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The global prevalence of myocardial infarction: a systematic review and meta-analysis

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Abstract

Background Myocardial infarction (MI) is one of the life-threatening coronary-associated pathologies characterized by sudden cardiac death. The provision of complete insight into MI complications along with designing a preventive program against MI seems necessary.

Methods Various databases (PubMed, Web of Science, ScienceDirect, Scopus, Embase, and Google scholar search engine) were hired for comprehensive searching. The keywords of "Prevalence", "Outbreak", "Burden", "Myocardial Infarction", "Myocardial Infarct", and "Heart Attack" were hired with no time/language restrictions. Collected data were imported into the information management software (EndNote v.8x). Also, citations of all relevant articles were screened manually. The search was updated on 2022.9.13 prior to the publication.

Results Twenty-two eligible studies with a sample size of 2,982,6717 individuals (<60 years) were included for data analysis. The global prevalence of MI in individuals <60 years was found 3.8%. Also, following the assessment of 20 eligible investigations with a sample size of 5,071,185 individuals (>60 years), this value was detected at 9.5%.

Conclusion Due to the accelerated rate of MI prevalence in older ages, precise attention by patients regarding the complications of MI seems critical. Thus, determination of preventive planning along with the application of safe treatment methods is critical.

Keywords Prevalence, Myocardial infarction, MI, Heart attack

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Background

Myocardial Infarction (MI) is one of the life-threatening coronary events with SCD [1] and the most severe clinical presentation of coronary artery disease (CAD) [2]. This pathology is divided into two categories of ST-elevation MI (STE-MI) and non-ST-elevation MI (NSTE-MI). Since unstable angina is the imminent background for MI, it is also considered an acute coronary syndrome (ACS) status [3].

More than 3 million individuals develop STE-MI each year, and more than 4 million people represent STE-MI pathology. Although MI is mainly detected in developed countries, it is also detected commonly in developing countries [4–7]. In a published study with 19,781 CAD patients, the MI prevalence was found 23.3% [8]. In recent years, a considerable decreasing trend in STE-MI incidence was detected in European countries and the United States [9, 10].

MI is the main cause of human death, globally [11]. Although the global rate of MI-associated mortality was totally decreased, the incidence of heart failure (HF) is at a high level [12]. The mortality and morbidity rates are high in MI-related HF [13, 14]. HF induces detrimental impacts on the healthcare systems of the United States, affecting 6 million individuals, 300,000 deaths per year, and approximately $40 billion in costs [15]. Also, the economic impact of MI is at a high rate. In 2010, more than 1.1 million hospitalizations following MI attacks were reported in the United States, with an estimated direct cost of $450 billion [16]. Body weakness is a common complication in cardiovascular diseases and is also a common syndrome among the elderly causing weight loss, fatigue, physical manipulation, decreased walking speed, and low body activity [17]. Obesity, sedentary lifestyle, hypertriglyceridemia, or inflammation markers (such as high-sensitivity C-reactive protein [hs-CRP]), are mostly independent cardiovascular (CV) risk factors associated with insulin [18]. Various published articles represented a general increase in the prevalence of cardiovascular risk factors (especially diabetes, cholesterol and obesity, and even smoking) [19–22]. In MI patients < 55 years, smoking was found a unique cardiovascular risk factor in 80% of cases [23].

The present systematic review and meta-analysis study seems beneficial for health system policymakers requiring the prevalence of MI patients during the allocation of health care resources. We believe that elimination of the complications and reduction in mortality rate need comprehensive assessment approaches.

Methods

In this study, the primary search was conducted on June 6, 2022. Databases of PubMed, Web of Science, ScienceDirect, Scopus, Embase, and Google scholar search engine were hired for definition of searching strategy. Also, the main keywords of "Prevalence", "Outbreak", "Burden", "Myocardial Infarction", "Myocardial Infarct", and "Heart Attack" were used for comprehensive searching with no time and language-associated restrictions. Following paper selection, the related citations were imported to the information management software (EndNote v.8x). Finally, in order to secondary screening, all citations of the collected articles were reviewed manually. The searching was also updated on September 13, 2022.

Inclusion and exclusion criteria

All gathered studies reporting the MI prevalence, available full texts, and studies with sufficient data (number of samples, percentage of MI prevalence) were totally included in this study. Also, case–control studies, cohort investigations, case series, case reports, reviews, repetitive papers, studies with insufficient data, papers with unavailable full texts, and conference studies were excluded.

Study selection

The Endnote software (v. X8) was hired to organize the selected studies. Duplicate studies were detected and merged together. In primary screening, irrelevant studies were removed following assessment of the titles and abstracts. Then, the full texts of the remaining articles were screened according to the inclusion and exclusion criteria. All screening protocols were conducted by two independent authors in order to accelerate the credibility index and inhibit the potential searching bias. Corresponding author was also responsible for the management of possible disagreements among the researchers. Finally, 33 studies were included for quality control assessment.

Quality control assessment

For validation and the quality control assessment, an observational study-associated checklist (The Strengthening the Reporting of Observational Studies in Epidemiology checklist (STROBE)) was used. This STROBE checklist consisted of six assessment scales of Title, Abstract, Introduction, Methodology, Results, and Discussion with 32 evaluation items including Title, Problem Statement, Study Objectives, Type of Study, Statistical Population, Sampling Method, Appropriate Sample Size Determination, Variables Definition, and the Procedures, Data Collection Tools, Statistical Analysis Methods and Findings. The article with STROBE scoring ≥ 16 was considered good and moderate (included in the study), and articles < 16 were poor quality (excluded from the study).

Data extraction

The eligible data were extracted by two researchers based on the previously prepared checklist (containing the Author's name, Year of publication, Research region, Sample size, Disease prevalence, and Age).

Data analysis

The heterogeneity of the studies was assessed using I^2 test. Also, the Egger test was used for publication bias assessment. All statistical analysis was applied in Comprehensive Meta-Analysis software (Version 2).

Results

Whole eligible data (6462 studies systematically and 134 investigations manually) regarding the prevalence of MI were collected based on the PRISMA guideline and categorized into two groups of individuals < 60 and ≥ 60 years. All the papers were imported into the information management software (EndNote v.X8). Among the total number of 6596 studies, 4566 duplicate investigations were detected and merged together. During the primary screening, the Title and Abstract of the remaining studies were assessed. Subsequently, 1879 investigations were excluded due to the irrelevant contents. Following the secondary screening, the full texts of the papers were assessed (118 studies were also excluded in this stage). Eligible collected papers were assessed based on the STROBE checklist, and the studies with poor-quality methodology were removed from the investigation. Finally, 32 high-quality papers were included for systematic review and meta-analysis study (Table 1) (Fig. 1).

Data analysis of 20 eligible studies with a sample size of 5.071.185 individuals > 60 years was conducted, and I^2 index represented a high heterogeneity rate ($I^2 = 99.7\%$). Meta-analysis assessment revealed that the global prevalence of MI in individuals > 60 years was 9.5% (95%CI: 7.7–11.6) (Fig. 2). Also, no publication bias ($p = 0.113$) was found in this age group (Fig. 3). Following data analysis of 22 eligible studies with a sample size of 29.826.717 individuals < 60 years, the I^2 index showed a high heterogeneity rate ($I^2 = 99.9$). The global MI prevalence in this age group was found 3.8% (95%CI:2.7–5.3) (Fig. 4). Also, no publication bias ($p = 0.064$) was detected (Fig. 5).

Discussion

This systematic review and meta-analysis study in the first investigation examine the global prevalence of MI in two groups of individuals < 60 and > 60 years. The global prevalence of MI < 60 years was detected 3.8% according to 22 studies with a sample size of 29.826.717 individuals. This value was also found 9.5% in the remaining 20 studies with a sample size of 5.071.185 patients > 60 years.

Following gender categorization, the prevalence of MI in males was found almost 5 folds greater than the females [44]. In a large number of other published studies, a high prevalence of MI was reported in males (> 60%) compared to females [56–79]. On the contrary, other literature reported higher MI prevalence in females, probably due to the sedentary lifestyle, metabolic syndrome, and similar risk factors [80].

Based on the geographical distribution, there were different results representing the MI prevalence including 10.4%, 0.1%, 0.2%, and 2.5% in Sudan, Senegal, Nigeria, and Kenya, respectively. These geographical differences in MI prevalence were probably associated with lifestyle, disease prevention plans, and the level of availability of medical diagnosis resources [81–84].

Extracted data from a large, diverse, community-based population represented a considerable decrease in MI prevalence (after 2000) and incidence of ST-segment elevation (in recent decades) [2]. Although the statistical analysis of CAD prevalence and the related mortality rate showed a decremental trend, the statistics of published literature (before 2002) had no report [85–92].

Various studies conducted in the United States (after 2000) revealed a considerable decremental trend in the incidence of AMI and the rate of hospitalization [2, 93]. The rate of AMI incidence also decreased in Sweden between 2001 to 2008 which was higher in males [94]. A similar trend conducted in the Netherlands from 1998 to 2007 also reported the same results [95]. Respectively, 33% and 31% reduction of AMI rates in males and females were reported in England (2002 to 2010) [96]. Another study showed a steady decline in AMI and mortality rates in most regions of Europe [10]. This study was consistent with the findings of the present investigation reporting that a reduction in MI prevalence was probably associated with innovation of preventive medical protocols and a parallel improvement in risk factors management [95, 97–99].

The prevalence of angina and MI decreased considerably over the 12-year period. The reduction in the prevalence of cardiovascular diseases (CVD), including angina and MI, may result from application of preventive medical procedures and management of risk factors [45]. On the contrary, a high prevalence of undiagnosed MI (26.9%) was also reported. Consequently,

Table 1 Studies obtained and information extracted from them

Authors	Region	Year	Sample size	Number of patients	Prevalence	Age	Instruments
Chow, C. M and et al. [24]	Canada	2005	3,318,117 4,118,589 4,746,631 5,077,402 3,637,171 2,396,167 1,744,169 749,088	975 2477 8216 36,183 99,768 131,361 172,095 85,474	0.0 0.1 0.2 0.7 2.7 5.5 9.9 11.4	12–19 20–29 30–39 40–49 50–59 60–69 70–79 80 ≤	Self-reported data
Assante, R and et al. [25]	Italy	2015	2420	758	31.3	36–14	Between January 2009 and December 2013, 2420 consecutive subjects (258 inmates and 2162 non-inmates) with suspected or known coronary artery disease underwent stress myocardial perfusion single-photon emission computed tomography (MPS) to our institution
Carrillo, X and et al. [26]	Spain	2011	479	58	12.1	49–38	questionnaire about cocaine use and frequency of use as well as a urine test for cocaine within 48–72 h of admission
Bosch, X and et al. [27]	Spain	2010	402 370 467	5 19 34	1.2 5.1 7.2	34–25 44–35 54–45	standard questionnaire
Bulow, B and et al. [28]	Sweden	2000	33	1	3.03	46–6	hypopituitary patients
Chung, E. H and et al. [29]	USA	2007	161	119	73.9	45–18	using data retrieved from the National Cardiovascular Data Registry at Lahey Clinic, who underwent cardiac catheterization for AMI from June 2001 to December 2004
Domingos, F and et al. [30]	Portugal	2011	23,349	443	1.9	45–18	The sample used in the fourth NHS was randomly selected from a mother sample used by the NIS for studies with families among residents in private households from a representative sample of households from the mainland and the autonomous regions of Azores and Madeira, using a system of stratification and systematic selection
Gikas, A and et al. [31]	Greece	2008	0 600 527 787 258 199	0 9 20 70 109 38	0 1.5 3.8 8.9 23.8 19.1	34–20 44–35 54–45 64–55 74–65 75 ≤	Self-reported data
Gisondi, P and et et al. [32]	Italy	2011	482	174	36.09	55–52	using a structured questionnaire
Ingelfinger, J. A and et al. [33]	Indian	1976	120	14	11.6	60–40	Twelve-lead electrocardiograms (ECG) were obtained in the post-prandial state from 351 male and 350 female Pima Indians
Khan, H and et al. [34]	Texas	2022	1409	93	6.6	64 <	Hospital patient data for those with and without a history of MI were obtained from the Project FRONTIER database for rural West Texas counties
Kitamura, A and et al. [35]	Japan	2002	17,404	114	0.65	59–40	The surveyed population included all male employees aged 40 to 59 years who worked for eight industrial companies in Osaka, the second largest metropolitan city in Japan

Table 1 (continued)

Authors	Region	Year	Sample size	Number of patients	Prevalence	Age	Instruments
Lampe, F. C and et al. [36]	UK	2001	3718 5617 5714 3655 1637 22,179	15 33 33 26 11 132	0.4 0.5 0.5 0.7 0.6 0.5	44–40 49–45 54–50 59–55 64–60 69–65	The prevalences of current angina symptoms and history of diagnosed CHD were ascertained by questionnaire in 1978–80, 1983–85, 1992, and 1996
Lautsch, D and et al. [37]	USA	2019	39,100 48,927	3501 6152	9 12.6	74–65 75 ≤	We included de-identified adult patients with T2DM with at least one encounter in the CPRD database between 1 January 2018 and 31 December 2018 in the analysis and extracted the full health records of these patients
McCullough, Peter A and et al. [38]	USA	2008	301 2857 5324 8837 8740 3185	1 20 58 179 211 99	0.4 0.8 1.3 2.4 3.2 4.9	19–18 29–20 39–30 49–40 59–50 64–60	Community volunteers completed surveys regarding past medical events and underwent blood pressure and laboratory testing
Okoth, K and et al. [39]	UK	2017	1,475,676	2440	0.16	50–16	A series of annual (1998–2017) cohort and cross-sectional studies were conducted to estimate incidence rates and prevalence in men and women aged 16–50
Otaki, Y and et al. [40]	USA	2013	1981	42	2.1	58–40	Coronary CT Angiography Evaluation for Clinical Outcomes: An International Multicenter Registry (CONFIRM) is an international, multicenter, observational registry of 27,125 consecutive patients who underwent ≥ 64–detector row CCTA for suspected CAD at 12 centers from 2003 to 2009
Sato, K and et al. [41]	Japan	2020	3485 2601 510	537 266 223	15.4 10.2 43.7	79–70 89–80 90 ≤	The Miyagi AMI Registry is a prospective, multicenter, and observational study
Shaper, A. G and et al. [42]	British	1984	1838 1898 1974 2025	31 62 102 133	1.7 3.3 5.2 6.6	44–40 49–45 54–50 59–55	The prevalence of ischaemic heart disease was determined by an administered questionnaire and electrocardiography in 7735 men aged 40–59 years drawn at random from general practices in 24 British towns
Zeller, T and et al. [43]	Germany	2014	15,340	1980	12.9	58–39	High-sensitivity assayed troponin I was measured in the Scottish Heart Health Extended Cohort ($n = 15$ 340) with 2171 cardiovascular events (including acute coronary heart disease and probable ischaemic strokes), 714 coronary deaths (25% of all deaths), 1980 myocardial infarctions, and 797 strokes of all kinds during an average of 20 years follow-up
Zeidan, R. K and et al. [44]	Lebanon	2016	506 351 234 270	15 26 16 25	2.9 7.3 7 9.2	50–40 60–50 70–60 70 ≤	We carried out a cross-sectional study using a multistage cluster sample across Lebanon. We interviewed residents aged 40 years and older using a questionnaire that captured the presence of CHDs and their risk factors (RFs)

Table 1 (continued)

Authors	Region	Year	Sample size	Number of patients	Prevalence	Age	Instruments
Yoon, S. S and et al. [45]	Maryland	2012	3598	76 317	2.1 8.8	40–59 60 ≤	A total of 21,472 adults aged ≥ 40 years from the 2001–2012 National Health and Nutrition Examination Survey were included in the analysis. The analysis was conducted in 2015
Valentine, R. J and et al. [46]	America	1994	59	17	28.8	46–36	We studied the peripheral and coronary arterial circulations of 59 consecutive male military veterans diagnosed with premature peripheral vascular disease (age of onset :::;45 years) affecting the lower extremity
Schelbert, E. B and et al. [47]	ICELAND	2012	936	248	26.4	81–72	From a community-dwelling cohort of older individuals in Iceland, data for 936 participants aged 67 to 93 years were analyzed, including 670 who were randomly selected and 266 with diabetes
Kumar, A and et al. [48]	USA	2008	3224	368	11.4	78–66	Cardiovascular Health Study participants free of both clinical cardiovascular disease and major ECG abnormalities were included
Bahrmann, P and et al. [49]	Germany	2013	302	38	12.5	86–74	An emergency department (ED) of a city hospital covering a population of approximately 1 million in Germany Participants: A total of 332 consecutive unselected patients were recruited
Bethel, M. A and e et al. [50]	U.K	2017	2004	823	41.1	75 ≤	was a randomized, double-blind, placebo-controlled trial
Cauley, J. A and et al. [51]	USA	2016	5876	820	13.9	83–67	we performed a prospective study of 5994 men, primarily white, age 65 + years recruited at six US clinical centers
de la Torre Hernandez, J. M and et al. [52]	Spain	2017	3576	385	10.7	85–76	A 31-center registry of consecutive patients older than 75 years treated with primary angioplasty. Clinical and procedural data were collected, and the patients underwent clinical follow-up
Golledge, J and et al. [53]	Australia	2014	11,742	1711	14.5	76–67	A risk factor questionnaire which contained a question about salt intake was included as part of a population screening study for AAA in 11,742 older men. AAA presence was assessed by abdominal ultrasound imaging using a reproducible protocol
Ikeda, Y and et al. [54]	Japan	2014	14,464	74	0.5	76–67	The Japanese Primary Prevention Project (JPPP) was a multicenter, open-label, randomized, parallel-group trial. Patients (*N* = 14 464) were aged 60 to 85 years, presenting with hypertension, dyslipidemia, or diabetes mellitus recruited by primary care physicians at 1007 clinics in Japan between March 2005 and June 2007, and were followed up for up to 6.5 years, with last follow-up in May 2012

Table 1 (continued)

Authors	Region	Year	Sample size	Number of patients	Prevalence	Age	Instruments
Teo, K. K and et al. [55]	Canada	2009	904	326	37	65 ≤	We conducted a pre-specified analysis of outcomes in stable CAD patients stratified by age and randomized to PCI OMT or OMT alone in the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive druG Evaluation) trial

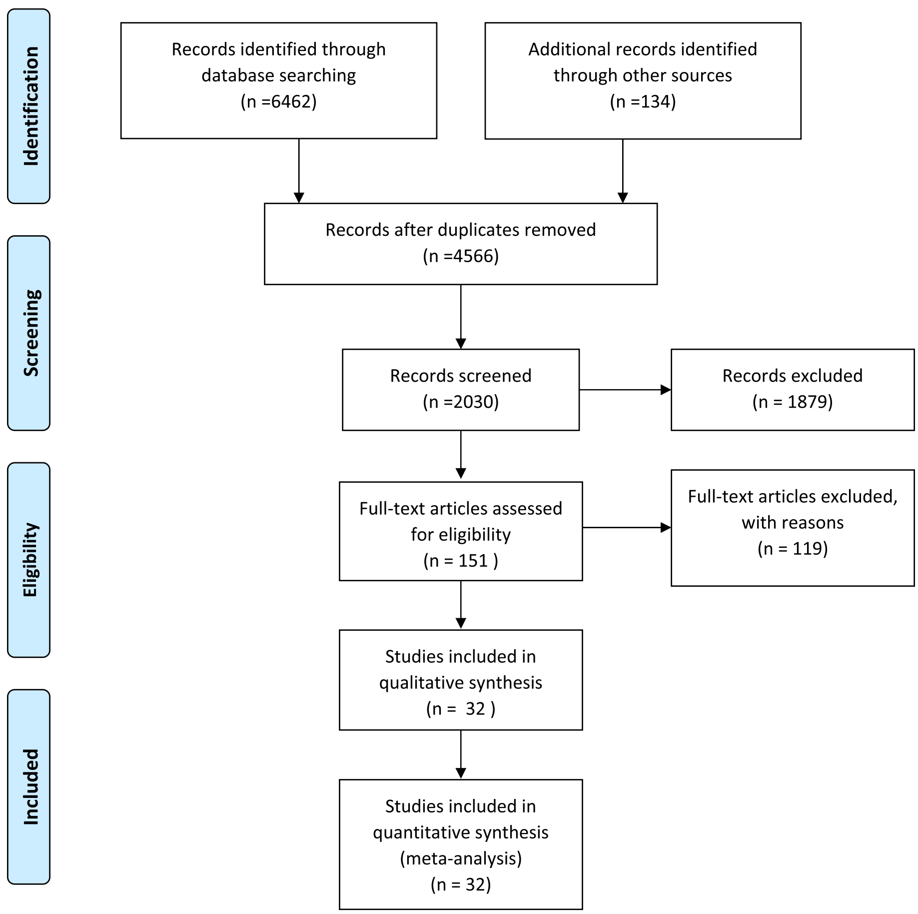

Fig. 1 Reviewing, screening and extracting articles based on PRISMA process

more participants (17%) had un-diagnosed MI, and others (9.6%) represented diagnosed MI [47]. In another study, the incidence of definitive MI diagnosis in hospitalized patients was 272/100,000 individuals (aged 30–74) [87].

The high rate and increased severity of CAD in patients with a family background were directly related to the risk of MI in younger ages and both genders [40]. The scientists also found that cocaine addicts are 7 times more at risk of heart attack [100]. Notably, an increased rate of MI incidence was detected in people < 55 years during 1997–2005 [101]. In parallel, various studies reported an annual increase (4%) in the incidence of AMI among women aged 35 to 54 years in Western Australia (from 1996 to 2007) and an increase among women aged 20 to 49 years (from 1994 to 2004). In these studies, the accelerated prevalence of smoking (especially among young females), obesity, and the lack of physical activity have been reported in adolescents and young adults [102–108].

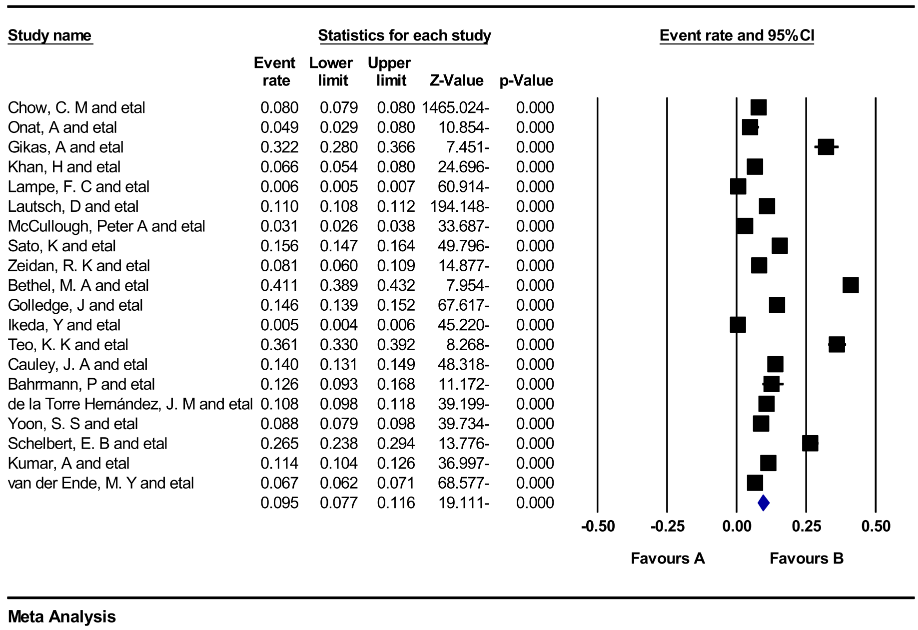

Fig. 2 Forest plot representing the global prevalence of myocardial infarction in age group > 60 years based on the random effects model

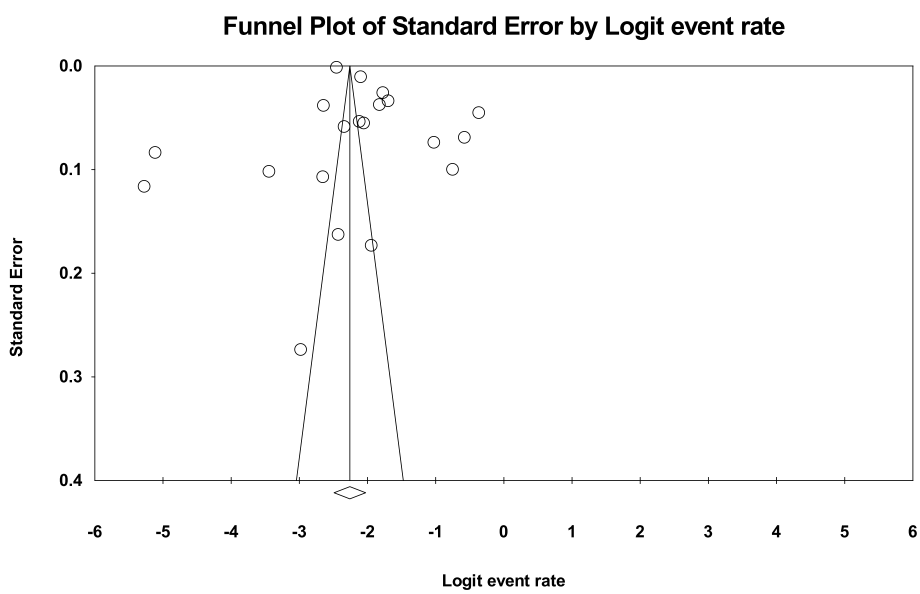

Fig. 3 Funnel plot representing the distribution bias of eligible collected studies

In this study, a higher prevalence was reported in people over the age of 60. In the results reported in the global epidemiology study of ischemic heart disease, which was based on the results of the global burden of disease study, it was reported that ischemic heart disease has a high upward trend with It shows increasing age and the growing trend continues until the age of 89 [109].

Limitations

Since the age range explained in published studies had no similarity to the age groups in the present study, some eligible papers were excluded. Although, almost half of the studies were conducted in specific subpopulations (such as other heart disease and diabetic patients admitted to the emergency department); difficult conclusions regarding the MI prevalence in general population were possible.

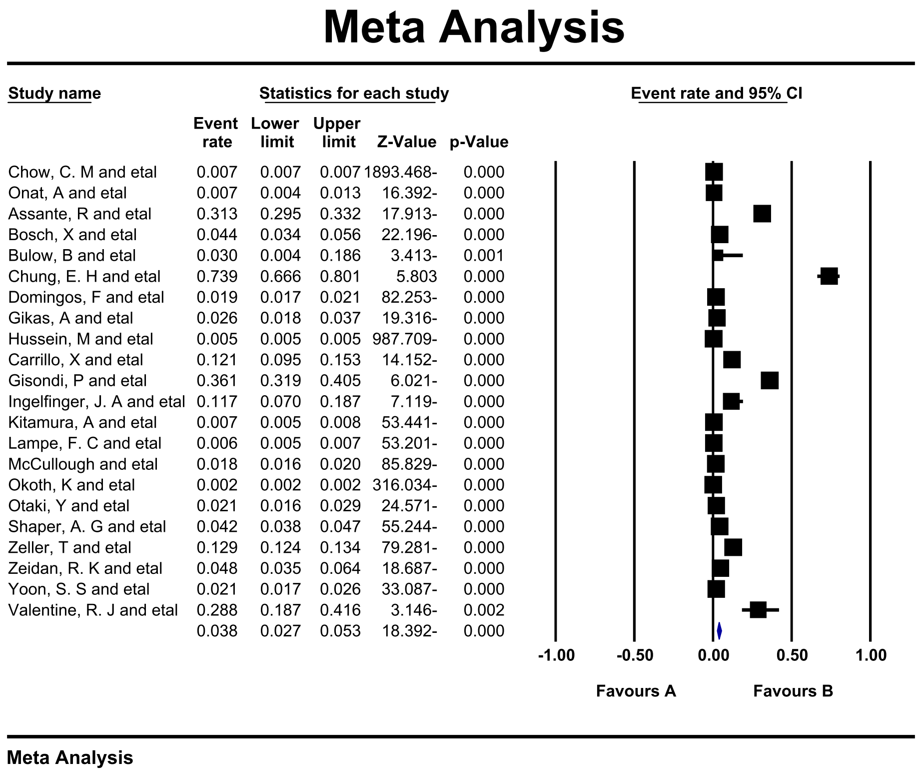

Fig. 4 Forest plot representing the global prevalence of myocardial infarction in the age group < 60 years (random effect model)

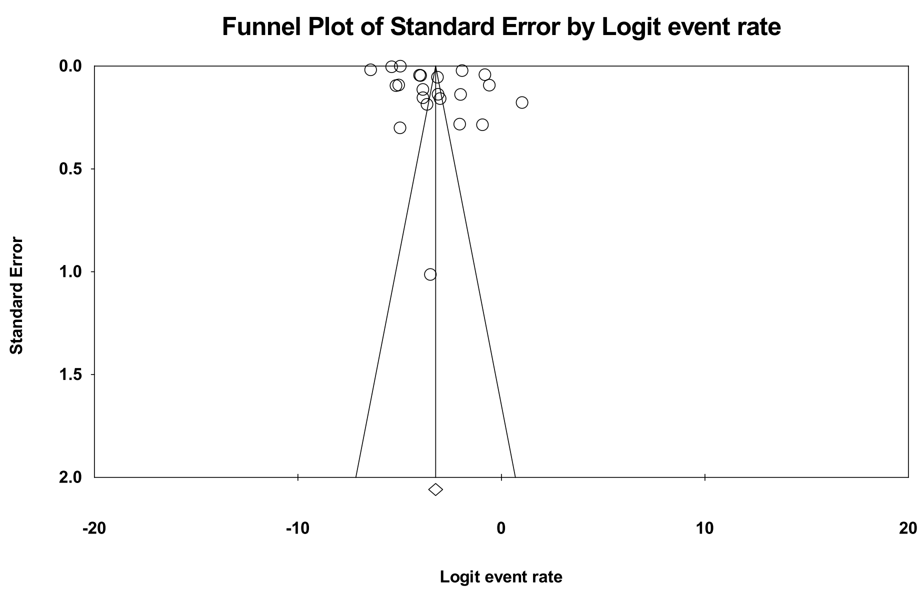

Fig. 5 Funnel plot representing publication bias in eligible collected studies

Conclusion

According to the findings of the present study, the prevalence of MI in people < 60 and > 60 years old were 3.8% and 9.5%, respectively. Therefore, based on the results of the studies that have been reviewed and included in the meta-analysis, the high prevalence of MI was reported to be higher in individuals > 60 years which is considered a warning for health policymakers regarding the importance of this age for diagnosis and screening procedures of MI.

Abbreviations

WoS	Web of Science
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
STROBE	Strengthening the reporting of observational studies in epidemiology for cross-sectional study
MI	Myocardial infarction

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Authors' contributions
NS and FM contributed to the design, MM statistical analysis, participated in most of the study steps. MM and AA and SR and LAH and AAK and SHSH prepared the manuscript. All authors have read and approved the content of the manuscript.

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Declarations

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