Domestic Fuel Shortage and Indoor Air Pollution

The obligation to provide both water and fuel for domestic use, particularly in conditions of increasing environmental degradation, is a massive burden on poor urban and rural women and girls. In addition, the health effects of domestic use of biomass fuels (wood, dung, agricultural residues) and coal are suffered largely by women. Important issues can be summarized as follows:

$ women are hit hardest by shortage of fuel, since the onus is on them to find solutions.

$ household coping strategies can affect nutritional status since fuel availability affects cooking habits and food availability.

$ better understanding is needed of the health impact of restricting poor communities access to natural resources.

$ the linkages between fuel, food, water, women’s time and women’s health warrant further exploration.

$ dung-work illustrates the linkage between women’s work and their status.

$ where biomass fuels are commonly used, similar rates in women and men are now being found for diseases such as chronic bronchitis and cor pulmonale; age of onset of cor pulmonale in women is early.

$ women’s respiratory disorders in India are linked to domestic exposure to cooking smoke; however, respiratory disease in women often goes untreated.

$ undetected pneumoconiosis in rural women may be caused by a combination of dust from maize grinding and smoke from biomass fuel.

$ high lung cancer rates in Chinese women can be attributed to the combined effects of passive smoking and the domestic use of poor quality coal.
Energy and rural women's work

The world has entered an era of higher energy costs. Until recently, the impact of these was cushioned by large reserves of "free" wood and other biomass fuels. But the distinction between "free" traditional fuels and modern "expensive" fuels has become meaningless as environmental degradation has reduced supplies and increased costs. In many urban areas, woodfuel may be as expensive as kerosene or gas, and in rural areas the costs of free collection in terms of women's time, energy and wellbeing are excessive.

In most developing countries, the household sector is still the largest single energy consumer, and the poorer the country, the more likely this is. In low-income countries such as Burkina Faso, Ethiopia and Nepal, the household sector accounts for more than 90% of total energy consumption. Deforestation and desertification are the most serious consequences of the reliance on "free" biomass fuels. But agricultural productivity begins to fall well before these disasters strike. Use of tree, crop and animals residues for fuel deprives the soil of recycled nutrients and reduces crop yields along with the land's capacity to support livestock.

Women are hardest hit by this crisis since they are largely responsible for subsistence food production and must increase their labour inputs when productivity decreases. Moreover, male assistance for land clearing and ploughing is often no longer available due to migration an avenue often closed to women for social mobility reasons. Similarly, as the quality and quantity of forest and water resources decline, the time and effort that must be devoted to fuel and water collection, two of women's traditional tasks, also increase. Women therefore have to work harder and longer, using child labour to help them. They are forced to cut down on family living standards, while at the same time they try to squeeze more output and income from the land thereby often contributing to the destruction of the ecological base.

These are among the major findings of an ILO research project on energy and rural women's work in several Asian, African and Latin American countries, carried out by multidisciplinary national teams. The studies showed that, confronted with changes in fuel availability due to deforestation, rural households are being forced to make various adjustments that adversely affect their living standards. The adjustments produce negative effects on work patterns, family nutrition and health, the environment, agricultural productivity, and incomes. These in turn have a bearing on the urban fuel crisis.
The double and triple burden on rural women of household maintenance, family agricultural tasks and income generation, means that in the countries studied, women work considerably longer hours (11.4 hours daily) than men (8.0 hours daily). In virtually all the villages observed, cooking and fuel collection were two of the most time-consuming activities.

**Energy shortages imposes lifestyle changes**

In villages where women have to spend more time on fuel collection, they compensate by spending less time on cooking, which can result in lower nutritional levels. Spending less time on cooking is an extreme reaction to fuel shortage. Cooking fewer meals, eating cold or leftover foods, snacks or processed foods and even changing diet have been reported as fuel-saving strategies in the Sahel countries, Haiti, Mexico and Nepal. Additionally, many of women's key income-generating activities such as food processing, beer brewing, and fish smoking are fuel-intensive and difficulties in procuring adequate supplies of fuel threaten this income.

The quantities and types of foods cooked play an important role in determining fuel use per head. Coastal villages in Peru and Ghana where fish consumption is high use much less cooking fuel than inland villages relying on hard staples such as maize, cereals, potatoes and cassava. This suggests that studies on fuel-saving methods should look carefully at foods requiring high energy inputs.

This research indicates that between 5 and 20% of household expenditure goes on fuel: mainly kerosene, and between 50 and 91% on the food budget. Due to low cash incomes, even this minor use of commercial fuel affects food and other expenditure. This trend will continue unless rural incomes rise.

Water boiling and heating were found to be "luxury" uses of fuel and are frequently curtailed when fuel is scarce. However, washing is essential for health and heating is often essential for survival. In cold mountainous regions such as the Andes, Himalayas and Ethiopian highlands, as much fuel may be used for heating as for cooking. Indoor air pollution is a further health problem in biomass-dependent areas.

The heavy overall workload imposed on women, including carrying fuelwood, affects their health, particularly if their energy output exceeds their intake. Fuel loads weighing 25-35 kg on average, and often much more, are carried over long distances.

And while forest workers are provided with special equipment for their work, women who collect fuel for subsistence must do so with their bare hands and primitive tools.
Fuel scarcity hits urban poor hard

The urban poor may have even greater problems with fuel scarcity as their incomes have not kept pace with the rising prices and they cannot fall back on subsistence production or their own labour in fuel gathering. A recent survey in Addis Ababa found that over two-thirds of the cash income of the lowest income group is spent on cooking fuel. Many of the fuel-saving strategies adopted by this group are deleterious to nutrition and health. Because they cannot afford the kind of stoves needed to burn more efficient fuels, the poor continue to rely on woodfuels even though their cost is as high or higher than kerosene, gas or electricity. Official subsidies often favour modern fuels, overlooking the inability of the poor to either switch to a modern fuel or support the costs of traditional fuels. Measures are therefore urgently needed to enable poor urban households to meet their minimum basic energy needs.

Women are disproportionately affected by the effects of environmental degradation on incomes and family welfare. The most important of these is long-term decline in agricultural productivity, and hence in food production. To compensate for reduced yields, women are forced to cultivate their millet or sorghum over larger areas and to work harder to achieve the same output. Yet the connections between the water, food and fuel crisis and the impact on women are only beginning to be made. Clearly, energy provides a very effective starting-point for addressing rural and urban women's priority concerns over food, income and time saving.

Summary of the work of:
Domestic energy shortage in northern India

Perception is still widespread that inefficient domestic cooking stoves are a major cause of deforestation. Domestic energy issues in developing countries, therefore, often remain centred around fuel saving. But fuel saving makes sense only to people experiencing fuel shortage. And even then, fuel efficient stoves can provide no more than a partial coping mechanism; they cannot address the underlying causes of fuel shortage, which need to be dealt with simultaneously.

A number of lessons have been learned following the large-scale and mainly unsuccessful attempts of the 1970s and 1980s to encourage use of improved stoves as a means of saving fuel and reducing deforestation. Among the most important of these is the finding that domestic firewood consumption is often only a minor contributor to deforestation, that energy saving may not be the first priority of women end-users of domestic energy, and that if stove design is not based on women’s priorities, large-scale use of improved stoves cannot be expected. These lessons must be put into practice in the context of a broader understanding of the underlying problems if current efforts are to be more successful.

Scarcity of biomass fuels is often part of a much larger problem related to the source of people’s livelihood. In other words, the domestic energy problem cannot be dealt with in isolation. For people whose basis for survival is being destroyed along with their sources of domestic energy, attempts to increase the amount of energy available are meaningless.

Field experience in India shows that saving biomass energy is only one of rural women’s priorities. They are equally or more interested in removing smoke from the kitchen, having cleaner pots to minimize daily scrubbing, protecting themselves from the heat of the fire during the hot summer months, maintaining cleaner kitchens or cooking areas, and, above all, increasing personal comfort while cooking. Women are, in other words, more concerned about saving their own energy during cooking-related tasks than simply reducing cooking fuel consumption. It is only in those areas where collecting firewood is a burdensome task that reducing firewood consumption is a major priority.

In less than three decades, increased commercialization of forests and forest produce, coupled with the conversion of forests into agricultural land under the
"grow more food" campaign of the 1960s, has led to significant deforestation and fuel scarcity in northern India. Periodic failure of the rains, and the resultant drying up of wells, streams and ponds, has compounded these problems and drinking water supplies are threatened. Few income-generating opportunities are available to compensate for the loss of natural resources. Cattle have perished in large numbers, and malnutrition and disease have become rife. Out-migration is now common. The very foundation of the subsistence economy collapsed, largely as a result of unsustainable exploitation of the forests. In these circumstances, the energy crisis was only one facet of a much larger crisis which could not be addressed in isolation. The only real solution lay in environmental rehabilitation of the area.

**Loss of control over local resources**

Examining the factors responsible for the massive destruction of forests in northern India showed that, despite a growing population, local requirements for firewood and timber played only a minor role. More destruction had been caused by clearance of forest land by local people for conversion to agricultural use. The most important factor, however, had been the nationalization of forests. Through that single measure, the local population's access to natural resources had been drastically curtailed and these rights transferred to the industrial/commercial/urban sector. The energy crisis was only one aspect of the local population's general impoverishment through this process.

With assistance, some villages are now rehabilitating the common lands. Initially, the produce from these efforts will be used only within the village concerned. Only when a surplus has been established will it be sold outside. Re-establishment of vegetation on the denuded lands, together with soil conservation measures, will slowly rebuild the ecological cycle. Through this process, the domestic energy crisis will also slowly resolve itself.

Many areas of the developing world suffer similar problems. Unorganized, underprivileged people, particularly women, are increasingly deprived of access to local natural resources in favour of powerful and organized urban industrial groups. Attempts to deal with domestic energy issues in these areas through partial interventions such as improved stoves make little sense unless the larger processes are also taken into account. It is the destruction of local control and over-exploitation of local resources for consumption in the urban industrial sector which has created the energy crisis in such areas. Solutions to domestic energy shortages in such areas must therefore be based on re-establishing more equitable access to natural resources, and ensuring local management and control. Only within this framework can improved stoves find a meaningful place.
This is an excellent clarification of the problems underlying domestic fuel shortage and the necessity of taking a holistic approach to such problems. However, the health aspects of indoor smoke exposure, which are not addressed in the context of this article, provide a justification for continuing to encourage the adoption of improved stoves, while linking such work with the issues raised here.

Summary of the work of:
Dung, women's work and women's status

Cattle dung plays a central part in everyday life in rural north India. Dung collection is considered as exclusively women's work; although dung is acknowledged as a resource, men will not handle it and are ridiculed if mentioned in connection with such work. Men's refusal to be contaminated leaves women with no option but to perform this work.

Research was carried out in two villages of Uttar Pradesh, one Hindu and the other Muslim. The sex ratio of the villages is 1175 males per 1000 females. Farming patterns have changed rapidly in the last 80 years, and the main staples are now wheat, rice, and the main cash crop, sugar-cane. These are grown on more extensive areas of cultivated land than hitherto.

Over 80% of households in the two villages own an average of three animals. Dung is privately owned; only if it is lying in a public place can it be gathered by those who do not own cattle. All cattle are owned by men, but dung work is largely a matter for women. Their access to dung is through the complex relationships of production operating among men. These involve women in intricate animal care rotas governing the dung to which they have access.

Recent switch to dung as fuel

There is some evidence to indicate low-caste men's involvement in dung work in the past, but more showing that low-caste women performed dung-work for higher-status Hindu and Muslim women. This is now uncommon, and even the richest peasant households have to do most of their own dung work. Older residents of the villages remember when most cooking was done with wood, gathered from land now under sugar-cane. It is only within living memory that ecological changes have compelled women to cook with dung-cakes, and its use spread to women in higher status groups.
Dung is used for three purposes: as building material and plaster, in work undertaken only by women; as cooking fuel, for which it is much appreciated since it burns slowly and produces good simmering heat; and as fertilizer. Making dung-cakes can take up to two hours a day, depending on how much dung a woman has access to and the amount of cooking fuel required. Dung-cakes are not produced during the hot pre-monsoon period, when grubs destroy them, or during the monsoon itself, when they cannot be dried.

Dung and dung-cakes are produced primarily for home use. Villagers therefore have difficulty in placing a monetary value on them, although limited sale of dung-cakes takes place in the local town. As the work involved is regarded as family labour, women are not paid for their dung-work, nor do they obtain any acknowledgement of the contribution this work makes to household production. Dung-work receives little attention in development literature, despite its use as a major household fuel source. It has been estimated that 30% of India's rural energy consumption is derived from animal wastes, while a figure as high as 80% has been cited for Pakistan. The authors refer to a frequently cited source claiming that 400 million tonnes of cattle-dung are burned annually in Asia and Africa, leading to the loss of 20 million tonnes of potential grain output. However, it is portrayed as a cooking fuel used only in the absence of other, better, fuels.

The valuation of work by gender

Women's work is closely linked with the land in terms of water, fuel and fodder collection, and processing of foodcrops. The increase in cultivated land and the corresponding loss of grazing land has resulted in a decrease in the number of animals supported in the villages, and a correspondingly smaller amount of dung. Of this, proportionately more must be used as fuel due to shortage of wood. This has the effect of increasing women's work, as does the practice of stall-feeding animals rather than grazing them, which requires the investment of more time in fetching fodder and water.

Women's obligation to undertake tasks refused by men can be interpreted as both cause and effect of their overall low status. The unusual sex ratio among the most extreme in India and the high female mortality rates both strongly suggest neglect of both infant and adult females. In some lower-caste groups, social patterns now appear to be changing from bridewealth (payment to the bride's family), in favour of the dowry system (payment to the groom's family). This could be a result of the increasing difficulty women experience in finding paid labour, or due to male reluctance to permit their presence in the labour force. Consequently, women's economic value has declined, and there has been a corresponding rise in dowry deaths and harassment of brides.
This example of dung-work illustrates how social norms permit a job involving hard labour and considerable economic value to be performed by women without this input generating any additional entitlements. Because the work is derided, and women share in its negative valuation, it is seen as drudgery and can provide no self-esteem for women. In addition, the task is not perceived as significant to the household economy - a false perception derived from the negative valuation. In common with all other "women's work", it is not the importance or otherwise of the task itself, but the low value given it because it is done by women, which creates this vicious circle of which the outcome is women's restricted access to resources and the fruits of their own labour. Unless these deep-rooted prejudices change, women's status and hence their health will continue to be jeopardized.

Summary of the work of:

Health effects of indoor air pollution in rural India and Nepal

This review discusses the health impact of indoor air pollution from biomass fuel in India and Nepal. Among the most significant findings is earlier onset in women than in men in north India of *cor pulmonale* (right-sided heart failure), and more severe congestive heart failure. This is attributed to exposure to domestic smoke. In Nepal, in contrast with earlier studies, high prevalence rates for chronic bronchitis were found in both men and women, and a cause-effect relationship between domestic smoke pollution and chronic bronchitis was established. It is only comparatively recently that the extent of women's exposure to risk from indoor air pollution has been recognized and research in this direction begun.

India

In several states of India, a high incidence of chronic *cor pulmonale* has been observed, amounting to 10\(\text{B}^30\%\) of cardiac cases. One hospital-based study noted a similarity of incidence in the two sexes over a 15-year period despite statistical evidence that 75\% of men, but only 10\% of women, were smokers. In addition, the age of onset of *cor pulmonale* in women was 10\(\text{B}^5\) years earlier than in men. Tobacco smoking is an important cause of chronic bronchitis in men, but is relatively less important in women. The study concluded that among women these illnesses were due to exposure to primitive smoky fireplaces from childhood onwards.

Among the women studied, not only was onset of *cor pulmonale* earlier, but congestive heart failure was more severe, and cardiac enlargement and disturbance of pulmonary function greater, with a severe loss of exercise tolerance. Autopsy findings in women showed pulmonary disease, although cough and expectoration may not always have been important symptoms. It therefore appears that in Delhi, domestic air pollution is probably the cause of the higher prevalence and earlier onset of *cor pulmonale* in women, while in southern India, lower incidence of *cor pulmonale* may be attributed to generally better ventilated cooking areas.

In Ahmedabad, a study of incidence of cough, cough with expectoration, dyspnea (difficulty in breathing), and lung abnormalities found a statistically significant higher incidence among women cooking with smoky fuels. Women also frequently complained of eye irritation from cooking smoke.

A three-year prospective study in Bombay of urban and rural areas found that many
of the respiratory symptoms exhibited by the rural populations were similar to those reported for moderately or severely polluted urban areas. Use of woodfuel was given as one of the explanations of this finding.

**Nepal**

A study in one urban and three rural areas of Nepal in 1988 recorded a very high prevalence rate of chronic bronchitis and *cor pulmonale*. A striking feature of this study was the similarly high prevalence rate for chronic bronchitis in both men and women. This contrasts with earlier studies which showed lower prevalence rates among women. Tobacco smoking is common in both men and women in all of the study areas except in urban Kathmandu, where the smoking prevalence rate in women is only 14.2%. However, most women in the rural areas were light smokers (less than 10 cigarettes/day), suggesting that the high prevalence of chronic bronchitis was probably primarily due to their exposure to domestic smoke while cooking. The difference in exposure hours was statistically significant in women in all study areas.

This study attempted to quantify the hours of exposure to domestic smoke pollution and to clarify its relationship to chronic bronchitis. It was the first study to document definitive evidence regarding this relationship, which had been suggested by previous studies. In two areas, a statistically significant positive correlation was found between prevalence of chronic bronchitis and exposure to domestic smoke pollution in both smokers and non-smokers. In one cold, high-altitude area, all members of the community were exposed, so it was not possible to compare the prevalence of exposed and non-exposed groups. In these circumstances, a large number were also exposed for more than eight hours a day, which provided the opportunity to observe the effect of longer hours of exposure versus shorter hours elsewhere. A significant correlation was found among smokers of both sexes at eight or more hours of exposure. This study has been taken as establishing a dose-response, and hence cause-and-effect relationship, between domestic smoke pollution and chronic bronchitis.

All cases of chronic *cor pulmonale* in this Nepalese study were complications of chronic bronchitis. Although most of the women who smoked were light smokers, the prevalence of chronic *cor pulmonale* was similar for the two sexes. This suggests domestic smoke pollution to be an important factor in producing *cor pulmonale*, although statistical tests to establish this relationship could not be performed due to small numbers.

A 1985 study of lung function in Nepalese women established a decline in function as duration of exposure to smoke increased. The study was carried out in a rural area where indoor air pollution is severe, but which is free of industrial and atmospheric pollution. The decline was found to be statistically significant among
smokers, but not among non-smokers. This indicates synergism between domestic smoke pollution and smoking. Deterioration of lung function ultimately leads to disability and loss of productivity through shortness of breath.

Work carried out in high-altitude areas of Nepal also points to a correlation between acute respiratory infection (ARI) in infants and exposure to domestic smoke. ARI is a leading cause of infant mortality in the developing world. Further studies in Nepal and elsewhere are currently attempting to establish this relationship.

This review, as well as other contributions in this section, points out that lung disease associated with indoor smoke exposure may be asymptomatic for a prolonged period, masking the extent of ill-health from this cause and contributing to under-reporting. In a number of other countries where the problem can be expected to be severe due to reliance on traditional biomass fuels by large proportions of the population, it is unrecognized or poorly recognized as a health issue with particular implications for women and infants.

Summary of the work of:


Biomass fuels are used widely in the developing countries, predominantly in rural and poor urban areas. They are composed of complex organic matter, vegetable protein, and carbohydrates incorporating carbon, nitrogen, oxygen, hydrogen, and certain other elements in trace amounts. Smoke emission from domestic fuels is a major source of indoor air pollution, especially in the rural communities of developing countries, and contains pollutants that adversely affect health. Chronic bronchitis and cor pulmonale are reported to be associated with the use of this fuel in non-smoking rural women in India and Nepal. This study in Chandigarh, India measured blood carboxyhaemoglobin (COHb) levels in non-smoking women and related these to the cooking fuel used.

Fuels commonly used for cooking and other domestic purposes in India include biomass, kerosene oil, and liquid petroleum gas (LPG). The pollutants derived from these fuels include several known carcinogens, such as benzoapyrene (BaP), and various toxic substances, among them carbon monoxide, sulphur dioxide, nitrogen dioxide, formaldehyde, asbestos fibres, microorganisms, and aeroallergens. In an earlier study, the authors found high blood carboxyhaemoglobin concentrations after acute exposure to smoke from biomass fuel. This study extends these observations, documenting the level of indoor air pollution produced with fuels commonly used for cooking in India specifically kerosene, LPG, and biomass fuel.

The study was carried out on 114 women exposed to different cooking fuels and residing in Chandigarh and adjoining areas. Of these, 29 women used kerosene, 28 used biomass fuel and 30 used LPG. Women using gas as cooking fuel were mostly from the middle class and those using kerosene or biomass were representative of the lower socioeconomic class. Women who smoked and those with any existing respiratory disease were excluded from the study. The type of fuel used, average duration of cooking and number of years of cooking were noted. Controls were selected from hospital attendants who had done no cooking for seven days. An exposure index was calculated by multiplying the number of years of cooking and the average hours of cooking per day.
All three fuels produce high COHb levels in cooks

It was found that there was no significant difference in COHb levels between the three groups of fuel users. The subjects exposed to the three different fuels did, however, show significantly higher COHb levels than the controls who had not been exposed to these fuels during the previous week. LPG users had the highest values, followed by biomass and kerosene users. The COHb concentration and the time interval between the last exposure and blood sampling showed a negative correlation in all three groups, though this was significant only for the women using biomass fuel and LPG. COHb was lower in women whose sample was taken 60 minutes or more after the last exposure. Although COHb tended to rise with exposure index in all three fuel groups, the trend was significant only in those using LPG.

The blood COHb concentrations in non-smoking healthy subjects exposed to three different types of cooking fuel were two to five times higher than those in a non-smoking healthy control population. The difference was significant. The COHb values are similar to those observed in chronic tobacco smokers. The relatively high mean COHb concentration among healthy controls of 3.52% was possibly a result of their exposure to environmental smoke and pollution. The high concentrations of COHb in biomass fuel users conform with the findings of other studies of women working in poorly ventilated kitchens in India and Guatemala.

In the case of liquid petroleum gas stoves, COHb concentrations were surprisingly high. The emission from this type of stove contains a small amount of carbon monoxide. This is normally converted rapidly into carbon dioxide, but if the burner of the stove is not cleaned properly and the holes are blocked, there will be significant emission of carbon monoxide. Encouraging proper cleaning of stove vents and providing adequate ventilation in kitchens could prevent some respiratory illness in developing countries.

This study showed that three different cooking fuels produced unacceptable levels of indoor air pollution during cooking, as indicated indirectly by blood COHb concentrations. The findings are of concern as many people in developing countries make their first move up the fuel ladder from biomass fuels to kerosene and gas. Without adequate control of emissions and proper ventilation, such a move may not necessarily remove the health risks.
A further issue of concern not addressed in this study is carbon monoxide (CO) uptake by the fetus. Fetal blood is more susceptible to CO than is maternal blood. There is some evidence that CO exposures result in higher fetal COHb levels over time than maternal levels, and that fetuses take longer than their mothers to eliminate CO when the exposure has ended. This has implications for pregnant women as low birth weight and fetal damage is associated with CO exposure. Where women are cooking in poorly ventilated conditions using traditional fuels, the dangers of prolonged or repeated exposure are great and cooking frequency therefore needs to be considered in addition to emission levels in estimating the health risk to mother and fetus.

Summary of the work of:
Chronic respiratory disorders among women

Chronic respiratory diseases, particularly chronic bronchitis and emphysema, are a major cause of disability, second only to cardiovascular diseases. Various studies have identified chronic bronchitis as the commonest respiratory disorder in chest clinics of north India. However, these have been mixed population studies in which males outnumbered females. Very little research has been carried out to establish the risks to women. In a hospital which accepts only women, the authors investigated chest clinic patients to identify the pattern of chronic respiratory disorders in women of Delhi.

A retrospective analysis was carried out between 1973 and 1986 on 1532 female patients who attended a chest clinic in New Delhi. The patients were aged between 12 and 83 years. The proportion of smokers in this study was 6.6%, which is high compared to the 2.2% in the urban female population of Delhi, but low in comparison to the 11% in the rural population of Delhi. Prevalence of smoking was high in the elderly age group, possibly explained by the fact that older women have an established status in the family and are less bound by cultural constraints and social taboos.

High prevalence of exposure to kitchen smoke was an important observation of this study. A total of 705 patients (46%) reported regular exposure to kitchen smoke, as a result of cooking with coal, wood and cowdung; exposure was high in those aged over 40 years, and highest (71.2%) in the 50-59 year age group. It was low among the younger women (12.3% in the 12-19 year age group and 30% in the 20-29 year age group); this can probably be explained by changes in recent years to smokeless fuels such as cooking gas and kerosene, and to electric cooking appliances.

Nearly one-third of patients showed evidence of chronic bronchitis, and one-quarter of bronchial asthma. Bronchial asthma is said to be a disease affecting younger age groups. It is common in males, with a 2:1 ratio, but becomes equalized between the sexes by the age of 30. Of the 1532 women, 399 (26%) were found to be asthmatic. The prevalence of bronchial asthma reported from two other chest clinics was 13% and 24% respectively. In this study, the highest prevalence (44%) was recorded in the second decade of life and became progressively lower for subsequent age groups.

Chronic bronchitis with or without emphysema was found to be the commonest...
disorder in this study. Nearly 32% of the patients showed evidence of chronic bronchitis. This figure corresponds to that reported for various chest clinics where male patients outnumber women, for example 30%, 31.3% and 35% for three other clinics. Thus, although chronic bronchitis is thought to be more common in men due to exposure to environmental and industrial dust and smoke, and higher incidence of smoking, this study shows that the rates of chronic bronchitis among men and women are equal.

Nearly 42% of all patients over 40 (total 649) showed evidence of chronic bronchitis. Prevalence of exposure to kitchen smoke was also high in this group (427 out of 649 reported cooking with coal, dung, or wood) as was smoking incidence. The high prevalence of chronic bronchitis in these middle-aged and elderly women can probably be attributed to these factors.

A total of 223 patients were found to have bronchiectasis, and an additional 86 had bronchiectasis together with chronic bronchitis. Thus, nearly 20% of patients had clinical or radiological evidence of bronchiectasis. These figures are high compared to those for other chest clinics where male patients outnumbered females, showing that bronchiectasis is more common in women. The high prevalence can probably be attributed to repeated untreated respiratory tract infections in women. In addition to their high prevalence of kitchen smoke exposure (66%) and smoking (11%), women are often deprived of much needed medical attention due to social, cultural and economic constraints.

Pulmonary tuberculosis was diagnosed in 363 patients, most commonly women in their thirties. However, accurate estimates for women cannot be obtained from this study as most pulmonary tuberculosis patients are referred to tuberculosis clinics and not treated in chest clinics.

Evidence of cor pulmonale was found among 130 patients. This is high in comparison to the 0.8% and 2% reported from other clinics, but again no conclusions can be drawn as the majority of cor pulmonale patients seem to receive treatment at cardiac rather than chest clinics. Various cardiac clinics in India attribute between 10 and 40% of their attendance to cor pulmonale patients. Maximum prevalence of cor pulmonale was found in the over-60 age group, although prevalence was also high in patients over 40. Chronic bronchitis with or without emphysema was found to be the commonest cause of cor pulmonale (63.8%), followed by bronchiectasis (21.8%), pulmonary tuberculosis (7.7%) and bronchial asthma (5.4%).
It appears that exposure to kitchen smoke, coupled with tobacco smoking, is a major cause of chronic bronchitis in women, and that chronic bronchitis plays a persistent role in the evolution of cor pulmonale. The promotion of smokeless appliances for cooking, and health education campaigns against smoking, are therefore strongly advocated.

Summary of the work of:
Pneumoconiosis in rural women

A form of pneumoconiosis has been observed in rural African women, termed "Transkei silicosis" or "Hut Lung". A cluster of 25 women was investigated in whom the disease was diagnosed. The cause was attributed to silica particles inhaled while hand-grinding maize between rocks, in addition to inhaling smoke emissions from biomass fires. It is considered that biomass emissions are more significant in the aetiology of this condition than exposure to quartz dust. This is an important consideration given the large numbers of women in developing countries whose domestic duties regularly include hand-grinding and cooking with biomass fuel.

In rural Transkei, women cook on biomass fires inside poorly ventilated huts without chimneys. From the age of 10 years, girls and women grind maize for about 45 minutes each day to produce the grain required for the staple diet of the average rural family. Dry maize kernels are crushed into a fine powder with an oval hand-held grinding rock. The preferred rock is sandstone, composed of almost 100% quartz, but dolerite, which contains almost no quartz, is more freely available and more commonly used. It has been estimated that the average young woman aged between 20 and 25 years has already ground maize daily for at least 8 years. By their fifth decade, when most cases of Transkei silicosis are discovered, lengthy exposure has already occurred. On the basis of this evidence a preventive programme was launched to encourage the use of hand- or motor-driven machinery to replace traditional methods.

Patients with symptoms of Transkei silicosis are commonly seen in one major South African hospital, and the authors here report the clinical, radiological, physiological, histological and other abnormalities found in a cluster of 25 women with the condition. All conformed to the following criteria: rural residence; exposure to smoke from cooking fires or habitually grinding grain; no history of industrial or mining exposure; radiographic changes compatible with pneumoconiosis; lung biopsy evidence of pneumoconiosis; no bacteriological or histological evidence of active tuberculosis. As relatively few quartz particles were identified in lung sections, concentrations of respirable quartz dust, non-quartz-containing dust, and smoke were examined in rural houses.

Methods of traditional food preparation and cooking, and the conditions under which these take place, were observed in two villages. Smoke levels were measured during cooking on open fires fuelled with maize cobs, wood, and dried cowdung. Personal samplers were used to measure respirable dust concentrations during maize grinding. Measurements were taken both during grinding and stamping of maize.
An appreciable though low concentration of respirable quartz was liberated during grinding with sandstone but not with dolerite or through stamping. The most exposed maize grinder was exposed to time-weighted averages for quartz similar to those of the least exposed gold miner. These values are well within the recommended limits for time-weighted averages of industrial quartz exposure, and are within the levels at which disease is not expected to occur within 35 years.

The total respirable dust concentrations during maize grinding approached those of the dustiest mine activities and often exceeded the recommended industrial time-weighted averages. In addition, the average smoke concentrations during cooking far exceeded those permitted in industry. Three of the women did not grind maize, but experienced similar exposure to smoke in poorly ventilated dwellings. Total respirable dust concentrations approached those seen in the most heavily exposed gold miners, and smoke concentrations were unacceptably high. Women are exposed to smoke for longer each day than to the dust of grinding, particularly in cold weather.

Of the 25 women examined (mean age 43, range 20-84 years) 17 were non-smokers, 5 were tobacco pipe smokers, and 3 smoked under 11 cigarettes a day. Seven of the women had evidence of previous tuberculosis, 14 were without symptoms but had been referred for investigation of abnormal chest radiographs, 13 had mild acute respiratory tract symptoms suggesting acute infective bronchitis, and only 4 had presented because of chronic respiratory symptoms. The radiological features were compatible with pneumoconiosis. One patient had *cor pulmonale* and 6 showed radiological changes compatible with healed tuberculosis. Lung function tests showed airflow limitation in 16 patients, suggesting airway disease which could not be attributed to tobacco smoke or previous tuberculosis, and therefore likely to be the result of smoke inhalation.

### Dust and smoke combine to cause hut lung

The data suggest that domestic smoke may be more important than maize grinding in causing pneumoconiosis in these women. As the study included patients in their early 20s, heavy dust exposure from an early age appears likely. The combined evidence suggests that "Transkei silicosis" is a pneumoconiosis of mixed aetiology, with major contributions from "nuisance dust" of inorganic origin and smoke from biomass fires. Quartz dust seems to contribute in some patients but probably to a minor degree. The term "hut lung" seems appropriate for this condition, in recognition of its mixed aetiology and occurrence in other areas of southern Africa where similar domestic conditions prevail.

More detailed studies are required to establish whether women with more severe forms of this condition have been exposed to respirable quartz. Another variable
might be the young age at which women are first exposed to the dust. Infants secured to the mother's back during grinding and food preparation, for example, are in close proximity to the source. The role of previous tuberculosis also remains to be defined. We may also speculate whether hut lung predisposes the affected individual to tuberculosis, as is the case with occupational silicosis.

Hut lung appears to progress very slowly over many years of exposure without causing illness or disability. Most patients had no respiratory symptoms and only mild radiological and physiological abnormalities. Attention is usually drawn to their radiographs when they present with incidental acute bronchitis. Progressive massive fibrosis develops in a minority and may progress to respiratory failure with cor pulmonale and death. The radiological appearance is that of pneumoconiosis and histologically it ranges from simple anthracosis to progressive massive fibrosis.

Hut lung occurs as a result of exposure to both quartz- and non-quartz-containing dusts as well as smoke from biomass fires. The implications for the large numbers of women exposed to risk from both cooking and grinding operations, and with limited access to health care, are great. Preventive campaigns in rural areas are needed, focusing on improved ventilation of cooking huts through the use of chimneys, general reduction of nuisance dust and exposure, and grinding with quartz-free rock or preferably mechanized grinders. Such measures need to be applied in all rural communities practising similar traditional cooking methods.

These interesting conclusions are available because South Africa is in the unique position of combining sophisticated medical and technological services with the problems of the poorest developing countries. It should be noted that this disease could be detected only through radiographs administered for other purposes, to which poor urban and rural populations of most developing countries have little access.

Summary of the work of:
Lung cancer and indoor air pollution in China

The lung cancer mortality rate in Xuan Wei County, Yunnan Province, China, is one of the country's highest. Particularly among Chinese women, lung cancer mortality is more closely associated with indoor burning of "smoky" coal than with tobacco smoking. In contrast to wood and smokeless coal, smoky coal emissions have high concentrations of particles containing mutagenic organics. This study suggests an aetiologic link between domestic smoky coal burning and lung cancer in Xuan Wei.

Among the predominantly farming population of about 1 million in Xuan Wei County, tobacco smoking is common in males (40% or more), but rare in women (less than 0.1%). Local residents have traditionally used one of three major fuel types for domestic cooking and heating, namely "smoky" coal, "smokeless" coal, or wood. Cooking is carried out in shallow, unvented pits, resulting in high indoor air pollution levels. Women are customarily responsible for tending the fire and cooking, while men generally spend most daylight hours outside the home.

Annual age-adjusted lung cancer rates for the period 1973-1979 in Xuan Wei county were 27.7 in males (among China's highest), and 25.3 in females (China's highest). The similarity in rates between men and women is unusual. In Xuan Wei, lung cancer was the only surveyed cancer for which mortality exceeded the national average. Unadjusted annual lung cancer mortality rates vary greatly among the county's communes, but are highest in those where smoky coal is burned in more than 80% of homes. Rates are also highest in the central communes where smoky coal mines are situated. Lung cancer mortality in Xuan Wei is therefore thought to be associated with the domestic use of smoky coal. This association is particularly strong in women, who rarely smoke. However, given the broad variation in mortality across communes with smoky coal mines, the possibility that other specific environmental determinants of lung cancer play a role cannot be ruled out.

Comparison between two communes

To further evaluate the relationship between smoky coal use and lung cancer in Xuan Wei, a comparison was made between two communes. In one, mortality was high and smoky coal the predominant fuel, while in the other, mortality was low and the main fuels used were wood and smokeless coal. Concentrations of airborne particles
inside homes using smoky coal and wood were very high; they were considerably lower in homes using smokeless coal. The smoky coal samples also revealed the highest mutagenic activity, and were consistent with the epidemiologic findings that is, the samples with the highest mutagenic activity came from areas with the highest rates of lung cancer mortality, while those with low mutagenic activity were derived from communes with low lung cancer mortality.

In one commune, where lung cancer rates are highest and smoky fuel is used, residents are exposed to very high indoor particulate concentrations more than 100 times the US ambient air 24-hour standard. The particles from smoky coal combustion are mainly of a size that remain longer in the air and which can be effectively deposited in the lung after inhalation. These contain high levels of carcinogenic polyaromatic hydrocarbon (PAH) compounds. Indoor benzo(a)pyrene (BaP) concentrations during cooking are comparable to occupational exposure levels, such as those in coke oven plants.

The differences in PAH concentrations and mutagenicity in the two high-mortality communes are mainly due to differences in the particulate concentrations during cooking. Differences in particulate concentration are chiefly the result of differences in cooking habits. In one commune only breakfast and supper are cooked each day, whereas in two others, three meals are usually cooked with a fire lit for shorter periods. This requires more frequent starting and stoking, and hence generates higher smoke emissions than a steady fire. The presence in the smoky coal samples of several chemical compounds known to be carcinogenic may contribute to the high lung cancer rates in the two communes where smoky coal consumption is highest. Other compounds also showed significant mutagenicity in the smoky coal samples.

This study, like others, does not suggest any association between domestic open-fire woodsmoke and lung cancer. Both the less efficient lung deposition of the large particles from wood combustion, and the lower concentrations of biologically active compounds may contribute to the low rate of lung cancer in the commune using predominantly wood for fuel. Unlike smoky coal, 90% of the particles from smokeless coal were soot and unburned fuel, which may explain the lower lung cancer rates in the commune where it is widely used. The accumulated epidemiological, physical, chemical and toxicological findings of this study therefore suggest an etiological link between indoor smoky coal burning and lung cancer.
Coal is already a major domestic fuel for poorer communities in many countries, for example India, China, South Africa, and Vietnam, and may come to be used in many more as pressure on woodfuel resources increases. In view of the health risks to women of domestic coal use, it is essential that poor quality coal is processed adequately or that adequate smoke evacuation measures are installed in homes prior to further promotion of coal and coal-stoves.

Summary of the work of:
Respiratory effects of passive smoking and coal heating in China

In many parts of the world, including China, a major source of indoor air pollution is the use of free-standing, unvented coal stoves for home heating. There is growing evidence that indoor air pollution can adversely affect respiratory health; recent research in Beijing indicates that reduced pulmonary function in adults is associated with indoor air pollution from coal heating. This study of women who had never smoked evaluates the combined effects of passive cigarette smoking and coal heating at home on reported prevalence of respiratory symptoms.

A survey of 973 women, working in three similar textile mills in Anhui Province, China, was undertaken in 1992. All were between 20-40 years of age, had never smoked, and had middle or high school education. 35% of the women lived in homes heated with coal stoves.

Prevalence of four symptoms out of five (chest illness, cough, phlegm, and shortness of breath (SOB)) was found to be generally higher for women living in homes where both coal heating and smokers were present. The effects of passive smoking were more pronounced in homes using coal heating. Prevalence of chest illness, cough, phlegm, and SOB were found to be approximately 2.4, 2.1, 2.8, and 2.2 times higher, respectively, for women living in homes with both coal heating and more than one smoker than for women in homes without coal heating and with no smokers. The prevalence of a fifth symptom (wheeze (wheezing or whistling from the chest)) was not positively associated with cigarette smoke, but was positively associated with coal heating.

Multiple logistic regression analysis of these data controlling for age, job title, and mill of employment produced similar results. Prevalence of chest illness, cough, phlegm, and SOB was significantly associated with women living in homes with smokers and coal heating.

To determine whether socioeconomic differences between households may partially confound the association between respiratory symptoms and indoor air pollution, the living space in square meters per person resident in each home was calculated for a subset of 909 participants in the study. Logistic regression analysis controlling for square meters living space per household member and combined income of each woman and her husband, in addition to age, job title, and mill of employment, suggested that the association between indoor air pollution and respiratory
symptoms was not due to inadequate control of income or crowding.

In this study, when evaluated separately from coal heating, the association between passive cigarette smoking and respiratory symptoms was relatively weak. However, the combined effect of both passive cigarette smoke and coal heating was pronounced and statistically significant. Both these patterns are largely consistent with other studies. While associations between passive cigarette smoke and increased respiratory symptoms have been observed in children, this association is not as well established in adults.

Significant differences in prevalence of respiratory symptoms were observed between women working in administrative areas at the textile mill versus those who working in manufacturing, suggesting differences in occupational exposures. Nevertheless, the association with in-home passive cigarette smoking and coal heating did not diminish after controlling for age, mill, and type of work.

A major implication of this study is that health effects of passive cigarette smoking need to be evaluated within the context of combined exposures to multiple sources of indoor air pollution. Effects of passive cigarette smoke and effects of coal heating respectively were larger when both sources of indoor pollution were present. In homes with no other major indoor air pollution sources, the health effects of passive cigarette smoke on adults may be relatively small. However, in many parts of the world where the majority of homes are heated by unvented combustion, combined respiratory health effects may be substantial.

Summary of the work of: