Bidi and cigarette smoking and risk of acute myocardial infarction among males in urban India

T Rastogi, P Jha, K S Reddy, D Prabhakaran, D Spiegelman, M J Stampfer, W C Willett, A Ascherio

Death from myocardial infarction (MI) in India is exacerbated by smoking of bidis or cigarettes. Smoking among 309 men with incident MI was compared to 618 age matched controls; 56% of the individuals with MI and 26% of controls were current smokers. Current smokers had a relative risk of 4.7 (95% confidence interval [CI] 3.2 to 6.9) compared to never smokers. Relative risks for smoking more than 10 cigarettes or 10 bidis daily were 9.1 (95% CI 4.7 to 17.7) and 8.1 (95% CI 4.3 to 15.3), respectively. It is estimated that smoking may cause 53% (95% CI 47% to 64%) of MIs among urban males in India.

METHODS
Details of case and control selection, exclusion criteria, measurements made, and interview procedures have been published previously. Ethics approval was received from all participating hospitals and from the Harvard School of Public Health. In brief, eligible cases were men aged 21–74 years hospitalised with incident acute MI among eight urban hospitals in Bangalore and New Delhi between 1999 and 2000 (female smoking is uncommon in India (Jha P, personal communication, 2005) and we do not report here on the results of the 41 women with MI interviewed). Definite diagnosis of MI was based on clinical examination, electrocardiogram, and cardiac enzymes. A total of 363 men met eligibility criteria, and 309 were included in the study; 34 eligible cases were excluded for the following reasons: fatal incident MI patients (n = 21), discharged before interview could take place (n = 18), too sick to be interviewed (n = 9), and not willing to be interviewed (n = 6). For each case, two controls matched by age (within five years) and hospital were obtained from non-cardiac outpatient clinics or inpatient wards. Controls comprised relatively healthy men with minor ailments or conditions. We identified 623 eligible controls, five of whom refused participation. Subjects were interviewed in person, and asked to report the number of bidis and/or cigarettes smoked per day. Anthropometric measures were also obtained. Analyses of cigarette and bidi smoking and risk of MI used standard conditional logistic regression, first controlling for age and hospital, and then, in addition, other potential risk factors demonstrated in previous studies. These risk factors include body mass index (< 21 kg/m², ≥ 21–23, ≥ 23–26, ≥ 26), waist to hip ratio (< 0.91, > 0.91–0.95, > 0.95–0.98, > 0.98), physical activity (none, < 155 met-min per day of exercise, ≥ 155), history of hypertension (yes, no), history of diabetes (yes, no), history of high cholesterol (yes, no), family history of coronary heart disease (yes, no), alcohol intake (no intake, any intake), education (none, primary school, middle, secondary, higher secondary, college, graduate/professional), household income (< 3000 rupees per month, 3000–6000, 6000–10 000, > 10 000), and being Hindu (yes, no).

Population attributable risk was calculated using the prevalence of smoking in the adult (30+) male urban population (prevalence 31%) and the relative risk observed with current smoking in our study (population attributable risk = \[\frac{\text{prevalence of smoking}}{\text{RR of smoking} - 1} + 1\]).

RESULTS
Fifty six per cent of the 309 male cases and 26% of the 618 male controls currently smoked either bidis or cigarettes. Overlap of bidi and cigarette use was low; only 16% of current bidi smokers used cigarettes and 14% of current cigarette smokers used bidis. Compared to never smokers, current smokers were younger, had lower body mass indexes and physical activity levels, and higher levels of alcohol intake (data not shown).

Current and former smokers had significantly increased risk for MI, with current smokers having a higher risk than former smokers (table 1).
In comparison to never smokers, current smokers had an age adjusted relative risk (RR) of 4.6 (95% confidence interval (CI) 3.4 to 6.4). This risk changed little with multivariate adjustment. In multivariate analysis of bidi smoking (table 2), persons consuming more than 10 bidis per day (median 20 bidis/day) had an RR of 9.1 (95% CI 4.7 to 17.7; p for trend < 0.0001). In multivariate analysis of cigarette smoking, persons consuming more than 10 cigarettes per day (median 15 cigarettes/day) had an RR of 7.3 (95% CI 3.9 to 13.8; p for trend < 0.0001) in comparison to never smokers. After excluding men who consumed both cigarettes and bidis (n = 27), risk estimates for bidi smoking did not change substantially, while risk in the higher category of cigarette smoking slightly increased though with wider confidence intervals. No significant interaction was found between bidi or cigarette smoking and other coronary risk factors, although the statistical power to detect small interactions was limited.

**DISCUSSION**

Our fourfold increased risk associated with current smoking for non-fatal MI is consistent with findings from the Interheart study, where a threefold elevation in risk was observed.4 Two western studies have already documented that the RRs for smoking are more extreme (even at lower absolute risks) at younger ages.6,7 The observed risk for non-fatal MI are about double that shown for fatal MI in India.5 The higher RRs for non-fatal MI might be accounted for partly by higher quitting rates before death. Misclassification of smoking in fatal MI studies would tend to attenuate risk estimates. The true estimate of risk might be accurately shown in non-fatal MI studies where persons with no prior history of any cardiovascular disease are included. Our ex-smoking prevalence of 15% among MI cases and 13% among controls is significantly higher than that reported in the general population.5,9 This implies that the early detection of MI risk among cases or clinical attention and access to hospital care among controls might lead to higher quit rates. This would tend to lower our observed risk ratios.

Notably, our results are remarkably consistent with an earlier retrospective study of 300 cases and 300 controls (93% of which were males) from one hospital in India.5 An unadjusted pooled Mantel-Haenszel RRs for MI with smoking for the two studies among current smokers is 3.7 (95% CI 2.9 to 4.6, test for heterogeneity 0.13, p = 0.7).

The observed current smoking prevalence among our controls of 29% is about the same as that seen in urban males in India in two surveys of 100 000 households,2 and of one million households (Jha P, personal communication, 2005) Thus, we estimate that smoking causes 53% (95% CI 47% to 64%) of MIs among urban males in India (using a male adult smoking prevalence of 31%).

The large RRs and a dose–response relationship with increased bidi or cigarette smoking, comparable to that seen in an earlier study,7 support a causal relation. Potential sources of bias in our study are not likely to have greatly affected the observed risks. There was little difference in risks between different sources of controls (clinics or inpatient wards; data not shown), suggesting that selection bias was minimal. Although health conscious individuals may have been more likely to participate in the study, overall participation rates were high. Controls were slightly more educated but had lower incomes than cases. However, controlling for recorded socioeconomic factors did not alter our findings significantly. Differential recall of smoking history was likely to be modest because smoking is recalled relatively easily. Our study provides risk estimates for tobacco smoking in urban India among males. Rural areas have

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**Table 1** Relative risk (RR) of acute incident myocardial infarction (MI) among males according to smoking history

<table>
<thead>
<tr>
<th>Smoking status*</th>
<th>Cases n=309</th>
<th>Controls n=618</th>
<th>Age and hospital adjusted RR (95% CI)</th>
<th>Multivariate adjusted RR (95% CI)</th>
<th>Number of smoking associated MI cases† (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>82</td>
<td>359</td>
<td>1.0</td>
<td>1.0</td>
<td>–</td>
</tr>
<tr>
<td>Ever</td>
<td>220</td>
<td>240</td>
<td>4.0 (3.0 to 5.4)</td>
<td>3.9 (2.8 to 5.6)</td>
<td>163 (74%)</td>
</tr>
<tr>
<td>Former</td>
<td>47</td>
<td>77</td>
<td>2.7 (1.7 to 4.1)</td>
<td>2.6 (1.6 to 4.3)</td>
<td>29 (69%)</td>
</tr>
<tr>
<td>Current</td>
<td>173</td>
<td>163</td>
<td>4.6 (3.4 to 6.4)</td>
<td>4.7 (3.2 to 6.9)</td>
<td>136 (79%)</td>
</tr>
</tbody>
</table>

*Never smokers (reference group) does not include cigarette smokers, bidi smokers, or users of other forms of tobacco (n = 57 cases and n = 19 controls used other forms of tobacco only). Ever smokers include former and current cigarette or bidi smokers. Current smokers include current smokers of cigarettes or bidis.

†Smoking associated number of MI cases calculated as (1−1/risk ratio) × number of cases who smoked in that group.

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**Table 2** Relative risk (RR) of acute incident myocardial infarction (MI) in males according to amount of current cigarette or bidi smoking

<table>
<thead>
<tr>
<th>Smoking status*</th>
<th>Median (cigarette or bidi)per day</th>
<th>Cases n†</th>
<th>Controls n‡</th>
<th>Age and hospital adjusted RR (95% CI)</th>
<th>Multivariate RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never smokers</td>
<td>0</td>
<td>82</td>
<td>359</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Bidi smokers:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 per day</td>
<td>4</td>
<td>16</td>
<td>39</td>
<td>1.9 (1.0 to 3.6)</td>
<td>2.0 (0.9 to 4.4)</td>
</tr>
<tr>
<td>&gt;10 per day</td>
<td>20</td>
<td>71</td>
<td>39</td>
<td>8.8 (5.2 to 14.8)</td>
<td>8.1 (4.3 to 15.3)</td>
</tr>
<tr>
<td>Test for trend; p value</td>
<td></td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarette smokers:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 per day</td>
<td>3</td>
<td>44</td>
<td>65</td>
<td>3.1 (1.9 to 4.9)</td>
<td>3.2 (1.8 to 5.7)</td>
</tr>
<tr>
<td>&gt;10 per day</td>
<td>15</td>
<td>61</td>
<td>28</td>
<td>9.4 (5.4 to 16.2)</td>
<td>9.1 (4.7 to 17.7)</td>
</tr>
<tr>
<td>Test for trend; p value</td>
<td></td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Never smokers does not include bidi smokers, cigarette smokers, or users of other forms of tobacco. Current smokers of bidis and cigarettes are presented.

†Approximately n = 19 cases and n = 8 controls smoked both cigarettes and bidis and are represented in both groups.
different disease patterns, access to care, and differences in smoking patterns. The ongoing Registrar General of India's one million death study will provide further data on smoking hazards in different regions including rural India and among different background disease rates.

The implication for tobacco control is clear: that reduced smoking will reduce the leading cause of adult death in India. Tobacco prevention in India is beginning to be addressed at the national level with legislation that bans advertising, sponsorship of sports, and cultural events by tobacco companies, smoking in public places, and sale of tobacco products to people younger than 18 years of age.

Our results add additional impetus in particular to cessation: some 70–80 million males over the age of 30 smoke, with vascular disease, tuberculosis and cancers being the major cause of premature mortality and disability among these men. Avoidance of tobacco related disease over the next few decades will require current smokers to quit, with the greatest benefits if quitting occurs before the onset of disease.

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