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Prevalence of cardiovascular diseases among the urban and rural geriatric population of India: A meta-analysis

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Abstract---Background: The geriatric population is defined as the population aged 60 years and above. Cardiovascular diseases are the most common diseases prevailing among the geriatric population of India. Cardiovascular diseases are the diseases involving heart and blood vessels. These diseases include hypertension, stroke, heart attack, heart failure, etc. Aim: The present study aimed at finding the pooled prevalence of cardiovascular diseases among the geriatric population of India by using meta-analysis. Materials and Methods: In this study, we have included various studies from different parts of India by searching databases like Google Scholar, Pub Med, etc. from the year 2003 to 2020. Meta-analysis was conducted using the random effect model in R software version 3.4.3. to compute the pooled prevalence of cardiovascular diseases among the geriatric population of India along with 95% confidence interval. Results: The prevalence of cardiovascular diseases among the geriatric Indian population included 5,426 study subjects from 20 studies in urban areas and 11,781 subjects from 29 studies conducted in rural areas of India respectively. The overall prevalence of cardiovascular diseases among geriatric population of India was 36.6% (95% CI: 31.9%-41.3%). The prevalence of cardiovascular diseases among the geriatric Indian population in rural areas was 34.98% (95% CI: 31.32%-38.63%) whereas the prevalence of cardiovascular diseases among geriatric Indian population in urban areas was 39.27% (95% CI: 33.96%-44.58%) respectively. Conclusion: The results indicated that the prevalence of cardiovascular diseases among the geriatric Indian

population residing in urban areas was higher than that of geriatric Indian population residing in rural areas.

Keywords---cardiovascular diseases, confidence interval, geriatric, meta-analysis, prevalence, systematic review.

Introduction

Ageing is a natural phenomenon that is faced by every human being in his/her life span. Ageing has been one of the most important developments in this century all over the world and will be one of the major challenges in the next millennium. [1] It is progressive, pervasive and inevitable in all human beings. It is defined as the process of deterioration in the functional capacity of an individual that results from structural changes, with advancement of age. The elder persons are precious asset of a country. They are the ones who contribute their knowledge and experience for the progress of a country.

Ageing is a sign of successful development in medical sciences and technology, living standards and education but the geriatric population also raise unique social, economic and clinical challenges including a growing demand for increasingly complex healthcare services. The demographic transition with ageing of population is a global phenomenon which demands international, national, regional and local action. [2] Between 2015 and 2050, the proportion of people living above 60 years in the world will nearly double from 12% to 22%. [3] Population ageing is a worldwide phenomenon and India is no exception. Indian population has grown three times in the past 50 years, but the elderly population has increased more than four times. It took more than 100 years for the aged population to double in most of the countries in the world, but in India, it has doubled in just 20 years. According to population census 2011, there are nearly 104 million elderly persons in India which constitutes approximately 8% of the total nation's population. [4]

The geriatric population suffers from several morbidities such as cardiovascular diseases (CVDs), diabetes, depression, cancer, arthritis, kidney problems, psychological diseases, etc. Age plays a vital role in the deterioration of cardiovascular functionality, resulting in an increased risk of cardiovascular diseases (CVDs) in older adults. Cardiovascular diseases are a type of non-communicable diseases i.e. they are the diseases that are not caused by infectious agents and are the diseases of long duration and slow progression. CVDs contribute nearly half of the non-communicable deaths. They are the diseases involving heart and blood vessels. They are caused by disfunctioning of heart and blood vessels and include hypertension (high blood pressure), coronary heart disease (heart attack), cerebrovascular diseases (stroke), peripheral heart disease, heart failure, rheumatic heart disease, congenital heart disease. Hypertension, diabetes, dyslipidaemia, obesity, smoking, physical activity, poor diet, and alcohol consumption are the most common risk factors for cardiovascular diseases. [5]. Cardiovascular diseases are a major cause of mortality all over the world as well as in India. According to WHO Report, an estimated 17.9 million people died from cardiovascular diseases representing 31%

of all the global deaths worldwide and out of these deaths 85% are due to heart attack and stroke. [6]

Materials and Methods

Meta-analysis is the quantitative review and synthesis of results of related but independent studies. It is a way of taking the results from a large number of research papers and merging these results to get more statistically viable analysis, to try to get a trend over a large population of test subjects.

Literature Search

The search strategy, selection of publications and the reporting of results for review were conducted in accordance to the PRISMA (Preferred Reporting Items for Systematic Review and Meta Analyses) guidelines. We searched data bases like MEDLINE/Pub Med, Google Scholar, journals, thesis, etc. from the year 2003 to 2020. Internet searches used combination of keywords such as prevalence, cardiovascular diseases, hypertension, elderly, morbidity, etc. for finding the prevalence studies of cardiovascular diseases among geriatric population in India. (Figure 1)

Selection of studies

All identified research papers were independently reviewed by the reviewers. Disagreements among the reviewers were resolved by considering the facts mentioned in PRISMA checklist.

Inclusion criteria

The studies that met the following criteria were included in the present meta-analysis:

- The design of the studies was cross-sectional.
- The age-group included in our analysis was 60 years and above.
- The studies were conducted among the Indian population.
- They were prevalence studies after the year 2002.

Exclusion criteria

Those studies which did not satisfy the above mentioned criteria were excluded from the present study. We also excluded the studies in age-specific prevalence was not reported. Also, the studies in which calculated proportions act as outliers were also excluded so as to make the data of proportions as normal.

Data extraction and methodological assessment

Data extraction was done by the second and fourth reviewer, and checked by the first and third reviewer and the whole process was discussed by all the reviewers. The eligible studies were further reviewed and we extracted the information of author, year of publication, gender, location, total number of subjects, number of

cases, type of study, etc. from each included study and summarized the data in the form of a table.

Statistical Analysis

We performed the meta-analysis on the data using the statistical software R version 3.4.3. The random effect model was used to find the pooled estimate of the prevalence of cardio-vascular diseases among the geriatric population of India. The random effect meta-analysis allowed for heterogeneity by assuming that underlying effects follow normal distribution. Cochran's Q and I^2 were used to measure heterogeneity across the studies and 95% confidence intervals had also been reported in our analysis. Graphical representation of meta-analysis was done by using forest plots and funnel plots.

Results

Literature review

Figure 1 summarizes the search strategy carried out. Our search strategy identified around 658 articles. Out of these, 358 duplicate articles were excluded. We also excluded 185 articles after screening their title and abstract. The full text of remaining 110 articles was screened and 65 articles were further excluded because of lack of inclusion criteria and the remaining 43 articles were finally included in our study.

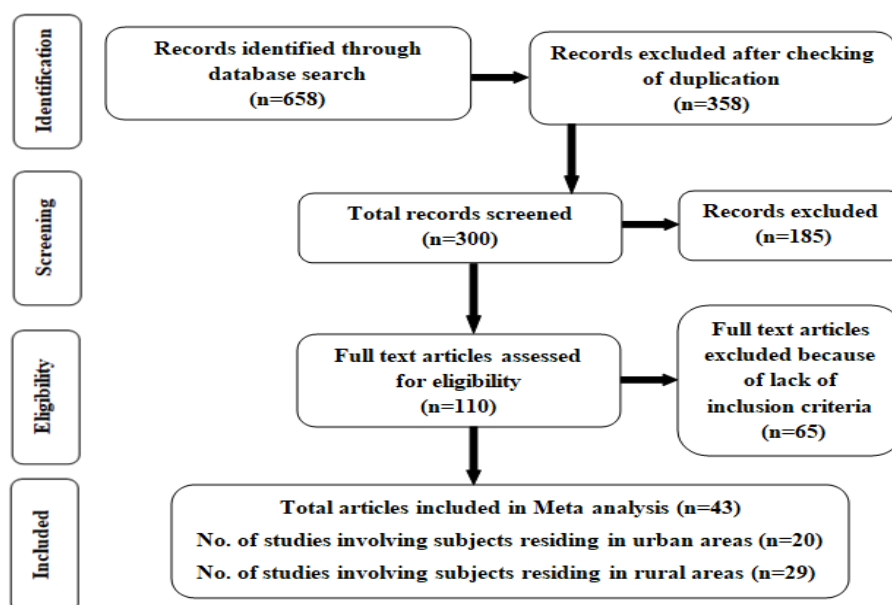


Figure 1. Flowchart showing the selection process of relevant studies

Study characteristics

We have included about 43 studies in the meta-analysis of cardiovascular diseases among geriatric population of India. The included 43 articles involved 20 studies based on geriatric population residing in urban areas whereas the other 29 studies based on rural geriatric population of India. Table 1 showed the characteristics of each of the study involved in our analysis after applying the exclusion criteria.

Table 1
Study characteristics of each study

Study name	Study period	Study design	State	Sampling method	Age-group	Sample size
Joshi <i>et al.</i> ¹²	2001	cross-sectional	Haryana	cluster sampling	≥60	200
Prakash <i>et al.</i> ¹³	2003	cross-sectional	Rajasthan		≥60	300
Purty <i>et al.</i> ¹⁴	2002-2003	cross-sectional	Tamil Nadu	Simple random sampling	≥60	320
Kishore <i>et al.</i> ¹⁵	2004	cross-sectional	Uttarakhand		≥60	285
Lena <i>et al.</i> ¹¹	2003	cross-sectional	Karnataka		≥60	213
Srinivasan <i>et al.</i> ¹⁶	2004-2005	cross-sectional	Banglore	Stratified sampling	≥60	356
Bharati <i>et al.</i> ¹⁷	2008	cross-sectional	Tamil Nadu	Simple random sampling	≥60	225
Bhatt <i>et al.</i> ¹⁸	2008	cross-sectional	Gujarat	Simple random sampling	≥60	218
Khanam <i>et al.</i> ¹⁹	2004	cross-sectional	Bangladesh	Simple random sampling	≥60	452
Kamble <i>et al.</i> ²⁰	2011	cross-sectional	Maharashtra	Systematic random sampling	≥60	494
Gupta <i>et al.</i> ²¹	2002-2003	cross-sectional	Madhya Pradesh	Systematic random sampling	≥60	208
Singh <i>et al.</i> ²²	2009-2010	cross-sectional	Punjab		≥60	743
Esam <i>et al.</i> ²³	2011-2012	cross-sectional	Bareilli	Systematic random sampling and PPS sampling	≥60	126
Sharma <i>et al.</i> ⁹	2010	cross-sectional	Himachal Pradesh	Multi-stage simple random sampling	≥60	400
Qadri <i>et al.</i> ²⁴	2011	cross-sectional	Haryana	Simple random sampling	≥60	660
Choudhary <i>et al.</i> ²⁵	2012	cross-sectional	Gujarat	Simple random sampling	≥60	200
Chandrashekhar <i>et al.</i> ⁷	2008	cross-sectional	Karnataka	Systematic random	≥60	370

				sampling		
Barman <i>et al.</i> ²⁶	2013	cross-sectional	Bihar		≥60	160
Gupta <i>et al.</i> ²⁷	2011-2012	community based cross-sectional	Haryana	Cluster sampling	≥60	836
Kumar <i>et al.</i> ²⁸	2013	community based cross-sectional	Puducherry	PPS sampling	≥60	300
Alam <i>et al.</i> ²⁹	2014	cross-sectional	Chattisgarh	Multi-stage simple random sampling	≥60	320
Banjare <i>et al.</i> ³⁰	2012	cross-sectional	Odisha	PPS, systematic sampling	≥60	310
Davalagi <i>et al.</i> ⁸	2013	cross-sectional	Karnataka	Simple random sampling	≥60	180
Dutta <i>et al.</i> ³¹	2012	cross-sectional	Assam	Multi-stage sampling	≥60	370
Ghosh <i>et al.</i> ³²	2011	cross-sectional	Bihar		≥60	431
Kalyan <i>et al.</i> ³³	2014	cross-sectional	Haryana		≥60	200
Kumar <i>et al.</i> ³⁴	2014	cross-sectional	Uttar Pradesh	Stratified sampling	≥60	402
Sahukaiah <i>et al.</i> ³⁵	2010-2011	cross-sectional	Mumbai	Simple random sampling	≥60	220
Bartwal <i>et al.</i> ³⁶	2014	cross-sectional	Uttarakhand	Systematic sampling	≥60	440
Gupta <i>et al.</i> ³⁷	2014	cross-sectional	Punjab		≥60	534
Jain <i>et al.</i> ³⁸	2014	cross-sectional	Maharashtra	PPS sampling	≥60	600
Kalathingal and Xavier ³⁹	2016	cross-sectional	Kerala	cluster sampling	≥60	324
Jacob and Kannan ⁴⁰	2010	cross-sectional	Kerala	cluster sampling	≥60	403
Reddy <i>et al.</i> ⁴¹	2017	cross-sectional	Telangana	Systematic random sampling	≥60	1265
Singh <i>et al.</i> ⁴²	2015-2016	cross-sectional	Bihar	Systematic random sampling	≥60	383
Venkateshkrishna and Suresh ⁴³	2015	cross-sectional	Karnataka		≥60	1452
Zare <i>et al.</i> ⁴⁴	2017-2018	cross-sectional	Hyderabad		≥60	1353
Kumar <i>et al.</i> ⁴⁵	2018	cross-sectional	Chennai	Simple random sampling	≥60	150
Singh and Dey ⁴⁶	2009	retrospective	Sikkim	Simple random sampling	≥60	215
Gupta <i>et al.</i> ⁴⁷	2018	cross-sectional	Haryana	Simple random sampling	≥60	300
Vimala and Phalke ⁴⁸	2019-2020	cross-sectional	Maharashtra		≥60	120

Vidhyashree <i>et al.</i> ⁴⁹	2019	cross-sectional	Tamil Nadu		≥60	300
Usha <i>et al.</i> ⁵⁰	2019	community based cross- sectional	Uttarakhand	Simple random sampling and PPS	≥60	400

Meta-analysis

In this study, we have taken a systematic review of prevalence of cardiovascular diseases among the geriatric population of India. Finally, we have included 43 studies in our analysis. Meta-analysis of prevalence of cardiovascular diseases among geriatric population in urban areas of India included 5,426 subjects from 20 studies. (Table 2) The pooled estimate of prevalence of cardiovascular diseases among geriatric population in urban areas was found to be 39.27% (95% CI: 33.96%-44.58%). This study had found significantly heterogeneity ($I^2=94.3\%$ and Cochran's $Q=332.70$, $p=0.001$) among 20 studies. (Table 3) The forest plot (Figure 2) and funnel plot (Figure 3) represented the proportion of subjects affected due to cardiovascular diseases per study and pooled estimate of prevalence of cardiovascular diseases among geriatric population in urban areas of India.

Table 2
Prevalence of cardiovascular diseases among geriatric population in urban areas

S.No	Study Name	N	Cases	Proportion	95%-CI	%W (Random)
1	Joshi <i>et al.</i> ¹²	100	56	0.5600	[0.4572-0.6592]	4.6
2	Prakash <i>et al.</i> ¹³	300	144	0.4800	[0.4222-0.5382]	5.1
3	Srinivasan <i>et al.</i> ¹⁶	356	176	0.4944	[0.4413-0.5476]	5.1
4	Bhatt <i>et al.</i> ¹⁸	218	75	0.3440	[0.2812-0.4112]	5.0
5	Bharati <i>et al.</i> ¹⁷	82	44	0.5366	[0.4230-0.6475]	4.4
6	Gupta <i>et al.</i> ²¹	208	93	0.4471	[0.3783-0.5174]	5.0
7	Sharma <i>et al.</i> ⁹	200	112	0.5600	[0.4883-0.6299]	4.9
8	Choudhary <i>et al.</i> ²⁵	200	80	0.4000	[0.3315-0.4715]	5.0
9	Chandreshkhar <i>et al.</i> ⁷	185	37	0.2000	[0.1449-0.2650]	5.1
10	Barman <i>et al.</i> ²⁶	160	81	0.5062	[0.4262-0.5861]	4.8
11	Kumar <i>et al.</i> ²⁸	300	127	0.4233	[0.3668-0.4814]	5.1
12	Sahukaiah <i>et al.</i> ³⁵	220	70	0.3182	[0.2572-0.3842]	5.0
13	Davalagi <i>et al.</i> ⁸	180	34	0.1889	[0.1345-0.2538]	5.1
14	Alam <i>et al.</i> ²⁹	320	159	0.4969	[0.4408-0.5530]	5.1
15	Gupta <i>et al.</i> ²⁷	534	235	0.4401	[0.3975-0.4833]	5.2
16	Jain <i>et al.</i> ³⁸	600	277	0.4617	[0.4212-0.5025]	5.2
17	Zare <i>et al.</i> ⁴⁴	530	148	0.2792	[0.2414-0.3195]	5.2
18	Singh <i>et al.</i> ⁴²	383	81	0.2115	[0.1717-0.2558]	5.2
19	Kumar <i>et al.</i> ³⁴	150	42	0.2800	[0.2098-0.3591]	4.9
20	Usha <i>et al.</i> ⁵⁰	200	54	0.2700	[0.2098-0.3372]	5.0

Table 3
Tests of Heterogeneity

Tests of heterogeneity	Prevalence	LCI 95%	HCI 95%	Weight (%)
Pooled Statistics	0.3927	0.3396	0.4458	100.00
Heterogeneity	4.18	3.63	4.82	
I-squared	94.3	92.4	95.7	
Cochran's Q	332.70			
χ^2 , p	0.001			
τ^2	0.0136			

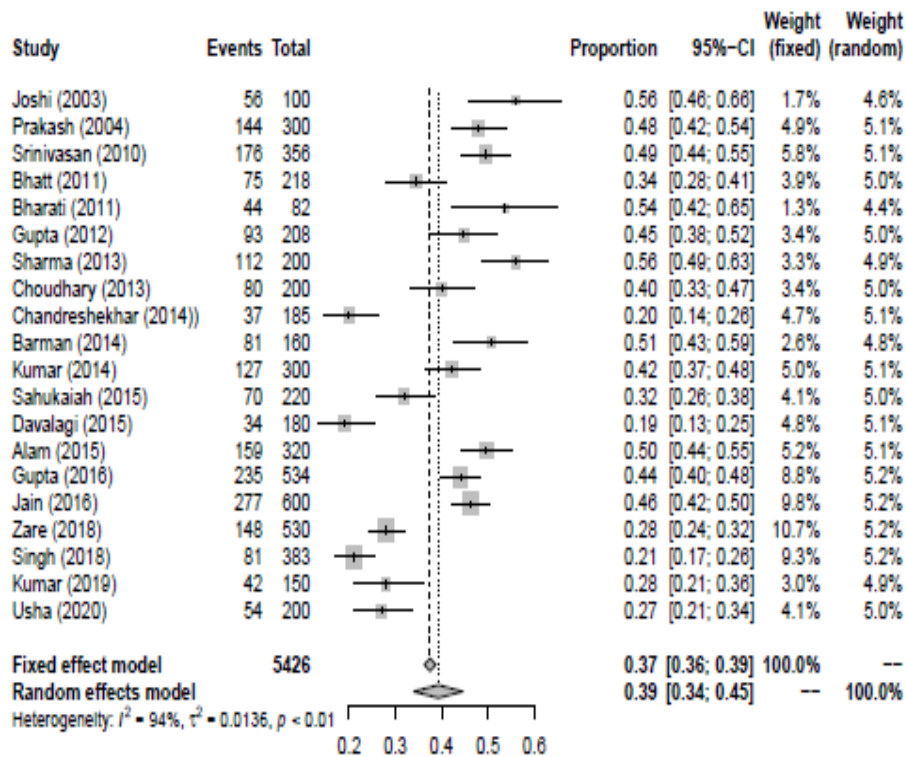


Figure 2. Forest plot showing the prevalence of cardiovascular diseases among geriatric population in urban areas of India

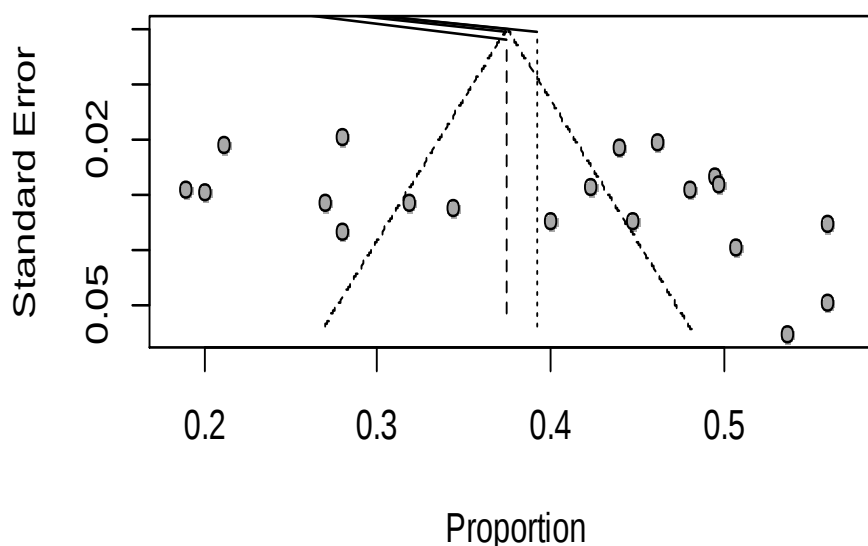


Figure 3. Funnel plot for prevalence of cardiovascular diseases among geriatric population in urban areas of India

Meta-analysis of prevalence of cardiovascular diseases among geriatric population in rural areas of India included 11,781 subjects from 29 studies. The pooled estimate of prevalence of cardiovascular diseases among geriatric population in rural areas of India was found to be 34.98% (95% CI: 31.32%-38.63%). This study has found significantly heterogeneity ($I^2=94.6\%$ and Cochran's $Q=515.58$, $p=0.0001$). The forest plot (Figure 4) and funnel plot (Figure 5) represented the proportion of subjects affected due to cardiovascular diseases per study and the pooled estimate of prevalence of cardiovascular diseases among the geriatric population residing in rural areas of India.

Table 4
Prevalence of cardiovascular diseases among geriatric population in rural areas of India

S. No	Study Name	N	Cases	Proportion	95%-CI	% W (Random)
1	Joshi <i>et al.</i> ¹²	100	42	0.4200	[0.3220-0.5229]	3.0
2	Purty <i>et al.</i> ¹⁴	320	83	0.2594	[0.2122-0.3111]	3.5
3	Kishore <i>et al.</i> ¹⁵	285	118	0.4140	[0.3563-0.4736]	3.4
4	Lena <i>et al.</i> ¹¹	213	126	0.5915	[0.5223-0.6582]	3.3
5	Bharati <i>et al.</i> ¹⁷	132	58	0.4394	[0.3532-0.5284]	3.1
6	Khanam <i>et al.</i> ¹⁹	452	175	0.3872	[0.3420-0.4338]	3.5
7	Kamble <i>et al.</i> ²⁰	494	119	0.2409	[0.2038-0.2811]	3.6
8	Singh <i>et al.</i> ²²	743	217	0.2921	[0.2596-0.3262]	3.6
9	Esam <i>et al.</i> ²³	126	53	0.4206	[0.3333-0.5118]	3.1
10	Sharma <i>et al.</i> ⁹	200	50	0.2500	[0.1916-0.3160]	3.4
11	Qadri <i>et al.</i> ²⁴	660	294	0.4455	[0.4071-0.4843]	3.6
12	Chandrashekhar <i>et al.</i> ⁷	185	28	0.1514	[0.1030-0.2113]	3.5
13	Gupta <i>et al.</i> ²⁷	836	172	0.2057	[0.1788-0.2348]	3.7

14	Ghosh <i>et al.</i> ³²	431	178	0.4130	[0.3661-0.4611]	3.5
15	Kumar <i>et al.</i> ³⁴	402	137	0.3408	[0.2945-0.3894]	3.5
16	Dutta <i>et al.</i> ³¹	370	134	0.3622	[0.3131-0.4134]	3.5
17	Kalyan <i>et al.</i> ³³	200	56	0.2800	[0.2190-0.3477]	3.4
18	Banjare <i>et al.</i> ³⁰	310	60	0.1935	[0.1511-0.2420]	3.5
19	Bartwal <i>et al.</i> ³⁶	440	176	0.4000	[0.3539-0.4475]	3.5
20	Kalathingai <i>et al.</i> ³⁹	324	100	0.3086	[0.2588-0.3621]	3.5
21	Venkateshkrishna and Krishna ⁴³	1452	547	0.3767	[0.3517-0.4022]	3.7
22	Reddy <i>et al.</i> ⁴¹	1265	384	0.3036	[0.2783-0.3297]	3.7
23	Jacob <i>et al.</i> ⁴⁰	403	201	0.4988	[0.4489-0.5487]	3.5
24	Zare <i>et al.</i> ⁴⁴	303	148	0.4884	[0.4309-0.5463]	3.4
25	Singh <i>et al.</i> ⁴²	215	41	0.1907	[0.1405-0.2497]	3.5
26	Gupta <i>et al.</i> ⁴⁷	300	147	0.4900	[0.4321-0.5481]	3.4
27	Vimala <i>et al.</i> ⁴⁸	120	31	0.2583	[0.1828-0.3462]	3.2
28	Vidhyashree <i>et al.</i> ⁴⁹	300	117	0.3900	[0.3345-0.4477]	3.4
29	Usha <i>et al.</i> ⁵⁰	200	75	0.3750	[0.3077-0.4461]	3.3

Table 5
Tests of Heterogeneity

Tests of heterogeneity	Prevalence	LCI 95%	HCI 95%	Weight (%)
Pooled Statistics	0.3498	0.3132	0.3863	100
Heterogeneity	4.29	3.82	4.82	
I-squared	94.6	93.2	95.7	
Cochran's Q	515.58			
χ^2 , p	0.0001			
T^2	0.0093			

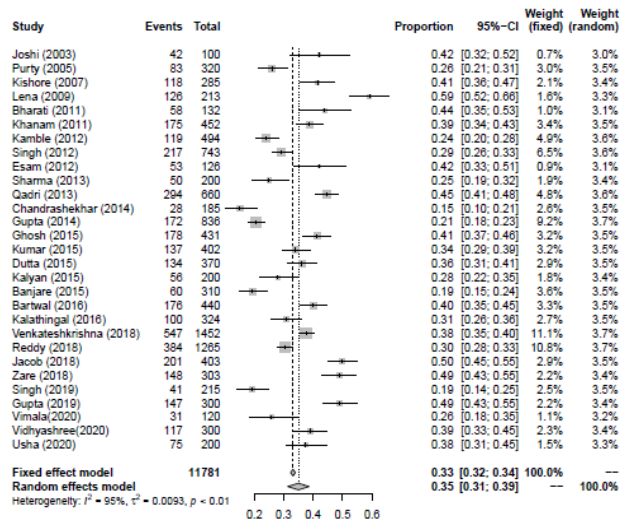


Figure 4. Forest plot showing the prevalence of cardiovascular diseases among geriatric population in rural areas of India

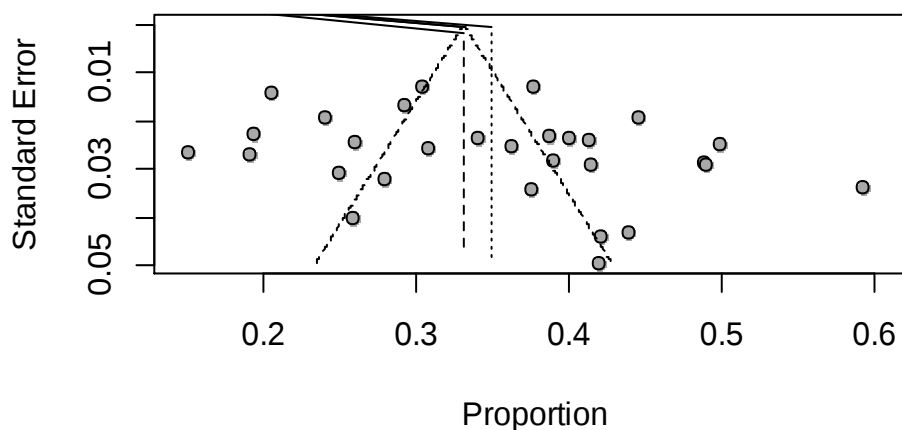


Figure 5. Funnel plot showing the prevalence of cardiovascular diseases among geriatric population in rural areas of India

Discussion

In the present analysis, we attempted to provide the point estimate of prevalence of cardiovascular diseases among geriatric population in India along with 95% confidence interval. The estimated overall prevalence of cardiovascular diseases among geriatric population in India was 36.77% (95% CI: 32.19%-41.48%) and the estimated overall prevalence of cardiovascular diseases among geriatric population in urban areas was 39.27% (95% CI: 33.96%-44.58%) which was higher than the prevalence (20.0%) reported by Chandrasekhar *et al.* (2014) in Gulbarga. [7] The lowest prevalence of cardiovascular diseases among geriatric population in urban areas was observed by Davalagi *et al.* (2015) in Karnataka [8] and the highest prevalence was observed by Sharma (2013) in Shimla. [9]. The estimated overall prevalence of cardiovascular diseases among geriatric population in rural areas of India was 34.98% (95% CI: 31.32%-38.63%) which was higher than the prevalence (15.14%) reported by Chandrasekhar *et al.* (2014). [7] The lowest prevalence (5.3%) of cardiovascular diseases among geriatric population in rural areas was observed by Bodhke (2019) in Maharashtra [10] and the highest prevalence was observed by Lena (2009) in Mangalore (Karnataka). [11] The high prevalence of cardiovascular diseases in urban geriatric population and rising prevalence in rural areas must raise an alarm for health care professionals to take immediate steps for improving geriatric care in the country.

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