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Review

The effects of coronary artery calcium screening on behavioral modification, risk perception, and medication adherence among asymptomatic adults: A systematic review

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ABSTRACT

Objective: To perform systematic review of the effects of screening for coronary artery calcium (CAC), a subclinical marker of coronary artery disease (CAD), on behavioral or lifestyle modification, risk perception, and medication adherence.
Methods: We searched through CINAHL, PsychInfo, Web of Science, Cochrane Central Register of Control Trials, and PubMed (Medline) for studies on the effects of CAC screening in asymptomatic individuals across three major domains: behavioral modification, risk perception for CAD, and medication adherence. We extracted data from the retrieved studies, assessed and synthesized the information.
Results: Of the 15 retrieved studies, three were randomized control trials and 12 were observational studies. CAC score was ascertained either as total score, quartiles, or standardized Agatston's ordinal scale. While all the 15 studies involved issues related to behavioral and medication adherence, four involved risk perception of CAD. Although no standardized approach was used in these studies, CAC screening enhanced medication adherence in 13 of the 15 studies, while the others were mixed.
Conclusion: CAC screening improved medication adherence and could likely motivated individuals for beneficial behavioral or lifestyle changes to improve CAD. The mixed results suggest the need for further research because screening for subclinical atherosclerosis has significant implications for early detection and prevention of future cardiovascular events by aggressive risk factors modification.
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1. Introduction

Cardiovascular disease (CVD), the leading cause of morbidity and mortality in the United States (U.S.), contributes to significant health and economic burden on individuals and societies [1]. In the U.S., CVD alone accounts for 1 in 3 deaths and total direct and indirect costs of more than $300 billion per year [1]. Coronary artery disease (CAD), the commonest form of CVD, accounts for 1 in 6 deaths in the U.S. [1]. Coronary atherosclerosis starts in a subclinical phase and slowly progress over years before the development of clinical cardiovascular events [2]. While 80% of the 180,000–250,000 sudden cardiac deaths (SCDs) in the U.S. are attributed to CAD [3,4], 50% of all SCDs occurs in persons without prior overt diagnosed CAD [5]. Additionally, a significant number of patients that experience silent myocardial infarction (MI) remains asymptomatic, especially those with other comorbid conditions. Risk assessment tools such as the Framingham Risk Score (FRS) and the European Heart Score based on established traditional CAD risk factors (age, hypertension, dyslipidemia, diabetes and smoking) have been useful in determining the risk of CAD in asymptomatic adults [6,7]. However, these tools explain 60–65% risk for CAD [8–10], thereby often underestimating the risk among patients with subclinical disease [11,12]. This has given rise to the need for other screening methods or tools to assess the risk for CAD, especially in asymptomatic individuals.

Coronary artery calcium (CAC), detected by computed tomography (CT), is a subclinical marker of CAD that predicts the risk of CAD with high prognostic significance among asymptomatic individuals [13]. Assessment of CAC enables risk stratification diagnosis of CAD and directs the treatment and management of CAD among asymptomatic individuals. The amount of calcium deposits along the atherosclerotic coronaries arteries [26] in an individual helps estimate the severity of the risk for CAD [14,15] and predicts future cardiac events, including MI and SCD [16]. Several studies have shown that CAC is an independent predictor of coronary events [17–19], and particularly useful in the reclassification of individuals at low or intermediate risks for CAD [19,20] by traditional risk score assessment [21]. It has been reported that asymptomatic individuals with CAC $\geq$100 were 7–10 times more likely to have cardiac events than those with CAC score of zero [18], and those with CAC >1000 had 36% chance of MI or cardiac mortality within 28 months [22]. Additionally, studies have demonstrated a strong positive correlation between CAC and traditional risk factors [23,24]. Thus, the presence of these risk factors increases the amount of calcium deposits in coronary arteries as indicated by high levels of CAC scores, thereby augmenting the risk of CAD. While the existing evidence supports the importance of CAC in predicting future cardiovascular events [1,8,13], an emerging area of interest is the effects of the knowledge about CAC score in motivation for beneficial behavioral change, risk perception, medication or treatment adherence, and positive health outcomes [25–27].

Reduction of CVD morbidity and mortality requires primary and secondary prevention through behavioral or lifestyle modification and control of risk factors, along with early detection through screening tools [25,28]. CAC score is a screening tool that facilitates early detection of CAD and improves risk stratification in asymptomatic individuals [20], with the potential to improve treatment, management, and prevention strategies [29]. However, the effects of knowledge of CAC score in modifying an individual's behavior, risk perception of CAD, and adherence to treatment or medication for other comorbid conditions has not been adequately studied [30,31]. Therefore, we conducted a systematic review of the literature on CAC scores as a motivational tool for positive behavioral change, risk perception, and medication adherence. This review on the utility of CAC in CAD management and prevention is important because patient's compliance with established recommended guidelines for traditional risk factors reduction has been limited [32]. As such, this review will provide insight on the importance of CAC screening and scores, and has broader implication for clinical practice, behavioral interventions, policy development.

2. Methods

2.1. Literature search and selection

In December 2013 and March 2014, two librarians at the James H. Quillen College of Medicine at East Tennessee State University performed a comprehensive literature search in five databases, including CINAHL, PsychInfo, Web of Science, Cochrane Central Register of Control Trials, and PubMed (Medline), using search terms ([“coronary artery calcium”] AND [“motivation” OR “lifestyle” OR “risk perception” OR “medication adherence”]) provided by the researchers (Fig. 1). All the retrieved publications were imported into the online reference management system, RefWorks, and screened for duplicates (Fig. 2). The screening for the studies was initially conducted using titles and abstracts of articles. Full text of articles was retrieved and reviewed where there is lack of clarity. The retrieved articles were supplemented using a snowball technique with search through bibliographies of articles included in the study. We included only full text original articles and those reported in English language. The inclusion criteria used to select the studies were: 1) Population consisting of asymptomatic individuals without prior diagnosis of CVD; 2) CAC score as a subclinical marker of CAD; 3) Study individuals with CAC score obtained using computed tomography (CT); 4) Individuals with behavior or lifestyle modification after screening of CAC and/or visualization of the calcium deposits in the coronary arteries.

2.2. Data extraction

Three of the researchers (HMM, TP, and MB) reviewed the publications and examined the references of the selected studies. The data extracted include author's name, population size and characteristics, mode of recruitment of participants, study design, location where participants were recruited, follow-up period,