**World Health Organization**

 **INDOOR AIR QUALITY GUIDELINES: HOUSEHOLD FUEL COMBUSTION 2014**

**A “Cut and Paste” Summary**

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**PM levels have to be very low to protect health**

1. Among the key findings is that for several important health outcomes, including child acute respiratory infections, exposure to the key pollutant– fine particulate matter, or PM2.5 – needs to be brought down to low levels in order to gain most of the health benefit. The other main finding is that most of the solid fuel interventions promoted in recent years have not even come close to these levels when in everyday use, and there is a need for much more emphasis on accelerating access to clean household fuels. ( pg. XIV)

**Avoid the use of coal and kerosene**

1. The need to avoid the use of unprocessed coal as a household fuel, in light of the specific health risks. The need to avoid the use of kerosene as a household fuel, in light of concerns about emissions and safety. (pg. XV)

**4.3 million deaths (indoor pollution)**

1. Global burden of disease estimates have found that exposure to HAP from cooking results in around 4 million premature deaths *(2,3)*, with the most recent estimates from WHO reporting 4.3 million deaths for 2012. *(4)*. HAP is responsible for nearly 5% of the global disease burden (expressed as disability-adjusted life-years (DALYs)), making it globally the single most important environmental risk factor *(3)*. (pg. 1)

**0.4 million deaths (outdoor pollution)**

1. HAP is also a substantial contributor to outdoor air pollution-related deaths due to emissions into the ambient environment, responsible for around 0.4 million deaths (12% of the total from ambient air pollution (AAP)) *(3)*. (pg.1)
2. **Summary of published WHO air quality guideline values** (OUTSIDE AIR)

Pollutant PM2.5 (μg/m3)

Mean concentration

24 hours: 25 μg/m3

Year: 10 μg/m3

Pollutant CO (mg/m3)

Mean concentration

8 hours: 10 mg/m3

24 Hours: 7 mg/m3 (pg. 11-12)

**Model used to approximate indoor pollution**

1. The input data used for the model were obtained from measurements made in India, and are summarized in Table 2.4.

Air exchange rate (α) per hour **15**

Kitchen volume (V) m3 **30**

Device burn time hours per day **4**

The **single zone** model, which assumes that the pollutant emitted into room air is uniformly mixed throughout the space. Concentration is determined by emission rate and a number of other factors that can be incorporated into the model, including duration of combustion, room volume and air exchange rate.

Single zone models have been applied in work on household energy and air pollution for around 30 years, and this approach was adopted for the current purposes. (pg.23)

**Strength of recommendation**

The strength of the recommendationwas set as either:

• **strong**: the guideline development group agrees that the quality of the evidence combined with certainty about the values, preferences, benefits and feasibility of this recommendation means it should be implemented in most circumstances;

or

• **conditional**: there was less certainty about the combined quality of evidence and values, preferences, benefits and feasibility of this type of recommendation meaning there may be circumstances or settings in which it will not apply.

**Recommended emission rate: PM and CO per minute**

1. Scoping question 1: What device and fuel emission rates are required to meet

WHO (annual average) air quality guidelines and interim target-1 (IT-1) for

PM2.5 and the (24-hour average) air quality guideline for CO?

Recommendation Emission rate targets

Strength of Recommendation: strong

PM2.5 (unvented) 0.23 (mg/min)

PM2.5 (vented) 0.80 (mg/min)

CO (unvented) 0.16 (g/min)

CO (vented) 0.59 (g/min) (pg.34)

1. These ERTs will result in 90% of homes meeting WHO AQG values for PM2.5 (annual average) and CO (24-hour average). This assumes model inputs for kitchen volume, air exchange rate and duration of device use per 24 hours, as set out in Table R1.1.

Intermediate emission rate targets (IERTs) show the rates that will result in 60% of homes meeting IT-1 for PM2.5 (Table R1.2) and 60% of homes meeting the 24-hour AQG for CO (Table R1.3). The value of 60% is arbitrary, but was selected so that a majority of homes would meet the specified guideline level.

Separate guidance is provided for unvented and vented stoves as those technologies with chimneys or other venting mechanisms can improve indoor air quality through moving a fraction of the pollutants outdoors. (pg. 35)

 **Intermediate Emission rate targets**

*Unvented PM 2.5*

Intermediate ERT 1.75 mg/min

*Vented PM 2.5*

Intermediate ERT 7.15 mg/min

 **Intermediate Emission rate targets**

*Unvented CO*

Intermediate ERT 0.35 g/min

*Vented CO*

Intermediate ERT 1.45 g/min (pg.36)

**Outdoor and indoor cooking**

1. There are many areas where outdoor or semi-outdoor cooking is prevalent, for which ventilation is clearly greater and would result in a higher percentage of homes meeting the AQGs than those estimated for the ERTs. Studies show that people cooking outdoors still receive high exposure when using traditional stoves. Furthermore, as previously discussed, emissions to the outdoor environment reduce community ambient air quality, which in turn contributes to lower indoor air quality. Thus, although the emission rate targets apply to indoor environments, maximizing protection can only be achieved if all devices meet these targets regardless of indoor or outdoor usage. (pg. 39)

**The need for chimneys**

Evidence provided in the systematic review of *Intervention impacts on HAP and exposure* (Review 6) demonstrated that despite achieving large percentagereductions of PM2.5 compared to baseline (solid fuels with traditional stoves)none of the improved solid fuel stoves reviewed reached the WHO IT-1 forannual average kitchen PM2.5 (and therefore did not meet the AQG). A few types of vented (chimney) stoves did reach levels close to WHO IT-1, in the range of 40–60 μg/m3. These findings can be used as a guide to the current in-field performance of a range of technology and fuel options. (pg.45)

**Multiple stove use continues**

1. A common finding was that many (if not most) households continue to use the existing device or fuel when a new one is introduced, for cultural and practical reasons such as lack of affordability and uncertain supply in the case of a commercial fuel such as LPG. An important conclusion therefore was that for most households, the transition to exclusive use of very low emission devices and fuels will occur over time, with a progressive shift towards a higher proportion of energy usage provided by the newer, cleaner options. It is also the case that in more economically challenging conditions, households may revert to increased use of traditional stoves and fuels. (pg.46)

**CO achievable**

1. The systematic review of the impacts of interventions found that most of these achieved CO levels below the 24-hr WHO guideline of 7 mg/m3. (pg. 47)

**Coal use not advisable**

1. Scoping question 3:Should coal be used as a household fuel?

Recommendation

Strength of recommendation: Strong

Unprocessed coal should not be used as a household fuel.

Summary of evidence

The evidence for this recommendation is drawn from the following sources:

a) Assessment by IARC of the carcinogenicity of emissions from household combustion of coal;

b) systematic reviews of risk of specific outcomes with household use of coal, and evidence from the IER function relating PM2.5 exposure level to lung cancer risk; systematic review of health risks associated with toxic contaminants in coal. (pg. 49)

**Kerosene use is discouraged**

1. Scoping question 4:Should kerosene be used as a household fuel?

Recommendation

Strength of recommendation: Conditional

The household use of kerosene is discouraged while further research into its health impacts is conducted. (pg.53)

Remarks:

a) Existing evidence shows that household use of kerosene can lead to PM levels that exceed WHO guidelines, substantially so in developing country homes using simple unvented combustion technologies (e.g. wick cookstoves and lamps). Levels of CO, NO2, polyaromatic hydrocarbon (PAH), and SO2 may also exceed guideline levels provided in *Air quality guidelines - global update*

*2005* or *WHO Guidelines for indoor air quality: selected pollutants (13, 14).*

b) Epidemiological evidence on risks of respiratory and other health outcomes is currently not conclusive.

c) The risk of burns, fires and poisoning, associated with the use of kerosene in

LMICs is a cause for concern.

d) For this recommendation, a low quality of evidence was available for disease risks from kerosene combustion emissions, and a moderate quality of evidence for safety risks with kerosene use. (pg.53)

**Climate change and health**

1. While there are opportunities for synergy between climate policies and health, policies will need to be carefully designed to obtain these synergies and avoid unintended adverse effects on climate and/or health. Thus there is a need for research to support the development of co-control policies (Table R.5.1). (pg.57)

**Solid fuel stoves important**

1. As recognized in these guidelines, and specifically in Recommendation 2, which addresses policy during transition, improved solid fuel stoves will continue to make an important contribution to the needs of a substantial proportion of lower income and rural homes where primary use of clean fuels is not feasible for some time to come. Work to develop substantially improved solid fuel stoves should continue in parallel with, but not hinder or displace, efforts to encourage transition to clean fuels. The contribution of solid fuel stoves to the mix of devices and fuels promoted will depend on the completeness of combustion that can be achieved when such technologies are in everyday use (as demonstrated through emissions testing), and the consequent reductions in health risks. (pg.62)

**Levels of CO and PM higher than expected in clean fuel studies**

1. Even allowing for variability and differing circumstances, it is clear that the measured levels of PM and CO in homes using clean fuels are much higher than predicted. This does not undermine the model, but points towards other explanations. These include continued use of the traditional stove (even in stove/fuel evaluation studies), along with the new one (known as stacking), other emission sources in and around the home (kerosene lamps, waste burning), and external sources such as fuel combustion from other homes and other sources of combustion contributing to outdoor air pollution entering all homes. (pg.123)

**Model based on 75% of pollution going up the chimney**

1. The emissions model allows for ventilation (with a flue or chimney) by assuming (based on empirical data from several studies and countries) that the fraction of total emissions entering the room lies between 1% and 50% with a mean of 25% and standard deviation of 10%. On average, therefore, it is expected that emissions entering the room from vented stoves are 75% lower than with unvented stoves. (pg.123)

**Importance of Regional Centers**

1. Most testing results to date (see Stove Performance Inventory Report 20121 and Clean Cooking Catalog http://catalog.cleancookstoves.org) have come from laboratories in developed countries. More laboratory and field testing capacity is needed, especially in developing countries where the use of solid fuels for cooking and the resulting household air pollution (HAP) are major concerns. Developing capacity by setting up regional testing and knowledge centers (RTKCs) is ongoing through grants and training workshops. The aim is to establish sustainable institutions that can provide high quality testing services and catalyze regional activities. These centers are working together as a consortium to standardize methods and establish best practices and common data formats to share testing results. (pg.150)