ORIGINAL RESEARCH ARTICLE

# Risk Factors of Diabetes and Its Comorbidities Among Elderly in India: Evidence from Longitudinal Aging Study (LASI)

**Vekutulu Chiero[1*], KC Das[2]**

[1,2]International Institute for Population Sciences, Mumbai, India

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## ABSTRACT

**Context/Background:** Chronic diseases like diabetes are at risk of developing heart disease. Therefore, it is crucial to identify the high-risk population, which would help policymakers and interventionists focus on vulnerable groups. This study aims to determine the prevalence, risk factors, and coexistence of other diseases with diabetes.

**Methodology:** Secondary data from Longitudinal Aging Study in India (LASI), Wave 1 (2017-18) was used for the study. A sample of 65,562 men and women aged 45 years and above have been included in the analysis. Univariate, bivariate, and multivariate statistical analysis was used for the analysis.

**Results:** Overall, (12.4%) of Indians have self-reported diabetes. The prevalence of diabetes is (12.9%) among men and (11.9%) among women. Geographic variations were observed with higher rates in south India. Depression, lack of physical activity, obesity, increase in age, family history of diabetes, higher level of education, and wealth quintile were all significant risk factors for diabetes among men and women. Diabetes is associated with other chronic conditions such as heart disease, hypertension, and diseases of the bones and joints.

**Conclusions:** Although self-reported data underestimate the disease burden, it is evident that the prevalence of self-reported diabetes is high. India should address the risk of diabetes by promoting and encouraging a healthy lifestyle.

**Key words:** Diabetes, Comorbidity, Self-reported, Elderly, India, Risk factors

## ARTICLE INFO

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***Correspondence:** Vekutulu Chiero (Email: aveluchiero17@gmail.com)

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## INTRODUCTION

India is currently experiencing an unprecedented wave of demographic changes. While increasing longevity and falling fertility have resulted in a 'demographic dividend,' which led to dramatic growth in the population of elderly aged 60 years and above. There is a substantial increase in the global share of older people aged 60 years and above and will continue to reach 2 billion by 2050.[1-3] Noncommunicable diseases (NCDs) are typically present in individuals aged 55 years or older in developed countries. Their onset occurred in India a decade earlier, less than age 45. The elderly is one of the most vulnerable groups in terms of NCDs.[1,4] Diabetes mellitus (DM) is a chronic metabolic disease characterized by elevated blood glucose.[5] Type 2 diabetes is the most common diabetes, usually in adults, when the body does not produce insulin. Universally in 2019, 463 million people lived with diabetes. And 77 million individuals are living with diabetes in India.[6-8]

The prevalence of diabetes differs significantly not only between countries but as well within countries. In India, in the review of several studies, the prevalence of diabetes ranges from (7.5%) to (24%) and shows that diabetes increases with an advance in wealth status.[4,9] *S*everal studies have found that diabetes increases gradually with advancing age. It is also affected by biological factors; however, they are influenced by numerous socioeconomic, demographic, and lifestyle factors.[10-12]

The survey conducted in Gujarat shows that risk factors associated with diabetes were obesity, lack of physical activity, and living a sedentary life.[13] In several studies male gender, body mass index BMI and the increased waist-hip ratio were positively correlated with diabetes.[14-16] A study in the metropolitan city of Delhi found that obesity, hypertension (25.9%), and diabetes (19.1%) were most commonly associated.[17] Another study has found that factors strongly associated with comorbid diabetes and hypertension include the elderly age group, obesity, and a family history of diabetes.[18]

The epidemiological transformation associated with changes in food habits and decreased physical activity is the fundamental cause of the diabetes epidemic.[12] Multiple non-modifiable risk factors such as age, ethnicity, and family history have been prospectively associated with diabetes mellitus.[19] Diabetes-related complications include kidney disease, neuropathy, blindness, and result in a heavy economic burden on the health care system.[20] Diabetes increases the risk of many serious health complications, high blood pressure, stroke, and CVD are common problems in diabetes patients.[21,23]

As, it is said that genetics lock the gun, whereas lifestyle pulls the trigger, studies have shown that a lack of physical activity is strongly associated with diabetes. With the adoption of the western lifestyle and due to the change in lifestyle and urbanization, diabetes mellitus is rising globally among the elderly. Therefore, they are at high risk of developing heart diseases, and this is one of the most significant challenges to health care, with the rising aging population in India. Moreover, it is essential to understand and identify the high-risk group understanding how diabetes differs in countries as large as India is vital for targeting prevention and intervention.[11, 22] As discussed above there are numerous studies in India. However, due to the diversity of the Indian population, study to date is restricted to the regional, state, or community level. Moreover, most studies focus on the adult population and limited research has generalized to the entire Indian elderly population. The recent Longitudinal Aging Study in India (LASI) study has data at the state level covering the maximum of elderly people. Therefore, the present study aims to examine the prevalence of diabetes, identify the risk factor and associated morbidities.

## METHODOLOGY

**Data source:** This study has utilized the secondary data from the Longitudinal Aging Study in India (LASI), Wave 1, which was conducted from (2017-18) under the aegis of the Ministry of Health and Family Welfare (MoHFW), Government of India, coordinated by the International Institute for Population Sciences (IIPS), Mumbai in collaboration with the Harvard T.H. Chan School of Public Health (HSPH) and the University of Southern California (USC).[1] The wave-1 of LASI covers all 30 states and 6 Union Territories of India (excluding Sikkim) with older adults aged 45 years and above and their spouses regardless of age. LASI data was collected based on internationally comparable research designs and tools for national policy-making and long-term scientific research. The survey provides reliable and continuous scientific data on India's older population's health, social, mental, and economic well-being. This study focuses on self-reported diabetes. Various socio-economic, demographic, and lifestyle characteristics based on men and women have been used. A sample of 65,562 men and women aged 45 years and above have been included in the analysis.

**Variables:** Various questions such as the health problems of individuals were asked, including 'Has any health professional ever diagnosed you with diabetes or high blood sugar?'. Therefore, the outcome variable utilized for the present study is "Diabetes": Ever diagnosed with diabetes "1=Yes, 0=No". This study incorporates several predictor variables to understand their relationship with the outcome variables. The socioeconomic and demographic, and lifestyle factors that have been included in the analysis are age, sex, education, caste, religion, Monthly Per Capita Expenditure (MPCE) quintile, marital status, family history of diabetes and hypertension, Body

Mass Index (BMI), abdominal obesity by waist circumference, depression, physical activity, smoking, alcohol use, use of smokeless tobacco, work status, place of residence ("rural" and "urban"). And several self-reported diseases in the form of ("yes," or "no") such as cancer, lung disease, heart disease, stroke, bone/joint disease, physical or mental impairment, neurological or psychiatric illness, high cholesterol hearing, and vision problems.

**Statistical analysis:** Bivariate, and multivariate statistical analysis was performed using STATA 16, [Texas 77845 USA College Station, Stata corp]. The prevalence of diabetes was estimated by sex and place of residence among older men and women in all the states and UTs of India. Multivariate binary logistic regression has been carried out to estimate the odds ratio of lifestyle behaviour on the occurrence of diabetes, without controlling socio-demographic factors and after controlling these factors. Furthermore, the chi-square test measures the association between diabetes and other morbid conditions.

# RESULTS

### Prevalence of diabetes by states and residence

**Table 1** shows the prevalence of self-reported diabetes among older men and women in various states and UTs of India. The prevalence of diabetes is (12.4%). The prevalence of diabetes is (12.9%) among men and (11.9%) among women. Among all the states, Kerala men and women have shown the highest prevalence of diabetes, i.e., (32.8%) and (28.3%) respectively. Overall, it is observed that the prevalence of self-reported diabetes is higher among older men as compared to women in India.

**Table 1: Self-reported prevalence of diabetes among elderly (45+) men and women by states/UTs in India, LASI Wave 1, 2017-18**

| State | Sample Size (n) | Men | Women | Total | Rural | Urban | Total |
|---|---|---|---|---|---|---|---|
| **North** | **11966** | **12.2** | **10.9** | **11.5** | **7.9** | **17.7** | **11.5** |
| Chandigarh | 932 | 20.3 | 22.6 | 21.9 | 0 | 22.0 | 21.9 |
| Delhi | 1171 | 20.6 | 17.6 | 18.9 | 4.5 | 19.1 | 18.9 |
| Haryana | 1757 | 8.8 | 7.3 | 8.7 | 6.2 | 13.3 | 8.7 |
| Himachal Pradesh | 1255 | 11.4 | 14.0 | 13.2 | 12.5 | 20.3 | 13.2 |
| Jammu & Kashmir | 1486 | 6.1 | 10.3 | 7.8 | 5.0 | 14.2 | 7.8 |
| Punjab | 1972 | 12.6 | 18.0 | 17.0 | 12.7 | 24.5 | 17.0 |
| Rajasthan | 2131 | 10.7 | 6.3 | 8.4 | 6.6 | 14.1 | 8.4 |
| Uttarakhand | 1262 | 10.3 | 8.3 | 9.7 | 6.6 | 17.6 | 9.7 |
| **Central** | **8907** | **8.4** | **6.3** | **7.3** | **5.6** | **13.4** | **7.3** |
| Chhattisgarh | 1901 | 8.3 | 6.1 | 7.2 | 4.4 | 16.5 | 7.2 |
| Madhya Pradesh | 2717 | 6.7 | 5.7 | 6.3 | 4.3 | 11.7 | 6.3 |
| Uttar Pradesh | 4289 | 9.0 | 6.4 | 7.7 | 6.2 | 13.7 | 7.7 |
| **East** | **11580** | **10.1** | **8.9** | **9.5** | **6.5** | **19.3** | **9.5** |
| Bihar | 3297 | 7.9 | 7.7 | 7.8 | 6.7 | 15.7 | 7.8 |
| Jharkhand | 2228 | 11.3 | 7.7 | 9.9 | 6.4 | 20.3 | 9.9 |
| Odisha | 2621 | 9.6 | 6.7 | 8.2 | 6.5 | 18.2 | 8.2 |
| West Bengal | 3434 | 10.4 | 10.1 | 11.6 | 6.3 | 20.4 | 11.6 |
| **Northeast** | **8513** | **8.7** | **6.9** | **7.7** | **6.2** | **13.2** | **7.7** |
| Arunachal Pradesh | 982 | 8.9 | 5.1 | 6.9 | 7.6 | 4.1 | 6.9 |
| Assam | 2019 | 8.6 | 6.4 | 7.6 | 6.3 | 13.5 | 7.6 |
| Manipur | 1251 | 14.1 | 8.5 | 10.1 | 7.5 | 14.3 | 10.1 |
| Meghalaya | 886 | 2.3 | 4.4 | 3.8 | 2.5 | 8.6 | 3.8 |
| Mizoram | 1129 | 7.0 | 7.2 | 8.8 | 3.6 | 13.5 | 8.8 |
| Nagaland | 1202 | 5.3 | 8.3 | 7.7 | 5.9 | 12.4 | 7.7 |
| Tripura | 1044 | 10.4 | 7.9 | 9.5 | 7.3 | 14.6 | 9.5 |
| **West** | **8894** | **14.2** | **12.7** | **13.4** | **9.6** | **18.6** | **13.4** |
| Dadra & Nagar Haveli | 989 | 10.2 | 7.8 | 9.9 | 5.2 | 14.1 | 9.9 |
| Daman & Diu | 903 | 23.2 | 13.3 | 18.2 | 14.3 | 19.3 | 18.2 |
| Goa | 1265 | 24.3 | 21.8 | 23.8 | 19.9 | 25.7 | 23.8 |
| Gujarat | 2145 | 13.5 | 14.0 | 13.2 | 9.6 | 18.2 | 13.2 |
| Maharashtra | 3592 | 14.4 | 12.2 | 13.3 | 9.5 | 18.6 | 13.3 |
| **South** | **15702** | **20.2** | **20.1** | **20.2** | **14.9** | **27.9** | **20.2** |
| Andaman & Nicobar | 1113 | 13.9 | 21.0 | 21.2 | 16.0 | 29.8 | 21.2 |
| Andhra Pradesh | 2399 | 19.9 | 17.7 | 19.3 | 15.1 | 29.4 | 19.3 |
| Karnataka | 2083 | 17.4 | 26.4 | 16.9 | 8.9 | 31.2 | 16.9 |
| Kerala | 2300 | 32.8 | 28.3 | 28.8 | 27.4 | 30.4 | 28.8 |
| Lakshadweep | 1062 | 24.1 | 20.0 | 23.3 | 17.4 | 24.1 | 23.3 |
| Puducherry | 1288 | 22.8 | 23.0 | 24.2 | 4.4 | 26.6 | 24.2 |
| Tamil Nadu | 3205 | 20.1 | 19.7 | 21.0 | 17.3 | 24.9 | 21.0 |
| Telangana | 2252 | 14.2 | 11.0 | 14.2 | 7.3 | 27.4 | 14.2 |
| **India** | **65562** | **12.9** | **11.9** | **12.4** | **8.6** | **20.5** | **12.4** |

The prevalence of diabetes is (8.6%) in rural areas and (20.5%) in urban areas. In rural areas, among all the states Kerala has shown the highest prevalence of diabetes i.e., (27.4%). In urban areas, Karnataka has shown the highest prevalence (31.2%). Overall, it is observed that the prevalence of diabetes in urban areas has higher rates as compared to rural areas in several states of India.

**Risk factors for diabetes**

**Table 2** two models have been applied to see the effect of lifestyle behaviour on the occurrence of diabetes, without controlling socio-demographic factors and after controlling these factors. In the first model, modifiable risk or health behaviour risk is included, and in the second model along with health behaviour all the socio-economic and demographic are included in the analysis.

**Table 2** and **model 1** evaluate the association between various lifestyle behaviour risks and diabetes among both men and women and the total India after controlling socio-demographic factors. The risk of diabetes was 1.2 times higher among both men and women (AOR=1.18; CI: 1.04-1.26) who have depression all the time compared to those who never or rarely have depression. And it remains the same before and after controlling for socio-economic factors. Those elderly men and women who never had vigorous physical activity are 1.2 times (AOR=1.25; CI: 1.14-1.36) and 1.1 times (AOR=1.12; CI: 1.01-1.25) more likely to have diabetes compared to those who have to perform physical activity every day. Moreover, it increases to 1.7 times (AOR=1.66; CI: 1.52-1.79) in men and 1.6 times (AOR=1.60; CI: 1.45-1.77) in women after controlling socio-economic and demographic factors. In the case of elderly men, the use of smokeless tobacco and smoking shows to have a negative impact on diabetes. For women, use of smokeless tobacco, smoking, and alcohol use shows a negative impact on diabetes. However, it disappeared after controlling for socioeconomic factors.

**Table 2** and **model 2** evaluate the association between various behaviour risks and demographic and socioeconomic characteristics with diabetes among men and women. Among men who have normal BMI and overweight/obese are 1.3 times (AOR=1.31; CI: 1.18-1.44) and 1.8 times (AOR=1.79; CI: 1.59-2.01) respectively more likely to have diabetes compared to those who are underweight whereas among women who have normal BMI and overweight/obese are 1.5 times (AOR=1.49; CI: 1.31-1.70) more likely to have diabetes compared to those who are underweight. Again, men and women who have abdominal obesity by waist circumference are 1.4 times (AOR=1.39; CI: 1.23-1.57) and 1.5 times (AOR=1.50; CI: 1.50-1.82) respectively more likely to have diabetes compared to those elderly who doesn't have abdominal obesity.

**Table 2: Adjusted odds ratio and confidence interval showing the effect of lifestyle behaviour on diabetes: Result from logistic regression analysis, LASI Wave-1, 2017-18**

| Background Characteristics | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| | Adj OR | 95% CI | Adj OR | 95% CI | Adj OR | 95% CI | Adj OR | 95% CI |
| ***Modifiable risk*** | | | | | | | | |
| **Depression level** | | | | | | | | |
| Rarely/never® | | | | | | | | |
| Sometimes | 1.01 | [0.94,1.10] | 1.05 | [0.97,1.15] | 1.09* | [1.01,1.18] | 1.13** | [1.05,1.23] |
| Often/all the time | 1.17** | [1.05,1.30] | 1.18** | [1.06,1.32] | 1.15** | [1.04,1.26] | 1.15** | [1.04,1.27] |
| **Physical activity** | | | | | | | | |
| Daily® | | | | | | | | |
| Weekly | 0.95 | [0.84,1.08] | 0.99 | [0.87,1.14] | 0.92 | [0.78,1.08] | 0.95 | [0.80,1.22] |
| Monthly | 1.14 | [0.95,1.34] | 1.08 | [0.90,1.35] | 0.90 | [0.74,1.11] | 0.86 | [0.70,1.06] |
| Hardly/never | 1.66*** | [1.52,1.79] | 1.25*** | [1.14,1.36] | 1.60*** | [1.45,1.77] | 1.12* | [1.01,1.25] |
| **Smokeless tobacco** | | | | | | | | |
| Never® | | | | | | | | |
| Used in the past | 0.97 | [0.81,1.16] | 1.11 | [0.92,1.35] | 1.15 | [0.89,1.49] | 1.14 | [0.88,1.50] |
| Currently using | 0.61*** | [0.56,0.67] | 0.87** | [0.79,0.97] | 0.75*** | [0.67,0.84] | 0.92 | [0.82,1.03] |
| **Smoking** | | | | | | | | |
| Never® | | | | | | | | |
| Past smokers | 1.00 | [0.90,1.15] | 0.91 | [0.80,1.04] | 0.72 | [0.51,1.02] | 0.88 | [0.61,1.26] |
| Currently smoking | 0.53*** | [0.48,0.59] | 0.69*** | [0.62,0.76] | 0.27*** | [0.19,0.38] | 3.9 | [0.28,0.55] |
| **Alcohol** | | | | | | | | |
| No® | | | | | | | | |
| Yes | 0.97 | [0.90,1.06] | 1.00 | [0.92,1.09] | 0.55*** | [0.43,0.70] | 0.75 | [0.59,0.97] |
| **BMI** | | | | | | | | |
| Thin/underweight® | | | | | | | | |
| Normal | | | 1.31*** | [1.18,1.44] | | | 1.19*** | [1.07,1.32] |
| Overweight/obese | | | 1.79*** | [1.59,2.01] | | | 1.49*** | [1.31,1.70] |
| **Abdominal obesity by waist circumference** | | | | | | | | |
| No® | | | | | | | | |
| Yes | | | 1.39*** | [1.23,1.57] | | | 1.65*** | [1.50,1.82] |

Continue....

| Background Characteristics | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| | Adj OR | 95% CI | Adj OR | 95% CI | Adj OR | 95% CI | Adj OR | 95% CI |
| ***Non-Modifiable risk*** | | | | | | | | |
| **Age** | | | | | | | | |
| 45-59® | | | | | | | | |
| 60+ | | | 1.57*** | [1.44,1.72] | | | 1.60*** | [1.48,1.73] |
| **Education** | | | | | | | | |
| No schooling® | | | | | | | | |
| Primary | | | 1.25*** | [1.09,1.43] | | | 1.36*** | [1.22,1.53] |
| Secondary | | | 1.47*** | [1.32,1.64] | | | 1.08*** | [1.08,1.30] |
| Higher | | | 1.75*** | [1.57,1.97] | | | 1.09 | [0.98,1.22] |
| **Caste** | | | | | | | | |
| SC® | | | | | | | | |
| ST | | | 0.78** | [0.66,0.92] | | | 0.72*** | [0.62,0.84] |
| OBC | | | 1.01 | [0.90,1.14] | | | 0.95 | [0.85,1.06] |
| Others | | | 1.01 | [0.90,1.14] | | | 1.06 | [0.94,1.18] |
| **Religion** | | | | | | | | |
| Hindu® | | | | | | | | |
| Muslim | | | 1.09 | [0.98,1.23] | | | 1.19*** | [1.07,1.32] |
| Christian | | | 1.08 | [0.93,1.26] | | | 1.37*** | [1.20,1.57] |
| Others | | | 1.15 | [0.97,1.37] | | | 1.13 | [0.96,1.33] |
| **Marital Status** | | | | | | | | |
| Currently married® | | | | | | | | |
| Widowed | | | 0.62** | [0.44,0.90] | | | 1.99*** | [1.40,2.84] |
| Divorced, Separated, Disserted | | | 0.69 | [0.46,1.02] | | | 1.79** | [1.21,2.66] |
| **MCPE quintile** | | | | | | | | |
| Poorest® | | | | | | | | |
| Poorer | | | 1.29*** | [1.33,1.46] | | | 0.94 | [0.83,1.06] |
| Middle | | | 1.31*** | [1.15,1.49] | | | 1.14* | [1.02,1.28] |
| Richer | | | 1.57*** | [1.38,1.78] | | | 1.25*** | [1.12,1.41] |
| Richest | | | 1.79*** | [1.58,2.03] | | | 1.38*** | [1.23,1.55] |
| **Work status** | | | | | | | | |
| Never worked® | | | | | | | | |
| Work in the past | | | 0.81* | [0.67,0.97] | | | 1.0 | [1.40,2.84] |
| Currently working | | | 0.62*** | [0.56,0.67] | | | 0.58*** | [1.21,2.66] |
| **Family history of Diabetes** | | | | | | | | |
| No® | | | | | | | | |
| Yes | | | 2.81*** | [2.59,3.05] | | | 2.57*** | [2.38,2.78] |
| **Residence** | | | | | | | | |
| Rural® | | | | | | | | |
| Urban | | | 1.67*** | [1.54,1.81] | | | 1.68*** | [1.56,1.81] |

It is evident from the analysis that age has a significant positive effect on diabetes i.e., elderly aged 60+ men and women are 1.6 times (AOR=1.57, CI: 1.44-1.72) and 1.6 times (AOR=1.60, CI: 1.48-1.73) respectively, more likely to have diabetes as compared to elderly aged (45 to 59). The odds of having diabetes are increasing with an increasing year of schooling for men whereas, in the case of women, the elderly who have received primary are 1.4 times (AOR=1.36, CI: 1.22-1.53), more likely to have diabetes than those women who did not receive any education. Those men and women who belong to ST have 0.78 times (AOR=0.78, CI: 0.66-0.92) and 0.72 times (AOR=0.72, CI: 0.62-0.84) lower risk of diabetes than SC women. Widowed men have 0.62 times (AOR=0.62, CI: 0.44-0.9), reduced risk of having diabetes compared to married men, and widowed women are 2 times (AOR=1.99, CI: 1.40-2.84), more likely to have diabetes than currently married women. The odds of having diabetes in men and women increase incrementally in the MCPE quintile. Elderly men and women currently working are 0.62 (AOR=0.62 CI: 0.56-0.67) and 0.58 (AOR=0.58 CI: 1.21-2.66) times less likely to have diabetes than to elderly who never worked. Elderly men and women who have a family history of diabetes have 3 times (AOR=2.81, CI: 2.59-3.05) and (AOR=2.57, CI: 2.38-2.78) more likely to have diabetes than those who do not have a family history of diabetes. Elderly men and women who reside in urban areas have 1.7 times (AOR=1.67, CI: 1.54-1.81) and 1.7 times (AOR=1.68, CI: 1.56-1.81) more likely to have diabetes compared to elderly who resides in rural areas.

### Coexistence of diabetes with various morbid conditions

**Table 3** Present the percentage of diabetes in various morbid conditions among men and women in India. In the case of men, a significant association has been found between diabetes and all other diseases taken into account in the study. In the case of women, except for physical/mental impairment, another morbid condition considered in the study is found to be significantly associated with diabetes. Among men, (30.6%) who have hypertension have diabetes, (20.3%) have a comorbidity of cancer and diabetes,

**Table 3: Percentage of diabetes by various morbid conditions among men and women in India, LASI Wave-1, 2017-18**

| Morbid Conditions | Men | | Women | | Total | |
|---|---|---|---|---|---|---|
| | % | $\chi^2$ | % | $\chi^2$ | % | $\chi^2$ |
| **Hypertension** | | | | | | |
| No | 7.6 | 2600*** | 6.5 | 2400*** | 7.03 | 4900*** |
| Yes | 30.6 | | 25.1 | | 27.3 | |
| **Cancer** | | | | | | |
| No | 13.2 | 6.9** | 12.4 | 19.2*** | 12.8 | 25.2*** |
| Yes | 20.3 | | 21.2 | | 20.8 | |
| **Lung disease** | | | | | | |
| No | 13.1 | 11.1*** | 12.2 | 40.3*** | 12.6 | 47.3*** |
| Yes | 15.8 | | 17.3 | | 16.5 | |
| **Heart disease** | | | | | | |
| No | 12.5 | 363.7*** | 11.9 | 395.8*** | 12.2 | 762.4*** |
| Yes | 31.0 | | 32.1 | | 31.5 | |
| **Stroke** | | | | | | |
| No | 12.9 | 150.7*** | 12.3 | 111.7*** | 12.6 | 267.1*** |
| Yes | 28.6 | | 28.4 | | 28.5 | |
| **Bone/joint disease** | | | | | | |
| No | 12.7 | 64.7*** | 11.5 | 162.0*** | 12.1 | 213.5*** |
| Yes | 17.7 | | 17.4 | | 17.5 | |
| **Physical/Mental Impairment** | | | | | | |
| No | 13.1 | 13.7*** | 12.4 | 1.78 | 12.7 | 12.8*** |
| Yes | 15.8 | | 13.4 | | 14.5 | |
| **Neurological/Psychiatric disease** | | | | | | |
| No | 13.2 | 17.5*** | 12.4 | 16.6*** | 12.7 | 34.2*** |
| Yes | 18.6 | | 17.3 | | 17.9 | |
| **High cholesterol** | | | | | | |
| No | 12.3 | 831.7*** | 11.4 | 978.4*** | 11.8 | 1800*** |
| Yes | 44.2 | | 40.2 | | 41.9 | |
| **Hearing problem** | | | | | | |
| No | 13.0 | 18.0*** | 12.2 | 27.9*** | 12.6 | 45.9*** |
| Yes | 16.2 | | 15.9 | | 16.1 | |
| **Vision problem** | | | | | | |
| No | 7.9 | 825.5*** | 7.6 | 739.7*** | 7.7 | 1600*** |
| Yes | 19.1 | | 17.6 | | 18.3 | |

Note: ® Reference group; Adj OR= Adjusted Odds Ratio, * Significant at 5% level of significance, ** significant at 1% level of significance, and *** significant at 0.1% level of significance.

(15.8%) have a comorbidity of lung disease and diabetes, (31 %) have a comorbidity of heart disease and diabetes, (28.6%) have a comorbidity of stroke and diabetes, (17.7%) has comorbidity of bone/joint disease and diabetes, (15.8%) has comorbidity of physical/mental impairment and diabetes. (18.6%) has comorbidity to Neurological/Psychiatric disease and diabetes, (44.2%) with diabetes have high cholesterol, (16.2%) of the elderly have a comorbidity of hearing problem and diabetes, (19.1%) of the elderly has comorbidity of vision problem and diabetes. Among women, (25%) have a comorbidity of hypertension and diabetes, (21.2%) have a comorbidity of cancer and diabetes, (17.3%) have a comorbidity of lung disease and diabetes, (32%) have a comorbidity of heart disease and diabetes, (28.4%) has comorbidity of stroke and diabetes, (17.4%) has comorbidity of bone/joint disease and diabetes. (17.3%) has comorbidity of Neurological/Psychiatric disease and diabetes, (40.2%) with diabetes have high cholesterol, (16%) of the elderly have a comorbidity of hearing problem and diabetes, (and 17.6%) of the elderly has comorbidity of vision problem and diabetes.

## DISCUSSION

This study attempted to determine the prevalence of self-reported diabetes by sex and to find out the socio-economic, demographic, and lifestyle risk factors associated with diabetes. Furthermore, it aims to understand the coexistence of diabetes with other morbid conditions. The result shows that the prevalence of self-reported diabetes is higher among elderly men than women but without much difference. A similar result was reported in additional studies.[21,22] However, it contradicts a study in rural Uttarakhand.[17] Additionally, it is observed that both prevalence of self-reported diabetes and hypertension are higher among urban areas as compared to rural areas in India. A comparable result was reported in some studies in India.[11,23] The reason can be explained, as the urban population considerably experiences more obesity, as they engage in less physical activity compared to the rural population.[24] It is also observed that the prevalence is higher in the south Indian states, which may be explained by their rich diet and their way of life.

From the study, it is evident that for elderly men, the odds of having diabetes increase with an increasing level of education; however, it was vice versa in the case of women, the comparable result was reported in a study conducted in Uttarakhand.[17] Elderly men who are widowed, divorced, or separated are less likely to have diabetes, contradicting elderly women. Working men and women are less likely to have diabetes than the elderly who never worked. Elderly men and women who have a family history of diabetes are three times (approx.) more likely to have diabetes, a similar result was reported in a study conducted in Punjab[11, 22] since diabetes can be hereditary and is caused by genetic factors.

Men and women who are obese/overweight, have abdominal obesity by waist circumference, have depression, and have less physical activity are more likely to have diabetes. Several studies in India found equivalent results[11,14,21] exercise helps maintain healthy blood pressure, weight, and blood sugar levels. The current study also aims to show the effects of lifestyle elements including drinking alcohol, using smokeless tobacco, and smoking. The three elements mentioned above have a detrimental effect on diabetes. Nevertheless, this may be due to the nature of the data, which does not account for the amount, frequency, or duration of the use of alcohol, smoking, or smokeless tobacco in the study. The study also determines that both elderly men and women having diabetes has a significant association with other morbid conditions such as cancer, lung disease, heart disease, stroke, bone/joint disease, neurological/ psychiatric disease, high cholesterol, hearing, and vision problem.

India should not miss the opportunity to address the significant risk of diabetes before the situation gets out of control. Since if these trends continue, it will pose challenges to achieving the global target to reduce NCD deaths. Being old is not a disease. However, it makes the elderly vulnerable to numerous diseases such as non-communicable diseases. When it comes to interventions, promote a healthy lifestyle such as regular exercise to have a weight control. Lifestyle changes are measures to efficiently reduce diabetes, although having a family history is a very high risk of having both diabetes. However, it is quoted that genetics locked the gun, and lifestyle pulled the trigger.

## Strengths and Limitations of the Study

The strength of the study includes the large and nationally representative sample, which enables comparisons between states and urban and rural settings. Additionally, the study took into account all relevant risk factors. However, it was unable to investigate the association between diabetes and the individual's dietary habits. The major limitation of the study is that since the study is self-reported it suffer from recall biases, therefore it may result in an underestimation of prevalence. As LASI data does not provides measured diabetes, therefore it cannot be directly compared with clinical data. Self-reported data might be faulty due to low educational level of respondents, reluctant to disclose the diseases. Despites all this, as mentioned in the methodology LASI data was collected based on internationally comparable research designs and tools for long-term scientific research.

## Conclusion

The study revealed several key risk factors, including increased age of elderly, higher wealth quintile, family history of diabetes, obesity, less physical exercise and elderly currently working. Although self-reported data underestimate the disease burden. However, it is quite evident that the prevalence of diabetes is high and remains higher in some advanced states, it is also prevalent in less developed states and the high prevalence of this chronic disease will be an enormous burden to the health system within the state and the national level. The National Program for control of diabetes in specific should be considerately implemented by the Government by promoting awareness and should be expanded and given a focus on the high-risk population.

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