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.

Myocardial infarction (MI) is a leading cause of mortality and disability of adults in urban and rural India, and occurs at a younger age than in western populations. For example, about 30% of all estimated MI mortality occurs at ages 45–59 years in India, versus only 14% in high income countries. Male smoking of cigarettes or, more commonly, bidis—small unfiltered cigarettes hand rolled in a temburni leaf—is well established in India and has been recently documented as a major cause of death among Indian men, with much of this resulting from vascular and respiratory disease. Smoking of cigarettes and bidis has been associated with a twofold risk for fatal MI in India. The risks of smoking for non-fatal MI are less well established in India. The large hospital based "Interheart" case-control study, which included some 2171 patients from "South Asia", found a threefold relative risk of MI for smoking, with a population attributable risk of 37%. We know of only one study in India (based at one referral hospital) that examined the risk of smoking bidis or cigarettes and non-fatal MI. The risks of smoking for non-fatal MI were among a younger population than that seen in the Interheart or other western studies. Indeed, even within largely western populations, the international World Health Organization MONICA (multinational monitoring of trends and determinants in cardiovascular disease) project recently reported a nearly fivefold elevation in risk for non-fatal MI associated with current smoking in younger men.

Given the younger age of onset of cardiovascular disease in Indians and the unique patterns of bidi use, it is critical that risk for non-fatal MI be assessed in this population. We report here a case-control study of acute incident MI from eight hospitals in two cities in the north and south of India, and the risks associated with both cigarette and bidi smoking.

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.5 6 The observed risk 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.4 10 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.7 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,8 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,11 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>
<thead>
<tr>
<th>Smoking status*</th>
<th>Cases (n)</th>
<th>Controls (n)</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 (92%)</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. Ever smokers include former and current cigarette or bidi smokers. Current smokers include current smokers of cigarettes or bidis.

**Table 2** Relative risk (RR) of acute incident myocardial infarction (MI) in males according to smoking history

<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:</td>
<td>p value &lt;0.0001</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</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:</td>
<td>p value &lt;0.0001</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</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.

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

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different disease patterns, access to care, and differences in smoking patterns.\(^1\)\(^2\) 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.\(^3\)\(^4\)\(^5\)

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.\(^6\)\(^7\)

Our results add additional impetus in particular to cessation: some 70–80 million males over the age of 30 smoke,\(^8\)\(^9\) 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.\(^1\)\(^2\)

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Competing interests: none declared

Study design and data collection were done by TR, AA, WCW, KSR, DP, DS. Data analysis and interpretation were done by TR, PJ, AA, WCW, MUS, DS. Manuscript preparation was done by TR and PJ with critical feedback on the manuscript provided by AA, WCW, MUS, KSR, DP, DS.

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