kerosene	1	3

which is slightly lower than the Kenya minimum average wage of Ksh 13,572 (USD 121) per month (Kenya National Bureau of Statistics, 2021). Only a few households (4 out of 22) reported earning between Ksh 10,000 to 30,000 (USD 89–268) a month. In addition to LPG, five out of the 22 participants used kerosene or charcoal briquettes as secondary sources of cooking fuel (Table 1). The rest of the participants used LPG exclusively.

Participants divided their general cooking practices into ordinary days versus days they had social functions within their households. Such social function days affected the type of fuel used, size of the cooking pot, and the meals prepared. On ordinary days, most respondents stated that they cooked generally three times a day, with some households reporting slightly more times for cooking within a day based on need, such as when schools were closed or having relatively younger children. On social function days, a variety of meals were prepared that participants noted warranted fuel stacking to save on time and accommodate big-sized pots. Gender roles within households were clearly defined, with women culturally obliged to take primary responsibility for cooking with limited assistance from spouses or elder children. Although men provided resources, decision making on purchasing kitchenware was characterised by participants as women's responsibility.

### General perceptions of the enhanced pots: Appearance and safety

Participants' overall perceptions of both types of enhanced pot were generally very positive. In terms of appearance, respondents found both the Turbo pot and the Flare pan to be attractive, and this was part of their appeal. One key aspect of their design that was noted was the handles, which are absent from the local *Sufuria*. Some participants regarded these as a useful safety feature, which made the pots easier to manage while cooking. They explained how they didn't have to use rags to avoid getting burnt while cooking using the enhanced pots.

*“Those handles don't contract heat, you can even send your child to go and remove the lid and whatever you want done, because the sufurias have no handles and thus one need Kamata (metal Sufuria handler)”*, [IR12: 13 kg LPG user, aged 30 years].

However, another participant noted the importance of careful handling of the Turbopot to avoid getting burnt from the heat that is retained by the pot after cooking:

*“They are safe but don't move close to the pot immediately after cooking. You see this mark I got from Turbo, I think I was careless and I had just removed it from the gas, so when I bent my hand [touched it], it was very painful.”* [IR13: 13 kg LPG user, aged 39 years].

Other features, such as the transparent glass lids were viewed as well designed and facilitated easy monitoring while cooking:

*“Very nice lids for the pot, they are glass lids that enable you to monitor without necessarily removing the lids from the pots...Unlike the ones we have its very difficult to see the progress of food while cooking one has to remove the lid.”* [IR11: 13 kg LPG user & fuel stacker, aged 42 years].

Participants also viewed the weight of the pots as a sign of both quality and durability – as one participant notably remarked *“that weight talked a lot”*. They were thus perceived as a potentially long-term household asset.

### Experience with use of the enhanced cooking pots

#### Perceived cooking ability

Users contrasted cooking using enhanced pots with using standard *Sufurias* for a variety of both traditional and 'modern' dishes. Respondents felt that the enhanced pots were able to prepare 'modern' foods such as rice, spaghetti, meat, and Irish potatoes as well as 'traditional' dishes such as *matoke* (mashed bananas), *ugali* (stiff maize flour porridge) and *githeri* (mixture of beans and maize). Whilst participants

viewed both enhanced pots as good for boiling, many preferred the Flare pan for frying because of its non-stick coating, weight and well-fitted lid.

Participants viewed the Turbopot as being fast and consistent in heat retention, resulting very well-cooked food.

*“For instance, while cooking ugali in Turbo, you can reduce the heat and let it simmer for some time, but [with] the sufurias, if you reduce the heat then ugali might turn out raw.”* [IR2: 6 kg LPG user, aged 54 years].

*“I prepared tea, rice, vegetables, githeri and also beef; in fact with beef, Flare is the best, it cooks it soft and also have a good taste and color. Unlike the control one [Sufuria] which doesn't cook meat so well, those pots you dropped really makes meat delicious.”* [IR6: 6 kg LPG user, aged 32 years].

The enhanced pots' ability to keep food warm was reported as a strong feature that would encourage their use. In comparison to the Sufuria, both pots had the capacity to retain food warm for a number of hours:

*“The ordinary one [Sufuria] can hardly last even an hour, but these one [Turbo] even more than 3 hours foods will still be warm ...Like during Ramadhan I used it very often because once cooked at 3pm, it will be ready for serving at 6pm after people are done fasting.”* [IR14: 13 kg LPG user, aged 25 years].

*“Well both [pots] are nice ...they cook pretty fast and also food can stay warm for like 3 hours, but these of mine food doesn't even stay longer than 10 mins.”* [IR4: 6 kg LPG user, aged 35 years].

Furthermore, positive attributes on quality of food prepared by the enhanced pots were highlighted by both neighbours and family members:

*“They used to talk about the food prepared in this household, that it was very delicious and doesn't burn at all, like when I cook rice from these (Sufurias) it easily gets burnt. Even the first day I cooked with Turbo, my husband doubted whether the food was well cooked but when he tasted the food, I could see him smiling. Turbo has really upgraded my lifestyle”* [IR1: 13 kg LPG user, aged 41 years].

*“[...] there is a woman who once said this Rice is well cooked and even wanted to know the type, they confuse to those high-grade rice, but in real sense, it's ordinary rice prepared on Turbo...Turbo cooks slowly and consistently.”* [IR14: 13 kg LPG user, aged 25 years].

Pot size was an important feature influencing the sustained use of the enhanced pots, with some participants indicating the need for smaller pots (e.g. for cooking baby meals and for certain smaller foods such as *chapati*, frying eggs) and others for larger pots (e.g. that might be needed for social gathering):

*“That Turbo is very big you cannot fry eggs unless you want to fry like 10 eggs but even still, it was deep. Also, I never prepared my child's food, because it was big, that size was not accommodative for some meals.”* [IR9: 13 kg LPG user, aged 23 years].

*“When people visit, I have to look for very big Sufuria that will cook for all those visitors and also, I have to borrow a very big jiko, that can be used to accommodate those sufurias ... to cook variety of meals”* [IR5: 13 kg LPG user, aged 28 years].

#### LPG use and reported savings with the enhanced cooking pots

Participants reported refill costs of around Ksh 2000 (USD 18) for a 13 kg cylinder and Ksh 900 (USD 8) for a 6 kg refill, including transport costs. Savings for paying for the refills were made individually or through *Chamas* (informal cooperative societies used to pool savings and offer micro-credit). Respondents also explained that they could either pay cash in full or on installments, depending on trust levels with the gas distributors.

*“You can have small amount [of money], then take to the seller and pay in installments and finally have it; when I go to the company it's roughly 2000 Ksh, because it's 1820 Ksh and additional 100 Ksh for transport... When I don't have money, I pay deposit of 1000 then get back to pay the rest so that I can get it [the refill] and I am a regular customer he can't deny me.”* [IR6: 13 kg LPG user, aged 38 years]

Participants reported a general feeling that using the enhanced pots was lowering their gas consumption. With normal use of Sufuria for cooking, participants estimated that 13 kg cylinders would last around one month, and 6 kg cylinders around two to three weeks but with the enhanced pots, some participants reported two or three extra weeks of usage.

*“... like I previously said, before I started using these pots, my gas would last up to one month, but later on it got to last additional days, say one and a half months or almost two.”* [IR2: 6 kg LPG user, aged 54 years].

*“I am sure my gas was saved, basing on [Turbo] ability to use low gas, cook fast and keep food warm, although I didn't use enhanced pots for cooking everything. I am sure if I used it for everything, I could have saved quite more than what I have already, and I know since I refill every month this time it will take even longer. For up to two weeks additions”* [IR14: 13 kg LPG user, aged 25 years].

The perceived ability to save gas through use of the enhanced pots was attributed to cooking speed as well as high energy retention levels.

#### Time saving associated with use of enhanced pots

Another positive aspect of the enhanced pots reported by participants was that of saving significant amounts of cooking and cleaning time in comparison with the standard cooking pots. Participants reported saving up to half the standard cooking time than using their local Sufuria. As one described:

*“[Turbo] takes 25 minutes to cook beans but the ordinary Sufuria last for one hour”* [IR6: 13 kg LPG user, aged 38 years].

Other participants likened the enhanced pots to perform similarly to a pressure cooker:

*“While cooking ugali, something I observed is that you don't have to put in the full amount of heat, just get the heat to medium, and prepare your ugali. It [Turbo] has ways of absorbing and retaining the heat. I can't equate it to that Sufuria but I can equate it to a pressure cooker.”* [IR8: 13 kg LPG user & fuel stacker, aged 48 years].

On time savings due to cleaning, both Turbo and Flare pots were described as quick and easy to clean, a matter of “rinse and use” with much less effort and resources required.

*“[enhanced pots] are easy to wash, they don't waste time while cleaning, they shine and when placed somewhere they beckon you to reuse them”* [IR8: 13 kg LPG user & fuel stacker, aged 48 years].

Even for those foods such as *ugali* renowned for sticking to pots and making cleaning difficult, participants commented how this was minimal on the enhanced pots. This small difference, enabled participants to easily wash and cook different foods in the same pot. Notably, this included brewing tea which is usually done in a designated pot in many Kenyan households to avoid tainting the taste of the tea:

*“When it comes to washing that enhanced pot [Turbo], it is usually very easy, even when you prepare ugali in it, it gets cleaned easily; you just need to soak it for 5 mins. So, cleaning is easy, and also when people say that you cannot prepare different meals on the same Sufuria that prepares tea. This particular one [Turbo] doesn't have such issues; once cleaned, you can even prepare tea with it”.* [IR1: 13 kg LPG user, aged 41 years].

However, one respondent pointed to some challenges in washing the bottom outer part of the Turbopot due to ridges that caused challenges in washing and was time consuming:

“Well, so I realized that it's very difficult to wash on the bottom compared to the inside, for someone to understand.... I mean the ridges were problematic, needed to have placed the steel wool horizontally, I mean you just had to figure out how to clean outside but the inside was okay.” [IR10: 13 kg LPG user, aged 40 years].

#### Reasons for continued fuel and ‘pot stacking’

Although participants viewed the enhanced pots positively in terms of general cooking, for social occasions where a variety of dishes in large quantities were required, some participants described a need to use different sources of fuel and type and size of cooking pots in order to save time and manage the cooking effectively.

“When people visit, I have to look for very big *Sufuria* that will cook for all those visitors and also, I have to borrow a very big *jiko* [cookstove], that can be used to accommodate those *sufurias* [IR1, 6 kg LPG user & fuel stacker, 26 years].

Also, by the inability to pay for a new gas refill, when unexpectedly running out of gas:

“[...] sometimes this gets you haven't saved enough to buy a new gas [refill], so I needed to have look for stove again and buy paraffin for use while looking for money [IR11: 13 kg LPG user & fuel stacker, aged 42 years].

Further, among current fuel stackers in this study, a participant reported that long duration dishes such as *githeri* continued to be prepared with charcoal. The participant believed that much as enhanced pots could save energy, it was impractical to prepare *githeri* on gas since it is energy intensive and requires long-cooking time, as explained below:

“The only meal I cannot prepare on the gas is *githeri* and this is for convenience purposes. *Githeri* consumes very high fuel, regardless of whether the pot used saves energy or not, *githeri* will definitely use too much energy, and also the time taken to cook this particular meal is long, so I find it easy cooking from outside.” [IR8: 13 kg LPG user & fuel stacker, aged 48 years].

#### Adoption of the enhanced pots and prospects for wider uptake

Study respondents lauded their positive experiences with use of the enhanced pots compared to their ordinary pots; they were perceived as being time and fuel saving, and able to prepare good quality dishes. Thus, most participants agreed that there was much less or no need to use alternative sources of fuel regardless of the type of food cooked.

“They are fast so now I never thought of using other sources of fuel, what for, when use of [Turbo] can save gas.” [IR5: 13 kg LPG user, aged 28 years].

“Yes, the pots you brought me are very good and I felt they are not worth being placed on a charcoal (*jiko*), because [Flare] prepares food well, fast and delicious and also because they have well fitted tops which, while cooking food doesn't take much time to be ready. It cooks really fast.” [IR2: 6 kg LPG user, aged 54 years].

One indicator of how impressed the participants were with the enhanced pots was that, whilst the research team had made clear these were an imported product offered for research purposes, the majority of respondents attempted to find them in local markets:

“I was expecting that they [enhanced pots] are already in the market, so I thought that maybe this was a way of advertising them; one day when I walked to the ‘Kamukunji’ market (known to have all sorts of utensils), I spent almost the whole day looking for Turbo but what I saw was imitations.” [IR10: 13 kg LPG user, aged 40 years].

“One time while in Nairobi town. I wanted to see whether I could get Turbo. I moved up and down in town but never saw anything compared to

Turbo, I could only see imitations... I asked around but people didn't have an idea of what I was talking about, I only saw imitations.” [IR1: 13 kg LPG user, aged 41 years].

#### Cost perceptions and willingness to pay for the enhanced pots

Given participants' low socio-economic status, cost and payment modalities emerged as very important factors for adoption. However, participants also discussed the perceived quality of the enhanced pots as being an important factor for uptake. The weight, appearance and presence of a lid were perceived as signs of good quality and a worthwhile investment.

“I am sure they will be selling them at a very high cost first of all, so the mentality that cheap is expensive would have helped. I would probably look and wonder why they are selling it so costly and maybe try one because they are also unique. The appearance, and weight is so significant in terms of quality. Also, the handles, there is something good also about proper handling of pots, and also the lid.” [IR10: 13 kg LPG user, aged 40 years].

One participant did note the importance of the experience of using the pots for adoption.

“Sometimes people don't buy expensive things because they don't understand them, but a one-on-one experience is very key.” [IR4: 6 kg LPG user, aged 35 years].

When asked about the expected cost of the enhanced pots, participants guessed a price ranging between Ksh 1000 to 4000 (approximately USD 9–36), dependent on the size of the pots, a significantly higher price than a local *Sufuria* which retail at around Ksh 500 (USD 4.5).

“That one is sure to be costly. I even told my fellow women I am sure that they would go for something like 4000 or 3000 Ksh, I told them but we would rather sweat to have them because they are worthy.” [IR1: 13 kg LPG user, aged 41 years].

Comparisons were made with the cost of pressure cookers, another relatively expensive and available cooking technology.

“I can estimate it to be close to a pressure cooker, that is 9 litres and I bought one for around 2,000 Ksh and some coins on top, meaning this Turbopot should start from around 3,000 Ksh” [IR10: 13 kg LPG user, aged 40 years].

Participants suggested that cost barriers could be overcome through the use of subsidies or a range of payment options, such as installments, particularly to help those with competing priorities and limited access to credit.

“Hire-purchase with 3 monthly installments, also those that can afford cash can do so... Like 200 shillings a day” [IR12: 13 kg LPG user, aged 30 years].

The use of the micro-credit *Chama* system was also suggested as both a providing credit to purchase them, and as discussed in the next section, a means of marketing the pots.

“I have *Chama*; I can pay slowly until I am done paying for them [new pot]; even my friend was telling me that we can buy, we can pool funds and buy [Turbo] for each one us in turns” [IR12: 13 kg LPG user, aged 30 years].

#### Suggested approach to promote adoption of the enhanced pots in the community

Participants were keen to suggest ways of facilitating uptake of the pots in the wider community. Many stated that they would be happy to demonstrate to friends and neighbours how the pots work, invite them to taste food prepared with the new pots or lend them out so that other people could have first-hand experience. They also suggested promotion

through the *Chama* system.

*“Chamas can be very good avenues to market; you see now, when we go to initiate them to chama where we can pool funds and buy for people in turns. So that way they may be made available in so many households”* [IR14: 13 kg LPG user, aged 25 years].

Some suggested using public spaces, such as the administrative chief's office, or preferably market places, to demonstrate the benefits of cooking with the pots. Participants also emphasized that the key promotional messages should be cooking speed and fuel saving, as this then reinforces the message that this is an investment that will reduce recurrent expenditure. In addition, weight, the ability to cook consistently under low gas heat, to retain heat for long hours, ease of cleaning, and a well-fitting lid, were also suggested as key marketing messages.

Finally, almost all participants suggested the need for a range of pot sizes, and bundling 2–3 pots together with a pan to cater for all cooking needs:

*“I would be very glad, especially if there were of different sizes; I would aspire to probably have like 3 [pots], so that I can use for different purposes, for instance one that is sizeable to cook different types of foods that would be very okay with me.”* [IR11: 13 kg LPG user & fuel stacker, aged 42 years].

## Discussion

The experiences and perceptions of household cooks in an informal settlement in Nairobi presented here indicate that they viewed these energy efficient cooking pots as providing both a positive cooking experience and potential fuel savings. These positive experiences and perceptions further suggest that the adoption of enhanced cooking pots may play a significant role in the sustained use of cleaner cooking technologies. However, there remain a number of considerations, such as availability and costs, and local cultural norms around different cooking practices, that might impact on their adoption.

Participants in this exploratory study felt that improved cooking times, the ability to keep food warm for longer periods, the unique design features, the material and weight of the pots and a fully-fitted lid, all contributed to the improved efficiency and fuel saving properties of the enhanced pots. In addition, participants reported positive fuel saving effects with some users estimating the enhanced pots added approximately two to three weeks to the duration of a standard LPG cylinder when compared to use of standard pots.

Fuel/stove stacking is a practice shaped by a range of factors, such as costs and availability of cleaner fuels, local cooking practices and household needs, time savings, health benefits and the ability to cook traditional dishes (Puzzolo et al., 2016; Shupler et al., 2022). Whilst previous studies have examined the impact of improved cookstoves and improving access to cleaner fuels on reducing fuel stacking and its associated effects on household air pollution (Hollada et al., 2017; Leary et al., 2021; Sharma, Parikh, & Singh, 2019; Shupler et al., 2022), we are unaware of previous published studies examining the role of energy efficient cooking pots on reducing fuel stacking and encouraging the transition to cleaner cooking technologies. The majority of the participants in our study reported a reduced need for fuel stacking following the adoption of the intervention pots. Continued stacking with kerosene or charcoal largely related to being unable to afford LPG refills, is a significant issue in poor communities not helped by the reimposition of the 16 % VAT rate on LPG in 2021 (Shupler et al., 2022), although reduced to 8 % the following year. A more complex picture was found for those with long cooking times, such as *githeri*, with some participants perceiving this as wasting expensive LPG, as noted in other qualitative studies (Leary et al., 2021; Ochieng et al., 2020). The majority felt the fuel-saving properties of the pots facilitated the sustained use of gas to cook these dishes. For many, the enhanced pots' ability to cook both 'modern' and traditional staple Kenyan dishes led them to become the

preferred cookware within the household.

Similarly, socio-cultural preferences and the perceived influence of the taste of food were also found to be important in the adoption of the enhanced cooking pots, with participants reporting positively on the taste of dishes prepared with the enhanced pots. These factors were also found to be associated with adoption of modern cooking technologies and fuels in studies conducted in other countries (Hollada et al., 2017; Quinn et al., 2021) where cultural norms, food taste preferences or perceived quality of food, influence transition to cleaner cooking.

This range of positive factors reported by participants within the study suggests that there is a potential role for these energy efficient pots to play in helping to facilitate the transition toward cleaner fuel use, even in low resource setting, such as the informal settlements around Nairobi. As previous studies have discussed, the adoption of cleaner cooking technologies is a process shaped by a range of cultural, social, and economic factors operating at household and community levels (Puzzolo et al., 2016; Stanistreet et al., 2019; Vigolo et al., 2018), thus the evidence presented here is at best indicative of how uptake of these enhanced cooking pots may play a part in this process. Further qualitative research would usefully explore in more depth the longer-term acceptability of the pots in terms of local cooking practices and tastes, perceived fuel savings, and household finances.

A key issue that is difficult to address through a small-scale, exploratory study is that of the willingness to pay for the enhanced pots. As part of the RCT, the costs of the pots provided to participants was covered by the research project. The costs and accessibility of the enhanced pots potentially present significant barriers to uptake. Currently, the Turbopots are only available in the US as a high-end commercial and consumer product. They were imported for use in this pilot study, and their US retail price was not disclosed to participants during the interviews. An 8-quart (7.5 l) Turbo stockpot costs around USD 80 at retail (<https://turbopot.com/collections/for-home>). The 6-quart Flare pan, was only available in the UK and US (at a retail cost of close to USD 150). The Flare pan was imported for use in this pilot study before the production line was stopped by the manufacturing companies in both countries. In addition, both pots are covered by international patents. The pot manufacturers have expressed interest to the research team in exploring the potential for making the enhanced pot much more affordable in lower-income countries such as Kenya, such as by locating pot manufacturing in-country and making changes to product materials and “finishing” (particularly in the case of the Flare pan). Such measures could significantly decrease the overall pot costs, making them more affordable for households with lower incomes.

Some of the evidence presented here indicates potential commercial viability of the pots for the urban Kenyan market, with clear consumer ‘willingness to pay’. Based on their positive experiences of using the enhanced pots, a number of study participants reported making attempts to purchase the enhanced pots in their local market without success. Participants suggested demonstrations in the use of the pots as part of a marketing campaign for encouraging their wider adoption in the community. In addition, availability of the pots in varying sizes was mentioned as a desirable feature for wider adoption, important for households being able to prepare different types of meals.

In terms of overcoming the affordability barrier, a variety of payment methods were suggested as a means to support low-income earners acquire the pots. In particular, hire purchase with the ability to pay in monthly installments and the use of local women's groups (*Chamas*) where members could pool funds to purchase pots in rotation (facilitated by their monthly contributions), were popular suggestions. These findings are consistent with a number of other studies where different payment modalities are reported as helping households purchase modern goods (Hsu et al., 2021; Person et al., 2012; Quinn et al., 2018 Oct). *Chamas* in Kenya are very common and an important mechanism for managing financial credit within communities with households coming together in groups called Savings and Credit Cooperatives (SACCOs) (Hsu et al., 2021; Pope et al., 2018). In such groups, members co-

guarantee each other, pooling funds to buy goods ranging from household equipment to land and property. These informal loan operations involve saving in rotation with the pooled fund being available to members of the group as required (Feather & Meme, 2019).

This exploratory study has helped understand the potential for enhanced cookware (fuel efficient cooking pots) to be adopted for more sustained and exclusive clean cooking with LPG (and gas more in general). The pots were found to be socially acceptable, desirable and capable of meeting the local cooking needs of resource poor households in Kenya to promote more efficient, clean cooking. The results are also directly relevant for scaling the technology providing useful information for commercial retailers/pot manufacturers planning to locate production and distribution of the products in sub-Saharan Africa. Considerations on ways to protect consumers from counterfeit pots being sold in the market (e.g., through a standard mark of quality and distributorship) will be an important factor for a successful market expansion and achievement of fuel savings to promote more exclusive use of clean fuel.

### Study limitations

This research adopted purposive sampling in recruiting participants taking part in the SSIs. The research team attempted to select a good representation from both LPG user groups (13 kg–more intensive; 6 kg–less intensive users) in order to collect as many experiences and perceptions as possible from different LPG user groups to give representation to the wider local slum context. We cannot exclude the possibility that some participants may have been looking to give favorable accounts of the enhanced pots based on a desire to be given the pot at the end of the study or to simply please the researchers. However, as most participants highlighted positive attributes of the enhanced pots, and many described attempts to buy them in the local markets for their long-term use, we believe the results are a genuine reflection of their experience and desire to adopt the pots for everyday cooking.

The fact that the study was conducted in informal urban settlements means that the views of rural and peri-urban households were not captured, missing out on additional information on the ability of the enhanced pots to cook more traditional meals (beyond *ugali* and *githeri*, which were very common in our study setting). However, many of the enhanced pot features such as increased heat retention, having a lid and ease of washing are likely to apply to all types of local cuisines, independent of context.

With regards to gender considerations, the study targeted primary cooks, which resulted in the majority of participants being women. As documented in the literature, gender dynamics in decision-making is a core factor in adoption of cooking fuels/appliances/cookware, with women often culturally obliged with primary responsibility for cooking and men often taking financial decisions on purchasing of new kitchenware (Austin & Mejia, 2017; Stanistreet et al., 2014). While the study may have not fully captured the views of men, the primary goal of this research was to understand cooks' views of the acceptability and suitability of the new cookware to meet daily cooking needs in a Kenyan setting.

Finally, any transition to cleaner fuels and enhanced cookware is also facilitated through consensus from both male and female in a couple, based on their awareness and cultural roles (Malakar et al., 2018). Any future research should put men into context to better understand the feasibility of transition to use clean energy/enhanced cookware and how decision-making dynamics for the purchase of new goods can be influenced by goods' benefits, prices and local availability.

### Conclusion

To our knowledge, this is the first study to explore the potential for improved fuel-efficient cooking pots to facilitate sustained clean cooking with LPG through the perceptions of low-income urban households

adopting the technology. Users reported very positive experiences with the enhanced pots, including improved efficiencies and reduced time for cooking as well as ability to cook all type of meals when compared to traditional cooking pots. The enhanced pots were considered both aspirational and desirable, often being positively compared with the attributes of pressure cookers. Users offered numerous suggestions of usage tips, techniques, and marketing messages that would accelerate adoption of the enhanced pots. In addition, users expressed a willingness to pay for them at a price between two and five times the price of ordinary *Sufuria* pots. These findings suggest how effectively and easily the enhanced pots could be adopted to replace traditional cooking pots in Kenya, thereby encouraging more sustained use of clean fuel with concomitant reduction in fuel stacking.

For successful market scale up in the urban Kenyan market, the pot manufacturers will need to adapt their supply chains, materials and manufacturing processes, pricing strategies and payment modalities to match the 'ability to pay' of lower income households to ensure a critical mass of Kenyan customers for commercial viability. Whilst willing to pay substantially more than traditional cooking pots, households indicated the highest affordable price to be about half of the current retail price for the equivalent Turbopots currently marketed to household users in USA, but higher than the wholesale price in the country of origin. Therefore, local manufacturing could be a game-changer, allowing innovative pot designs such as these to become affordable for lower-income earners and potentially to contribute to gas savings and, with their non-conductive handles, a safer cooking experience as well.

The findings further indicate that locally appropriate payment modalities will be important to supporting and stimulating demand. These modalities may consist, for example, of splitting the purchase price across multiple payments (e.g., through microcredit or pay-by-installment), or creating 'cooking bundles' that combine the cooking pots with initial LPG cooking equipment (stove, cylinder, etc.) or with a series of other cooking pots/pans or utensils. Further research is warranted to explore cooking pot technology adoption under full market conditions to identify and evaluate the mechanisms that can better support the spread of such energy-efficient cookware.

### Authorship contribution

**Willah Nabukwangwa:** Methodology, Training, Data collection, Thematic analysis, Writing original draft preparation. **Stephen Clayton:** Methodology, Training, Writing original draft preparation. **James Mwitari,** Conceptualization, Writing – review & editing, Supervision. **Arthur Gohole,** Project administration, Training, Writing – review & editing. **Elizabeth Muchiri:** Conceptualization, Writing – review & editing. **Dan Pope:** Methodology, Writing – review & editing, Funding acquisition. **Elisa Puzzolo:** Conceptualization, Methodology, Thematic analysis, Writing – original draft preparation, Supervision, Funding acquisition.

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### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.



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