WHO Indoor Air Quality Guidelines: Household Fuel Combustion

Review 9: Summary of systematic review of household kerosene use

Summary of published review and additional recent studies prepared by:
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Summary

Background
Kerosene (paraffin) is widely used for cooking, lighting and heating in low and middle-income countries (LMICs), and for heating in some developed countries. A number of epidemiologic studies have reported an increased risk of a range of serious respiratory and other disease outcomes associated with household use of this fuel.

Objectives and key questions
The aim of this review was to summarize the evidence, drawing primarily on a recently published systematic review, relating to the following key questions:

1. How is kerosene used in households, including technology types used for combustion, and fuel quality?
2. What types and levels of pollutants are emitted, and what area concentrations and personal exposure levels result?
3. What is the evidence for health risks, as reported from epidemiologic studies?

Methods
Since a systematic review addressing these questions was published in 2012, this review provides a summary and discussion of that systematic review. Included studies, up to December 2011, covered use of kerosene fuel, technologies and fuel type, emissions, micro-environmental levels, toxicology, epidemiology and health risks. English and Chinese language studies were eligible (no studies in Chinese identified). Meta-analysis of the epidemiologic studies was not carried out due to wide variation in health outcomes considered. The findings of four additional epidemiologic studies published since the completion of the review search period are also discussed.

Findings
In addition to studies on kerosene use, technologies, emissions and exposure, a total of 25 epidemiologic publications were identified. In LMICs, simple wick-type stoves and lamps are most commonly used, and result in considerably higher levels of most emissions than pressurized devices. Levels of $PM_{2.5}$ were found to exceed WHO air quality guidelines, substantially so with simple devices; guideline levels for some other pollutants may also be exceeded. The systematic review found suggestive evidence that kerosene use increased the risk of several adverse health outcomes, including cancer, respiratory infections and asthma, tuberculosis (TB) and cataract, but that methodological quality and results were highly variable. Overall, it was judged that, while the epidemiologic evidence overall was insufficient for conclusions to be drawn, the levels of emissions of and exposure to, health damaging pollutants were consistent with significant risk of adverse health outcomes. The additional recently published studies provided further evidence of statistically significantly elevated risks of adverse pregnancy outcomes and child acute lower respiratory infections (ALRI).

Conclusions
The use of kerosene in households, particularly with simple technologies which are commonly employed in LMICs, results in emissions of health-damaging pollutant at levels consistent with risks to health. The available epidemiologic evidence, although being insufficient for conclusions to be draw (and assessed as of low quality overall), finds some evidence of increased risk of multiple important disease conditions. These emission-related risks are in addition to those described for burns, fires and poisoning from kerosene (Review 10). Further research to describe and quantify the health risks is needed, and meanwhile, where cleaner and safer alternatives are available, a switch to these is to be encouraged.

1. Background

Kerosene has been used as a household fuel since the mid-19th Century. Today, in developed countries, electricity has reduced reliance on household-level kerosene use to low levels, but in low and middle-income countries, kerosene is still used regularly by many millions of households as a primary cooking fuel and as a primary lighting source. An indeterminate, but significant, further number of people rely on kerosene as a secondary source of household cooking and lighting energy. Worldwide, an estimated 500 million households still use kerosene for lighting.

Not uncommonly, kerosene has been advocated and/or classified (e.g. in research and surveys) as a "clean" alternative to biomass fuels for cooking, along with liquefied petroleum gas (LPG), biogas and electricity, as was the case with many of the epidemiological studies reviewed (Review 4: Health impacts of HAP). However, little research has been conducted to support this contention. There is in fact a growing body of evidence linking use of kerosene with a range of adverse health effects, particularly in low-income countries. These risks are in addition to the high risks already established for kerosene with burns, house fires and poisoning (Review 10: Safety).

Key questions

Given this background, the following questions were identified in order to inform recommendations on the household use of kerosene:

1. How is kerosene used in households, including technology types used for combustion, and fuel quality?
2. What types and levels of pollutants are emitted, and what area concentrations and personal exposure levels result?
3. What is the evidence for health risks, as reported from epidemiologic studies?

The main focus for these questions is low and middle-income countries, although evidence from developed countries – where relevant - would be included.

A recently published systematic review by Lam et al. addresses these questions by providing a thorough overview of the uses and health risks of this fuel, covering emissions, micro-environmental pollutant levels and exposure, and epidemiological evidence*(1)*. This review is summarized and discussed in the following sections, together with a small number of studies published following the systematic review search period.

2. Methods

The literature search was carried out using the following keywords: "kerosene," "kerosine," and "paraffin," combined with any of "epidemiology," "toxicology," "emissions," "respiratory," and "exposure,".

Further details of the search, including languages and numbers of epidemiological studies found (by disease outcome) are summarized in Box 1. Studies which investigated use of kerosene combined with other

Box 1: Systematic review of kerosene use, emissions and health risks [1]

- Period of search: to December 2011
- Databases: PubMed, Toxline and Web of Science; reference lists and internet search engines.
- Inclusion, use of fuel, technologies, emissions, micro-environmental levels, toxicology, health outcomes.
- Studies included (health outcomes): cancer (4); Respiratory symptoms (10); Asthma and allergic conditions (6); ALRI (2); TB (2); cataract (1).
- Languages: English, Chinese (no relevant publications were found in Chinese.

fuels were excluded.

3. Summary of emissions, exposure and toxicology

Kerosene is a transparent liquid, composed primarily of a mixture of hydrocarbon chains 6-16 carbon atoms in length. Naphthenes and aromatics are also present at smaller proportions. Two grades are generally available in developed countries for household use, 1-K and 2-K, depending on the level of impurities, particularly sulphur and aromatics. These impurities reduce combustion efficiency and increase the potential for generation of health-damaging products of incomplete combustion. In countries where kerosene is government-subsidized to make it more accessible to the poor, it is sometimes mixed with the more expensive diesel, as an automotive fuel.

Combustion of kerosene emits many health-damaging pollutants, including particulate matter (PM), carbon monoxide (CO), formaldehyde (CH_2O), polycyclic aromatic hydrocarbons (PAH), sulphur dioxide (SO_2) and nitrogen oxides (NOx). The emission rates and composition depend on the quality of fuel, and the device type, with the latter being the largest source of emission variability. For heating, convection and radiant heaters are used, with higher emissions of CO usually from the former and higher emissions of NOx generally associated with the latter. Emissions and micro-environmental pollutant measurement data for heating are reported in Lam et al. In summary, there is strong laboratory and field evidence that levels of fine PM, NO_2 and SO_2 can exceed WHO guidelines in homes using kerosene as a heating fuel.

For lighting, wick and pressurized lamps are available, with the former being most widely used in low-income countries. Lam et al report emissions and micro-environmental data for simple wick and hurricane (wick enclosed in glass column) lamps, and pressurized lamps (one study). In summary, although studies are few and none have measured concentrations in real-world settings, emissions are considerably higher for wick lamps. Micro-environmental (in-home) levels of PM can be substantial, with a range of 20-400 µg/m^3 $PM_{2.5}$ during use of wick lamps. The type of lamp, fuel quality, and flame condition (high vs. low) are important. Extended periods of time spent by the user in close proximity to the lamp may contribute to high exposures.

For cooking, either wick or pressurized devices are used, with wick stoves being more common and producing more emissions. Studies of kitchen and personal exposure levels found respirable PM in the range of 340 to more than 1000 µg/m^3, and CO also exceeding guideline levels under some conditions. A finding with potentially important implications for health risk was that the ratio of area PM concentration to personal PM exposure concentration was higher for kerosene users than biomass users, possibly due to differences in user-habits, such as kerosene users spending more time closer to the stove. Other studies have found genotoxic PAH and non-methane hydrocarbon (NMHC) emission factors (e.g. gPM/kg fuel burned) to be higher from kerosene than wood stoves, although total emissions of these pollutants are less due to the higher energy density of kerosene.

Toxicity is also reviewed by Lam et al, based on evidence from occupational and animal studies. Two aspects are considered, namely toxicity from exposure (dermal, inhalation, ingestion) of unburned fuel, and toxicity from combustion products. Notably, animals studies of combustion products report evidence of oxidative stress and tissue inflammation, with atherosclerotic changes and lung damage.

4. Epidemiology

The review by Lam et al. identified studies on cancer, respiratory conditions and eye disease, summarized in Table 1. For cancer, three were found on lung cancer, all reporting increased odds ratios (although one only after more than 30 years of kerosene use). One study reported a significantly increased risk of salivary gland cancer, although interpretation was difficult due to the few cases and multiple exposures included.

Ten publications reported investigations of a somewhat broad category of ‘respiratory symptoms and/or spirometry’. Although there was evidence of associations of kerosene use with wheeze and cough, and with reduced spirometric values, this was considered inconclusive due to inconsistencies, including variations in reference fuel categories, ages of the studied populations, and symptoms reported. Six studies were found that reported on risk of asthma and allergy. Findings were also inconsistent, constraining interpretation. For respiratory infections, two studies were identified on ALRI and two on TB, and in neither case were these pairs of studies consistent. Possibly reflecting relatively high personal exposures from lighting, one of the tuberculosis studies found an odds ratio (OR) of 9.43 (95% confidence interval [CI]: 1.45-61.3) for kerosene lamp use, but an OR of 3.36 (95% CI: 1.01-11.22) for kerosene stove use. Despite these findings, possible selection bias and the inconsistencies between studies prevented firm conclusions, and emphasized the need for further research.

Since completion of the review by Lam et al, four new studies have been published with additional evidence of links between kerosene use and adverse pregnancy outcomes, neonatal death and cataract. Lakshmi et al (2013) analysed the 2003-04 Indian district level household survey and reported adjusted odds ratios for stillbirth of 1.36 (1.10, 1.67), p=0.004 for cooking with kerosene, and of 1.15 (1.06, 1.25), p=0.001 for kerosene lamps.*(2)* Epstein et al (2013) analysed the Indian National Family Health Survey-3 and found adjusted effects of kerosene use on mean birth weight of -103 gm (-153.5, -59.4), p<0.001; and odds ratios for low birth weight of 1.51 (1.08, 2.12) and neonatal deaths of 2.88 (1.18, 7.02), p<0.05.*(3)* In a cross sectional study of 143 women in Nepal, Pokhrel et al (2013) reported a non-significant adjusted odds ratio for nuclear cataract with kerosene cooking of 5.18 (0.88, 30.38).*(4)* Finally, Bates et al (2013) reported from a cross-sectional study in Bhaktapur, Nepal, that risk of child ALRI with kerosene cooking was significantly increased in comparison with homes using electricity, with an OR of 1.87 (1.24, 2.83).*(5)*

5. Discussion and conclusions

5.1 Overall assessment of the quality of evidence

The systematic review on the health risks of kerosene use compiles evidence on fuel grade and devices used for cooking, heating and lighting, emissions of health damaging pollutants, area concentrations of pollutants in homes, and epidemiological studies of a range of health outcomes. Assessment of the quality of the available evidence takes account of all of this information in order to assess consistency of the epidemiological findings with what is known about the types and levels of emissions from various kerosene-using devices in common usage.

A reasonable number of studies are available for heating (7) and cooking (9), but only two for lighting, which provide evidence that micro-environmental levels of $PM_{2.5}$ and other health damaging pollutants can exceed WHO AQG levels. For simple wick devices, $PM_{2.5}$ levels were in the range 20-400 µg/m^3 for lighting and 340 to more than 1000 µg/m^3 for cooking. These levels of indoor pollutants can be expected to be lead to substantially increased risk of multiple adverse health outcomes.

A total of 25 epidemiological publications were identified from the systematic review, reporting on the risk of kerosene use mainly for cooking, with a few related to heating and lighting. Disease outcomes included (number of studies) were cancer [lung (3), salivary gland (1)], respiratory symptoms/spirometry (10), asthma and allergic conditions (5), ALRI (2), TB (2) and cataract (1). Due to the large amount of heterogeneity in study methods, quality and findings, as well as small numbers of studies for most of the outcomes, meta-analysis was not attempted, and grading (GEPHI) not applied. GRADE domains have been used as a guide to assessing quality. An additional four studies, published since completion of the systematic review, are also reported and discussed.

Study designs
All of the studies were observational, the majority (13) cross-sectional, with the remainder case-control. The majority were carried out in developing countries, with a few in more developed countries. Exposure comparisons were described according to fuel type, comparing kerosene with a range of other fuels, which included wood, other biomass and coal in some studies, and was not specified in five. Outcome assessment was variable, ranging from clinical diagnoses and spirometry, to reported symptoms.

Risk of bias
Ten of the studies did not adjust for confounding factors in their analysis. This, combined with the potential for exposure misclassification due to comparison of kerosene use with other polluting fuels (or unspecified comparison), suggests a potentially high risk of bias in a substantial number of the studies. These sources of possible bias apply across sets of studies reporting on most of the study outcomes, and for example, none of the three studies of lung cancer reported adjusted odds ratios.

Indirectness
The review combines indirect evidence (on pollutant emissions, micro-environmental (area) concentrations and human exposures) with direct evidence on risks for a range of adverse health outcomes. Thus, direct evidence (albeit of low quality) is available, and there is consistency between emissions of and exposure to health damaging pollutants and risk of disease.

Precision
The majority of studies included sufficient numbers of cases (case-control) and subjects (cross-sectional) for reasonable precision for all of the outcomes, although those with few participants less so. Precision of pooled estimates was not available as meta-analysis was not conducted.

Heterogeneity
Heterogeneity in key aspects of study design has been noted above. No formal assessment of statistical heterogeneity was carried out, but considerable variation in results for exposure to kerosene use was noted, both within and between studies.

Publication bias
No formal assessment of publication bias was conducted as outcomes were heterogeneous for some outcomes, and numbers of studies were too few for other outcomes. Unpublished studies were not included, but the search did seek Chinese language publications (although none were eligible).

Summary
The assessment of overall quality of the available evidence found quite extensive evidence that emissions from kerosene use for cooking, heating and lighting lead to levels of health-damaging pollutants which exceed WHO Air Quality Guidelines, and considerably so for use of wick-type devices. Available data for exposures from lighting were more limited than for

other uses. The epidemiological evidence appeared vulnerable to bias and demonstrated considerable heterogeneity in findings for several outcomes, and was assessed to be **low** quality. Overall, however, this evaluation found that the high levels of emissions of health damaging pollutants were consistent with elevated health risks, and further research should be conducted which avoids the limitations of many of the existing studies. A particular problem with many previous studies was that kerosene had been combined with other fuels in the data analysis and reporting of results. This prevented useful interpretation. It was also noted in this assessment that four studies published after completion of the systematic review found significantly increased risks for several health outcomes.

5.2 Conclusions

Kerosene remains widely used, particularly for lighting and cooking, in developing countries, but also as a heating fuel in some developed regions, notably Japan and some European countries. Combustion technologies vary, but the majority used for cooking and lighting in low income countries are simple wick-based types. Although fuel grade and contaminants (e.g. sulfur), combustion source and type (e.g. lamp or stove) and operator conditions impact emissions, there is ample evidence that use of household kerosene devices can lead to PM levels that exceed WHO guidelines, substantially so in developing country homes. Levels of CO, PAH, NO_2 and SO_2 may also exceed guideline levels. The epidemiological evidence, however, although addressing a range of cancer and non-malignant respiratory, allergic and ocular outcomes, does not yet allow strong conclusions nor reliably quantified risk estimates. There is some suggestion of increased risks of cancer, respiratory symptoms and infections (including TB), but interpretation is made difficult by inconsistent results, varying outcome definitions, and sometimes uncertain exposure comparisons.

Overall, however, the combination of widespread use, high levels of exposure to PM and other health damaging pollutants, and tentative epidemiological evidence suggests there should be strong concern about the possible or likely health impacts of kerosene combustion, in addition to the risks of burns, fires and poisoning discussed in 'Review 10: Safety'. In conclusion, the evidence does not support treating kerosene as a clean fuel option, in contrast to LPG, natural gas and electricity. Further research that addresses the limitations of current evidence on health risks of kerosene use is required. In the meantime, the use of cleaner and safer alternative fuels and technologies is encouraged.

Table 1. Summary of results for epidemiologic studies investigating kerosene use as a possible risk factor for health effects. Source *(1)* Reproduced with permission

Reference	Region, Country	Study Type	Number of Participants[#]	Kerosene Exposure	Comparison Fuel(s)	Results for Kerosene Use[‡]	Covariates in model
I. Lung cancer							
Leung (1977)	Hong Kong	CC	44/316 women	Cooking	NS	OR = 17.8 (6.2-70)[†]	Unadjusted
Chan et al. (1979)	Hong Kong	CC	189/189 women	Cooking	Wood, gas	OR = 1.51 (0.97-2.4)	Unadjusted
Koo et al. (1983)	Hong Kong	CC	200/200 women	Cooking	Mainly wood, grass, LPG, gas, charcoal	OR = 0.75 (0.32-1.70)[†]	Unadjusted
II. Salivary gland cancer							
Zheng et al. (1996)	Shanghai, China	CC	41/414 people 20-75 yrs	Cooking	Coal, gas	OR = 3.0 (1.4-6.8)	Age, gender, income, vegetables, liver consumption, silica exposure, head x-rays
III. Respiratory symptoms and/or spirometry							
Azizi & Henry (1990)	Kuala Lumpur, Malaysia	CS	1,414 children, 7-12 years	Cooking fuel used at home	NA	As % of predicted: FVC, 95.8 ($p<0.001$) FEV_1, 95.7 ($p<0.001$) FEF_{25-75}, 96.8 ($p > 0.05$) PEFR, 97.2 ($p<0.05$)	Height, weight, age, gender, school, passive smoking, mosquito coils, ethnicity, asthma, allergy, parental education
Azizi & Henry (1991)	Kuala Lumpur, Malaysia	CS	1,501 children, 7-12 years	Cooking fuel at home	NA	OR (95% CI) for chronic cough/phlegm, 1.2 (0.8, 1.7); persistent wheeze, 1.4 (1.0, 2.1); asthma, 1.3 (0.9, 1.7); chest illness, 1.0 (0.6, 1.7).	Unadjusted
Behera et al. (1994)	India	CS	3,318 women	Cooking	NA	As % of predicted: FVC, 76.7 FEV_1, 91.9 PEFR, 74.7	Unadjusted
Behera et al. (1998)	India	CS	200 school children, 7-15 yrs	Cooking fuel used at home	NA	PEFR as % of predicted: Boys, 67.6 Girls, 72.3	Unadjusted
Awasthi et al. (1996)	Lucknow, India	CS	650 pre-school children	Cooking at home	LPG	On day of interview, one or more of runny nose, cough, sore throat, breathlessness,	Remaining indoors during cooking, number sleeping

Reference	Region, Country	Study Type	Number of Participants[#]	Kerosene Exposure	Comparison Fuel(s)	Results for Kerosene Use[‡]	Covariates in model
						stridor, wheeze. OR = 0.87 (0.46-1.65)	in bedroom, income, cigarettes smoked indoors
Triche et al. (2002)	Connecticut & Virginia, U.S.A.	CS	890 infants, 3-5 months	Heating	No kerosene heating	RR (95% CI) for: wheeze episodes, 0.85 (0.59-1.21) wheeze days, 0.90 (0.64-1.25) cough episodes, 1.07 (1.00-1.15) cough days, 1.01 (0.93-1.10)	Other heating fuels, dwelling size, maternal asthma/allergies, mother's education, child's gender and birth season, no. children in household, breastfeeding.
Triche et al. (2005)	Connecticut & Virginia, U.S.A.	CS	888 women who gave birth	Heating	No kerosene heating	RR (95% CI) for 1 hr per day kerosene heater use: Wheeze, 1.06 (1.01-1.11) Tight chest, 1.02 (0.99-1.05) Laryngitis, 1.01 (0.97-1.04) Phlegm 0.98 (0.93-1.01) Cough, 1.01 (0.99-1.03) Nasal symptoms, 1.01 (0.99-1.03) Sore throat, 1.00 (0.97-1.02)	No. Children in house, multifamily dwelling, allergy, education, race, gas stove use, state of residence, fireplace use, gas space heater use, wood stove use.
Mallol et al. (2008)	Santiago, Chile	CC	100/100 13-14 yrs	Cooking or heating fuel at home	Gas, wood	For wheeze: OR = 1.3 (0.7–2.5)	Unadjusted
Bueso et al. (2010)	Honduras and El Salvador	CS	1,827 children, mean age 13 ± 1.2 months	Cooking fuel	Electricity	OR (95% CI) for: wheeze, 1.95 (0.85-4.44); recurrent wheeze, 2.78 (0.95-8.25)	Electric fans, water supply, flooring, education, employment, dust in home, area pollution, mold on walls, people in household.
Mustapha et al. (2011)	Nigeria	CS	1,397 children, 7-14 yrs	Cooking fuel	Gas	OR (95% CI) for: wheeze (12 mo), 0.57 (0.16-2.12) night cough (12 mo) 1.76 (0.75-4.13) Asthma (ever), 0.13 (0.01-1.78) Phlegm (rainy season) 2.83 (0.85-9.44) Rhinitis (ever) 1.26 (0.53-3.00)	Traffic near home, pollution around home, other cooking fuels, smokers in household, crowding, pets, child's age and gender.
IV. Asthma and allergic conditions							
Azizi et al. (1995)	Kuala Lumpur, Malaysia	CC	158/201 Children 1-60 months	Stove at home	Other stove	For asthma: OR = 0.90 (0.50-1.60)	Unadjusted

Reference	Region, Country	Study Type	Number of Participants[#]	Kerosene Exposure	Comparison Fuel(s)	Results for Kerosene Use[‡]	Covariates in model
Mohamed et al. (1995)	Nairobi, Kenya	CC	77/77 children, 9-11 years	Cooking fuel at home	Wood, charcoal, gas, electricity	For asthma: OR = 0.82 (0.38-1.77)[†]	Unadjusted
Ng'ang'a et al. (1998)	Kenya	CS	1,226 children, 8-17 years	Cooking fuel at home	Charcoal, gas, electricity	For exercise-induced bronchospasm: OR = 1.17 (0.74-1.84)	Age, gender, breast feeding, family history of asthma, domestic animals, ventilation, parental education, vehicle exhaust exposure, urban/rural residence
Venn et al. (2001)	Jimma, Ethiopia	CS	9,844 people	Cooking	Biomass, gas, electricity	OR (95% CI): skin sens 1.95 (1.02, 3.73). wheeze, 1.55 (1.01, 2.38) rhinitis, 2.57 (1.76, 3.75) eczema, 2.99 (1.78, 5.04)	Age, gender, socio-economic status based on family occupation
Dagoye et al. (2004)	Jimma, Ethiopia	CS	7,155 children, 1–4 years	Cooking fuel at home	Biomass	Wheeze and daily use: OR = 3.36 (1.77-6.36)	Age, gender.
Golshan et al. (2002)	Isfahan, Iran	CS	561 females, 1 month to 85 years.	Portable stoves for cooking and heating	NA	OR (95% CI) for: ever asthma, 5.01 (1.45-17.32) current asthma, 62.4 (7.49-520) chronic bronchitis, 1.27 (1.02-1.66)	Age, history of pulmonary infection, bread baking, family size, wood fuel use.
V. Acute lower respiratory infections							
Sharma et al. (1998)	Delhi, India (2 slums)	CS	642 infants < 1 year	Cooking fuel at home	Wood	Kusumpur Pari: OR = 0.95 (0.59,1.52)[†] Kathputly: OR = 1.98 (1.1.4, 3.45)[†]	Unadjusted
Savitha et al. (2007)	Mysore, India	CC	104/104 children, 1 month to 5 years.	Cooking fuel at home. Lighting.		Cooking: OR = 0.15, exact 95% CI: 0.04-0.43 Lighting, OR = 19.4, exact 95% CI:5.7-101.	Unadjusted
<u>VI. Tuberculosis</u>							
Pokhrel et al. (2010)	Pokhara, Nepal	CC	125/250 women 20-65 yrs	Cooking Lighting	Gas Electricity	OR = 3.36 (1.01–11.22) OR = 9.43 (1.45–61.32)	Age, religion, income, area, literacy, house type, smoking, alcohol consumption, vitamin supplements, family TB history, kitchen ventilation.

Reference	Region, Country	Study Type	Number of Participants#	Kerosene Exposure	Comparison Fuel(s)	Results for Kerosene Use‡	Covariates in model
Lakshmi et al. (2010)	Chandigarh, India	CC	126/252 women,	Cooking	LPG	OR = 0.49 (0.21-1.20)	Age, education, kitchen type, family TB history, smoker in family
VII Cataract							
Pokhrel et al. (2005)	Nepal/India	CC	206/203 women 35-75 yrs	Lighting	Electricity	OR = 1.37 (0.81–2.32)	Age, stove type, kitchen ventilation, literacy, work outside, incense use.

† Calculated from data in paper
‡ Parentheses contain 95% confidence intervals for relative risk estimates (including odds ratios)
# Number of cases/number of controls (for case-control studies)

Key:
CC Case-control study
CS Cross-sectional study
FEF_{25-75} Forced expiratory flow 25-75%
FEV_1 Forced expiratory volume in one second
FVC Forced vital capacity
NA Not applicable
NS Not specified
OR Odds ratio
PEFR Peak expiratory flow rate

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