ORIGINAL ARTICLE

Unflued gas heaters and respiratory symptoms in older people with asthma

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ABSTRACT

Background Unflued gas heaters (UFGHs) and cookers are a major contributor to air pollution in homes. Gas appliances have been associated with adverse respiratory outcomes in children and, less consistently, adults. There have been very few studies on the effects of gas appliances on the respiratory health of older people.

Objectives This study investigated the daily lung function and respiratory symptoms of older people (>55 years of age) who did and did not use an UFGH as a primary source of heating.

Methods 71 patients with asthma were recruited for the study. Each patient participated for one 12-week winter period. All patients recorded daytime and night-time symptoms in a diary and completed morning and evening peak flow and forced expiratory volume in 1 s for the study period. General estimating equations were used to measure the associations between symptoms and lung function outcomes and same and previous day (lag 1) UFGH exposure.

Results Same and previous day (lag 1) UFGH exposure was associated with significantly increased ORs for wheeze and dyspnoea compared with days on which no heating was used. Furthermore, there were significant increases in the average odds of reported wheeze and dyspnoea per hour of UFGH heater use. Small but significant reductions in morning to evening peak flow and forced expiratory volume in 1 s were observed on the days an UFGH was used compared with days when other heating was used or there was no heating.

Conclusion Exposure to UFGHs may have a detrimental effect on symptoms and lung function in older people with mild to moderate asthma.

INTRODUCTION

Unflued gas cookers and heaters are a major source of nitrogen dioxide (NO_2), nitrous acid and carbon monoxide (CO) indoors.[1] They can also emit formaldehyde and produce water vapour.[2] In Australian homes combustion gases from unflued gas heaters (UFGHs), particularly NO_2, can be significantly elevated during their operation, with peak concentrations reaching as high as 700 $\mu g/m^3$.[3] Although high peak NO_2 concentrations can be obtained when using an unflued gas stove,[4] UFGHs have been shown to be the major source of both indoor concentrations and personal exposure to NO_2 in Perth, Western Australia, where the study was conducted.[5]

Exposure to gas appliances or indoor NO_2 has been associated with an increase in respiratory symptoms in children and worsening of asthma in children and adults.[6] The Institutes of Medicine

(US) recently concluded that NO_2 is one of the few indoor pollutants for which there is sufficient evidence of a positive association between NO_2 and asthma exacerbations.[6] However, the findings remain inconsistent,[7] and the Institutes of Medicine recommended future research to target population subgroups that are likely to be most exposed to determine the relationship between exposure of indoor NO_2 and asthma.[6]

Older people, particularly those with existing cardio-respiratory diseases, may be more prone to the effects of air pollution than younger age groups.[8] Few studies have addressed the adverse effects of indoor air pollution on respiratory health in older people.[9] Some studies have, directly or indirectly, investigated the effect of either gas appliances[10 11] or indoor NO_2[12 13] on respiratory health in older age groups, but the results are conflicting. Older people, on average, spend more hours at home than other age groups (with the exception of infants),[14] especially if they have a chronic illness.[15] As ageing is associated with a decline in body thermoregulation and impaired peripheral temperature perception,[16] older people have a greater need for heating during the winter.[17] An increased need for heating in winter, combined with reduced home ventilation, can contribute to an accumulation of indoor pollutants, raising the risk of exposure to combustion products.[9] The aim of the study was to investigate if using an UFGH during winter is detrimental to the respiratory health of older people with asthma.

METHODS

Subjects and protocol

Patients with asthma over 55 years of age were recruited from a patient database at the Lung Institute of Western Australia (LIWA). Apart from age, inclusion criteria were a history of physician-diagnosed asthma with evidence of symptoms in the past 12 months. Exclusion criteria were current smoking and the presence of respiratory comorbidities, such as doctor-diagnosed chronic obstructive pulmonary disease (COPD).

The study was conducted over two consecutive 12-week winter periods (2007 and 2008) but each patient only participated for one winter season. On recruitment, baseline lung function (spirometry) was measured and patients completed a questionnaire. During the 12-week study period people were asked to complete a daily respiratory symptom diary in the morning and evening. Patients also recorded the use of heaters and cookers during each day. All patients were provided with an electronic lung

function monitor to measure morning and evening lung function. Patients were visited every 2 weeks to collect and replace completed diaries. The study was approved by the University of Western Australia Human Research Ethics Committee.

Techniques
Baseline lung function
Baseline spirometry was measured, in accordance with the American Thoracic Society guidelines,[18] in the patient's home using a portable spirometer (EasyOne Spirometer, ndd Medizintechnik AG, Zurich, Switzerland). Up to five measurements were collected to obtain at least two technically satisfactory manoeuvres. Quality grades of C or greater were accepted. Measurements were recorded for forced vital capacity, forced expiratory volume in 1 s (FEV_1), peak flow (PEF) and mid-expiratory flows (FEF_{25-75}). Data were downloaded using Easyware software (Easyware V.2.9, ndd Medizintechnik AG, Zurich, Switzerland). Predicted values were calculated using published reference values.[19]

Baseline questionnaire
Two questionnaires were completed by the patients on the first home visit. The first questionnaire asked about the home environment, including primary heating and cooking fuels, age of house, distance of home from busy roads, and presence of pets.[20] The second questionnaire included questions on asthma severity (intermittent/mild or persistent), age at asthma diagnosis, seasonal asthma and medication. The questionnaire was based on severity criteria specified by the Australian National Asthma Council and has been used previously.[21] Data on previous smoking patterns were also collected.

Symptom diary
Self-reported respiratory symptoms were recorded separately for each day and night on a 14-day diary. Patients were asked to indicate the presence and severity of symptoms on a scale of 0–3, with 0=none, 1=mild, 2=moderate, 3=severe. Symptoms included wheeze, cough and dyspnoea. Patients completed the diary at night (for daytime symptoms) and on first rising in the morning (for night-time symptoms). Reliever medication usage was also recorded. Patients were asked to record if, and for how long, a heater or cooker was used when they were at home on each day. If patients had more than one type of heater they were asked to specify the type of heater that was used on a particular day.

Daily lung function
Patients were provided with an electronic lung function monitor (PiKo-1, Ferraris Cardiorespiratory Co, Louisville, Colorado, USA) to measure lung function first thing in the morning and before retiring in the evening. Patients were instructed to measure lung function prior to taking any asthma medication. The PiKo-1 measures FEV_1 and PEF and has been compared favourably with the mini-Wright PEF metre.[22] Patients were trained in using the monitors during the first home visit. At least three, and up to a total of five, measurements were collected in the morning and evening and recorded in the diary.

Statistical analyses
Baseline data
Baseline lung function, age at the time of the study, age at first diagnosis of asthma and asthma severity parameters were compared among patients who used an UFGH as the primary heating source and those who had other heaters using Student t tests, Mann–Whitney U tests and χ^2 tests.

Study data
Symptom frequencies (wheeze, cough and dyspnoea) and mean PEF and FEV_1 measurements across the entire study period were compared for the following exposure groups: days on which UFGHs were used versus days on which other forms of heating were used; days on which UFGHs were used versus days on which no heaters of any kind were used; and days on which other heaters were used versus days on which no heaters of any kind were used. Daily heater use was analysed as a dichotomous 'yes/no' variable for each measurement day. Relationships between daily hours of heater use and both symptoms and lung function were also investigated separately for UFGHs and other heaters. Same day and previous day (lag 1) analyses were conducted.

For symptom frequency, daytime and night-time symptoms were combined and the presence and severity were collapsed into dichotomous variables (none/mild and moderate/severe). The percentage of measurement days with symptoms was assessed for each patient. Use of asthma reliever medication (yes/no) on each measurement day was also assessed.

Lung function was assessed in two ways. First, as the daily difference, as a percentage, from the mean for each patient across the whole study period. This was analysed separately for morning and evening PEF and FEV_1, although only the evening values were assessed for same day exposures. Second, changes from morning to evening for PEF and FEV_1 were investigated using the following calculation:

$$(\text{Morning PEF/FEV}_1 - \text{evening PEF/FEV}_1)$$

$$/\text{morning PEF/FEV}_1 (\%)$$

Only same day exposures were assessed for morning to evening change. Analyses were also conducted for each patient to determine intra-individual variability of FEV_1 and PEF over the study period. All lung function variables were normally distributed.

Generalised estimating equations (GEE) with an autoregression AR(1) (within-subject) correlation structure were used for advanced analysis. Analyses were conducted to investigate daily lung function and symptoms with daily heater use, as a dichotomous variable and reported hours of use. All GEE estimates were adjusted for other factors, including age and gender, use of gas cookers (yes/no), smoking in the home (yes/no), meteorological conditions and ambient NO_2. Meteorological records for ambient daily temperatures and relative humidity, and outdoor NO_2 concentrations were obtained for each study day from urban monitoring stations. Further, both calendar day and the relative day of the study were included in the models. For the GEE models, Gaussian models with identity link functions were used for percentage changes in PEF and FEV_1 relative to the overall mean for each patient. This relative 'intra-individual' measure was used in preference to absolute lung function values, which can vary among patients because of differences in height, age and other attributes unrelated to the exposure of interest. For dichotomised outcomes binomial models with logit link functions were used to derive ORs. Missing and incomplete data were assessed for each patient. Residual analyses were conducted to identify outlying measurements. All statistical analyses were conducted with Stata/MP 10.0.

The study had at least 80% power (with type I error probability $\alpha=0.05$) to detect differences in risk estimates of symptoms with an OR of at least 1.30. For lung function measurements, the study had at least 80% power to detect

Table 1 Baseline characteristics of patients

Baseline characteristics	UFGH (n=33)	Other heating (n=38)	p Value
Demographics			
Sex (F/M)	18/15	23/15	0.641
Age (years)*	70.0 (64.0—71.0)	67.5 (66.0—76.0)	0.132
Occupation (prof/semi/trades)†	19/6/7	21/11/4	0.345
Socioeconomic Index* ‡	83.0 (61.0—91.5)	81.0 (67.5—94.0)	0.867
Baseline lung function measurements			
% Pred FVC§	96.9 (21.7)	98.5 (20.1)	0.492
% Pred FEV$_1$§	76.0 (16.1)	79.3 (25.9)	0.467
% FEV/FVC§	64.3 (10.0)	64.0 (14.3)	0.930
% Pred PEF§	87.1 (22.3)	90.7 (26.0)	0.383
Clinical parameters			
Asthma severity (intermittent/persistent)	17/15¶	18/20	0.301
Daily inhaled corticoid steroid use	28/33 (85%)	34/38 (90%)	0.912
Ex-smokers	17/33 (53.1%)	15/37‡ (46.9%)	0.253
Age at asthma diagnosis (years)*	23.0 (5.0—53.0)	36.0 (13.5—55.0)	0.316
Seasonal asthma	21/33 (65.7%)	19/38 (50.0%)	0.334
Symptoms occurring primarily in winter	16/32 (50%)	13/35 (37.1%)	0.164

*Median (IQR).
†Prof, professional; semi, semi-professional; trades, tradesperson.
‡Index of socio-economic disadvantage based on residential address.
§Mean (SD).
¶Missing data point.
UFGH, unflued gas heater; FEV$_1$, forced expiratory volume in 1 s; FVC, forced vital capacity; PEF, peak expiratory flow; Pred, predicted.

differences of 2.8% change from the average subject measurement in the exposed (UFGH) group for PEF, and 4% change from the average subject measurement in the exposed (UFGH) group for FEV$_1$ (with type I error probability α=0.05).

RESULTS
Baseline data
Seventy-seven patients were recruited into the study. Two patients were excluded due to comorbidities and four withdrew because they could not complete the requirements of the study. A full set of data were analysed for 71 patients. All patients were Caucasian with similar socioeconomic backgrounds, as determined by last or current occupation and residential address (table 1). Thirty-three (46.5%) patients used UFGHs as their primary source of heating. Primary heating fuel for the 'other' group included electricity (n=23), flued gas (n=9), oil (n=2), closed wood heater (n=2) and open fireplace (n=1). One patient did not use any heating. Flued gas was included in the 'other' group as this has previously been shown not to increase indoor NO$_2$ concentrations.[6] There were no significant differences between the two groups with regards to age at time of study,

Table 2 Symptom frequency (%) and lung function on days with and without heating

	Days UFGH used (n=1713 days)	Days other heater used (n=2421 days)	Days no heating used (n=1388 days)
Symptoms*			
Wheeze	13.4 (2.2—37.5)	10.4 (0.0—43.2)	0.5 (0.0—27.1)
Cough	0.0 (0.0—3.4)	0.0 (0.0—3.2)	0.0 (0.0—1.6)
Dyspnoea	0.0 (0.0—2.1)	0.0 (0.0—4.2)	0.0 (0.0—0.6)
Lung function†			
morning PEF (litres/min)	310 (111)	297 (100)	296 (102)
evening PEF (litres/min)	313 (107)	298 (95)	305 (103)
morning—evening change PEF (%)	1.86 (5.73)	2.36 (6.55)	3.66 (6.25)
morning FEV$_1$ (litres)	1.90 (0.57)	1.83 (0.60)	1.86 (0.58)
evening FEV$_1$ (litres)	1.90 (0.55)	1.82 (0.59)	1.86 (0.59)
morning—evening change FEV$_1$ (%)	0.63 (5.53)	0.67 (8.26)	2.44 (6.32)

*Median (IQR).
†Mean (SD).
UFGH, unflued gas heater; FEV$_1$, forced expiratory volume in 1 s; PEF, peak expiratory flow.

age at asthma diagnosis, past smoking, daily inhaled corticoid steroid use and asthma severity (table 1).

There was no difference in ambient conditions on days the different heaters were used. There were also no differences in the patterns of usage for the different types of heaters. UFGHs were used on 64% of days and other heaters were used on 67% of days. The daily average (SD) number of hours of heater use on those days was 5.3 (1.9) h and 5.4 (0.3) h, respectively.

Symptoms
Symptom frequencies for the study period are presented in table 2. Using the fully adjusted GEE model, positive associations were observed between a number of symptoms and UFGH use (table 3). ORs were significantly elevated comparing UFGH days with days on which no heaters were used for wheeze (same day and lag 1), cough (lag 1) and dyspnoea (same day and lag 1). There was no effect on reliever medication usage. The odds of dyspnoea were significantly elevated with the use of other heaters compared with no heating at lag 1 (table 3).

ORs for wheeze (same day and lag 1) and dyspnoea (same day and lag 1) for hours of heater use were elevated for UFGH users but not other heater users (table 4).

Lung function
Raw lung function variables for the different heaters used are presented in table 2. In the fully adjusted GEE model there were

Table 3 Adjusted ORs (95% CI) of symptom occurrence usage by heater type

	Wheeze		Cough		Dyspnoea	
	Same day	Lag 1	Same day	Lag 1	Same day	Lag 1
UFGH versus other heater used (n=1713 vs 2421 days)	1.21 (0.99 to 1.48)	1.22 (1.00 to 1.50)*	0.77 (0.53 to 1.11)	0.79 (0.54 to 1.15)	0.78 (0.56 to 1.09)	0.79 (0.56 to 1.12)
UFGH used versus no heating (n=1713 vs 1388 days)	1.25 (1.05 to 1.50)*	1.22 (1.01 to 1.48)*	1.38 (0.91 to 2.09)	1.55 (1.00 to 2.40)*	1.87 (1.30 to 2.70)*	2.05 (1.41 to 2.99)*
Other heater used versus no heating (n=2421 vs 1388 days)	1.01 (0.88 to 1.17)	1.03 (0.89 to 1.20)	1.15 (0.83 to 1.59)	1.21 (0.85 to 1.71)	1.40 (0.99 to 2.00)	1.56 (1.07 to 2.28)*

Adjusted for age, gender, exposure to tobacco smoke, exposure to cooking gas, ambient temperature, humidity and external NO$_2$ levels.
*Significant finding (p<0.05).
UFGH, unflued gas heater.

Table 4 Adjusted ORs (95% CI) of symptom occurrence per hour of use for heater type

	Wheeze		Cough		Dyspnoea	
	Same day	Lag 1	Same day	Lag 1	Same day	Lag 1
Hours of UFGH use (n=33 patients; 1713 days)	1.05 (1.02 to 1.08)*	1.05 (1.02 to 1.08)*	0.97 (0.90 to 1.04)	0.97 (0.90 to 1.05)	1.07 (1.02 to 1.13)*	1.07 (1.02 to 1.13)*
Hours of other heater use (n=38 patients; 2421 days)	1.00 (0.98 to 1.02)	0.99 (0.97 to 1.01)	1.01 (0.97 to 1.05)	1.01 (0.97 to 1.05)	0.99 (0.95 to 1.04)	0.99 (0.95 to 1.03)

Adjusted for age, gender, exposure to tobacco smoke, exposure to cooking gas, ambient temperature, humidity and external NO_2 levels.
*Significant finding ($p < 0.05$).
UFGH, unflued gas heater.

no declines in PEF or FEV_1 (morning or evening) relative to the subject mean for same day or lag 1 UFGH use (table 5). However, when analysing exposure by hours of use there were small but significant percentage declines, relative to the subject mean, for morning PEF (-0.24% per hour of use, -0.41 to -0.07) and FEV_1 (-0.21, -0.38 to -0.03) for previous day UFGH use (table 6).

There was a significant decrease in the morning to evening changes in PEF and FEV_1 when UFGHs were used compared with other heater use and no heater use (table 5).

Missing data
Patterns of the missing and incomplete data were assessed to determine if there was any consistent pattern of absent results. One patient did not undertake lung function but completed all the other components; two others omitted ~20% of their lung function measurements. Sensitivity analysis was repeated with these patients excluded. No major shift in risk estimates was observed subsequent to their exclusion. Apart from these patients, data were missing completely at random, and hence were left missing.

DISCUSSION
There are very few data on the effects of heating sources on the symptoms of older people with pre-existing respiratory disease. The use of UFGHs is considered a risk for symptoms in children with asthma,[6] but older people are a group that may experience an even greater exposure to these heaters due to increased need for heating[17] and more time spent indoors.[14] In this study we found that UFGH use was associated with increased symptoms and small changes in lung function in older people with asthma. There was also evidence of an exposure—response relationship between UFGH use and both lung function and respiratory symptoms. These findings are suggestive of an adverse effect of UFGH in older people with existing respiratory illness.

There is a large body of literature on the adverse impacts of UFG appliances and/or indoor NO_2 on the health of residents,[6] mostly children. The evidence to date is considered to be suggestive of a causal relationship between the worsening of asthma symptoms and increased respiratory symptoms in children.[6] The evidence for adults is less consistent.[7] Previous studies with adults have focused on the use of gas stoves.[7 23–26] This study investigated UFGH use because this is the major predictor of concentrations of NO_2 in homes where the study was conducted.[5]

In this study we observed an association between UFGH use and wheeze, cough and dyspnoea. Furthermore, there were increased odds for reported wheeze and dyspnoea with increasing hours of UFGH use. Increased wheeze, cough and dyspnoea are commonly reported respiratory problems in previous studies,[25 27 28] although associations are not consistent.[23] A few cross-sectional studies have assessed respiratory symptoms and exposure to gas appliances in older people but the results are also conflicting.[10–13] Only two other panel studies have investigated relationships between indoor NO_2[29] or gas appliances[30] and daily respiratory symptoms in adults with asthma. Smith et al[29] reported associations between personal concentrations of NO_2 and symptoms in children with asthma but not in adults over the age of 50 years. Ostro et al[30] found an association between reported use of gas stoves and moderate to severe wheeze and cough in adults with asthma aged between 18 and 70 years. There was no stratification by age and therefore it is difficult to determine if older adults were more susceptible than younger adults.[30]

The increased odds of symptoms with UFGH use were observed mostly when compared with no heater use, although wheeze was also increased when compared with other heater use. There was evidence that any (UFGH and other) heater use was associated with increased dyspnoea and, therefore, other factors, such as indoor temperature, may be important. However, for wheeze and dyspnoea an exposure response with hours of UFGH, but not other heater use, was evident, suggesting that emissions from these heaters may be important. Emissions of combustion pollutants from UFGHs can remain high during the operation of the appliance.[3] Heater use and

Table 5 Adjusted relative percentage changes (95% CI), relative to subject mean, in PEF and FEV_1 by heater type

	Same day		Lag 1	
	Evening	Change morning—evening	Morning	Evening
PEF				
Days UFGH versus other heater used	0.71 (−0.19 to 1.61)	−1.13 (−2.15 to −0.12)*	−0.36 (−1.28 to 0.56)	−0.09 (−0.99 to 0.82)
Days UFGH used versus no heating	−0.50 (−1.39 to 0.38)	−2.53 (−3.58 to −1.49)*	−0.22 (−1.13 to 0.68)	0.14 (−0.77 to 1.06)
Days other heater used versus no heating	−1.21 (−1.79 to 0.45)	−0.78 (−1.76 to 0.20)	−0.38 (−1.16 to 0.41)	0.08 (−0.69 to 0.85)
FEV_1				
Days UFGH versus other heater used	0.43 (−0.53 to 1.38)	−0.92 (−1.98 to 0.14)	0.27 (−0.71 to 1.26)	−0.02 (−0.96 to 0.92)
Days UFGH used versus no heating	−0.31 (−1.24 to 0.63)	−1.77 (−2.82 to −0.71)*	−0.24 (−1.18 to 0.69)	−0.34 (−1.27 to 0.60)
Days other heater used versus no heating	−1.14 (−2.04 to 0.24)	0.84 (−1.90 to 0.22)	−0.27 (−1.20 to 0.65)	−0.18 (−1.09 to 0.73)

Adjusted for age, gender, exposure to tobacco smoke, exposure to cooking gas, ambient temperature, humidity and external NO_2 levels.
*Significant finding ($p < 0.05$).
UFGH, unflued gas heater; FEV_1, forced expiratory volume in 1 s; PEF, peak expiratory flow.

Table 6 Percentage (95% CI) lung function changes per hour of heater use

	Same day		Lag 1	
	Evening	Change morning—evening	Morning	Evening
PEF				
Hours of UFGH use (n=33 patients)	−0.08 (−0.25 to 0.08)	0.01 (−0.19 to 0.21)	−0.24 (−0.41 to −0.07)*	0.11 (−0.06 to 0.28)
Hours of other heater use (n=38 patients)	0.0 (−0.10 to 0.11)	0.00 (−0.13 to 0.14)	−0.02 (−0.13 to 0.09)	0.02 (−0.08 to 0.12)
FEV$_1$				
Hours of UFGH use (n=33 patients)	−0.06 (−0.23 to 0.11)	−0.05 (−0.26 to 0.16)	−0.21 (−0.38 to −0.03)*	0.03 (−0.14 to 0.20)
Hours of other heater use (n=38 patients)	−0.02 (−0.15 to 0.11)	−0.13 (−0.28 to 0.02)	−0.02 (−0.15 to 0.11)	−0.02 (−0.14 to 0.11)

Adjusted for age, gender, exposure to tobacco smoke, exposure to cooking gas, ambient temperature, humidity and external NO$_2$ levels.
*Significant finding (p<0.05).
UFGH, unflued gas heater; FEV$_1$, forced expiratory volume in 1 s; PEF, peak expiratory flow.

symptoms were recorded in the same diary and it is possible that this may lead to a reporting bias. However, if people were aware of the health effects of using UFGHs they would be less likely to use this type of heating.

In this study there were small but significant decreases in lung function associated with UFGH use. This included a decrease in the morning to evening change in PEF and FEV$_1$ on the days that UFGHs were used compared with days when other heaters were used or there was no heating. There were also small decrements in morning lung function (PEF and FEV$_1$) associated with increasing hours of UFGH use but not with increasing hours of other heater use. Data on the effect of NO$_2$ on lung function are inconsistent. Some epidemiological studies have reported small but significant decrements in lung function associated with exposure to NO$_2$[26] or gas appliances,[23][24] whereas others have found no association.[23] The findings of an across day change in lung function when using an UFGH may be analogous to a cross-shift effect. To some degree the results are consistent with a study by Ng et al,[26] who reported a decrease in PEF (3.4%) in non-smoking women with asthma after cooking on a gas stove. However, that study[26] found an actual decrease in lung function, while we observed a reduced increase in morning to evening lung function when compared with no heater and other heater use.

As with respiratory symptoms, we observed a dose—response relationship between lung function and hours of UFGH use, but not other heater use. Morning PEF and FEV$_1$ decreased with increasing hours of UFGH use on the previous day. Ng et al[26] also reported an association between increasing NO$_2$ levels during cooking and the post-cooking fall in PEF. An exposure—response relationship may indicate a real, albeit small, effect. As this was not evident with other heater use it is more likely to be related to combustion gases rather than indoor temperature. We did not have data on indoor NO$_2$ or temperature to investigate this further.

Patients in this study generally had mild to moderate symptoms and were still reasonably active. None of the patients were confined to their homes because of the severity of their disease. The effects of UFG appliances on older people with more severe symptoms or who are less mobile will be important to determine if this modifiable risk factor contributes to ongoing respiratory morbidity in older people.

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