Health related behaviours, especially smoking and tobacco use, are major determinants of health and lead to health inequities. Smoking leads to acute respiratory diseases, tuberculosis and asthma in younger age groups and non communicable diseases such as chronic lung disease, cardiovascular diseases and cancer in middle and older age. We observed an inverse association of educational status with tobacco use (smoking and other forms) in western Indian State of Rajasthan. In successive cross-sectional epidemiological studies- the Jaipur Heart Watch (JHW)- in rural (JHW-R; n=3148, men=1982), and urban subjects: JHW-1 (n=2212, men=1415), JHW-2 (n=1123, men=550) and JHW-3 (n=458, men=226), we evaluated various cardiovascular risk factors. The greatest tobacco consumption was observed among the illiterate and low educational status subjects (nil, 1-5, 6-10, >10 yr of formal education) as compared to more literate in men (JHW-R 60, 51, 46 and 36% respectively; JHW-1 44, 52, 30 and 18%; JHW-2 54, 43, 29 and 24%; and JHW-3 50, 27, 25 and 25%) as well as women (Mantel Haenzel test, P for trend <0.05). In the illiterate subjects the odds ratios (OR) and 95 per cent confidence intervals (CI) for smoking or tobacco use as compared to the highest educational groups in rural (men OR 2.68, CI 2.02, 3.57; women OR 3.13, CI 1.22, 8.08) as well as larger urban studies- JHW-1 (men OR 2.47, CI 1.70, 3.60; women OR 13.78, CI 3.35, 56.75) and JHW-2 (men OR 3.81; CI 1.90, 7.66; women OR 13.73, CI 1.84, 102.45) were significantly greater (P<0.01). Smoking significantly correlated with prevalence of coronary heart disease and hypertension. Other recent Indian studies and national surveys report similar associations. Health ethicists argue that good education and health lead to true development in an underprivileged society. We propose that improving educational status, a major social determinant of health, can lead to appropriate health related behaviours and prevent the epidemics of non communicable diseases in developing countries.

Key words Cardiovascular diseases - coronary heart disease - developing countries - health education - smoking - tobacco use

One of the major determinants of population health is its health-related behaviour\(^1\). Increasing life expectancy in US population has been shown due to a shift to healthier lifestyles. Forty two per cent of US adults were smokers in 1965 as compared to 23 per cent in 2001. Proportion of Americans 20 to 74 yr of age with high levels of serum cholesterol fell from 33 per cent in 1961 to 18 per cent in 2000. Primarily because of behavioural changes, the incidence of AIDS declined by nearly 50 per cent since 1992 and fatal crashes involving drunk driving declined from 30 per cent in 1982 to 17 per cent in 1999\(^2\). Each of these improvements in risk factors was facilitated by national campaigns that warned...
the population of the hazards of particular behaviours. Similar trends have been observed in many West European countries. Though these gains appear impressive at the macro level, at the subpopulation level the changes in most countries are confined to middle and high socio-economic groups and the decline in risk factors is either not present or very small in the low socio-economic status individuals. This has given rise to major health inequities within populations in the developed countries in context of both communicable as well as non-communicable diseases.

In India and other developing countries it is well known that the least privileged groups are more prone to suffer from acute and chronic infectious diseases, and poverty is a major determinant of mortality. Major infectious cause of mortality in India and many other developing countries include lower respiratory tract infections, HIV/AIDS, perinatal conditions, diarrhoeal diseases, tuberculosis, and malaria. All these are more prevalent among the lower socio-economic status subjects. Non-communicable diseases such as ischaemic heart disease, cerebrovascular diseases, chronic obstructive lung disease, cancer, and road traffic accidents are also major problems among adult populations in India. All these diseases are related to unhealthy lifestyles. Smoking and tobacco use is related in young individuals to infections such as lower respiratory tract infections and tuberculosis and in middle aged and the elderly to cardiovascular diseases, cancer and chronic lung diseases.

It is well known in the developed countries that smoking use is most prevalent among the least privileged groups. These groups are the unhealthiest and face the largest health inequities in terms of preventive, curative and rehabilitative therapies. Social determinants of health have been well studied in developed countries and are summarized by the World Health Organization as: social gradient, stress, early life, social exclusion, work, unemployment, social support, addiction including nicotine, food, and transport. In developing countries where illiteracy is rampant, educational status could be an important primordial determinant for many of these risk factors. Smoking as a marker of health inequity has not been studied in context of non-communicable diseases in developing countries. Here we propose that educational status is a major determinant of tobacco use in developing countries and that this could be used as a marker of health inequity (Fig. 1). It is suggested that increasing literacy levels should be an achievable solution to curb the tobacco epidemic.

Jaipur Heart Watch and recent Indian studies

Epidemiological studies that have serially evaluated non-communicable diseases and their risk factors are sparse in India. We have performed a
series of cross-sectional epidemiological studies using similar tools in the State of Rajasthan over the past 15 yr to determine cardiovascular risk factors and rural-urban differences. These studies are unique in study design and execution due to the fact that the studies utilized similar epidemiological tools, measurement techniques and training manuals. Thus, the results of the various studies are comparable and useful in examining urban-rural differences, time-trends of risk factors and location-based disparities in risk factors.

**Jaipur Heart Watch:** In the first study in a rural population in central Rajasthan conducted during 1992-1993, 3148 subjects (1982 men, 1166 women) aged >20 yr were evaluated using total community survey design. Educational level of the subjects was used to categorize socio-economic status. Literacy status correlated significantly with other markers of income such as occupation and housing type and was a good indicator of socio-economic status. In India, tobacco is consumed in multiple forms (predominantly smoking but also as chewable and oral forms) and many individuals use tobacco in multiple modes; we categorized all tobacco users as smokers. Overall prevalence of smoking was 51 per cent in men and 5 per cent in women. An inverse correlation of educational status and smoking was found (Spearman’s Rho men= -0.17, $P<0.001$; women= -0.06, $P=0.032$). In men prevalence of

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**Fig. 2.** Educational status and prevalence of tobacco use (smoking and other forms) in various study cohorts. Tobacco use was the highest among the rural subjects as well as the illiterate subjects and decline with increasing levels of education. There was an inverse correlation of educational level with tobacco use in both men and women in the rural cohort as well as urban Jaipur cohorts in the first Jaipur Heart Watch (JHW-1), second (JHW-2) and the third (JHW-3) studies ($P$ for trend <0.05). Blue bars indicate men and red bars women.
smoking or tobacco use was the highest among illiterate men as compared to those with 1-5, 6-10 and >10 yr of formal education (60 vs. 51, 46 and 36% respectively; Mantel-Haenzel P or trend <0.001). Among illiterate women it was 6 per cent as compared to those with 1-5 and >5 yr education (4 and 2% respectively, P for trend=0.029) (Fig. 2).

Among Jaipur urban subjects the first study (Jaipur Heart Watch-1) was conducted during 1993-1994, 2212 randomly selected subjects (1415 men, 797 women) were evaluated using cluster sampling for various cardiovascular risk factors18. Overall prevalence of smoking or tobacco use, predominantly smoking in men and chewable tobacco use in women, was 38 per cent in men and 19 per cent in women. There was a significant inverse correlation of smoking with educational status (Rho men= -0.19, P<0.001; women= -0.23, P<0.001). Smoking in the illiterate men and in those with 1-10, 11-15 and >15 yr of formal education was 44, 52, 30 and 18 per cent respectively (P for trend <0.05). In women it was 24, 23 and 2 per cent in illiterate, with 1-10, and >10 yr of education respectively. In the second study (Jaipur Heart Watch-2) conducted in 1999-2001, we evaluated 1123 subjects (men 550, women 573) using design similar to the previous study19. Smoking prevalence was 41 per cent in men and 21 per cent in women. There was a significant inverse correlation of smoking with educational status (Rho men= -0.49, P<0.001; women= -0.73, P<0.001). Smoking prevalence was 54 per cent in illiterate men as compared to 43, 29 and 24 per cent in other educational groups respectively; in women tobacco use was 28 per cent among the illiterate as compared to 3, 1 and 3 per cent in other groups (P for trend <0.05). Secular analysis revealed that, over the 7 yr period, in men smoking increased significantly among the illiterate by 10.4 per cent (95% CI 0.2-21.0%)20. In a single community study with low tobacco use we evaluated Punjabi Bhatia subjects for cardiovascular risk factors in the years 2001-2002 (n=458, men 226, women 232; Jaipur Heart Watch-3)21. The overall prevalence of tobacco use in this community was low (men 26%, women 2%) and there was a weak inverse correlation of educational status with smoking (Rho men= -0.11, P=0.103; women= -0.034, P=0.622) as compared to other studies in Jaipur but a significant difference in tobacco use according to the educational status was observed (Fig. 2).

The odds ratio (OR) and CI for smoking among the illiterate group as compared to the most literate group in various JHW study populations have been calculated. For men in various locations the OR varied from 2.68 (CI 2.02, 3.57) in rural subjects to 2.47 (1.70, 3.60), 3.81 (1.90, 7.66), and 3.00 (0.70, 12.80) in first, second and the third JHW studies respectively. In women, the OR were 3.13 (1.22, 8.08) for rural subjects and vary from 13.78 (3.35, 56.75), 13.73 (1.84, 102.45), and 1.71 (0.10, 28.87) in various urban groups respectively. These analyses showed that smoking and tobacco use in both rural and urban populations was inversely related to educational status and as compared to the most literate subjects the illiterate men were 2-4 times and women 3-15 times more likely to use tobacco. Socio-economic differentials were also observed in dietary intake in a separate study reported by Singhal et al from Jaipur22. Highly educated persons and those belonging to the most affluent class had significantly greater consumption of calories, polyunsaturated fats, fruits, vegetables and fibre as compared to the most deprived men and women. All these studies demonstrated that illiterate and less educated adults in both rural and urban areas of India are significantly disadvantaged in terms of adverse lifestyle and dietary variables, i.e., primordial cardiovascular risk factors.

We correlated smoking and tobacco use with prevalence of coronary heart disease and hypertension17,18. In the rural study and Jaipur Heart Watch-1, that were sufficiently powered to determine prevalence of coronary heart disease and hypertension, multivariate logistic regression analysis demonstrated that smoking was independent determinant of coronary heart disease in both rural and urban subjects. For coronary heart disease, multivariate odds ratio (after adjustment for age and several variables) in rural men was 2.50 (CI 1.09, 5.73) and in urban men 1.33 (1.00, 2.56). For hypertension prevalence in rural men it was 1.26
rural women 1.06 (0.52, 2.16), urban men 1.39 (1.07, 1.80) and urban women 1.82 (1.40, 2.23) \((P<0.05)\).

Other recent Indian studies: Venkatnarayan et al\(^\text{23}\) evaluated tobacco habits among a large population based sample of Delhi in late 1980s. Random sample of 13528 men and women of 25-64 yr was evaluated; 45 per cent (95% CI 43.8, 46.2) of men and 7 per cent (6.4, 7.6) of women were smokers. Education was the strongest predictor of smoking, and men with no education were 1.8 (1.5, 2.0) times more likely to be smokers than those with college education, and women with no education were 3.7 (2.9, 4.8) times more likely compared to college educated women. Compared with cigarette smokers, people with other forms of tobacco use were more likely to be older and married; had lower education, manual occupations, lower incomes, and body mass index; and did not drink alcohol or take part in leisure exercise. Gupta\(^\text{24}\) studied 99,598 low and middle income subjects in Mumbai for tobacco use and smoking in early 1990s. Permanent residents of city of Mumbai \(>35\) yr were interviewed (60% women, 40% men). Among women, prevalence of tobacco use was high (57.5%) but almost solely in the smokeless form. Among men, 69.3 per cent reported current tobacco use and 23.6 per cent were smokers. About half of smokers used bidi and the other half smoked cigarettes. Educational level was inversely associated with tobacco use of all kinds except cigarette smoking where no correlation was observed.

The second round of National Family Health Survey was conducted in 1998-1999 in 440 districts and 26 Indian states\(^\text{25}\). Apart from many parameters related to health behaviors, health status, and healthcare delivery, it also evaluated demographic, socio-economic and geographical distribution of tobacco consumption in 301984 individuals \(>18\) yr of age in 92447 households. Individuals with no education were 2.69 times more likely to smoke and chew tobacco than those with postgraduate education. The odds ratios derived from the fixed part of a multivariable five level binomial logit model for various educational groups were: for literacy up to postgraduate level (as comparator variable) 1.00, college 1.18, higher school 1.38, secondary school 1.85, primary school 2.37, and illiterate 2.69. Subjects in households belonging to lowest quintile of a standard living index were 2.54 times more likely to smoke than in highest group. Geographic determinants were very important and crude prevalence of tobacco use was 11-26 per cent in south Indian States, Punjab and Himachal Pradesh, 26-35 per cent in western Indian States, 35-48 per cent in central Indian States, and 48-79 per cent in eastern India. The north Indian State of Punjab had the lowest prevalence of tobacco consumption followed by Tamil Nadu, Goa, Kerala and Himachal Pradesh. Highest prevalence was observed in Mizoram, Arunachal Pradesh, Meghalaya, Manipur and Assam, all eastern Indian States. It was concluded that distribution of tobacco consumption was likely to maintain and perhaps increase the current considerable socio-economic differentials in health in India.

To determine influence of tobacco on mortality, Gajalakshmi et al\(^\text{13}\) in a retrospective case-control cohort study reported deaths due to medical causes in rural and urban cohorts in Tamil Nadu (43000 cases, 35000 controls). The death rates from medical causes of ever smokers were double than those of never smokers [risk ratio (RR) 2.1, 95% CI 2.0, 2.2]. Of this excess mortality among smokers, one third involved respiratory diseases chiefly tuberculosis (RR 4.5, CI 4.0, 5.0), a third involved vascular diseases (RR 1.8, CI 1.7, 1.9) and 11 per cent involved cancer (RR 2.1, CI 1.9, 2.4). It was concluded that smoking is a cause of half of male tuberculosis deaths in India and a quarter of all male deaths in middle age, and overall smoking currently causes 700,000 deaths per year in India chiefly from respiratory and vascular diseases. Thus smoking is an important cause of death and is a potentially reversible indicator of health inequities among middle aged and older individuals.

**Conclusions**

It is well known that poverty is bad for health\(^\text{6,26}\). Poor people have significant material deprivation and
multiple factors such as dirty water, poor nutrition and unhygienic living conditions combined with poor and difficult access to healthcare systems contribute to greater prevalence of communicable diseases as well as mortality in childhood and adolescence. This leads to greater infant and childhood mortality among the poor. In adults, the high mortality among the deprived people worldwide (except Africa) is due to non communicable diseases such as cardiovascular disease, cancers, endocrine, nutritional and metabolic diseases (e.g., diabetes), external causes (violence), respiratory disorders and digestive diseases. Determinants of such diseases are therefore important. Of the social determinants of health described by the WHO (social gradient, stress, early life, social exclusion, work, unemployment, social support, addiction, food, and transport), only a few appear important in developing countries such as India. We have observed that literacy levels are intrinsically related with smoking and tobacco use and it appears that improving literacy can reduce the burden of diseases, both communicable and non-communicable and decrease health inequities.

Amartya Sen describes real freedom that people have as the ultimate aim of any public policy. He values health status intrinsically and considers it more important than non-intrinsic or solely instrumental social goods such as income or health care. In this context different kinds of capabilities, specifically capability to avoid preventable morbidity and premature mortality or to be literate and numerate, are regarded both as ends in themselves and instrumentally important for achievement of other ends. Thus, improved education and health are regarded as major indicators of development. Kerala State in India is an important example. Large increases in literacy levels in this state have resulted in one of the lowest infant mortality rates in the world, despite the fact that the income levels of Kerala are not as high as in many developed countries. Kerala also has the highest life expectancy among all the Indian States. In 1991, the expectation of life at birth in males was 68.8 yr against an Indian average of 59.0 yr and the expectation of life at birth of females was 74.4 yr against a national average of 59.4 yr. Literacy levels appear to be the prime mover for this state of affairs. While reduced incidence of communicable diseases is responsible for a low infant mortality rate, the high life expectancy correlates with the low adult causes of death, especially non communicable diseases. Kerala has one of the lowest consumption of tobacco as reported in the National Family Health Survey. Thus, a low prevalence of tobacco use and other adverse lifestyle variables that are major determinants of non communicable diseases such as chronic respiratory diseases, cardiovascular diseases and cancer appear important in this regard.

Health ethicists have argued that smoking is a matter of personal choice and therefore no restrictions should be placed on its consumption by knowing adults. It has been counterargued that once the habit encroaches on public health domain and leads to substantial cost to the exchequer it no longer remains a matter of individual choice. It is clear that some people burden themselves and others in avoidable and undesirable ways by taking unjustified risks with their health. Smoking habit among the less privileged has helped in creation of health inequity in this group. Increasing educational status of the population helps in tobacco control and can ameliorate health inequities to a certain extent. Sir Geoffrey Rose, the famous epidemiologist, has opined that we need to examine the causes of the causes: the social conditions that give rise to high risk of non communicable disease whether acting through unhealthy behaviours or through the effects of highly stressful lives.

Thus, one of the major causes of non communicable diseases, viz., smoking and tobacco use, is highly prevalent in low socio-economic status subjects and inversely correlates with educational status. Improving the educational status of populations in developing countries such as India should be able to help control adverse lifestyle-associated diseases and lead to amelioration of the epidemic of non communicable diseases and related health inequities.

References


Reprint requests: Dr Rajeev Gupta, Department of Medicine, Monilek Hospital & Research Centre Sector 4, Jawahar Nagar, Jaipur 302004, India e-mail: rajeeyg@satyam.net.in