SUMMARY

This study has generated the relative risk for ALRI in children under five living in households using biomass fuel. These children had 1.38 times higher risk than children living in households using clean fuel. Given the use of biomass fuels for household energy and high prevalence of ARI in children in India, the findings of this study has strengthened growing evidence of significant health impacts. There was no association found between biomass use and pulmonary TB in this maiden attempt of examining the association in this region. This merits further exploration. The prevalence rate of COPD in this study is 2.44% in rural women. This is the first ever cross-sectional population based study that has estimated the COPD prevalence in non-smoking rural women, using objective lung function measurements in addition to clinical criteria.

IMPLICATION FOR THE STUDY OUTPUTS:

With household solid fuel use being a largely developing country issue with strong regional differences, it is anticipated that health indicators will have to rely on studies largely executed in specific regions of individual countries.

The study has contributed by providing large scientific database of health data and has also developed methods and protocols for large scale health assessments related to ALRI, TB and COPD for future applications in similar areas of research.

Currently, only two widely recognized environmental exposure indicators for population level household environmental health exist, both of which are

related to water quality and hygiene: levels of access to clean water and to sanitation. These are reported annually and separately for rural and urban areas by nearly every country, and are commonly cited as measures of ill-health risk and indicators of poverty.

This study provides new indicator for household air-quality-related hygiene: type of fuel use, though not an ideal measure of true exposure and risk, but has the extremely important benefit of being easily and cheaply determined by rapid surveys requiring no measurements.

Biomass will remain the principal cooking fuel for a large majority of rural households for many years to come. Hence, an effective mitigation strategy should employ a variety of options, from improvements in fuels and cooking technologies to housing improvements, such as kitchen configuration and ventilation conditions, to facilitating behavioral changes among women, children, and other household members (e.g., keeping children away from smoke).

Epidemiological studies such as what has been accomplished in this study paves the way for understanding opportunities for intervention design as well as in monitoring and evaluation of intervention effectiveness. Moreover, it is difficult to estimate the effectiveness of an intervention in situations where pre intervention estimates of health parameter is inadequate, which requires a demanding study design and analysis to examine or quantify causal associations (Arnold B). This study information in biomass using populations is also useful for future cross-sectional assessments that may be used to assess intervention efficacy or for making comparisons with other populations to frame an intervention.

Improved awareness among the study participants regarding respiratory illness and Indoor air pollution and several other risk factors during the study. This awareness was provided while interviewing the household members – Co-benefits.

Integration of the results from this study with exposure studies will help in *refining Burden on Disease estimates* that are attributable to indoor air pollution.Relative risk generated from this study can be used in the *future Comparative Risk assessment* undertaken by WHO - Burden on Disease estimates. Most disease burden calculations have to rely on routinely collected secondary health data to estimate baseline prevalence. These estimates are often aggregated at the national level, masking differences that may exist across states in India both in terms of exposures and outcomes. An increasing body of exposure information now available on solid fuel using households across multiple states in India show that 24-hr household concentrations of particulates from biomass combustion may range from 200 to 2000 µg/m^3 resulting in substantial differences in individual exposure across geographical regions (Balakrishnan K et al., 2002, 2004& 2006). With an increasing body of prevalence information across regions (states) where concomitant indoor pollution measurements are being made, it may be possible to increase the resolution of the association between biomass use and ARI incidence across a continuum of population exposures, this may then be used to inform national or regional burden of disease estimates in consistent ways that relate prevalence and attributable disease burdens to exposures.

High incidence of ARI in children under the age of five observed in this study highlights the *importance of the implementation of eradication programme and interventions* effectively in the rural community. The baseline

prevalence information generated in this rural population is also useful for future cross-sectional assessments that may be used to assess intervention efficacy or for making comparisons with other populations to frame an intervention. This study points out to the imminent need for interventions such as health education to avoid potential translation of repeated ARI into irreversible damage of the respiratory parenchyma which will affect their lung functions in adulthood.

The future health research priorities in the field of Indoor air pollution are integrating quantitative exposure and health studies. Most of the health studies used for burden of disease estimations used quantitative exposure metrics. The burden of disease has been estimated using odds ratios of adverse health outcomes in solid fuel users with respect to "clean fuel" users. The definitions of this "counterfactual" level of exposure are yet to be resolved in consensual ways. There is a large base of quantitative exposure information that has recently become available across multiple states in India but they are yet to be applied in health studies. The exposure and the health studies on IAP have largely remained separate from each other. While exposure assessment may add substantial costs limiting feasibility, future health studies that use a combination of measurements in a nested sub-set of health assessment households together with exposure models, are needed to close the gaps and minimize exposure misclassification.

Implementation of interventions and assessment of effectiveness of interventions: Biomass will remain the principal cooking fuel for a large majority of rural households for many years to come. Interventions like improved stove which will ensure more complete combustion of fuel and consideration of installation of chimneys to be considered. Studies from Guatemala, Kenya

have reported 50 -60%% reduction in PM2.5 concentrations in households using improved plancha chimney wood stove (Bruce et al., 2002; Zhang and Smith, 1999). Bruce et al 2002 reported that while the concentrations were reduced by 75%, the 24 hours average exposure of women reduced only by 35% and still remained high as women stayed most of the time in the kitchen area presumably resulting in high exposures. This confirms that providing improved stoves alone cannot be a single option in reducing the pollutants exposure but also the behavior pattern seem to be important determinant of exposure. The role of kitchen configuration, ventilation and behavior are also important determinants of exposure in addition to stove intervention.

In the reality of rural life, complete or substantial switching to cleaner fuels is rare, and people continue to rely on biomass fuels. Hence, an effective IAP mitigation strategy should employ a variety of options, from improvements in fuels and cooking technologies to housing improvements, such as kitchen configuration and ventilation conditions, to facilitating behavioral changes among women, children, and other household members (e.g., keeping children away from smoke) as given in the Table 19.

Table 19: Interventions for Reducing Exposure to Indoor Air Pollution

Source: Disease Control Priorities in Developing Countries, second edition, 2006,

*Genetic Studies:*The role of gene-environment interactions is in the nascent stage for air pollution related health effects. While some candidate biomarkers of exposure and early biological effect (in response to carcinogenic insults) have been identified in laboratory studies, they have not been widely applied in epidemiological studies. The role of some air toxics in carcinogenicity and single nucleotide polymorphisms in susceptibility remains largely unexplored in exposure settings commonly encountered in India.

*Studies in urban population***:** However, while most of solid fuel use related exposures occur in the rural indoors, the use and accompanying high exposures is not uncommon among the urban poor who may be receiving double burdens from polluted outdoor and indoor air. These populations living in meager dwellings often on roadsides face dual risks from indoor and outdoor emissions. Very limited information data is currently available however, to assess the scale and levels of such exposures. Community school programs in India that provide free noon meals to children continue to use

biomass fuels to cook in kitchens often situated adjacent to classrooms. Exposures from biomass fuels are therefore not limited rural household settings. Very limited information data is currently available however, to assess the scale and levels of such exposures.