PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Association between socioeconomic status and self-reported diabetes in India: a cross-sectional multilevel analysis
AUTHORS	Corsi, Daniel J ; Subramanian, S V

VERSION 1 - REVIEW

REVIEWER	Prof. A. Ramachandran President, India Diabetes Research Foundation Chairman, Dr. A. Ramachandran's Diabetes Hospitals Chennai, INDIA Competing Interest: Nil
REVIEW RETURNED	08-Feb-2012

THE STUDY	•The study, though done in a large a population, has yielded data which is only confirmative of existing knowledge, based on smaller studies. No novel data is produced. •The major limitation is that only self-reported prevalence of diabetes is collected which is liable to be influenced mainly by the place of residence (urban/rural), availability of health care facilities, economic and educational status. •Moreover, the data was collected in a relatively young population. This cannot reflect the trend occurring in the nation, where longevity of population in increasing. •Given the major limitations mentioned above, the data cannot be considered truly nationally representative.
RESULTS & CONCLUSIONS	•The study, though done in a large a population, has yielded data which is only confirmative of existing knowledge, based on smaller studies. No novel data is produced. •The major limitation is that only self-reported prevalence of diabetes is collected which is liable to be influenced mainly by the place of residence (urban/rural), availability of health care facilities, economic and educational status. •Moreover, the data was collected in a relatively young population. This cannot reflect the trend occurring in the nation, where longevity of population in increasing. •There have been a number of epidemiological data from different parts of India (some are referred to in the paper) and most of them have shown the relationship between diabetes and SES.
GENERAL COMMENTS	This is an analysis of the data collected in a cross sectional, national, household survey. The number studied is very large. The objective was to quantify the association between socioeconomic

status (SES) and type-2 diabetes in India.

The overall prevalence of diabetes was 1.5% and the prevalence was higher in persons with the highest levels of education and wealth.

Comments
•The study, though done in a large a population, has yielded data which is only confirmative of existing knowledge, based on smaller studies. No novel data is produced.

•The major limitation is that only self-reported prevalence of diabetes is collected which is liable to be influenced mainly by the place of residence (urban/rural), availability of health care facilities, economic and educational status.

•Moreover, the data was collected in a relatively young population. This cannot reflect the trend occurring in the nation, where longevity of population in increasing.

•There have been a number of epidemiological data from different parts of India (some are referred to in the paper) and most of them have shown the relationship between diabetes and SES.

•Given the major limitations mentioned above, the data cannot be considered truly nationally representative.

•Table-1 shows that the highest proportion of subjects studied were below 40 years of age. Although, India has a higher proportion of young type-2 diabetic subjects than the western population, their proportion is significantly lower than among those with age above 40 years.

Impression
The paper does not merit publication in BMJ Open.

REVIEWER	Dr Shifalika Goenka Associate Professor, Indian Institute of Public Health, Public Health Foundation of India, New Delhi, India.
REVIEW RETURNED	24-Mar-2012

| THE STUDY | Question number two: the overall method to "quanitfy the association between socio-economic status and type 2 diabetes" is inadequate as it is only based on self-reported diabetes" In fact the poor sections and those with lower education may be less aware of their diabetes status.

Question 7: The abstract/summary: Please report results from the model where BMI has been adjusted for as it would be inappropriate to report results where BMI is not adjusted for. Table 2 shows that where as there is a positive assciation with wealth and diabetes, it does not show a positive association between education and diabetes when BMI has been adjusted for. THat means in this sel-reported data analysis education does not show any association. In India you dont need to be educated to be rich, you can be a shop keeper, businessmen or broker. If you see the Odds ratio for the various states in India, the states with the largest number of undernourished people/children have lower risk of self-reported |

	diabetes. (What happens when nutrition programs elevate their nutritional status to normal- we dont know.) Also the conclusions in the abstract therefore need to be changed ALSO, separate out wealth and eduation as reported in a 'self-reprted' national survey.(since diabetes is silent especially in its initiatl years, even in developed countries the propoRtion of undignoased diabetes is high what to speak of India)
RESULTS & CONCLUSIONS	the conclusions are over ambitions- as there is a major limiation that it is self-reported- that needs to be corrected in the manuscript. Also, wealth and education dont show the same results, so the findings need to be teased out when reported and also mention self-reproted in the methodology in the abstract and in the conclusions. Also, if it(self-reported) is mentioned in the objectives then it would be better. (India' s vast majority of the population is illlieterate or poorly educated besides being and under nourished, so making self-reported a considerably less desirable methodology that what is the case in USA, so it is extermely important that it gets mentioned in the title, objective, methods, results and conclusion)
GENERAL COMMENTS	The title should clearly mention self-reported. there fore it should read " association between socio-economic status and sel-reported diabetes in India

REVIEWER	Lennarth Nyström Associate Professor in Epidemiology Senior Lecturer in Biostatistics Department of Public Health and Clinical Medicine Umeå University UMEÅ SWEDEN
REVIEW RETURNED	28-Feb-2012

THE STUDY	Survey design Page 6, line 37 "All ever-married and never-married women" Isn't that all women? Pagge 6, line 39 "a subsample of households were" How were these men in the 22 states selected? Page 7, line 10 "We restricted our analyses TO..." Page 7, line 8-28 How come that you lost 74-65=9000 men but 124-103=21000 women? A flow-chart would help! Page 8, line18 "Control variables" I do not like the concept. There are no control variables, maybe background characteristics Page 8, line 40 The categorisation of BMI is overlapping at 23 and 27.5. 18.5-22.9? 23.0-27.4? The 3-step analysis in Table 2 is not clearly describe. What is the difference between Model adjusted for... and Mutually adjusted model? Is the 2nd step (Mutually adjusted model) really contributing?
GENERAL COMMENTS	This is a well written scientific paper of a well-designed and large study. The study is not unique and similar results have been

presented before.

VERSION 1 – AUTHOR RESPONSE

Reviewer: Prof. A. Ramachandran

This is an analysis of the data collected in a cross sectional, national, household survey. The number studied is very large. The objective was to quantify the association between socioeconomic status (SES) and type-2 diabetes in India. The overall prevalence of diabetes was 1.5% and the prevalence was higher in persons with the highest levels of education and wealth.

Comments
The study, though done in a large a population, has yielded data which is only confirmative of existing knowledge, based on smaller studies. No novel data is produced.

Response: We thank the reviewer for this comment. It is important to note that our primary objective was to document the socioeconomic status-diabetes relationship throughout the whole of India as well as examine geographic variability in the prevalence in diabetes across states and local areas. Previous research on diabetes in India has generally focused on urban areas and has been limited to local or regional coverage. In addition, it has not been possible to explore geographic variability in a consistent manner using the smaller studies due to differences in sampling methodology, age groups studied and diabetes assessment criteria (using self-report or blood glucose measurements with or without self-reports of diabetes and/or current drug treatment).
We have substantially revised the introduction to reflect the need for the present study (pages 5-6). In addition, we have summarized all previous studies reporting on diabetes in India by socioeconomic status in Table 1.

•The major limitation is that only self-reported prevalence of diabetes is collected which is liable to be influenced mainly by the place of residence (urban/rural), availability of health care facilities, economic and educational status.

Response: We agree that the use of self-reported diabetes status is a potential limitation and this has been identified in the article summary (page 4). However we explored the potential for bias in our associations in several ways in order to strengthen the credibility of our findings. First, we conducted a sensitivity analysis considering respondents who reported "unknown" for their diabetes status in addition to those who identified as "diabetic" and "non-diabetic". These findings were nearly identical to the main analyses which are presented. Second, BMI is strongly associated with diabetes. We analyzed the mean and distribution of BMI (which was based on measured and not self-reported values in this study) and the findings were as expected, including for those who reported "unknown" (see Figure 5) which gives further face validity to the use of self-reports of diabetes status. In addition, has been suggested previously (see Subramanian SV, Subramanyam MA, Selvaraj S, Kawachi I. Are self-reports of health and morbidities in developing countries misleading? Evidence from India. Soc Sci Med 2009;68(2): 260-5).
Finally, a number of local studies identified in our literature review (see Table 1) used blood glucose measurements for the determination of diabetes status and these studies demonstrated positive SES-diabetes relationships which were similar and consistent with our study findings further validating the use of self-reports of diabetes prevalence. (See Table 1)
We have given additional discussion of these issues on page 17.

•Moreover, the data was collected in a relatively young population. This cannot reflect the trend occurring in the nation, where longevity of population in increasing.

Response: Again, we agree that this is a potential limitation and we have stated this clearly in the article summary (page 4) in the discussion (Page 17). This study covers ages 18-49 y (women) and 18-54 y (men). Demographically, India is one of the youngest nations in the world. According to the 2001 census, the ages covered in our study represent a majority (84%) of the adult population in India (18-69 y) and 47% of the total Indian population (at all ages). The 0-17 age group, which accounts for about 41% of the population in India, was excluded although the prevalence of diabetes would be expected to be low in this group. Women over the age of 50 and men over the age of 55 represent 12% of the population of India and the prevalence of diabetes is likely to be higher in this group, although these ages were not covered in the NFHS survey and we were thus not able to include in the present study. We have provided the above details of this limitation in the discussion (page 17).

•There have been a number of epidemiological data from different parts of India (some are referred to in the paper) and most of them have shown the relationship between diabetes and SES.

Response: Thank you for this comment. We have revised the paper accordingly to give more attention to the previous studies of SES and diabetes in India. These are summarized in detail in Table 1. In addition, we have identified limitations in the previous studies, specifically that a majority focused on urban areas, were done in selected regions of the country, used varying methods of recruitment, measurement of SES markers, and definitions of diabetes. Our study provides an important overview of diabetes prevalence in India as it has good coverage of all states and rural areas, and provides consistent sampling methodology and measurement of SES across India. In addition we are able to comprehensively examine the geographical patterning in the prevalence of diabetes and between-state variability in the strength and consistency of the association between SES and diabetes across all states. We have specifically outlined the rationale for the present study on pages 5-6.

•Given the major limitations mentioned above, the data cannot be considered truly nationally representative.

Response: We agree with the reviewer that the survey did not cover all age groups (described above); however the survey had coverage in over 99% of the geographic regions of India; and according to our estimates from the 2001 census, nearly 85% of the adult and middle aged population. The rural coverage of the NFHS is important as nearly 70% of the population of India is resident outside of the cities. Previous studies have not comprehensively assessed the prevalence of diabetes and relationships with SES in a representative sample of rural areas.

•Table-1 shows that the highest proportion of subjects studied were below 40 years of age. Although, India has a higher proportion of young type-2 diabetic subjects than the western population, their proportion is significantly lower than among those with age above 40 years.

Response: We agree that it is plausible that the prevalence of diabetes in India may have been underestimated in this survey due to the younger age groups; however it is also plausible that previous estimates have been somewhat overestimated due to the focus on urban areas. An appropriate follow up study would involve more consideration of the middle and older age groups using a similar sampling strategy with national coverage. Despite of the lower prevalence of diabetes recorded in the NFHS, the associations observed between SES and self-reported diabetes observed in our study were consistent with previous studies that included older age groups and are summarized

in Table 1.

Impression
The paper does not merit publication in BMJ Open.

Response: We hope with the above revisions and explanations, we have demonstrated that our study adds crucial evidence to the discussion on the social distribution of diabetes in India.

Reviewer: Lennarth Nyström

Survey design
Page 6, line 37
"All ever-married and never-married women" Isn't that all women?

Response: Yes that is correct. We have clarified this (page 8).

Page 6, line 39
"a subsample of households were"
How were these men in the 22 states selected?

Response: In these 22 states, men were selected from a random subsample of households in each PSU (about 6 households per PSU). We have clarified this in the text (Page 8).

Page 7, line 10
"We restricted our analyses TO..."

Response: We have changed this (page 8).

Page 7, line 8-28
How come that you lost 74-65=9000 men but 124-103=21000 women? A flow-chart would help!

Response: The primary reason for change in sample was the height and/or weight data were not available in ~5% of the sample and therefore only the analyses including BMI as an independent variable were restricted to the smaller sample. We have added a flow chart to make this more transparent. (see Figure 1)

Page 8, line18
"Control variables"
I do not like the concept. There are no control variables, maybe background characteristics

Response: Thank you to the reviewer for this comment. We have revised these to "background characteristics" as suggested. (Page 9)

Page 8, line 40
The categorisation of BMI is overlapping at 23 and 27.5. 18.5-22.9? 23.0-27.4?

Response: Yes the reviewer is correct. We have revised throughout to 18.5-22.9 and 23.0-27.4. (Page 10 and tables)

The 3-step analysis in Table 2 is not clearly described. What is the difference between Model adjusted for... and Mutually adjusted model? Is the 2nd step (Mutually adjusted model) really contributing?

Response: We agree that this was not clear. We have provided a detailed clarification to the modelling strategy on page 11 under "Analysis." The mutually adjusted model (model 4) presents a model where each of the three SES markers are adjusted for one another plus the background characteristics in order to show the effects of each SES variable in the presence of the remaining 2. This model was presented as an intermediate step to show fully adjusted associations between each marker of SES and diabetes prior to the inclusion of BMI.

This is a well written scientific paper of a well-designed and large study. The study is not unique and similar results have been presented before.

Response: We thank the reviewer for this positive response to our paper. We would like to emphasize the following unique aspects of our paper. First, this study is unique in its use of a nationally representative survey as the basis for analysis with good coverage all states and in rural areas of India. Second, we have described geographic variability in the prevalence of diabetes across states and local areas of India which has not been presented previously. Lastly, in this version of the manuscript we have included a further analysis of the between-state variability in the association between one marker of SES (household wealth) and diabetes across states (presented in Figure 4, Supplemental Table 2). This analysis was also not possible in previous studies due to limited geographical coverage.

Response:

Reviewer: Dr Shifalika Goenka

Question number two: the overall method to "quantify the association between socio-economic status and type 2 diabetes" is inadequate as it is only based on self-reported diabetes" In fact the poor sections and those with lower education may be less aware of their diabetes status.

Response: We agree that this is a potential limitation of the study and we have addressed this limitation in detail above. In the manuscript we have identified the potential limitation of the use of self-reported diabetes on page 4 and pages 16-17. We believe in spite of the potential limitation our findings are credible for the following reasons. First, we carried out a sensitivity analysis to examine the consistency of the SES-diabetes association's when we included individuals with unknown diabetes status. The results of this analysis, presented in Supplemental Table 3, were nearly identical to the main analyses. In addition, those with unknown status much more closely resembled those without diabetes in terms of body mass index (itself a strong determinant of diabetes) than individuals who reported a positive diabetes status. Lastly, our results of the associations between SES and diabetes were consistent with a number of previous studies conducted using blood glucose measurements for the determination of diabetes status, which further demonstrates that the use of self-reports as a methodology for identifying associations between SES and diabetes in India. Previous studies have been summarized in Table 1 and we have given additional discussion of this limitation on page 17.

Question 7: The abstract/summary: Please report results from the model where BMI has been adjusted for as it would be inappropriate to report results where BMI is not adjusted for.

Response: We have reported the BMI-adjusted associations for wealth in the abstract. In addition we have reported the association for education which has been adjusted for age, gender, religion, marital status, and place of residence. Our analysis uses a series of models which increasingly add additional covariates. Although we agree with the reviewer's interpretation that the association with education is

less consistent in the final model which includes diabetes, we still feel it is useful to include the results of the previous model in order to asses the attenuation in the education-self-reported diabetes odds ratio after further adjustment for BMI. Indeed, as can be observed in table 2, the attenuation in the odds ratios for education is much larger between model 3 and model 4 which included household wealth (from odds ratio of 1.87 to 1.12 for higher education) than between model 4 and model 5 which included BMI (from 1.12 to 1.01) suggesting that the independent association between education and self-reported diabetes is largely mediated by household wealth (which remained consistent between model 2 and model 4) and to a lesser extent BMI. We have added this point to page 13. The abstract has also been revised on page 2.

Table 2 shows that where as there is a positive assciation with wealth and diabetes, it does not show a positive association between education and diabetes when BMI has been adjusted for. THat means in this sel-reported data analysis education does not show any association. In India you dont need to be educated to be rich, you can be a shop keeper, businessmen or broker. If you see the Odds ratio for the various states in India, the states with the largest number of undernourished people/children have lower risk of self-reported diabetes. (What happens when nutrition programs elevate their nutritional status to normal- we dont know.)

Response: We agree in part with the reviewer on the interpretation of these findings. As described above, the association between education and diabetes was less consistent after adjustment for household wealth, and it was further attenuated (to a lesser extent) after the inclusion of BMI. This suggests the following: household wealth was the strongest socioeconomic factor that was associated with self-reported diabetes status, after its inclusion to the model the effects of caste and education were less consistent. Finally, after the inclusion of BMI there was some further attenuation in the effects of all three SES variables (caste, education and wealth) underscoring the importance of BMI as a determinant of diabetes. However the effects of household wealth remained positive and statically significant after including BMI indicating that there may be a social pathway which influences diabetes independently of BMI. This may be due, as the reviewer suggests, to individual lifestyle modification that comes with increasing wealth and/or standard of living which is independent of educational attainment. We have added this point to the discussion on pages 18-19.

In addition, the reviewer also raises a good point of the correlation between diabetes prevalence at the state level with rates of undernourished children in similar states. We are in agreement that it is uncertain the long terms effects on the development of diabetes in these populations which have been targeted for nutritional supplementation programs.

Also the conclusions in the abstract therefore need to be changed ALSO, separate out wealth and eduation as reported in a 'self-reprted' national survey.(since diabetes is silent especially in its initiatl years, even in developed countries the propoRtion of undignoased diabetes is high what to speak of India)

the conclusions are over ambitions- as there is a major limiation that it is self-reported- that needs to be corrected in the manuscript. (exlained above)
Also, wealth and education dont show the same results, so the findings need to be teased out when reported and also mention self-reproted in the methodology in the abstract and in the conclusions. Also, if it(self-reported) is mentioned in the objectives then it would be better.
(India' s vast majority of the population is illlieterate or poorly educated besides being and under nourished, so making self-reported a considerably less desirable methodology that what is the case in USA, so it is extermely important that it gets mentioned in the title, objective, methods, results and conclusion)

Response: We agree with the concerns of the reviewer and have tried to address them as described

above. We have added self-reported to the study title and throughout the manuscript. We have commented on the difference in association between wealth and education. As mentioned previously, we agree that there is a perceived lack of validity in the use of self-reports of diabetes (or other health conditions) in India. However, previous reports have suggested that such perceptions are not justified and that self-reports of several health conditions (including diabetes) have been shown to be consistent with expectations. For example, individuals with no education reported higher levels of sickness and health conditions sickness compared to those with the most education in two large surveys in India (see Subramanian, Soc Sci Med 2009). We acknowledge the limitations in obtaining prevalence estimates from self-reports of diabetes; however the data in this study are important in contributing to our current understanding to both the prevalence and determinants of diabetes in a much larger sample of the Indian population than has been previously considered.

The title shoudl clearly mention self-reported. there fore it should read " association between socio-economic status and sel-reported diabetes in India

Response: this has been changed.