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Using a cluster randomized controlled trial to determine the effects of intervention of battery and hardwired smoke alarms in New South Wales, Australia: Home fire safety checks pilot program

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ABSTRACT

Introduction: In 2014, Fire & Rescue New South Wales piloted the delivery of its home fire safety checks program (HFSC) aimed at engaging and educating targeted top "at risk" groups to prevent and prepare for fire. This pilot study aimed to assess the effectiveness of smoke alarms using a cluster randomized controlled trial. *Methods:* Survey questionnaires were distributed to the households that had participated in the HFSC program (intervention group). A separate survey questionnaire was distributed to the control group that was identified with similar characteristics to the intervention group in the same suburb. To adjust for potential clustering effects, generalized estimation equations with a log link were used. *Results:* Multivariable analyses revealed that battery and hardwired smoking alarm usage increased by 9% and 3% respectively among the intervention group compared to the control group. Females were more likely to install battery smoke alarms than males. Respondents who possessed a certificate or diploma (AOR = 1.31, 95% CI 1.00–1.70, P = 0.047) and those who were educated up to years 8–12 (AOR = 1.32, 95% CI 1.06–1.64, P = 0.012) were significantly more likely to install battery smoke alarms than those who completed bachelor degrees. Conversely, holders of a certificate or diploma and people who were educated up to years 8–12 were 31% (AOR = 0.69, 95% CI 0.52–0.93, P = 0.014) and 24% (AOR = 0.76, 95% CI 0.60–0.95, P = 0.015) significantly less likely to install a hardwired smoke alarm compared to those who completed bachelor degrees. *Conclusions:* This pilot study provided evidence of the benefit of the HFSC in New South Wales. Practical Applications: Fire safety intervention programs, like HFSC, need to be targeted to male adults with lower level of schooling even when they are aware of their risks.

1. Introduction

Globally, more than 300,000 deaths (Mock, Peck, Peden, Krug, & Organization, World Health, 2008) and 10 million disability-adjusted life years (DALYs; Peden, McGee, & Krug, 2002) are lost each year due to fire-related injuries. Records from the fire department of all house fires (excluding fires in apartments and mobile homes) in Dallas, USA, show that from 1991 through 1997, there were 223 injuries (91 fatal and 132 nonfatal) from 7,190 house fires, for a rate of 5.2 injured persons per 100,000 population per year (Istre, McCoy, Osborn, Barnard, & Bolton, 2001).

A past report found that in Australia, over the years 1996 to 2003, there were 52 deaths per year attributed to residential fires (Council, Australasian Fire Authorities, 2005). Putting this in context approximates to 1 person per 370,000. According to the Australian Fire and Emergency Service Authorities Council (AFAC), people who have a greater risk of dying as a result of being involved in a residential fire are adults aged 65 years and over, children aged 0–4 years, and adults affected by alcohol consumption. The groups at a higher risk of being injured in such a fire include: males, young children aged 0–4 years, adults aged 22–40 years, older adults (65 + years), low socio-economic status, poor educational background, ethnic minorities, individuals who smoke, and individuals who drink excessively (Council, Australasian Fire Authorities, 2005).

In the event of a residential fire outbreak, smoke alarms are normally the primary life safety strategy for residents. Smoke alarms have been considered as one of the most effective interventions in reducing fire-related injuries among residents in higher-income countries (Mock et al., 2008). According to a research conducted by the Fire Investigation and Research Unit (FIRU), a significant percentage of fire fatalities involve residents who do not have smoke alarms or who have smoke

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alarms that are out of order. A study in the United States revealed that during a house fire, injuries occurred more often in houses without functioning smoke alarms (Istre et al., 2001). There has been a substantial increase in the proportions of households with smoke alarms over the past three decades in some countries. For instance, in England and Wales, the proportion of homes with alarms increased from 0% in 1985 to 75% in 1995; the increase in the number of alarms coinciding with a substantial decline in fire deaths, although a number of factors apart from smoke alarms might have been responsible for the decline (Roberts & Diguiseppi, 1999).

The economic impact of fire-related injuries can be enormous and will adversely affect socioeconomic sectors, human settlements, ecological systems, and human health (Edelman, 2007) and understanding how to engage and educate targeted sub-populations at risk of future fire could contribute significantly in preventing fires and saving lives. This randomized controlled trial was undertaken to evaluate the effect of a home fire safety checks (HFSC) using a pilot program on the usage of battery and hardwired smoke alarms among households in New South Wales in Australia.

2. Methods

2.1. Study design

FRNSW for the HFSC pilot program developed a Fire Injury Risk Model (FIRM) that combined Mosaic lifestyle profile data, from the Australian 2011 Census, with accidental residential fires statistics from 2007 to 2012. FIRM identified two groups that were most at risk with higher propensity per household to have had a fire and that result in an injury. These are K42 Constant Struggle, single parents, and the elderly living side by side in rented flats in city central locations, and M49 Armchair Blues, single and step family households with stretched budgets in remote locations. They accounted for around 3% of the number of households in the New South Wales with approximately 10% of the incidents of fires.

The design of the pilot HFSC intervention consisted of home visit to randomly selected homes K42 and M49 homes in the high risk suburbs. The community safety personnel delivering the pilot conducted previsit to identified streets and undertook assessment for the appropriateness. The criteria used included the type of street, the safety of the personnel delivering the pilot, and any impediments to the program delivery such as breaks in the street. The number of households and suburbs visited in were limited by pilot available funds and disparity of the geographical area that they sought to provide the program to. The pilot HFSC program was inclusive of an evaluation component.

The delivery of the HFSC intervention program consisted of home fire safety check by FRNSW personnel; provision of verbal and written fire safety information; checking/testing of existence of smoke alarms and provision of replacement photoelectric smoke alarms or batteries as needed, and the supply of fire blanket and education on its use. The pilot HFSC program (the intervention) was delivered to 228 households in eight suburbs with one suburb in immediate aftermath of an overnight home fire incident. For the residents that received a HFSC visit their addresses and any names were extracted for the mailing list for the independent evaluation postal survey. All of the survey respondents were given an identifier that began with INT followed by a sequential number. The respondents were all sent survey package by post within four months of the HFSC visit that was inclusive of:

- A cover sheet explaining the study and inviting them to participate in the study. This included details of the $20 Coles Myer gift voucher that would be sent upon the receipt of a completed survey form.
- An information sheet detailing the purpose of the study and providing answers to common questions.
- A consent form.
- The intervention survey form that had the responder identifier number written in the left hand corner. The design of the questionnaire was based on external surveys and included questions on household views of the HFSC program.
- A self-addressed and stamped envelope to be used for the return of completed survey forms.

For all completed surveys, thank you letters were sent together with an activated $20 Coles Myers gift voucher with a printed thank you for participating the study. Reminder surveys packages were sent to all households that had not responded three weeks after the first package. Survey responses were obtained from 30 households in six suburbs with the low response rate attributed to delay in sending out the survey packages from the date of delivery of the program; the university stationary use in all aspects of the package; and other factors based on the study methodology such as vandalization of post-boxes in couple of the study suburbs during the period of data collection.

Control group households were identified by FRNSW with similar characteristics to the intervention group in the same suburbs with some geographical distance, buffer zone, between them to ensure that there is no flow-on effect from the intervention. Postal survey packages were sent to 425 households, almost double the number of intervention households in efforts to obtain similar number of respondents. The survey packages were comparable to that of the intervention group with the addition of fire safety information brochure. The same financial incentive was provided to the control group households and the timing and procedure for dissemination used for the control group were identical to the intervention evaluation. Completed surveys were returned from 50 households in six suburbs.

For both intervention and control group postal survey material, ethics approval was obtained by the researcher from the University of Western Sydney Human Ethics Committee (H10446). Receipted surveys were de-identified prior to their responses being data entered for analysis. Economic evaluation was undertaken of the HFSC program that entailed the collection of cost data of the HFSC program from FRNSW and estimation of benefits or savings from the intervention program. Scenario analysis was used for determining costs and benefits of further roll-out of the HFSC program beyond the pilot.

3. Intervention

This study was a cluster randomized controlled trial (CRCT) that involved participants from six postcodes in New South Wales, Australia. Participants were randomized to one of the two groups, namely, intervention group and control group. The intervention group was the households that had participated in the pilot HFSC program; the control group was the households with similar characteristics but who did not take part in the pilot program. The intervention group was furnished with a questionnaire while a separate questionnaire was distributed to the control group.

3.1. Statistical analysis

The Intention to Treat (ITT) population included all subjects who were randomized into control and intervention groups. Missing data for subjects were imputed using the Last Observation Carried Forward (LOCF) approach. Continuous data were summarized using descriptive statistics including the number of observations used in the calculation (n), mean, standard deviation (SD), minimum, median and maximum. Categorical data were summarized as counts and percentages of each category.

The two outcome variables (battery and hardwired) took a binary form such that respondents exposed to battery and hardwired alarms were coded as “1” while respondents with no access to battery and hardwired alarms were coded as “0”.