Indoor Air Pollution and Child Health in Pakistan

Report of a seminar held at the Aga Khan University, Karachi, Pakistan 29 September 2005

World Health Organization

This report was prepared by Dr Tauseef Ahmad Khan (Aga Khan University) and Dr Anita KM Zaidi (Aga Khan University), with input from the presenters and teams.

WHO wishes to thank Aga Khan University, Karachi, for hosting this workshop, and especially Dr Anita KM Zaidi for the major role played in organizing it. WHO is grateful to the Departments of Paediatrics (Prof. Z.A. Bhutta, Dr. A. Zaidi. Dr T.A. Khan) and Community Medicine (Prof. M. Kadir; Dr Z. Fatmi, Dr R. Siddiqui) for supporting the seminar.

Cover picture: House with an open fireplace, Northern Areas, Pakistan. (C) BACIP.

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Executive summary

Indoor air pollution (IAP) is one of the major risk factors for pneumonia related morbidity and death in children world-wide. It is also associated with other adverse health outcomes in children such as low birth weight and chronic bronchitis, and with lung cancer, cataract and possibly cardiovascular disease in adults. Biomass fuel (wood, crop residues, animal dung) which is being used in four fifths of all households in Pakistan is the major source of IAP when it is burned for cooking, space heating and lighting homes. Biomass is mostly burned in inefficient three-stone stoves leading to incomplete combustion and high levels of indoor air concentration of smoke. There is a dearth of scientific studies in Pakistan to relate IAP to health effects; consequently IAP is not a recognized environmental hazard at policy level.

A one day seminar was held at The Aga Khan University (AKU), Karachi, to raise awareness of household energy issues, indoor air pollution and its effect on child health. Participants discussed global evidence regarding health impacts of IAP, the role of energy utilization in alleviation of poverty, and possible interventions to improve child health outcomes in the context of sustainable development. The seminar was attended by over 400 participants from a wide range of organizations including NGOs involved with dissemination of fuel efficient stoves and health education, policy makers, international agencies and funding bodies. Presentations ranged from topics related to the situation of indoor air pollution and household energy issues globally and in Pakistan, to local initiatives such as fuel-efficient stoves and promotion of liquefied petroleum gas. Fuel-efficient stoves and cooking devices used by various non-governmental organizations in Pakistan were displayed in a related exhibition. During the final session, participants developed follow-up action points to raise awareness about indoor air pollution in Pakistan and develop locally acceptable and sustainable solutions. The event was covered in the press, television and radio.

The seminar was followed by a three day workshop for 20 participants from selected NGOs and academic institutions to develop proposals for research projects for selected sites to document the impact of interventions on air pollution on child health and social and economic circumstances of households.

Background

Indoor air pollution is one of the major risk factors for pneumonia and deaths from pneumonia in children, and also associated with other adverse health outcomes such as low birth weight and chronic bronchitis in children and lung cancer, tuberculosis, cataract and possibly cardiovascular disease in adults. Biomass fuel is the major source of IAP when it is burned for cooking, space heating and lighting homes.

Biomass is the major fuel used for cooking and heating in Pakistan, accounting for about 86% of total household energy consumption. Wood, crop residues and animal dung are the major sources of biomass fuels used in Pakistan. Biomass is mostly burned in inefficient three-stone stoves leading to incomplete combustion and high levels of indoor air concentration of smoke containing particles and harmful gases (CO, NO_x). There is dearth of scientific studies in Pakistan to relate IAP to health effects. IAP is not a recognized environmental hazard at policy level. Therefore, generally, few efforts have been undertaken in this regard so far in Pakistan.

The WHO Department of Child and Adolescent Health and Development recently commissioned a review of the situation in Pakistan, a country with both a high childhood pneumonia burden and high biomass fuel use.[1] This review was used as a background paper for the workshop.

[1] http://www.who.int/child-adolescent-health/New_Publications/CHILD_HEALTH/DP/WHO_FCH_CAH_05.06.pdf

Objectives of the seminar and subsequent workshop

The seminar was convened to:

- Raise awareness of household energy issues and indoor air pollution and its effect of health at policy level.
- Identify and discuss possible and locally acceptable interventions for improving indoor air pollution in the context of development projects.

The seminar was followed by a 3-day workshop with selected research and implementation organisations to:

- Develop proposals for research projects for selected sites to document the impact of the improvement of indoor air pollution on health, particularly child health.

Content of the presentations

Opening

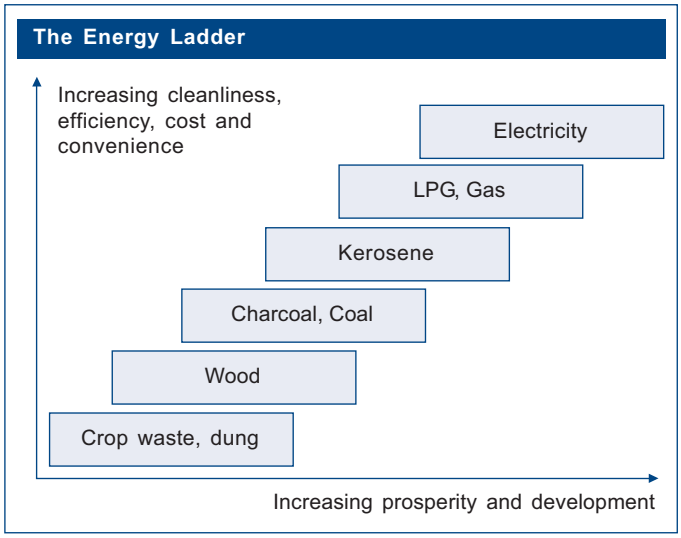
Dr Muhammad Khurshid, Dean Medical College and Professor Zulfiqar Ahmed Bhutta, Department of Paediatrics of The Aga Khan University, Karachi, welcomed all the participants on behalf of AKU.

Dr Hadi Bux Jatoi, Director General Health, Sindh, was the invited chief guest. A message was read on his behalf in which he sent a warm welcome to all the guests, including national and international experts who had gathered to try to solve problems of child health resulting from breathing heavily polluted air in their homes. He emphasized the importance of education and development to improve the health of people and highlighted the damage to the environment caused by cutting down of trees for firewood. The minister thanked all the participants at the end and hoped that they may come up with possible interventions for improving indoor air pollution in Pakistan.

To set the scene, Dr. Martin Weber, WHO, Geneva, gave an overview on the global situation of deaths in children under 5 years of age, and risk factors for deaths, of which indoor air pollution was one of the most important ones.

The health burden of indoor air pollution: Overview of the global evidence

Dr Nigel Bruce
Division of Public Health
University of Liverpool
Email: ngb@liv.ac.uk



Around half of the world's population still rely on solid fuels for their everyday household energy needs, some 2.4 billion on biomass (wood, animal dung and crop wastes) and 0.5 billion on coal (mainly in China). Globally, the use of these fuels is closely associated with poverty. Used mainly in open fires and simple stoves, often indoors, this leads to emissions of high levels of air pollutants with known adverse effects on respiratory and other organ systems. Women and young children are especially vulnerable to this pollution due to the role of women as cooks and principal carers of infants and young children. There is now mounting evidence linking this exposure to a number of important health outcomes. The strongest evidence exists for childhood acute lower respiratory infections (ALRI), chronic obstructive pulmonary disease (COPD) and lung cancer (where coal is used).

Other conditions with fewer studies and less consistent evidence include TB, asthma, cataract, low birth weight, stillbirth, cancer of the upper aero-digestive tract, and interstitial lung disease. Evidence from developed countries suggests that the risk of cardiovascular disease may also be increased. One limitation of almost all of this evidence is that exposure has not been measured directly, but instead assessed through proxies such as the type of fuel/stove used, or time spent near the stove. A consequence of this is that the relationship between exposure and risk cannot easily be quantified.

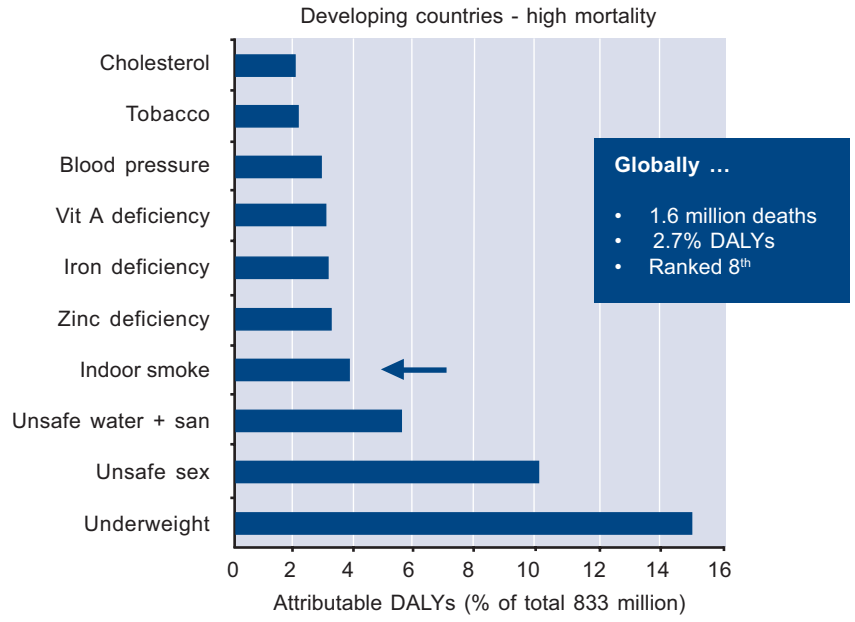
Women carrying firewood for cooking purpose

© Nigel Bruce

The use of solid fuels impacts on poor households in a number of other ways. Open fires place children at risk of burns. The requirement for firewood contributes to environmental damage in conditions of high population pressure and other demands on forests including building and agricultural land. A gender perspective highlights the ways in which household energy uses impacts mainly on the health and well-being of women. Reliance on inefficient and polluting energy systems also impacts on opportunities for development through constraints on income generation and issues such as poor lighting.

The overall burden of disease arising from the use of solid fuels was recently estimated as part of the WHO comparative risk assessment. Requirements that only robust evidence and direct impacts of indoor air pollution be included meant that just three health outcomes could be included: ALRI, COPD and lung cancer.

Indoor smoke 4th in global ranking of risk factors for Burden of disease in developing countries



Total estimates of 1.6 million excess deaths, and 2.7% of global disability-adjusted life years (DALYs) lost placed solid fuel use eighth in the global ranking of risk factors, and fourth among high maternal and infant mortality countries. Key epidemiological research priorities include the need to strengthen evidence on reductions in risk of the most important outcomes (particularly ALRI) achievable through feasible interventions, and to establish more firmly the links with birth weight and perinatal mortality which would add substantially to the attributable disease burden for solid fuel use. However, the evidence that is already available on health and other impacts of solid fuel use demands greater research, development and policy efforts to improve access of poor communities to cleaner and more efficient energy systems.

Table 1

Summary of evidence linking solid fuel use in developing countries to a range of health outcomes, set out according to whether or not evidence was sufficient to contribute to burden of disease estimates.

Health outcome	Age/sex	Status of evidence
Evidence sufficient to contribute to burden of disease calculation:		
Acute lower respiratory infections	< 5 years	**Strong** Some 15-20 observational studies for each condition, from developing countries. Evidence is consistent (significantly elevated risk in most, though not all, studies), the effects are sizeable, plausible, and supported by evidence from outdoor air pollution and smoking.
Chronic obstructive pulmonary disease	Adult women	
Lung cancer (coal exposure)	Adult women	
Chronic obstructive pulmonary disease	Adult men	**Moderate - I** Smaller number of studies, but consistent and plausible
Lung cancer (coal exposure)	Adult men	
Evidence not yet sufficient to contribute to burden of disease calculation:		
Lung cancer (biomass exposure)	Adult women	**Moderate – II** Small number of studies, not all consistent (especially for asthma, which may reflect variations in definitions and condition by age), but supported by studies of outdoor air pollution, smoking and laboratory animals.
Tuberculosis	Adult	
Asthma	Child and adult	
Cataracts	Adult	
Adverse pregnancy outcomes	Perinatal	**Tentative** Adverse pregnancy outcomes include low birth weight and increased perinatal mortality. One or a few studies at most for each of these conditions, not all consistent, but some support from outdoor air pollution and passive smoking studies.
Cancer of upper aero-digestive tract	Adult	
Interstitial lung disease	Adult	
Ischaemic heart disease	Adult	Several studies from developed countries have shown increased risk of exposure to outdoor air pollution at much lower levels than IAP levels seen in developing countries. As yet, no developing country studies.

The health and demographic impact of biomass fuel use: A cross country comparison

Anita K. M. Zaidi,
Department of Paediatrics,
Aga Khan University
Karachi, Pakistan

Over 50% of the world's population still relies upon traditional biomass fuel to fulfill their energy needs. The presentation examined the serious health, gender, and demographic consequences of traditional biomass fuel use. It was hypothesized that exposure to indoor air pollution in the form of particulate smoke generated by burning biomass may lead to high levels of infant and child mortality from acute respiratory infections and through other mechanisms. Using national data to make cross-country comparisons, it can be shown that biomass fuel consumption is highly correlated with infant and child mortality rates, even after controlling for income, education, and other variables. While our analysis does not assess whether relationship is causal, the empirical evidence suggests that traditional energy use patterns are associated with high mortality rates in developing countries that rely heavily on biomass fuels. High mortality rates may, in turn, lead to high levels of fertility because of both the perceived "need" to replace children and risk aversion. The effect on fertility may be compounded by the utility derived from children's important labour contributions in gathering biomass fuel.

Thus the use of traditional biomass fuels may delay the demographic transition from patterns of high mortality–high fertility to patterns of low mortality–low fertility. These findings have important implications for the development of strategies to improve the quality of rural life and alleviate poverty in developing countries.

Indoor air pollution and rural life

Dependence on biomass exacts a heavy price on quality of life and health, especially among rural populations, women and children

Energy for sustainable development in the context of Millennium Development Goals

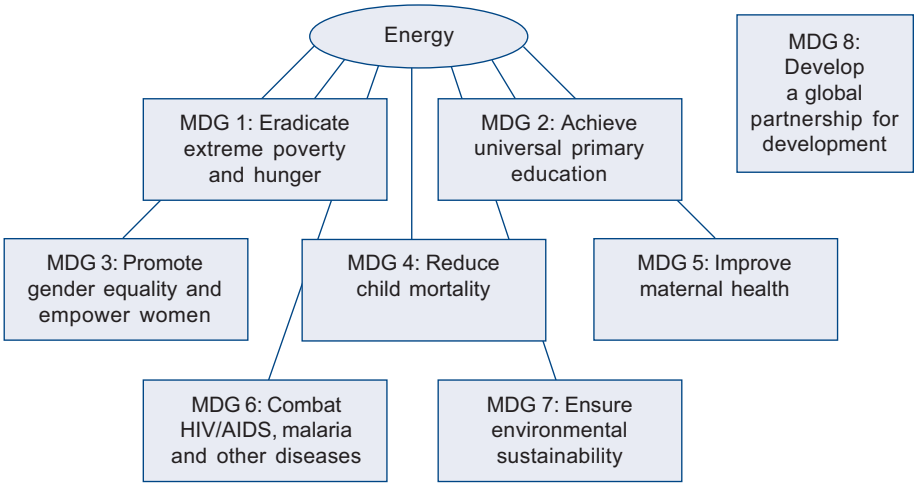
Abdul Qadir
United Nations Development Programme
Islamabad

The aim of the UNDP presentation was to highlight the linkages between energy demand and poverty reduction. There is a need to tap energy sources that simultaneously support human development over the long-term in *all* its social, economic and environmental dimensions. The provision of energy contributes towards the goal of poverty reduction as the lack of energy can severely hinder many aspects of human development.

UNDP is working towards achieving the Millennium Development Goals (MDG) and energy is recognized as a critical prerequisite to achieving them. Energy inputs are essential to generate jobs, industrial activities, and micro-enterprise and agriculture

outputs and hence allow greater productivity, which is important to achieving MDG1- eradicating extreme hunger and poverty. Evidence links higher school attendance to availability of energy, therefore the MDG2 - achieving universal primary education - is also addressed.

Millennium Development Goals and Energy



It is documented that the poorest of the poor are women and that the incidence of poverty falls disproportionately on women. Providing access to modern fuels eases women's domestic burden and allows extra time to pursue educational, economic and other opportunities, which directly empowers women and promotes gender equality. This addresses MDG3. MDG4, reducing child mortality, is also dependent on energy provision to the extent that the creation of means to boil water can reduce the incidence of death in the under-5 children due to water-borne diseases. Another important role of providing clean energy is to reduce the Indoor Air Pollution (IAP), particularly, in cold regions where people prefer to spend time in warm rooms or kitchens. Women and children get maximum exposure to indoor air pollution if clean energy sources are not practised.

Maternal health can also benefit from the provision of energy by attracting additional medical care facilities, such as health clinics and hospitals, which increases the chance of medical attention for expecting mothers. MDG 5 is thus also addressed. Moreover, because energy can help income generation, it directly increases the ability of households to afford medical attention, which helps improve maternal health.

The fight to control the spread of epidemics such HIV/AIDS, malaria etc- MDG 6- can be significantly improved through better communication methods, better storage means and improved access to health care- all of which cannot occur without adequate energy.

MDG7, which addresses the need to ensure environmental sustainability, is dependent on energy sources, because the continued use of fuel wood and charcoal leads to indoor air pollution from biomass combustion and to outdoor pollution, acidification of land and water and through the emission of greenhouse gases.

What is clear is that access to clean energy is crucial to achieving all the MDGs. However, the link between energy and the MDGs is not clear to all which results in this issue

being ignored on the policy and government level. The limited understanding in identifying the energy-poverty trap has led to the lack of data, visibility and interest in this area, which has resulted in failed poverty reduction strategies and inadequate policy intervention.

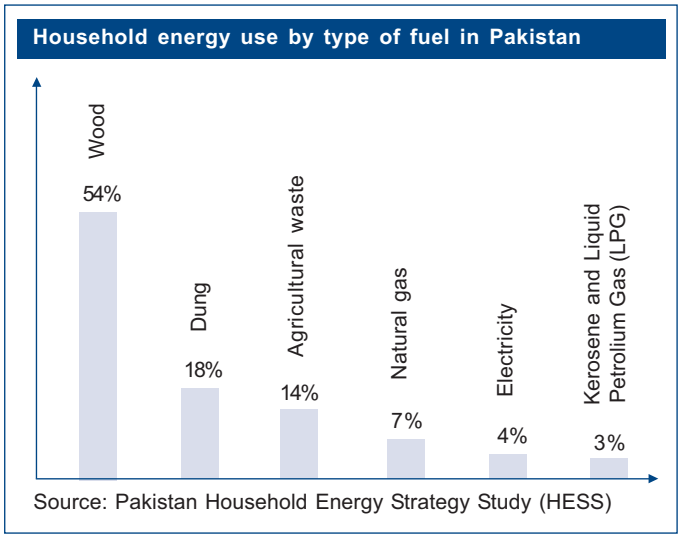
Indoor air pollution from household fuels in Pakistan

Dr Zafar Fatmi
Dept. of Community Health Sciences
Aga Khan University, Karachi, Pakistan
zafar.fatmi@aku.edu

More than two billion of the world's poorest people in developing countries rely on biomass for household energy needs. These fuels lead to indoor air pollution levels many times higher than developed countries. IAP exposure increases the risk of diseases, including pneumonia, chronic respiratory diseases and lung cancer.

Pakistan is a predominantly rural society with low literacy and high fertility with an average household size of seven. There is high infant mortality due to acute respiratory infections, diarrhoea, malnutrition and vaccine preventable diseases. The environment is colder in the northern than the southern part of the country. The house structures are more of the closed type as we move north.

Biomass meets about 86% of total domestic energy requirements. Ninety per cent of the rural and 60% of the urban households depend on biomass fuels. Among the household biomass energy sources wood accounts for 54%, dung 18%, crop residues 14%. Approximately 83% of biomass is used for cooking and rest for water and space heating.



Biomass use is proportionately greater among the poorest of the poor. However, there is evidence that consumption stays constant in rural areas even with increasing income, but the consumption sharply decreases with increasing income in urban areas. Therefore, the availability of alternative fuels is an important factor in the shift to cleaner fuel, particularly in rural areas. Balochistan consumes the largest amount of fuel wood per household, Punjab has the highest consumption of crop residues and Sindh has relatively less consumption of biomass due to urbanization. Half of the biomass is bought and the other half is collected for free. Free collection is more common in rural areas than urban areas. Women have the primary responsibility for biomass collection, and are also most closely associated with its combustion. They are therefore also believed to have the highest exposure of all members of the family.

The use of biomass in those households is more where labour resources, women and children, are available. Besides households there are 'rural industries' and 'village applications' of biomass in which women and children are involved, such as making

bricks, pottery ceramics, social ceremonies, *hammams* (hot baths) etc. The high prevalence of smoking among the population in Pakistan may also be contributing greatly to IAP, as many smoke inside their homes. Limited direct information regarding the health effects due to IAP is available in Pakistan. Small-scale interventions are being carried out by various agencies in Pakistan. The main interventions are improved stoves and biogas plants which were advocated for fuel-efficiency.

In conclusion, extensive use of biomass in Pakistan is causing high levels of IAP and exposure particularly to women and children. The attributable risk associated with IAP is well established through the global comparative risk assessment. Few studies have been conducted on indoor air quality and health effects in Pakistan. Poverty is clearly related with biomass use in Pakistan. Household energy data are comparatively better documented and there is a central role of women in the rural energy system, as they are involved in collection of biomass and cooking. Intervention studies conducted are small scale and inconclusive. IAP is not considered a priority health problem among the population and scientific community, therefore there is a need to raise awareness and collaboration among stakeholders.

Preliminary analyses of indoor air pollution and low birth weight (LBW) in Southern Pakistan

Dr. Amna Rehana Siddiqui
Department of Community Health Sciences (CHS)
The Aga Khan University, Karachi, Pakistan
rehana.siddiqui@aku.edu

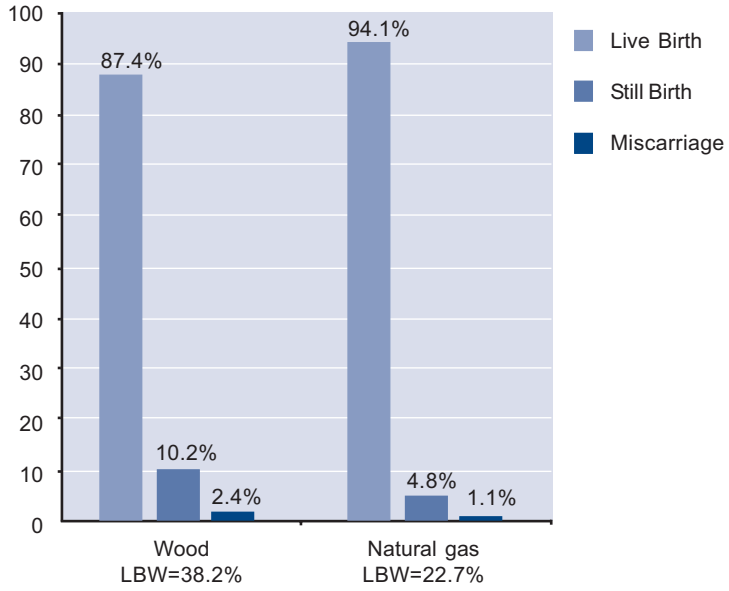
More than 21% of infants born in Pakistan have a birth weight less than 2500g, defined as low birth weight (LBW). In the postnatal period, LBW is associated with increased risk of mortality, morbidity, micronutrient deficiencies, and impaired psychomotor development. The relationship of prenatal exposure to indoor fuel smoke and occurrence of LBW has not been well studied, although associations of cigarette smoking and outdoor air pollution to increased risk of LBW have been reported. The leading cause of LBW in western settings is reported to be from maternal smoking as well as from exposure to environmental tobacco smoke. Prevalence of smoking is reported to be low in Pakistan, whereas use of wood for cooking fuel is common in rural and urban areas (>53%) with overall biomass use including wood, crop residues, and dung is more than 70%.

In developing country settings nutritional, reproductive, and socioeconomic factors are considered to be responsible for the occurrence of LBW. Recent reports from developing countries, from Guatemala, and Zimbabwe, have described the association of LBW with use of open fire for cooking. In addition, analyses from the Second National Family Health Survey of India (1998-99) report the occurrence of stillbirths related to a history of using biomass cooking fuel. All of these studies found wood or biomass as a proxy for exposure to indoor air pollutants. We present the results of the preliminary analyses of data on air pollution from communities situated in rural, semi-rural and semi-urban locations for pregnancy outcomes in southern parts of Pakistan from the province of Sindh.

A total of 1,404 pregnant women were enrolled through a maternal and child health surveillance programme from communities outside Karachi (Nara, Kotdiji, and Bilal Colony). During the years 2000 and 2001, all pregnant women from these areas were identified by field workers with the help of Lady health workers from the Government-based National Health Program.

Of the identified pregnant women, 53% used wood as cooking fuel. Of these 1404 women, 8% (n=112) moved out of the areas, and 13% (n=182) refused to participate. Of the women who had a complete follow up of pregnancy (n=1102), miscarriage was reported in 1.7% and stillbirth in 7.7%. Among wood users, 2.4% reported a miscarriage compared to 1.1% of natural gas (NG) users. Stillbirths occurred in 10.2% of wood users compared to 4.8% of NG users. Overall birth weight data were available for 941 women. LBW occurred in 31% of all live births, in 38% of offspring of mothers who reported use of wood for cooking fuel compared to 22% in mothers using NG as fuel (OR 2.11, 95%CI 1.57-2.81).

Comparison of live births, still birth and miscarriages by type of fuel used in pregnancy



A composite socioeconomic status (SES) variable was created by assigning scores to individual SES variables including water supply, toilet facilities, lighting source, housing construction, ownership of house, and housing density (occupants per room), so that a higher socioeconomic status had a higher score.

A multiple logistic regression model showed that use of wood fuel was associated with LBW (OR 1.74, 95% CI1.2-2.5), adjusting for per unit increase in body mass index (kg/m^2; OR 0.91, 95%CI 0.87-0.95), increase in gravida status per pregnancy (OR 0.93, 95%CI 0.87-0.99), history of receiving prenatal vaccine (OR 0.42, 95% CI 0.24-0.74), SES score <=3 (OR 1.07, 95% CI=0.73-1.55) and rural versus urban location (OR 1.06, 95%CI=0.73-1.55). In a sub sample of wood users (n=256) and NG users (n=215) data for maternal serum Vitamin A levels was also available. A multiple logistic regression model on this sub-sample also revealed similar results, with per unit increase of maternal serum vitamin A ug/dl (OR 0.96, 95%CI 0.95-0.98), providing protection from having a LBW offspring.

In a separate pilot study, air concentrations for carbon monoxide (CO) and particulate matter <2.5 microns (PM2.5) were measured in the year 2002. CO levels were measured in 13 houses during summer, and CO and PM2.5 were simultaneously measured in 12 houses during winter. CO was measured during summer and winter. Samples during summer averaged over a minimum period of 24 hrs per house, and women performed the cooking tasks as usual. During winter daytime CO and PM 2.5 levels were concurrently measured with an average duration of seven hours per house. Average CO levels were 21.6 ppm where wood was used as fuel and 3.3 ppm where NG was used as fuel. Average PM <2.5 levels were 9.7mg/m3 for wood use and 0.26 mg/m3 for NG use. CO levels were not different by season or by type of house construction. Similarly PM 2.5 levels did not appear to differ by the type of house construction in this setting. There was a high correlation between CO and PM2.5 concentrations.

These findings suggest an independent effect of indoor air pollution on birth weight and a need to evaluate maternal prenatal exposure to indoor air pollution from wood burning

fuel used for cooking in Pakistan. There is a need to consider socioeconomic status in the design phase of a study as confounding by rural urban locations, and socioeconomic status is difficult to account for.

Studying the health impacts of reduced indoor air pollution: the Guatemala randomised controlled trial

Dr Nigel Bruce
Division of Public Health
University of Liverpool
Email: ngb@liv.ac.uk

The Guatemala randomised trial was established to strengthen evidence on reductions in risk of ALRI in young children achievable through feasible interventions. The site of the study in the western highlands of Guatemala was selected following a series of exploratory studies, as an area with high rates of ALRI and a locally produced and popular chimney stove (the *Plancha*). A total of 534 homes using open fires, and with a pregnant woman or child under 4 months of age, were randomised to either receive a *plancha* stove, or continue using the open fire until the child was 18 months old (at which time a *plancha* stove was offered).

The Plancha Stove

© Nigel Bruce

Cases of ALRI in children were ascertained at three levels. The first level was through weekly household visits by field workers trained to recognise the key WHO defined symptoms of signs of ALRI, namely cough or difficulty breathing, rapid respiration and chest indrawing. Children with possible ALRI were referred to the second level, physicians working from local community centres (to help ensure blinding of the doctors to whether the child came from an open fire or plancha home). The physicians carried out a standardised clinical examination, which included pulse oximetry for all referrals apart from skin and eye complaints. All children with acute lower respiratory illness (pneumonia and other wheezing illness) were also tested for respiratory syncytial virus (RSV) by direct antigen test on naso-pharyngeal aspirate, and referred for a chest X-ray. Children were either treated at home, or referred to the third level, the local district hospital. Information was subsequently obtained from the clinical notes on admitted children. All deaths were investigated by verbal autopsy.

Measurement was also made of indoor air pollution and exposure levels, combining very detailed, repeated assessment of particulate matter (PM) of various sizes and carbon monoxide (CO) in a sub-sample, and repeated measurements of personal 48-hour average CO on all study children and their mothers.

A wide range of other information has been obtained in this study. The second principal health outcome assessed is respiratory health of the study children's mothers, including symptoms and lung function. Analysis is currently underway, and results will be presented during the coming year.

Fuel efficient stove project in Changa Manga forest, Punjab

Rina Saeed Khan
Escorts Foundation
Lahore
rinasaeedkhan@hotmail.com

The Escorts Group of companies is a business house based in Lahore. In 1994, Maryam Bashir, the daughter of the head of the group set up the Escorts Foundation. The aim of the Foundation was to improve the health, education and income generation in targeted villages located around Changa Manga forest near Lahore. The Escorts Foundation selected this forest for their project area since it was one of the more desperate examples of rural existence in central Punjab. Changa Manga is an irrigated forest that is a protected area of Pakistan. The project staff soon began to notice that the forest was being pillaged for firewood needed for the open fire stoves used in the villages. Smoke emitted from these stoves causes eye damage and life-long respiratory problems and also contributes to green house gas emissions.

Description of stove technology

- Chimney covering is an umbrella type structure to prevent rain water coming in
- An iron strip one foot long and 2 inches wide is used to strengthen opening of the firebox

In 1995, with the UNDP's GEF funding, the Escorts Foundation introduced fuel-efficient stoves in 24 villages in the area. Today, 11,578 fuel efficient stoves have been installed in 54 villages of Changa Manga. With these stoves, a woman can get through her day using half the fuel needed for a traditional stove. The fuel efficient stoves all have chimneys which ensure that the smoke flows out of the house. Escorts Foundation has adapted the implementation process and design in such a way that the fuel-efficient stove has become a cost-effective and sustainable intervention. The 'chimney set' can be made by recycling old steel bins, or the chimney can be made from mud to save costs.

Since the steel chimney is the most expensive material used in the stove (the other main materials are mud and hay) and mud chimneys are time consuming to make, Escorts is now planning to provide some free chimneys in each new village where it expands its work, to encourage others to adopt the stove. The local community readily accepts the model since Escorts has adapted this stove to meet local requirements, but Escorts has learnt that unless strict follow ups are conducted regularly, adoption rate falls.

Escorts' success in introducing and implementing the use of this stove is now being cited as a model in development and the Foundation is training other NGOs in making these stoves all across the country.

Household energy interventions in northern areas of Pakistan

Syed Fakhar Ahmed
(Ex Programme Manager-BACIP/Volunteer Resource Person AKPBS,P)

The Building and Construction Improvement Program (BACIP) of the Aga Khan Planning and Building Service, Pakistan was started in the Northern Areas in 1997 as an action research project to develop and implement simple, cost effective, culture-specific and environmentally friendly housing improvement products and approaches. The project

developed over sixty solutions to the various housing issues in the region and to date has installed about 12,500 units of the products in 6,000 households in over 100 villages benefiting about 54,000 people (48% women). The products ranged from various insulation techniques to water warming facilities and smokeless stoves. Seventy-one research-based manuals were prepared, defining and explaining the various techniques and technologies for the construction and manufacturing of the BACIP products.

Traditional village houses with open roof hole

BACIP also provides training to entrepreneurs for the manufacture, production and marketing of the BACIP products. Through its training and development activities the programme has provided training to 52 professionals, 200 entrepreneurs and 1000 craftspeople of the region.

Open fire in a house

Studies undertaken by BACIP had shown that various thermally efficient products reduced fuel wood consumption by up to 60% in the target areas. Preliminary field assessments suggest that BACIP housing products could reduce in-house smoke by 80% and reduce smoke and cold-related common diseases like ARI and pneumonia by up to 50%. Detailed studies are being planned. Other benefits were improved indoor environment through smoke free and dust free houses and diversified economic opportunities for the craftspeople and entrepreneurs.

BACIP Roof hatch window

Ninety percent of the 12,500 products installed were owner-financed and only 10% of the products were financed by the project as demonstration modules. The programme, through an agreement with the First Micro Finance Bank; facilitates micro credits to the buyers of the products and entrepreneurs for manufacturing. Through its activities to build capacity the programme provided training to various regional and national level organizations on the design and construction of the housing products that are being replicated in the various parts of the country, especially in NWFP. The program is being replicated in Southern Sindh and is now working in 50 villages of the Thatta District. The project developed some 13 housing products and solutions specifically for Sindh.

BACIP involves the local communities in its research process also. Problems are identified through discussion and consultation with the communities. Solutions are developed and placed in community houses for feedback and are revised upon feedback from the community and finalized upon the satisfaction of community household. Dissemination activities include radio programmes as well, where the voices of community households using BACIP products are broadcast through interviews and panel discussions.

Market place of fuel-efficient technologies in Pakistan

The market-place show was the last event in the seminar. Various NGO's had fuel efficient technologies on display. Examples are shown in the pictures.

Summary session

In a final session, the main messages from the workshop were distilled, and further action agreed upon. Below are the main points.

Global evidence

- Indoor air pollution has serious adverse health consequences, especially for women and children
- Indoor air pollution is now recognized as one of the leading risk factors responsible for poor health in developing countries
- Most indoor air pollution is related to household biomass (wood, animal dung, crop residues) energy use for cooking and heating by poor households who cannot afford cleaner fuels
- These biomass fuels are mainly gathered by women and children, who also suffer the most smoke exposure from burning these fuels
- Energy issues are intimately linked with all eight UN Millennium Development Goals, and as such are important issues for sustainable development and poverty reduction
- Detailed data on harmful effects of indoor air pollution are limited, especially in poor countries such as Pakistan, where the problem is most prevalent, and information on indoor air pollution in urban settings is also needed
- There are several promising interventions to reduce the levels of indoor air pollution: energy efficient stoves and technologies, use of cleaner fuels such as gas, or renewable energy fuels, and integrated community approaches to delivery.

The situation in Pakistan

- The problem of indoor air pollution has not received much attention in Pakistan because it does not clearly fall into the remit of any Ministry
- There is a lack of awareness among the population and among policy makers of linkages between energy, poverty, and health
- Some non-governmental organizations in Pakistan have made pilot interventions using energy-efficient stoves
- Interventions need to be locally acceptable, sustainable, and feasible for scale-up
- We need better documentation of improved health status (less pneumonia, higher birth weight, less eye and respiratory problems), as well as social and economic benefits, and environmental improvement after introduction of the interventions

Action required in Pakistan

- A multi-step national action plan is needed, and an inter-sectoral approach is critical
- A national platform of stakeholders involving the relevant ministries and the private sector through a public-private partnership model is the most promising approach
- The Planning Commission is best positioned to take the lead from the public sector side

- Academics, NGOs, and industry representatives should be involved from the private sector
- Public awareness should be raised by involving journalists and other key stakeholders
- Millennium Development Goals provide a strategic route to getting important issues such as indoor air pollution on the national agenda

Proposal development workshop of studies on indoor air pollution interventions in Pakistan and their impact on health

Contents of the workshop

A proposal development workshop was organised by the Department of Paediatrics and Child Health after the seminar in which interested groups/agencies were invited to develop proposals of health interventions to reduce indoor air pollution.

On the first day of the workshop, the various agencies were briefed on the reason of the workshop, namely to develop proposals for research projects to document the impact of the improvement of indoor air pollution on health outcomes. All the agencies were given the opportunity to give brief presentations introducing their general area of work. Background and methods presentations were given by Dr Nigel Bruce and Dr Mukesh Dherani, presenting a summary of the experience with interventions for reducing IAP in other countries, measuring air pollution and exposure and on design issues of studies evaluating interventions to reduce air pollution, respectively. This session provided a background to help develop possible study ideas further during the workshop.

Subsequently, facilitated group sessions were held in which the various agencies discussed possible project areas, study designs, and timelines. On the last day the agencies presented their possible plan of work and started preparing their letters of intent.

Brief overview of future plans of study by each of the participating development organizations

Effectiveness trial to reduce pneumonia rates in children through the use of fuel efficient stoves in District Matiari, Sindh

Aga Khan University

Drs Anita Zaidi, Rehana Siddiqui, Tauseef Khan & Mr Shujaat Zaidi

Biomass is the major fuel used for cooking and heating energy in Pakistan, accounting for about 86% of total household energy consumption. Wood, crop residues and animal dung are the major sources among biomass fuels used in Pakistan. Biomass is mostly burned in inefficient three-stone stoves, which lead to incomplete combustion and high levels of indoor air concentration of smoke. Few studies have been conducted in Pakistan to relate IAP to health effects. IAP is not a recognized environmental hazard at policy level, therefore generally few efforts have been undertaken in this regard so far in Pakistan.

The Aga Khan University has field based research projects for the improvement in health of children in the districts of Hala and Matiari, Sindh, 200 km from Karachi city. This rural district has a population of 250,000 living in 40,000 households. The main fuel used for cooking is biomass, including firewood and animal dung (85%), followed by gas (12.9%).

The study is planned to show whether the use of fuel-efficient stoves will lead to a decrease in pneumonia incidence of 20% and decrease mortality by 3% in children below 5 years of age. After pilot testing of the suggested fuel efficient stoves by measuring kitchen concentration of CO and $PM_{2.5}$ and assessing the construction and maintenance cost, the main intervention trial will be a cluster randomised trial with the village as the unit of randomisation. The roll-out of the intervention will be in a step-wedge manner with phased introduction of improved stoves in villages. Villages will be selected randomly, based on the availability of more than 80 % coverage by Lady Health Workers (LHW) from the national programme of Primary Health Care (PHC) and Family Planning. LHWs will be retrained in the Integrated Management of Childhood Illnesses (IMCI) protocol.

Continuous monitoring of indoor pollutants like CO and PM 2.5 will be performed on a randomly selected subset of households from improved stoves and traditional stoves. Similarly, measurement of personal exposure to CO in children under 5 years of age from the same households for both types of stove groups will be undertaken.

Outcomes assessment will be done through surveillance data for morbidity from health care facilities and households through LHWs. Active surveillance for child mortality will be performed by project staff. Incidence rates will be compared at a village level by type of stoves, and relative risks will be calculated adjusting for any confounders. Routine quality checks will be undertaken at all levels.

AKU has a basic infrastructure for administration of research activities including a research office, data management unit and residences for field staff. Local health committees are already in place in the majority of villages that will be instrumental in mobilization of community groups. AKU will provide the clinical and field-based expertise for this epidemiological research. Stove design and training for construction and maintenance will be obtained from the NGOs working with such technology, including BACIP, ESCORTS Foundation and CARITAS.

ESCORTS Foundation
Rina Saeed Khan, Zakia Khanum, Afzal Hameed

The project area is situated in the district of Kasur (south of Lahore), and the work is being conducted in villages surrounding the Changa Manga Forest which is situated in the areas of Teshsil Chunian and Teshsil Pattoki. There are approximately 1000 villages in these surrounding areas. The preliminary proposal by the Escorts foundation (EF) is to carry out (a) a before and after comparison study in those areas where intervention is yet to be carried out and (b) cross sectional comparison of villages with and without fuel efficient stoves (FES) in villages where implementation is already in process.

The use of a comparison group for the follow-up study will be considered further during proposal development (see below). The project's target scope is 80 villages – population 196,000. To date the team has worked in 54 villages with a total population of around 136,000.

The main objectives of the evaluation study are to assess the impacts of the FES on time for cooking, quantity of fuel used, money spent and consequences for social interaction among households. Information on these issues will be collected through a combination of structured interview, focus group discussions (FGDs) and key informant interviews. The EF does not have expertise in assessing indoor air pollution or exposure

levels, however, if sufficient funding were available, the necessary staff training will be provided along with procurement of equipment. FGDs and Key informant (KI) interviews will be carried out to assess in more depth the acceptability, affordability and use of FES, and perceived social, economic and health impacts of FES. It is planned that a detailed proposal (with budget) will be prepared in consultation with the AKU and the University of Liverpool through a dedicated proposal development workshop in due course.

CARITAS Foundation

Tariq Jawaid, Younis Masih, Ms Shaheen Yousaf & Ashar Naseer

Caritas Pakistan are involved in several developmental projects in many areas of Pakistan. They started fuel-efficient stove dissemination in 2001, in the regions of Hyderbad, Multan, Faislabad, Rawalpindi and Lahore with technical and financial support from the UNDP-Pakistan. The programme is primarily focused to the rural women, and employs appropriate strategies for capacity building at local level. A flexible approach is taken to collaborate with government as well as other non-governmental organizations. With more than two full implementation years the programme has learnt that awareness and information are crucial for creating a demand for fuel-efficient stoves (FES). The programme has also proven that FES could be disseminated even with no direct subsidy to end-users. The appropriateness of stoves in terms of acceptability and maintenance, follow up and supervision are crucial for the successful implementation and continuous usage of FES.

This programme has already promoted 2,658 FES in 20 districts in 35 selected villages. The progress is above the target set for the first phase (2003). The programme has already produced 19 master trainers and trained 1424 women to install FESat household level. During monitoring of the program it was found that 90% users were satisfied with stove installed and 95% stoves were still in use.

The preliminary proposal by Caritas is to conduct a 'before and after' evaluation study of the FES in 40 villages to assess the social, economic, time use and perceived impacts on the health of women and children. A cross sectional survey will be carried out in the selected houses before implementation of FES to assess the baseline information on time needed to prepare food, amount of fuel needed each day for food preparation, and self-reported signs and symptoms of irritation of the eyes, headache, cough and other respiratory symptoms. One year after the implementation of FES stoves another cross sectional survey will be carried to assess same outcome parameters described above and a statistical analysis will be carried out to assess the difference between the two surveys. The use of a comparison group for the follow-up study will be considered further during proposal development.

Efforts will also be made to measure particulate and CO levels before and after the intervention, however, this assessment is dependent on procurement of equipment and staff training. Focus group discussions (FGDs) and key informant interviews will also be carried out to assess in more depth the acceptability, affordability, use, advantages and disadvantages of the stoves. It is planned that a detailed proposal (with budget) will be prepared in consultation with the AKU and the University of Liverpool through a dedicated proposal development workshop in due course.

Aga Khan Planning and Building Services (AKPBSP)
Mr Khizer Omer, Dr Mohammad Nazeer, Gul Anaar, Qayum Ali Shah & Abid Hussain

Northern Areas and Chitral region are remote, unattended and poverty-stricken areas with extreme cold weather. There are approximately 1,300 villages with an average of 100 households per village. AKPBSP is working in over 200 communities in this area and has introduced fuel-efficient stoves.

The proposed cohort study is planned to look at the difference in various health outcomes and economic feasibility indicators in households with BACIP interventions fuel efficient stove versus houses without, while adjusting for confounders. The study will be carried out in the communities where AKPBSP is working over a period of one winter.

Rural Development Programme, Haripur
Muhammad Ahsan Khan, Ibrar Hussain Shah, Kausar Bano

Based on the learning and the useful experience of the successful implementation of the Fuel Efficient Stove Project (FESP 2000-2005) in 55 villages of the district and benefiting more than 50,000 population through fuel efficient technology, RDP will replicate the same model in 20 new villages of district Haripur in the next 20 months. The total population of district Haripur (2004) is 798000, and more than 70% of the population lives in rural areas. Almost 85% population of the district is dependent on biomass fuel. The majority of the population using biomass fuel is using traditional stoves with no knowledge of IAP hazards on women's and children's health. Health facilities are available in the city, whereas the quality of services is badly affected while moving from urban to rural areas. The total <5 population in the district is 111,720, whereas annual rate of pneumonia is 33516. Almost 67% of the population does not have access to piped water supply and more than 76% households do not have latrines.

With regard to health services, there is one DHQ hospital, 38 basic health units (BHU) and six rural health centres (RHC) working in the district. In addition to that there are 7 dispensaries, 2 mother child health care centres and one TB control program, totally insufficient for the population of eight hundred thousand. On average there is one doctor available for 36363 persons. 80% BHUs in rural areas are without a Medical Officer and normally managed by medical technicians.

The study aims to show that fuel efficient stoves contribute to a reduction of pneumonia and infants low birth weight in the rural areas of district Haripur. The study approach is a participatory impacts analysis, whereby a spectrum of methods and tools shall be used to elicit the project impacts in relation to children health. A questionnaire comprising both quantitative and qualitative information will be developed and used for data collection. Focused group discussion and semi Structured Interview (SSI) would be used as main methods for the collection of information. A cross-sectional survey documenting respiratory infections in the weeks before the survey will be undertaken before and after the interventions. At least two FGD would be required to ascertain the nature and magnitude of issues before and after the project interventions. In order to formally carry out this research study, a team of two female having research experience pertinent to health related issues shall be hired and given orientation of participatory research in social setting. In addition to that the services of two other female social mobilizers already mandated for the implementation of project would also be sought. Two females specifically hired for the research would be responsible for the data collection, whereas all the four females shall be used for carrying out other participatory exercises.

Data collection in all the intervened villages shall be carried out on house hold basis, whereby two things 1) Documentation of exposure and 2) health impacts of the project on pregnant women shall be main scheme of study. This impacts study shall be carried in partnership with Save the children US as a technical partner, AKU and WHO. Out come Measures will be pneumonia and low birth rates in the intervened villages. Details of case finding through the SCF supported health centres will be developed.

Annex 1: Institutions participating in the seminar

1. Aga Khan Planning and Building Services Pakistan (AKPBSP)
2. Aga Khan Health Services Pakistan (AKHSP)
3. Department of Paediatrics, Aga Khan University, Karachi
4. Department of Community Health Sciences, Aga Khan University, Karachi
5. ESCORTS Foundation, Lahore
6. United Nations Development Programme (UNDP), Islamabad
7. Department of Public Health, University of Liverpool, Liverpool
8. Department of Child and Adolescent Health, World Health Organization, Geneva
9. CARITAS Pakistan, Karachi
10. SGS-Lahore (Environmental Protection Agency), Lahore
11. Rural Development Programme, Haripur
12. NICH, Islamabad
13. Institute of Environmental Studies, Karachi University, Karachi
14. Human Development Programme, Aga Khan University, Karachi
15. Environment and Alternative Energy, Karachi
16. Aga Khan Medical College, Aga Khan University, Karachi
17. Swiss Speciality Chemicals, Karachi
18. Department of Psychology, Karachi University, Karachi
19. Chemical Department, Dawood College of Engineering, Karachi
20. Karachi Adventist Hospital, Karachi
21. NED University, Karachi
22. Lady Dufferin Hospital, Karachi
23. Al-Tamash Institute of Dental Medicine, Karachi
24. Mehran Trading, Karachi
25. International Commission on Occupational Health (ICOH), Pakistan
26. Department of Family Medicine, Aga Khan University, Karachi
27. Department of Medicine, Aga Khan University, Karachi
28. Department of Psychiatry, Aga Khan University, Karachi
29. Department of Microbiology, Aga Khan University, Karachi
30. Department of Pathology, Aga Khan University, Karachi
31. Department of Radiology, Aga Khan University, Karachi
32. Department of Biological and Biomedical Sciences, Aga Khan University, Karachi
33. School of Nursing, Aga Khan University, Karachi
34. The Aga Khan Foundation (AKF), Pakistan
35. PROGAS Pakistan Ltd
36. Special Children Centre, Pakistan Navy
37. Belkhi Memorial Foundation, Pakistan
38. Hamdard University, Karachi
39. Unilever Pakistan
40. Thardeep Rural Development Programme
41. Briofedix
42. Health and Nutrition Development Society (HANDS), Karachi

43. Pakistan Council for Scientific and Industrial Research (PCSIR) Laboratories Complex, Karachi
44. World Wildlife Fund(WWF), Pakistan
45. Civil Hospital, Karachi
46. Shell Pakistan
47. Environmental Protection Agency (EPA), Pakistan
48. Ziauddin Medical University, Karachi
49. Oxford Institute of Technology
50. National Institute of Child Health (NICH), Karachi
51. The World Conservation Union (IUCN), Pakistan
52. Dow Medical College, Karachi
53. Zulfiqar Press
54. Pakistan Agriculture Research Council
55. Pakistan Medical Research Council (PMRC), Islamabad
56. Manzil School
57. Crescent Bank
58. Mahmood Clinic
59. Usman Memorial Hospital
60. Jinnah Medical College and Hospital
61. Social Informer's Network
62. Zamzama Special Clinic
63. Energen
64. NHPU, Islamabad
65. Mehran Trading

Annex 2:
Agenda of the seminar on indoor air pollution from household fuels

'Assessing Impact on Child Health and Developing Effective Interventions'
Thursday, September 29, 2005
Aga Khan University Auditorium
Aga Khan University in collaboration with World Health Organization, Geneva

08:30 – 09:00	Registration
09:00 – 09:10	Opening remarks and introduction *Dr. Zulfiqar A. Bhutta,* Professor and Chair, Department of Paediatrics, Aga Khan University
09:10 – 09:20	Welcome Address *Dr. Mohammad Khurshid*, Dean Medical College, Aga Khan University
09:20 – 09:30	Address by the Chief Guest, *Dr. Hadi Bux Jatoi*, Director General Health, Sindh, Government of Pakistan

Session I

09:30 – 11:00	Health Effects of Indoor Air Pollution – Overview of the Global Evidence *Nigel Bruce*, University of Liverpool, United Kingdom Health and Demographic Impact of Biomass Fuel Use – A Cross-sectional Analysis *Anita Zaidi*, Aga Khan University, Karachi Session Chair - *Mehtab S. Karim,* Professor and Head Population and Reproductive Health Programme, Department of Community Health Sciences, Aga Khan University
11:00 – 11:15	Tea Break

Session II

11:15 – 12:30	Household Energy Use in the Context of the Millennium Development Goals *Abdul Qadir,* United Nations Development Programme Indoor Air Pollution in Pakistan – Review of the Evidence *Zafar Fatimi,* Aga Khan University, Karachi Session Chair - *Dr. Asma Fozia Qureshi,* Visiting Faculty Department of Community Health Sciences, Aga Khan University, Karachi
12:30 – 14:00	Lunch

Session III

14:00 – 15:00 Indoor Air Pollution – Low Birth Weight and other Adverse Birth Outcomes
Rehana Siddiqui, Aga Khan University, Karachi

The Guatemala Randomised Intervention Trial on Impact of Reduced Indoor Air Pollution on Childhood Acute Lower Respiratory Tract Infections and Other Health Outcomes
Nigel Bruce, University of Liverpool, United Kindom

Session Chair - *Dr. Shamim Qazi*, Child and Adolescent Health and Development, World Health Organization, Geneva

15:00 – 15:15 Discussions

15:15 – 15:30 Tea Break

Session IV

15:30 – 17:00 Household Energy Interventions in Rural Punjab
Raina Saeed Khan, Escorts Foundation

Household Energy Interventions in Northern Areas of Pakistan
Mr Fakhar Ahmed, Aga Khan Housing and Building Sevices

Market Place of Pakistan Household Energy and Air Pollution Reduction Projects
(Poster Display, Examples of Stoves and Other Technologies)
Rural Development Project Haripur, Caritas Foundation, Aga Khan Planning and Building Services Pakistan, Shell, and Action Aid Pakistan

Session Chair - *Dr. Martin Weber*, Child and Adolescent Health and Development, World Health Organization, Geneva

Annex 3: Agenda for the workshop

30 September to 2 October 2005
Aga Khan University Auditorium

Day 1 30 September 2005

8:30 – 9:00	Introduction to the day, summary of day 1, objectives of the workshop *Anita Zaidi, Martin Weber, Nigel Bruce*
9:00 – 9:30	1. Presentation Aga Khan Health Services Northern Area
9:30 – 10:00	2. Presentation Haripur
10:00 – 10:30	3. Presentation Escorts Foundation
10:30 – 10:45	Refreshments
10:45 – 11:15	4. Presentation Caritas Foundation
11:15 – 11:45	5. Presentation Hala group
11:45 – 12:15	Summary of experience with interventions for reducing IAP in Pakistan, with focus on effectiveness, acceptability and sustainability. Discussion of approaches and acceptability *S. Qazi*, WHO
12:30 – 13:30	Lunch
13:30 – 14:00	Measurement of air pollution and exposure *Nigel Bruce*
14:00 – 14:30	Issues in the design of studies for the evaluation of health and other impacts of household interventions designed to reduce indoor air pollution *Mukesh Dherani*
14:30 – 15:00	Introduction to group work 1: What interventions are possible and likely to be acceptable for improvement to air pollution in our project area? *Nigel Bruce*
15:00 – 15:30	Refreshments
15:30 – 17:30	Facilitated group work session 1Further discussion of project areas and work to date, in project groups, with individuals from other organisations added to groups *Individual groups with facilitators*

Day 2 1 October 2005

8:00 – 12:30	Field visit to Rehri Goth
12:30 – 14:00	Lunch
14:00 – 14:30	Plenary feedback from groups of day 1 *Anita Zaidi, Martin Weber, Nigel Bruce*
14:30 – 14:45	Introduction to group work 2: What is in place and what needs to be done
14:45 – 16:00	Group work 2: Deliberation of what is in place and what needs to be done (including coffee)
16:00 – 16:30	Feedback from group work
16:30 – 16:45	Introduction to group work 3
16:45 – 17:30	Group work 3

Day 3 2 October 2005

8:30 – 9:30	Plenary feedback from groups on the status of discussion, direction of work *Anita Zaidi, Martin Weber, Nigel Bruce*
9:30 – 10:30	Group work
10:30 – 10:45	Coffee
10:45 – 12:30	Group work
12:30 – 14:00	Lunch
14:00 – 15:00	Group work
15:00 – 15:15	Coffee
15:15 – 17:00	Plenary feed-back from groups, discussion of further work required, strategies to obtain funding
17:00 – 17:15	Closure

Annex 4:
List of agencies and institutions present at the workshop

1. Aga Khan Planning and Building Services Pakistan (AKPBSP)
2. Aga Khan Health Services Pakistan (AKHSP)
3. Department of Paediatrics, Aga Khan University, Karachi
4. Department of Community Health Sciences, Aga Khan University, Karachi
5. ESCORTS Foundation, Lahore
6. United Nations Development Programme (UNDP), Islamabad
7. Department of Public Health, University of Liverpool, Liverpool
8. Department of Child and Adolescent Health, World Health Organization, Geneva
9. CARITAS Pakistan, Karachi
10. SGS-Lahore (Environmental Protection Agency), Lahore
11. Rural Development Programme, Haripur

For further information please contact:

Department of Child and Adolescent Health and Development
(CAH)

World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland

Tel +41-22 791 3281
Fax +41-22 791 4853

e-mail cah@who.int
web site http://www.who.int/child-adolescent-health

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