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# Prevalence of angina and influence of risk factors among elderly: SAGE India data analysis

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### Abstract
Angina, or angina pectoris, refers to a sensation of tightness or constriction in the chest caused by an insufficient supply of blood to the heart muscle a condition particularly affecting the elderly population. This study aims to assess the prevalence and influence of risk factors of angina among individuals aged 50 years and older. Data were obtained from the India Wave 3 of the *Study on Global Ageing and Adult Health* (SAGE), comprising 6,719 older adults. Prevalence estimates were analysed using a logistic regression model. To estimate relative risk and risk difference, generalized linear models (GLM) were applied using the *Gaussian* family with a *log* link for relative risk, and an *identity* link for risk difference to ensure model convergence. The GLM results indicated that individuals aged 50-60 years, females, and those identifying as Muslim or other religions had a significantly higher likelihood of reporting angina. Medical risk factors such as a history of chronic lung disease (OR=3.45, $p$<0.001), depression (OR=3.76, $p$<0.001), hypertension (OR=2.56, $p$<0.001), and diabetes (OR=1.52, $p$<0.05) were identified as major contributors to angina risk. Relative risk analysis revealed that chronic lung disease increased risk by 11.5%, depression by 10.8%, and hypertension by 4.55% compared to those without these conditions. In contrast, non-modifiable and behavioural factors such as education, place of residence, body mass index, tobacco use, and alcohol consumption did not show a significant association with angina in this analysis.

**Keywords:** Angina, elderly, generalized linear model, odds ratio, relative risk

### Introduction
Angina or Angina Pectoris is a symptom of chest pain or discomfort caused by reduced blood flow to heart (Hemingway H *et al.*, 2008, Weien Schef K, *et al.* 2023) [4, 13] that ultimately affecting individuals' quality of life, especially among the elderly. Angina commonly identified as squeezing, pressure, heaviness, tightness or pain in the chest.

Studies have identified increase in age more than 60 years, family history of heart disease, Tobacco, Alcohol use, high blood pressure (Hypertension), Diabetes, Obesity, Stress, Drug misuse, cold temperature are as important risk factors which elevates Angina (Iqbal MN, *et al.*, (2016), NIH, Khadka P) [6].

In a cross-sectional Indian study, it was observed the prevalence of symptom-based angina was 4.9% among older men (Ahmed W, *et al.*, 2023) [1] and 7.02% older female (Hemingway H, *et al.*, 2008) [4] and it was about 2% to 7% among middle aged individuals in developed countries (Glader EL, Stegmayr B., 1999, Virani SS *et al.*, (2021) [3, 11]. Another Swedish cross-sectional study reveals the prevalence of angina was 3.5%. The National Survey of Health data analysis revealed that the prevalence of mild Angina (grade I) was 8.1% and moderate/severe angina (grade II) was 4.5% among adult population of Brazil (Debor Carvalho Maita *et al.* 2021) [2].

A study based on health examination of 2060 elderly aged 65 years and older in Taiwan revealed that the prevalence of angina was 15.0 among study population, 15.1% in men and 14.4% in women (Yu-Cheng Lin *et al.*, 2004) [15]. The prevalence of angina varies according to palace and person. Hence, this research aims to examine the prevalence of angina among the elderly (aged ≥ 50 years) and assess the influence of associated risk factors in India using data from the SAGE India study.

## Data and Methodology

To achieve the objectives, data were drawn from a longitudinal survey on *"Study on global Ageing and adult health* (SAGE)", Wave 3, conducted during 2019-2020. SAGE is a longitudinal collaborative project of World Health Organisation (WHO), Geneva, covering adults aged 50 years and older from nationally representative samples in China, Ghana, India, Mexico, Russian Federation and South Africa (Sekher TV, *et al.*, 2024) [10].

For the present study, data were derived from SAGE India Wave 3 (2019-2020), conducted by International Institute for Population Sciences (IIPS), Mumbai in collaboration with the WHO (Sekher TV, *et al.*, 2024) [10]. In addition to socio-demographic data, SAGE India Wave 3 collected information on a range of chronic diseases that contribute significantly to the non-communicable disease burden commonly seen in older adults. These include arthritis, stroke, angina, diabetes mellitus, chronic lung disease, asthma, depression, hypertension and edentulism. Further data were gathered on five health risk factors viz., tobacco use, alcohol consumption, intake of fruits and vegetables, physical activity, and environmental risk factors based on WHO recommendations from the NCD STEPS guidelines (WHO 2017) [14].

Detailed information on the survey design, instruments used, reports and data can be accessed from International Institute for Population Sciences website (IIPS). For the present study, data were analysed from a sample of 6719 elderly individuals (aged ≥50 years) from SAGE India wave 3.

The *self-reported* angina has been collected by "*yes*" to question as "has health care professional/doctor ever told you that you have angina or angina pectoris (a heart disease)?". Further information about age, sex, education level, religion, place of residence, body mass index (BMI), ever used tobacco, ever consumed alcohol, Hypertension, Diabetes, Chronic lung diseases, Asthma, Depression has been collected and listed in Table 1.

Initially the association between *non-modifiable risk factors* such as age, sex, ever been to school, Place of residence, BMI, *behavioural risk factors* such as ever used tobacco, ever consumed alcohol and *medical condition risk factors* such as hypertension, diabetes, asthma, depression and chronic lung disease with angina (no/yes) has been established by applying chi-square test. The significant variables considered for further analysis.

To estimate the prevalence and influence of risk factors, multivariable statistical analysis has been carried out between selected covariates and the likelihood of angina using generalized linear models (GLMs) in STATA 16 (64bit). Odds ratios (ORs) were estimated using a logistic regression model specified as *family* (binomial) *link* (logit) with exponentiated coefficients (*eform*). To estimate relative risk (RR), attempt is made with a *binomial* GLM, *link* (log); however, due to convergence issues, used a *Gaussian family* with *log link* and *robust* standard errors as an accepted alternative for modelling relative risk.

Risk differences (RDs) were estimated using a *Gaussian family* with *identity link* and *robust* standard errors, due to similar convergence limitations with the binomial-identity specification. All models were adjusted for age and relevant covariates, including demographic, behavioural, and medical risk factors. The robust option was applied to account for heteroskedasticity and to obtain valid standard errors under misspecification.

To establish the influence of risk factors on angina, three models were used. Model 1 with non-modifiable risk factors with angina, Model 2 adding behavioural risk factors and Model 3 adding medical condition risk factors. These models provide a comprehensive understanding of both relative and absolute associations of predictors with angina in the population.

## Results

Association between risk factors has been tested by applying Pearson Chi-square test for $p<.05$ and it has been observed BMI and Ever used tobacco (TOB) factors are significantly associated ($p<.05$) and other factors are highly significantly ($p<.001$) associated with Angina (Table 1).

To estimate the prevalence of angina and non-modifiable, Behavioural and Medical conditions risk factors, odds ratios has been calculated. The results are reported as adjusted ORs, RRs, and RDs with significance level and 95% confidence intervals.

Odds ratio (OR) or Relative risk (RR) greater than 1 indicates higher risk of angina compared to the reference group, while a value less than 1 suggests a protective association. For the RD model, positive coefficients indicate an increased absolute risk, and negative coefficients reflect a reduction.

The calculated odds ratio with three sets as Model-I, Model-II and Model-III is listed in Table 2. The results in Table 2 shows that elderly population belongs to age group 50-60 years, females, illiterate persons, belongs to Hindu religion and residing in rural areas are at elevated risk of reporting angina than their counter part among non-modifiable risk factors. Similarly, elderly who reported consumed alcohol are 1.46 (46%) times at risk and elderly reported ever used tobacco are 1.09 (9%) times at risk in reporting angina. Further among medical condition risk factors, elderly with chronic lung disease (3.499), with depression (3.761) are more than 3.5 times at risk than those who are not having chronic lung disease and not having depression in having angina. Elderly reported with Diabetes shows low risk factor (1.52 times OR) having angina when compare to Hypertension, Chronic lung disease or Depression. Among the selected risk factors "ever been to school", "ever used tobacco" products and "asthma" could not influence angina significantly (Table 2).

Odds ratio measures the odds of the event in experimental and control group whereas relative risk (RR) or risk ratio is the ratio of probability of an outcome in an exposed group to the probability of unexposed group which gives probabilities than proportions. Hence RR has been derived by using GLM and the results are given in Table 3 for Model-1, Model-II and Model-III. The relative risk values for the age group 61-70 and 70+ are lower than 50-60 years. However individuals age 70+ have a 1.4% lower risk of angina compared to the age group 50-60 years. Sex wise female has a 1.4% higher risk of angina than male. Among the medical condition factors, individual with hypertension show 4.5% (RR=1.0455, $p<.001$) higher risk, diabetes with 2.7% (RR=1.0265, $p<.001$) and elderly with chronic lung disease show 11.5% (RR=1.1151, $p<.001$) higher risk of angina.

Risk difference results are listed in Table 4 for Model-I, II and III. Risk difference also shows same trend identifying medical condition risk factors Hypertension, Diabetes, Chronic lung disease and depression as associate with elevated angina.

**Table 1:** Association between Angina and Non-Modifiable risk factors, Behavioural and Medical condition risk factors among Elderly, SAGE India data Wave 3.

| Risk Factors | | ANGINA | | | | | Chi-square |
|---|---|---|---|---|---|---|---|
| Non-Modifiable risk factors | | Yes | | No | | 6719 | |
| | | Number | % | Number | % | Total | |
| Age (AGE) | 50-60 | 91 | 3.2 | 2735 | 96.8 | 2826 | |
| | 61-70 | 118 | 5.0 | 2265 | 95.0 | 2383 | |
| | 71+ | 82 | 5.4 | 1428 | 94.6 | 1510 | 15.04** |
| Sex (SEX) | Male | 161 | 5.2 | 2913 | 94.8 | 3074 | |
| | Female | 130 | 3.6 | 3515 | 96.4 | 3645 | 11.24** |
| Ever been to school (EDU) | Yes | 189 | 5.1 | 3546 | 94.9 | 3735 | |
| | No | 102 | 3.4 | 2882 | 96.6 | 2984 | 10.79** |
| Religion (REL) | Hindu | 229 | 4.1 | 5349 | 95.9 | 5578 | |
| | Muslim | 62 | 5.4 | 1079 | 94.6 | 1141 | 4.03* |
| Place of Residence (PR) | Urban | 73 | 5.9 | 1162 | 94.1 | 1235 | |
| | Rural | 218 | 4.1 | 5266 | 96.0 | 5484 | 9.12** |
| BMI | Under weight | 47 | 3.6 | 1265 | 96.4 | 1312 | |
| | Normal | 143 | 4.1 | 3349 | 95.9 | 3492 | |
| | Over Weight / Obese | 82 | 5.4 | 1447 | 94.6 | 1529 | 6.2* |
| **Behavioural Risk Factors** | | | | | | | |
| Ever used tobacco (TOB) | Yes | 135 | 4.9 | 2612 | 95.1 | 2747 | |
| | No | 156 | 3.9 | 3816 | 96.1 | 3972 | 3.82* |
| Ever consumed Alcohol (AL) | Yes | 46 | 6.4 | 672 | 93.6 | 718 | |
| | No | 245 | 4.1 | 5756 | 95.9 | 6001 | 8.36** |
| **Medical Conditions risk factors** | | | | | | | |
| Hypertension (HT) | Yes | 156 | 7.6 | 1896 | 92.4 | 2052 | |
| | No | 135 | 2.9 | 4532 | 97.1 | 4667 | 76.3** |
| Diabetes (DI) | Yes | 67 | 8.0 | 769 | 92.0 | 836 | |
| | No | 224 | 3.8 | 5659 | 96.2 | 5883 | 31.26** |
| Chronic Lung Disease (LUNG) | Yes | 24 | 17.1 | 116 | 82.9 | 140 | |
| | No | 267 | 4.1 | 6312 | 95.9 | 6579 | 56.64** |
| Asthma (AS) | Yes | 28 | 8.1 | 317 | 91.9 | 345 | |
| | No | 263 | 4.1 | 6111 | 95.9 | 6374 | 12.57** |
| Depression (DP) | Yes | 20 | 13.8 | 125 | 86.2 | 145 | |
| | No | 271 | 4.1 | 6303 | 95.9 | 6574 | 32.02** |

NS=Not significant, ***p*<.001, **p*<.05

**Table 2:** Logit regression results of Odds ratio of non-modifiable risk factors, Behavioural risk factors and medical condition risk factors with Angina among elderly: SAGE India data

| Risk Factors | Model-I | | | Model-II | | | Model-III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Adj. odds ratio | 95% C.I | | Adj. odds ratio | 95% C.I | | Adj.odds ratio | 95% C.I. | |
| | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **AGE Group** | | | | | | | | | |
| 50-60 years (ref) | 1.000 | | | 1.000 | | | 1.000 | | |
| 61-70 years | 0.659** | 0.494 | 0.879 | 0.655** | 0.491 | 0.874 | 0.767* | 0.571 | 1.030 |
| 70+ | 0.596** | 0.430 | 0.826 | 0.585** | 0.422 | 0.811 | 0.686** | 0.491 | 0.960 |
| **Sex of the respondent** | | | | | | | | | |
| Male (ref) | 1.000 | | | 1.000 | | | 1.000 | | |
| Female | 1.455** | 1.110 | 1.906 | 1.287# | 0.952 | 1.741 | 1.398* | 1.027 | 1.903 |
| **Ever Been to School** | | | | | | | | | |
| Yes (ref) | 1.000 | | | 1.000 | | | 1.000 | | |
| No | 1.227# | 0.922 | 1.632 | 1.247# | 0.937 | 1.660 | 1.174# | 0.877 | 1.570 |
| Religion | | | | | | | | | |
| Hindu (ref) | 1.000 | | | 1.000 | | | 1.000 | | |
| Muslim, Others | 0.743* | 0.551 | 1.002 | 0.724* | 0.536 | 0.978 | 0.714* | 0.526 | 0.969 |
| **Place of residence** | | | | | | | | | |
| Urban(ref) | 1.000 | | | 1.000 | | | 1.000 | | |
| Rural | 1.393* | 1.038 | 1.869 | 1.396* | 1.039 | 1.876 | 1.258# | 0.931 | 1.700 |
| **BMI** | | | | | | | | | |
| Under weight | 1.000 | | | 1.000 | | | 1.000 | | |
| Normal | 0.878# | 0.625 | 1.234 | 0.864 | 0.614 | 1.214 | 0.946# | 0.667 | 1.340 |
| Overweight/obese | 0.643** | 0.440 | 0.940 | 0.625* | 0.426 | 0.916 | 0.813# | 0.548 | 1.208 |
| **Ever used tobacco** | | | | | | | | | |
| NO (ref) | | | | 1.000 | | | 1.000 | | |
| Yes | | | | 1.094# | 0.827 | 1.446 | 1.121# | 0.843 | 1.491 |
| **Ever consumed alcohol** | | | | | | | | | |
| NO (ref) | | | | 1.000 | | | 1.000 | | |
| Yes | | | | 1.460* | 1.014 | 2.102 | 1.343# | 0.925 | 1.952 |
| Hypertension | | | | | | | | | |
| NO (ref) | | | | | | | 1.000 | | |
| Yes | | | | | | | 2.556** | 1.969 | 3.319 |
| **Diabetes** | | | | | | | | | |
| NO (ref) | | | | | | | 1.000 | | |
| Yes | | | | | | | 1.521** | 1.110 | 2.084 |
| **Chronic lung diseases** | | | | | | | | | |
| NO (ref) | | | | | | | 1.000 | | |
| Yes | | | | | | | 3.499** | 2.055 | 5.958 |
| Asthma | | | | | | | | | |
| NO (ref) | | | | | | | 1.000 | | |
| Yes | | | | | | | 1.149# | 0.710 | 1.859 |
| **Depression** | | | | | | | | | |
| NO (ref) | | | | | | | 1.000 | | |
| Yes | | | | | | | 3.761** | 2.239 | 6.319 |

***p*<.001, **p*<.05, # Not significant. Model equation: GLM dv i.v1 i.v2i.v3, family (bin) NOLOG EFORM

**Table 3:** Generalized linear regression model for estimating the Relative risk for Angina with non-modifiable (MODEL I), behavioural risk factors (MODEL II) and medical condition risk factors (MODEL III)

| | Model I | | | Model II | | | Model III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Risk Ratio | [95% Conf. Interval] | | Risk Ratio | [95% Conf. Interval] | | Risk Ratio | [95% Conf. Interval] | |
| **Age Group** | | | | | | | | | |
| 50-60 years (ref) | | | | | | | | | |
| 61-70 years | 0.9835** | 0.9721 | 0.9950 | 0.9833** | 0.9719 | 0.9948 | 0.9910* | 0.9799 | 1.0022 |
| 70+ | 0.9789** | 0.9650 | 0.9930 | 0.9781** | 0.9642 | 0.9922 | 0.9861* | 0.9724 | 1.0000 |
| **Sex of the respondent** | | | | | | | | | |
| Male (ref) | | | | | | | | | |
| Female | 1.0165** | 1.0047 | 1.0284 | 1.0108# | 0.9977 | 1.0240 | 1.0142** | 1.0011 | 1.0273 |
| **Ever Been to School** | | | | | | | | | |
| Yes (ref) | | | | | | | | | |
| No | 1.0078# | 0.9962 | 1.0195 | 1.0085# | 0.9970 | 1.0202 | 1.0048# | 0.9937 | 1.0159 |
| **Religion** | | | | | | | | | |
| Hindu (ref) | | | | | | | | | |
| Muslim, Others | 0.9863# | 0.9715 | 1.0012 | 0.9852# | 0.9705 | 1.0002 | 0.9851* | 0.9707 | 0.9998 |
| **Place of residence** | | | | | | | | | |
| Urban(ref) | | | | | | | | | |
| Rural | 1.0167* | 1.0007 | 1.0329 | 1.0167** | 1.0008 | 1.0329 | 1.0121* | 0.9965 | 1.0280 |
| **BMI** | | | | | | | | | |
| Under weight | | | | | | | | | |
| Normal | 0.9950# | 0.9826 | 1.0076 | 0.9943# | 0.9818 | 1.0070 | 0.9981# | 0.9861 | 1.0104 |
| Overweight/obese | 0.9809* | 0.9653 | 0.9969 | 0.9798* | 0.9639 | 0.9959 | 0.9917# | 0.9764 | 1.0073 |
| **Ever used tobacco** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | 1.0032# | 0.9914 | 1.0151 | 1.0046# | 0.9931 | 1.0162 |
| **Ever consumed alcohol** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | 1.0209* | 0.9991 | 1.0433 | 1.0170* | 0.9960 | 1.0385 |
| **Hypertension** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | | | | 1.0455** | 1.0310 | 1.0601 |
| **Diabetes** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | | | | 1.0265** | 1.0050 | 1.0485 |
| **Chronic lung diseases** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | | | | 1.1151** | 1.0386 | 1.1972 |
| **Asthma** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | | | | 1.0081# | 0.9792 | 1.0378 |
| **Depression** | | | | | | | | | |
| NO (ref) | | | | | | | | | |
| Yes | | | | | | | 1.1079** | 1.0370 | 1.1836 |

**$p$<.001, *$p$<.05, # Not-Significant GLM angina covariates, family (Gaussian) link (log) NOLOG EFORM

**Table 4:** Generalized linear regression model for estimating the Risk difference for Angina (MODEL I, II, III)

| Variable | Model I RD (95% CI) | Model II RD (95% CI) | Model III RD (95% CI) |
|---|---|---|---|
| **Age** | | | |
| 61–70 years | 0.0161 (0.0074, 0.0248) | 0.0164 (0.0075, 0.0252) | 0.0163 (0.0075, 0.0252) |
| 71+ | 0.0206 (0.0102, 0.0310) | 0.0215 (0.0109, 0.0320) | 0.0219 (0.0113, 0.0325) |
| **Sex of the respondent** | | | |
| Female | 0.0126 (0.0044, 0.0208) | 0.0110 (0.0028, 0.0192) | 0.0108 (0.0027, 0.0189) |
| **Ever Been to School** | | | |
| No | 0.0062 (−0.0017, 0.0142) | 0.0061 (−0.0018, 0.0140) | 0.0053 (−0.0029, 0.0136) |
| **Religion** | | | |
| Muslim, Others | 0.0152 (0.0076, 0.0228) | 0.0142 (0.0065, 0.0218) | 0.0142 (0.0062, 0.0221) |
| **Place of residence** | | | |
| Rural | 0.0128 (0.0040, 0.0216) | 0.0129 (0.0040, 0.0217) | 0.0112 (0.0025, 0.0198) |
| **BMI** | | | |
| Normal | −0.0096 (−0.0170, −0.0022) | −0.0096 (−0.0170, −0.0023) | −0.0093 (−0.0166, −0.0019) |
| Over | 0.0125 (0.0040, 0.0209) | 0.0137 (0.0054, 0.0220) | 0.0136 (0.0053, 0.0219) |
| **Ever used tobacco** | | | |
| Yes | 0.0082 (0.0002, 0.0162) | 0.0146 (0.0065, 0.0227) | 0.0108 (0.0028, 0.0188) |
| **Ever consumed alcohol** | | | |
| Yes | 0.0195 (0.0109, 0.0280) | 0.0189 (0.0102, 0.0275) | 0.0162 (0.0076, 0.0248) |
| **Hypertension** | | | |
| Yes | 0.0736 (0.0629, 0.0843) | — | — |
| **Diabetes** | | | |
| Yes | — | 0.0426 (0.0308, 0.0543) | — |
| **Chronic lung diseases** | | | |
| Yes | — | — | 0.0835 (0.0434, 0.1235) |
| **Asthma** | | | |
| Yes | — | — | 0.0063 (−0.0021, 0.0146) |
| **Depression** | | | |
| Yes | — | — | 0.0302 (0.0144, 0.0461) |

**STATA Commands**

- **Odds ratio:** glm dv v1 v2 v3….family (bin) nolog eform
- **Relative risk:** glm dv v1 v2 v3….family (gaussian) link (log) nolog eform
- **Risk difference:** glm dv v1 v2 v3 …family (gaussian) link (identity) robust

## Conclusion and Discussion

Analysis of large-scale survey data based on self-reported angina indicates that 4.33% of elderly individuals aged 50 years and above are at risk. Using a Generalized Linear Model (GLM), the analysis showed that individuals aged 50-60 years, females, and those identifying as Muslim or from other religions were significantly associated with increased risk of angina. Among medical conditions, a history of chronic lung disease (OR=3.499, $p$<0.001), depression (OR=3.761, $p$<0.001), hypertension (OR=2.556, $p$<0.001), and diabetes (OR=1.521) were found to be major risk factors for angina.

The relative risk analysis indicated that elderly individuals with chronic lung disease had an 11.5% higher risk of reporting angina, followed by those with depression (10.8%) and hypertension (4.55%) compared to their counterparts. Only 2.6% of elderly individuals with diabetes were estimated to report angina. Asthma was not found to be a significant risk factor for angina in this model.

Among non-modifiable and behavioural risk factors, variables such as education, place of residence, body mass index, smoking, and alcohol consumption were not significantly associated with angina in this analysis.

Behavioural factors were not found to be significantly associated with angina, possibly because the present analysis is based on broad questions such as “Have you ever smoked tobacco or used smokeless tobacco?” and “Have you ever consumed a drink that contains alcohol (such as beer, wine, or spirits)?”. The data represents a limitation of this study and indicates the need for more in-depth analysis.

Furthermore, this study is based on self-reported angina. Extended analyses are required to analyse data by using standardized diagnostic tools such as the Rose Angina Questionnaire (Rose G, 1968) [9] for more accurate assessment and validation of angina prevalence.

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