Introduction
The determination of dietary energy requirements is still one of the most important issues that need to be tackled on priority basis, because large variation exists in defining adequate energy intake (EI). Nutritional status is usually associated with food intake which, in turn, is taken to be dependent on income and hence poverty. However, the level of income may not be the only determinant of food intake. There may be several other measures/indicators of poverty. Energy requirements might have changed due to changes in lifestyle. Individual EI and expenditure needs to be finely balanced, because both surplus and deficient EIs can be harmful to body function, and the recommended allowances for energy do not provide for a safety margin. Studies conducted specifically to compare EIs and anthropometry of adult men and women are few and the available literature is inconclusive. The present study was undertaken to examine the effect of various socio-demographic and some other factors on energy balance of Indian men and women, after accounting for differences in their activity and age.

Materials and Methods
The present cross-sectional study was conducted during April–June 2005 in selected rural, urban, and slum areas of Allahabad, Uttar Pradesh, India. A stratified multistage random sampling technique was used. A total of 1251 adult male and female respondents were finally included in the sample out of total 1979 volunteers participating in this study. Exclusions were mainly due to incomplete records/missing dietary data. The optimum sample size was calculated on the basis of a pilot survey with 68% prevalence of energy deficiency, 5% permissible error, and 99% confidence coefficient. An interview schedule was developed to obtain socio-demographic information such as background characteristics including age, social background, income, educational status, occupation, and lifestyle-related factors. EIs were obtained by the 24-h dietary recall method. The energy values of the diet, referred to as energy intake (EI) and computed energy requirement (CER), were obtained for each respondent. Activity was broadly judged on the basis of occupation as described by ICMR. Energy balance (CER–EI) was obtained by the algebraic difference between CER and EI. Energy deficit (ED) was indicated if EI was less than CER, and energy excess (EE), if EI was more than CER.

Statistical methods
Mean EI, CER, CER–EI, and differences between groups were assessed using Student’s t-test or ANOVA, as appropriate. Odds ratios along with 95% confidence limits were obtained. A logistic regression model was fitted to predict the probability and risk factors of energy deficiency/excess, taking CER–EI as a binary outcome variable. The forward likelihood ratio (LR) method was used to fit the logistic regression model. All statistical analysis was done using SPSS, version 12.

Results
The study included 604 (48.3%) males and 647 (51.7%) females, 337 (26.9%) from rural, 365 (29.2%) from urban, and 549 (43.9%) from slum areas representing various socio-demographic characteristics. There were 786 (62.8%) moderately active and 642 (51.3 %) having normal BMI. Table 1 presents EI, CER, CER–EI, and BMI...
in relation to social background, socioeconomic status, age, gender, educational status, activity, type of diet, and BMI. Significantly higher (P<0.001) EI was obtained for males (1789 kcal) compared to females (1492 kcal) and for non vegetarians (1703 kcal) compared to vegetarians (1585 kcal). Variability in EI according to age, activity, educational status, SES, social background, and BMI status also showed highly significant variability (P<0.001). Mean EI of the mixed population, comprising all socioeconomic classes, was found to be 1635 kcal per day, while mean CER was 2369 kcal per day. Mean EI–CER indicated a large energy deficit of 734 kcal per day, and average EI was 69% of CER. EI–CER showed significant variability in all subgroups, with respect to all factors studied, except the type of diet consumed. EI as percent CER was highest for urban dwellers (82%), for HIG (79.7%), for females (74.8%), for sedentary (78.4%), for moderately active (69.2%), and for the high BMI category (71.5%).

### Table 1: Energy intakes, computed energy requirements, and body mass index in relation to sociodemographic characteristics

| Characteristic | EI (kcal) | CER (kcal) | EI–CER | BMI | EI as % CER |
|----------------|-----------|------------|---------|-----|-------------|
| **Background** |           |            |         |     |             |
| Rural          | 1526 ± 534| 2495 ± 686 | -969 ± 787 | 18.2 ± 7.1 | 61.2 |
| Urban          | 1802 ± 415| 2180 ± 316 | -372 ± 465 | 24.2 ± 4.0 | 68.7 |
| Slum           | 1592 ± 513| 2419 ± 663 | -827 ± 708 | 18.6 ± 5.5 | 65.8 |
| **P value**    | F = 31.5  | F = 77.52  | F = 105.6 |     |             |
|                | P<0.001   | P<0.001    | P<0.001  |     |             |
| **SES**        |           |            |         |     |             |
| Low (LIG)      | 1572 ± 536| 2460 ± 695 | -888 ± 768 | 19.1 ± 5.8 | 63.9 |
| Middle (MIG)   | 1568 ± 501| 2413 ± 629 | -845 ± 690 | 19.3 ± 6.4 | 65.0 |
| High (HIG)     | 1769 ± 433| 2219 ± 388 | -450 ± 543 | 20.7 ± 5.2 | 79.7 |
| **P value**    | F = 22.1  | F = 53.12  | F = 70.1  |     |             |
|                | P<0.001   | P<0.001    | P<0.001  |     |             |
| **Age**        |           |            |         |     |             |
| 18–25          | 1562 ± 508| 2255 ± 557 | -692 ± 591 | 19.7 ± 3.2 | 69.3 |
| 26–35          | 1578 ± 526| 2392 ± 667 | -813 ± 717 | 20.8 ± 3.5 | 65.9 |
| 36–45          | 1653 ± 508| 2384 ± 590 | -730 ± 714 | 22.3 ± 4.2 | 69.3 |
| 46–60          | 1721 ± 526| 2383 ± 542 | -661 ± 745 | 22.4 ± 5.5 | 72.2 |
| >60            | 1671 ± 565| 2271 ± 574 | -599 ± 661 | 22.3 ± 5.3 | 73.6 |
| **P value**    | F = 4.1   | F = 2.5    | F = 12.8  |     |             |
|                | P = 0.002 | P = 0.04   | P<0.001   |     |             |
| **Gender**     |           |            |         |     |             |
| Male           | 1789 ± 509| 2771 ± 610 | -983 ± 795 | 19.6 ± 7.4 | 64.5 |
| Female         | 1492 ± 456| 1994 ± 256 | -502 ± 524 | 21.5 ± 4.6 | 74.8 |
| **P value**    | F = 4.1   | F = 161.32 | t = 29.6  |     |             |
|                | P = 0.002 | P<0.001    | P<0.001   |     |             |
| **Educational status** | |            |         |     |             |
| Illiterate/just literate | 1499 ± 558| 2315 ± 656 | -817 ± 737 | 19.2 ± 5.5 | 64.8 |
| Primary        | 1561 ± 494| 2517 ± 712 | -957 ± 731 | 18.8 ± 6.7 | 60.7 |
| Middle         | 1584 ± 450| 2516 ± 695 | -934 ± 740 | 19.2 ± 5.7 | 62.9 |
| High           | 1676 ± 476| 2557 ± 684 | -981 ± 818 | 18.6 ± 7.3 | 63.1 |
| Intermediate   | 1636 ± 430| 2347 ± 552 | -711 ± 657 | 22.1 ± 5.6 | 69.7 |
| Graduate       | 1807 ± 415| 2248 ± 373 | -441 ± 516 | 23.2 ± 5.7 | 80.4 |
| PG/others      | 1848 ± 431| 2243 ± 333 | -395 ± 486 | 23.8 ± 4.2 | 82.4 |
| **P value**    | F = 15.8  | F = 20.57  |         |     |             |
|                | P<0.001   | P<0.001    |         |     |             |
| **Type of activity** | |            |         |     |             |
| Sedentary      | 1819 ± 449| 2320 ± 334 | -500 ± 500 | 22.6 ± 5.3 | 78.4 |
| Moderate       | 1530 ± 461| 2210 ± 505 | -680 ± 638 | 20.4 ± 5.8 | 69.2 |
| Heavy          | 1801 ± 639| 3233 ± 707 | -1432 ± 925 | 17.4 ± 7.3 | 55.7 |
| **P value**    | t = 16.8  | t = 1.34   | t = 1.7  |     |             |
|                | P<0.001   | P<0.10     | P<0.18   |     |             |
| **Type of diet** | |            |         |     |             |
| Vegetarian     | 1585 ± 496| 2339 ± 596 | -754 ± 720 | 20.8 ± 5.6 | 67.8 |
| Nonvegetarian  | 1703 ± 508| 2409 ± 611 | -707 ± 697 | 20.4 ± 6.5 | 70.7 |
| **P value**    | t = 16.8  | t = 1.34   | t = 1.7  |     |             |
|                | P<0.001   | P<0.10     | P<0.18   |     |             |
| **Energy intakes** | |            |         |     |             |
| Not deficient* | 2292 ± 489| 2015 ± 285 | 276 ± 394 | 23.3 ± 5.1 | 113.7 |
| Deficient**    | 1551 ± 441| 2414 ± 618 | -863 ± 634 | 20.3 ± 6.1 | 64.2 |
| **P value**    | t = 37.7  | t = 43.7   | t = 30.2  |     |             |
|                | P<0.001   | P<0.001    | P<0.001  |     |             |

EI: Energy intake; CER: Computed energy requirement; BMI: Body mass index; EI–CER, EI=CER.
Bivariate analysis of factors influencing EI–CER is presented in Table 2. Respondents with ED comprised 88.7% of the population under study, even though one-third of them were from HIG. Individuals belonging to urban or slum background, high- or middle-income groups, illiterate/just literate group, and those involved in sedentary activity were found to be at significantly higher risk of being ED. Potential risk factors of ED on the basis of logistic regression analysis included being males, below 35 years of age, illiterate/just literate and involvement in moderate/heavy activity. SES was found to be the most significant risk factor for energy deficiency at an initial stage but at subsequent stages this factor lost its significance. The fitted logistic regression model to predict the probability ($P$) of individuals having ED was given by the following expression: $(P/(1−P)) = \text{Exp}(0.81 + 0.45 \times \text{Age below 35} + 1.01 \times \text{Male} + 0.71 \times \text{Illiteracy} + 0.53 \times \text{Moderate/heavy activity})$.

**Discussion**

The risk of ED was comparatively more among illiterate/just literate males below 35 years of age who were involved in moderate/heavy activity. Among less educated individuals, EI as %CER was also less and ED was larger as compared to those among highly educated individuals. Similarly for males and for younger age groups, EIs as %CER were lower and ED significantly higher as compared to those for females and for those above 35 years of age. Another important finding of the present study was that, contrary to expectation, social background and economic status ceased to be independent risk factors for ED. All groups including the HIG show ED, but it did not translate into poor nutritional status for HIG as judged by BMI. SES as such could not find place in the list of final risk factors but literacy and the type of activity were found to be significant risk factors. ED of HIG in the present study cannot be attributed to financial constraints. Their low EIs may also be the consequence of falling levels of physical activity. These findings suggest that poverty should not merely be defined on the basis of income or EI but some other measures of poverty should also be considered. “Capability Poverty Measure” (CPM) suggested by UNDP and “Human Poverty Index” (HPI) used in Human Development Report are some alternatives. However, if EI data are to be used to quantify the prevalence of poverty, then deficits in EIs of the group having financial constraints should be compared with those of a control group having no financial constraints. In India, Sukhatme had raised similar concerns, about 25 years ago, regarding the overestimation of poverty by comparing intakes with RDA and its importance for policy makers leading to some acrimonious debates. Thus, our findings also corroborate concerns regarding the need to adjust RDA. Food intake data based on 24-h recalls have generally been reliable because Indians are reported to be exceptionally good at estimating food portion sizes even though it has been criticized to exhibit the “flat-slope” syndrome. Hence, to minimize differences resulting due to different

**Table 2: Bivariate analysis of risk factors of energy deficiency**

| Characteristic            | Sample size (N) | N having EI < CER | % having EI < CER | Odds ratio (OR) | 95% Confidence interval of OR | P value |
|---------------------------|-----------------|-------------------|-------------------|-----------------|-------------------------------|---------|
| Social background         |                 |                   |                   |                 |                               |         |
| Rural                     | 365             | 288               | 78.9              | 1.00            | (2.12–4.93)                   | <0.001  |
| Urban                     | 549             | 507               | 92.3              | 3.23            | (2.18–6.16)                   | <0.001  |
| Slum                      | 337             | 314               | 93.2              | 3.65            | (1.72–4.86)                   | <0.001  |
| SES                       |                 |                   |                   |                 |                               |         |
| Low                       | 410             | 331               | 80.7              | 1.00            | (1.95–4.56)                   | <0.001  |
| Middle                    | 301             | 278               | 92.4              | 2.88            | (1.11–2.41)                   | 0.01    |
| High                      | 540             | 500               | 92.6              | 2.98            | (1.11–2.41)                   | 0.01    |
| Age (years)               |                 |                   |                   |                 |                               |         |
| 18–35                     | 545             | 487               | 89.4              | 1.00            | (0.39–0.82)                   | <0.005  |
| >35                       | 706             | 622               | 88.1              | 1.63            |                               |         |
| Gender                    |                 |                   |                   |                 |                               |         |
| Male                      | 604             | 553               | 91.6              | 1.00            |                               |         |
| Female                    | 647             | 556               | 85.9              | 0.56            | (1.36–3.03)                   | <0.001  |
| Educational status        |                 |                   |                   |                 |                               |         |
| Literate                  | 709             | 608               | 85.8              | 1.00            |                               |         |
| Illiterate/just literate  | 542             | 501               | 92.4              | 2.03            |                               |         |
| Type of activity          |                 |                   |                   |                 |                               |         |
| Sedentary                 | 303             | 255               | 84.2              | 1.51            | (1.02–2.23)                   | 0.03    |
| Moderate/heavy            | 948             | 754               | 79.5              | 1.00            |                               |         |
| Type of diet              |                 |                   |                   |                 |                               |         |
| Vegetarian                | 714             | 639               | 89.5              | 1.00            | (0.84–1.75)                   | .31     |
| Nonvegetarian             | 537             | 470               | 87.5              | 1.21            |                               |         |
| Overall                   | 1251            | 1109              | 88.7              |                 |                               |         |
methodologies, our study advocates comparison with an internal control group.

Conclusions and Suggestions
The study concludes that EI data should be interpreted with caution for the prediction of poverty- and food security-related questions. Poverty should not be defined merely on the basis of energy deficits but some broader measures of poverty like CPM and HPI should also be considered. Accordingly, for reducing the energy gap, some measures for reducing capable poverty should also be undertaken.

References
1. Svedberg P. Undernutrition Overestimated. Econ Dev Cult Change 2002;51:5-36.
2. Rizwanul I. Poverty and its effect on nutrition: some questions based on the Asian experience. Nutrition and Poverty. Papers from the ACC/SCN 24th Session Symposium Kathmandu. 1997.
3. UNDP. Human development report, New York; Oxford University Press; 1997.
4. Sukhatme PV, Margen S. Auto-regulatory homeostatic nature of energy balance. PV Sukhatme, editor. In: Newer concepts in nutrition and their implications for policy. Pune, India: Maharashtra Association for the Cultivation of Science Research Institute; 1982. p. 101-14. Ramachandran K. Nutrition monitoring and surveillance. Bull Nutr Found India January, 2006.

Source of Support: Nil, Conflict of Interest: None declared.