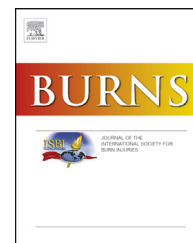


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# Burns and fires in South Africa's informal settlements: Have approved kerosene stoves improved safety?

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## ABSTRACT

This study is a follow-on to an intervention project that implemented South African Bureau of Standards approved kerosene stoves and safety education in 150 households of a Johannesburg informal settlement. An investigation conducted 12 months later established that 43 stoves had operational defects, yet 23 households continued using the faulty appliances. This study focuses on (1) the psychological and behavioural factors associated with continued use of faulty stoves by the 23 households, and (2), the specific technical failures of these stoves. The study involved one-on-one recall interviews with the households using defective stoves (N=21) and laboratory-based stove tests for seven of the affected appliances. The results indicate that the stoves had defects in critical safety features such as flame control and the self-extinguishing mechanism. Four stove malfunctions of minor burn affect were reported in the study. Continued use of the damaged stoves was significantly associated with the time from receipt of the stove to detection of first failure: stoves that failed later on were more significantly likely to remain in use as compared to those that failed sooner. The findings point to the need for strengthening enforcement of appliance standards, public education on kerosene stove use, and structural change for the energy-poor.

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## 1. Introduction

Burns and fire injuries are a major public health concern in under-resourced settings, but especially in South-East Asia and Africa [1]. The most affected communities are those with

low incomes, being reliant on transitional liquid fuels, and those with sub-standard dwellings in dense settlements [2]. Increased urbanisation and lack of affordable formal houses for low-income populations are reported to contribute to such injuries. It is estimated that 265 000 deaths occur globally each year from fires alone, with more deaths occurring from other forms of burns [1,3]. Mortality from burns is eleven times higher in developing than in developed countries [4].

Accidental or “non-intentional” burns are the most common in low-income South African households and mostly happen through stoves and heaters mishaps, from either faulty appliances, user ignorance or negligence, and are

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compounded by adverse home spatial layouts [5,6]. In this context, incidents from the use of simple kerosene stoves are especially indicated for liquid and flame burn casualties [7]. This is in contrast to India and other South Asian countries where intentional burns from suicides and homicides make up about 50% of deaths [8].

South Africa has one of the highest accidental burn mortality rates at 8.5 per 100000 compared to the world average of 5 in 100000 [9]. Apart from these deaths, many more individuals suffer from disfigurements, disability, trauma and economic losses. Key contributors for fires and burn injuries include overcrowded and spatially constrained informal dwellings that are made of flammable materials, the use of leaky poorly made combustion stoves [7], refuelling while the stove is lit [10], and leaving lit stoves or candles unattended.

Kerosene stoves are considered the leading cause of burn injuries in emerging market economies [11–14]. Apart from burns, kerosene use may contribute to household air pollution [15], poisonings [16] and climate forcing [17]. Kerosene stove-related mishaps are typically explosions, mainly associated with the wick-type stove design [10]. Also, mechanical instability of the stove and pot combination may cause scalding and food burns. Fuel contamination is another concern where kerosene is decanted and resold in unmarked containers, which is a common practice in South African informal settlements [18].

In South Africa, fires disproportionately affect residents of urban informal settlements. Informal settlements are residential areas in urban or peri-urban locations on land that has not been proclaimed through local authority processes [19]. Structures in these settlements are characterised by simple dwellings (shacks) constructed of either new or recycled materials including wood, cardboard, corrugated iron sheets or tarpaulins. The proportion of households residing in informal dwellings has declined from 16.4% in 2001 to 13.0% in 2016 [20]. However, the absolute population number of shack dwellers has risen over the same period, from 1.8 million to 2.2 million [20], despite the notable progress in providing formal houses to previously disadvantaged communities [21]. Residents of informal settlements frequently lack basic services, including access to clean, safe and reliable energy resources such as electricity and piped or bottled gas. As such, people depend on risky combustion technologies for energy services. The lack of knowledge on the safe use of the fuels and appliances intensifies the exposure to such risks. Moreover, because of the high density of dwellings, a fire in one shack can quickly become a settlement-wide conflagration.

South Africa promulgated kerosene stove standards in 2006 [22], largely motivated by the need to reduce fire and burn injuries in low-income households. Following promulgation, and with effect from 01 January 2007, the standard was declared a compulsory specification by the Department of Trade and Industry [23]. A key input of the standard is the requirement for a self-extinguishing mechanism in stove designs. These mechanisms ensure the flame is extinguished if the appliance is tilted beyond the stability limit. Subsequently, a model of a popular non-pressure stove was homologated and approved for sale in the country. The compulsory specification notice declares that “the homologation granted in respect of an appliance type pursuant to the

Specification may be withdrawn if the requirements in the Specification have not been maintained” [23, p. 6]. The National Regulator for Compulsory Specifications is mandated with enforcing compliance with the compulsory standard [24].

This article reports on a post-intervention assessment of South African Bureau of Standards (SABS) approved kerosene stoves. The aim is to clarify the safety performance of the approved stoves vis-à-vis the reference stove standard [22] and elucidate the reasons for user persistence with under-performing or defective stoves. Data were collected through one-on-one interviews with heads of intervention households that were using the defective stoves and laboratory assessment of stoves that were received from some of these households.

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## 2. Methods

This article derives from a safe stove intervention initiative that was implemented in June 2014 amongst a randomised sample of 150 low-income households in a Johannesburg informal settlement. For the randomization, a list of random coordinates for the area were generated, and the household closest to the coordinate was invited to participate in the study. The households were given information on the safe use of kerosene stoves and appropriate emergency responses, and thereafter issued with a new SABS-approved non-pressure kerosene stove. A follow-up survey conducted twelve months later revealed that 43 stoves (out of 135; 15 households had relocated) had malfunctioned, yet 23 of these households continued using the stove even though it had been self-assessed as faulty. The purpose of the current study (conducted six months after the follow up survey, at the end of 2015) was to clarify the technical failures of these stoves and to understand the motivation of the 23 households that had persisted with the use of the defective stoves. A South African University’s Research Ethics Review Committee approved the safe stove intervention study in December 2011. Informed consents were obtained with the interviewees.

The study methodology included two distinct, complementary procedures. The first stage involved one-on-one recall interviews with representatives of households that were using faulty stoves. The second procedure involved laboratory-based technical assessments of the faulty stoves to identify the modes of failure. The two procedures are explained in Sections 2.1–2.3.

### 2.1. Recall interview procedures and sample selection

After the 23 households had been identified, data collectors visited them to conduct the recall interviews, using a semi-structured questionnaire. The data collectors examined the following aspects: the purpose for which the stove was used, satisfaction with the stove when new, features of the stove that had failed, elapsed time when the failure(s) occurred, whether any incidents or injuries had resulted from the stove failure(s), and overall satisfaction with the stove. Five key stove safety features were examined: switching on, flame control, self-extinguishing, the tank cap, and the leak-proof tank. The study sought to assess the time in months from the

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