

Cardiovascular Risk Score – Review of Its Assessment Methods and Outcome

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Abstract

World Health Organization reported that cardiovascular disease (CVD) is the leading cause of death, which has taken approximately 17.9 million lives across the globe. Current studies identified high prevalence and severity of metabolic syndrome in children which is likely increase the incidence of premature death and contribute to the statistical number of cardiovascular disease and related events worldwide. Therefore, measurement of the cardiovascular risk score among the children, specifically adolescent need to be implemented in order to modify the risk and improve the disease outcomes. This review aims to identify the assessment methods and the implications. Full-text article on case control, cohort and cross-sectional studies published from 1st Jan 2012 until 30th September 2022, were searched using PubMed, CINAHL and Scopus. Teenagers or adolescent age range from 11 to 19 years were included in this study. The cardiovascular risk and score assessment methods as well as the outcomes of the assessment were included in this study. 8 out of 40 articles met the eligibility criteria and were selected. Two out of eight studies classify the risk factors into categories. One study classified the participants into high, medium and low risk group while another study categorised them into fit and unfit. Most studies agreed that assessment of CVD risk should focus on multiple risk factors instead of individual risk. Two studies suggest increase physical activities among children can reduce the obesity. Another study recommended family-based intervention to prevent CVD risk factors particularly obesity. In conclusion, predicting CVD from childhood and adolescence required a multifactorial assessment. Majority of study showed that multiple risk assessment is required to predict cardiovascular events and early interventions are needed in children who pose higher risk compared to others.

Keywords

CVD, risk assessment, children, teenagers, method, adolescent.

Introduction

In 2016, World Health Organization reported that cardiovascular disease (CVD) is the leading cause of death, which has taken approximately 17.9 million lives across the globe. This contributed for 31% of all death worldwide [1]. Although the cardiometabolic disorder occur mainly in adults, the evidence also shown that children are also at risk [2]. Since CVD is closely related to metabolic syndrome (Mets), current studies suggest that increase prevalence and severity of Mets in children is likely to lower the incidence age of CVD and death worldwide [3].

Pathogenesis of atherosclerosis started to take place in adolescence. Streak of fats, cholesterol and fibrous plaque begin to accumulate at the arterial wall at the very young age of 10 and slowly accumulate over time [4]. Many risk factors are associated with CVD. Among them are hypertension, obesity, hyperlipidemia and high fasting blood glucose which are also present in adolescents.

These risk factors seem to start in early stage of life. According to National Health and Morbidity Survey (NHMS) which conducted in 2015 reported, 63% of adults had at least one of these risk factors during their childhood [5]. This show that poor health condition tends to persist over time and warrants an early assessment earlier than 40 years old, the cut off age that are currently set for assessing the CVD score. Therefore, in this study our objectives are 1) to identify the assessment tools or methods for CVD risk score measurement in adolescent and 2) to identify the implications of assessing CVD risk among adolescents.

Methodology

The primary objective of this systematic review is to identify methods of cardiovascular risk score assessment among adolescents. The second objective of this review is to assess the outcome of those cardiovascular risk score assessment among the adolescent.

Criteria considering studies for this review are as below:

1. Age scope: Teenagers or adolescent age range from 11 to 19 years
2. Type of studies: Case reports, cross sectional and cohort studies
3. Type of assessment: Cardiovascular risk score assessment methods among adolescents
4. Type of outcome: Impact of cardiovascular risk assessment among adolescents

Search methods for identification of studies (including PRISMA flowchart)

Case control, cohort and cross-sectional studies published from 1st Jan 2012 until 30th September 2022, were searched using PubMed, CINAHL and Scopus. A total of 37 full text articles were selected. The search terms used were (CVD risk score OR CVD risk value) AND (assessment OR calculation) AND (adolescent OR children OR teenagers) AND (how OR method OR tools) AND (implications OR outcome OR impact). The geographical area covered are all countries and the language of the publication was restricted to English in all databases. The search strategy resulted in a total of eight studies which were included for this review. The PRISMA flow diagram for the search strategy is summarized in figure below.

Data collection and analysis

Data collection was done by three reviewers and checked by two reviewers, consisting of research assistant from the Kuliyah of Medicine and Family Medicine Specialist from Department of Family Medicine, Kuliyah of Medicine, International Islamic University Malaysia. All the papers were critically appraised using the STROBE statement.

Qualitative synthesis was done by descriptive comparison of the reviewed articles and their cardiovascular risk score assessment methods, the outcome of the cardiovascular risk assessment and risk of bias comparison. Meta-analysis was not done due to difficulty in obtaining some of the estimates which were not reported in the articles.

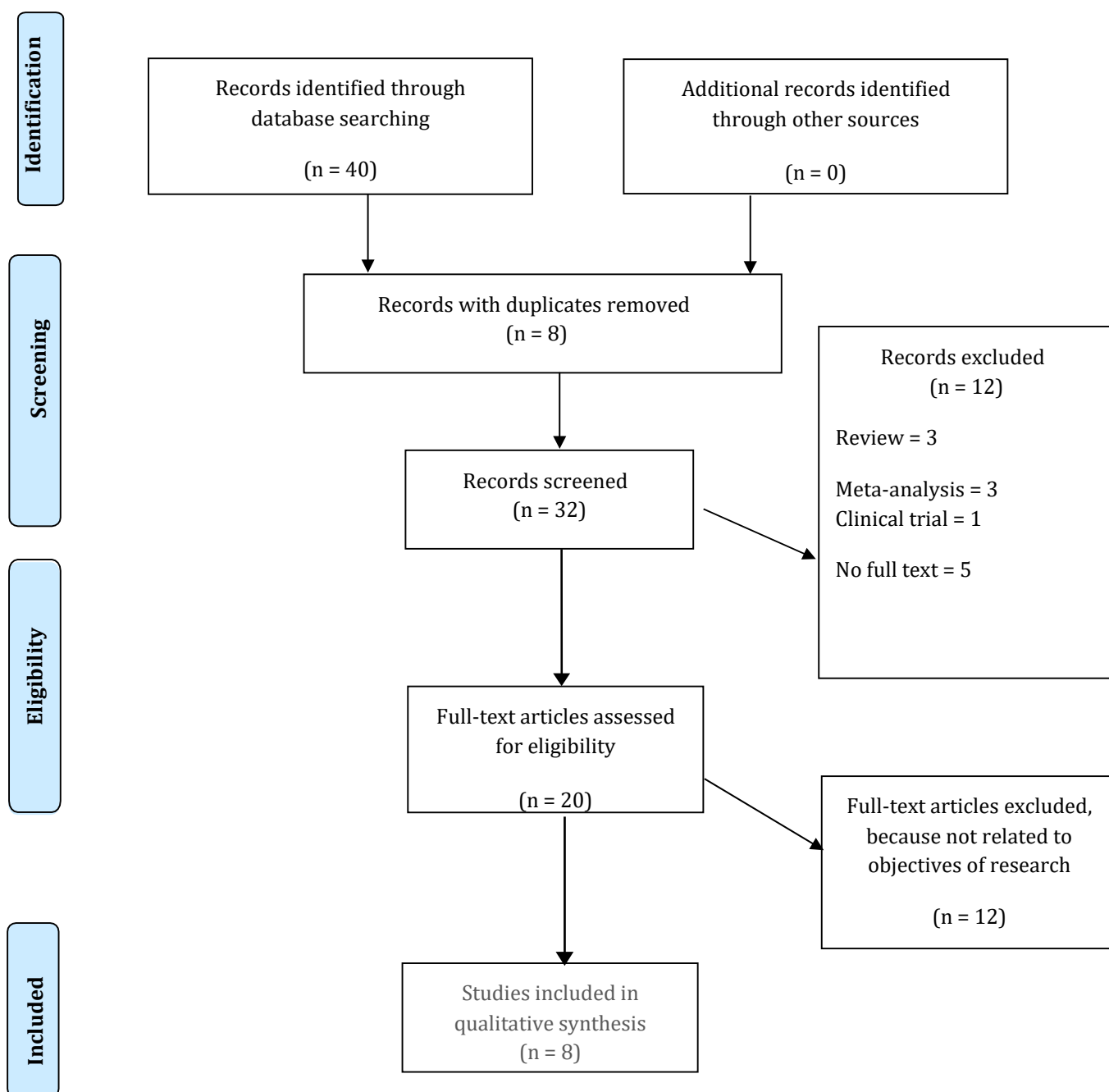


Figure 1: PRISMA Flow of Search Strategy

Results

Descriptive studies

Table 1: List of Review Articles and their Cardiovascular Risk Score Assessment Methods

Author	Study design	Sample size	Population	Period	CVD risk assessment methods
Thangiah et al 2020	Longitudinal study	1320	School student aged 13 in 2012 in Kuala Lumpur, Selangor and Perak.	2012 – recruitment phase 2014 – first follow up 2016 – second follow up	Clustering students into high, medium and low risk based on 8 risk factors (systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol: high-density lipoprotein cholesterol (HDL) ratio, HDL, low-density lipoprotein cholesterol (LDL), triglyceride, body fat and waist circumference)
Bailey et al, 2012	Cross-sectional	100	Children and adolescent age 10-14 years in 11 schools across Bedfordshire, UK with no contraindications to take part in physical exercise		Classify participants into fit and unfit. Those in fit class had a significantly lower clustered cardiometabolic score (sitting blood pressure, fasting blood glucose, total cholesterol, HDL and triglyceride) compared to unfit participants.
Lewit and Baker, 2018	Cross-sectional	224 students 217 mothers	Teenagers aged 12.9-14.4 years at various stage of puberty in 3 schools in Carmarthenshire,		Measure the pubertal status, anthropometric assessment of adiposity (skinfold

		207 fathers	Wales and their parents		thickness of biceps, triceps, subscapular and suprailiac along with weight-to-height ratio), SBP, DBP, high molecular weight adiponectin, blood glucose, insulin, triglyceride, fibrinogen, C-reactive protein concentrations, cardiovascular physical fitness, paternal and maternal BMI.
Sobrino et al, 2017	Cross-sectional	529	Portuguese healthy adolescent without any medical diagnosis of physical and mental impairment and currently not in any medication in 5 schools in Portugal's Northern Region with mean age 14.3 ± 1.7 years with CRP values <10mg/L		Measure the clustered cardiometabolic risk score (body fat percentage, SBP, total cholesterol to HDL ratio, triglyceride, insulin resistance and cardiorespiratory fitness), complement factors (C3 & C4), C-reactive protein, fibrinogen, leptin, white blood cells (WBCs), albumin, interleukin-6 and InflaScore (C3, C4, C-reactive protein, fibrinogen and leptin)
Lee et al, 2017	Cross-sectional	4837	Adolescent NHANES participants who age 12-20 years old		Measure the metabolic syndrome severity score

			excluding non-fasting status, pregnancy, active hepatitis-B infection, physician diagnosed diabetes and current use of antidiabetic or antihyperlipidemic medication.		(SBP, DBP, fasting blood glucose, triglyceride, BMI, HDL), ethnicity (white non-hispanic, black non-hispanic, hispanic), LDL, high sensitivity C-reactive protein (hsCRP), serum uric acid, Apo-B, dietary intake and physical activity.
Zhao et al, 2017	Cross sectional	3621	NHANES teenagers who age 12-17 years		Measure and compare between BMI, weight circumference (WC) and weight-to-height ratio (WHtR) with cardiovascular risk factors (SBP, DBP, triglycerides, HDL, LDL and fasting blood glucose,)
Stavnsbo et al, 2018	Cohort	22,479	Children and teenagers age 6-18 years in United States and part of Europe (North, South, Mid and Eastern)		Investigate 14 variables which are systolic blood pressure, diastolic blood pressure, WC, BMI, sum of four skinfolds, triglyceride, total cholesterol, HDL, LDL, total cholesterol:HDL ratio, glucose, insulin, homeostatic model assessment (HOMA) score and

					cardiorespiratory fitness
Choi et al, 2021	Cross-sectional	204	Teenagers aged 13-15 who are participants of Ewha Birth and Growth studies and had no missing value during follow up.		Measure and investigate metabolic syndrome score (BMI, fasting blood glucose, triglyceride, mean arterial pressure (MAP) and HDL) along with hsCRP and carotid intima-media thickness.

Outcome of the Cardiovascular Risk Score Assessment among Adolescents

Table 2: Outcome of the Cardiovascular Risk Score Assessment among Adolescents

Author of articles	Outcome of the Assessment
Thangiah et al 2020	High risk cluster students are more susceptible to attaining CVD in adulthood. Reliable and meaningful clustering of multiple risk factors is very important to identify the adolescent at high risk of CVD
Bailey et al 2012	Cardiorespiratory fitness may play an important cardioprotective role in children and adolescents Intervention in children and adolescent should focus on high intensity physical activity in order to reduce the likelihood of developing cardiometabolic illness in adulthood.
Lewit and Baker, 2018	Family and social environment to prevent obesity are best undertaken early in childhood, especially in boys.
Sobrinho et al, 2017	Clustered inflammatory biomarkers seem to have a better diagnostic accuracy in identifying an unfavourable cardiometabolic profile than single biomarker.
Lee et al, 2017	This study suggests, multiple inter-related factors in clinical CVD risk assessment along with continuous effort to combat obesity among adolescents.
Zhao et al, 2017	BMI, WC, and WHtR are good assessment in identifying the presence of cardiovascular risk factors.
Stavnsbo et al, 2018	Suggest common standard to define and assess cardiometabolic risk in children

Choi et al, 2021	Suggest early intervention of metabolic risk factors in early in life to reduce the risk of CVD in adulthood.
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Risk of bias in included studies

The overall risk of bias is based on the author's judgement and discussion with other reviewers for this systematic review.

Table 3: Risk of Bias in Reviewed Articles

Author	Selection bias	Exposure assessment bias	Confounder	Other bias	Overall risk of bias
Thangiah et al 2020	Low	Low	Low	None is identified	Low
Bailey et al 2012	Low	Low	Low	None is identified	Low
Lewit and Baker, 2018	Low	High as Self-assess pubertal status might lead to bias in report	Low	High as parents were asked to report child birth weight and other parameters, which might lead to recall bias	Moderate
Sobrinho et al, 2017	High as the selected five secondary schools, had collaboration agreements already established with the research center	Low	High as only apparently healthy adolescents were considered	None is identified	Moderate
Lee et al, 2017	Low	Low	Low	None is identified	Low
Zhao et al, 2017	Low	Low	Low	None is identified	Low
Stavnsbo et al, 2018	Low	Low	Moderate – as the age group was not homogenous among countries involved	None is identified	Low
Choi et al, 2021	Low	Low	Low	None	Low

Discussion

Increasing prevalence of obesity among children nowadays with other CVD risk factors such as high blood glucose, high triglyceride and low HDL may lead to decrease age of CVD incidence. Therefore, it is important to assess and manage these risks accordingly to avoid CVD in adulthood and ultimately reduce the premature death cause by CVD. In this systematic review, we discussed from two major topics which are the methods to assess the CVD risk score among adolescents and the outcome of such assessments.

In this study, we found that two out of eight studies classify the risk factors into categories. Out of these two, one study classified the participants into high, medium and low risk group and observed the risk factors over four years duration. In this study, more than 12% of the children remained in high-risk group, indicating the poor health conditions may persist over time. Another study conducted in UK investigates different perspective by classifying the participants into fit and unfit based on physical activities and then relates it with the clinical assessment. These classifications are very useful as they give the idea of stratifying the children and teenagers risk factors and may help researcher to develop comprehensive scoring system to predict the CVD event in children in adulthood as Framingham score risk that able to gives estimation of CVD in adults over 10 years period. Classification of CVD risk into risk stratification is also similar to those usually practiced in adult in which the relevance to be implemented in among young adulthood is really beneficial as spelled out in the studies.

Most of the studies observed in this study used metabolic syndrome to assess the cardiometabolic risk factors in the children. The International Diabetic Federation defined metabolic syndrome as presence of the abdominal obesity with at least two of the following risk factors: high triglyceride, low high-density lipoprotein, raised blood pressures and impaired fasting blood glucose [6]. Although each of these is an independent risk to CVD especially in adults, clustering them may confer additive risk beyond the level predicted by individual risk [7]. Since no clinically approved method to assess CVD in children developed, this approach has been widely used in paediatric epidemiology studies as this method takes account the continuous grade and cumulative nature of CVD [8-11]. However, the cut off points of certain components such as body waist measurement may differ from each country depend on their respective region. Therefore, the geographical background should consider in assessing the components.

Another two studies assessed some non-traditional inflammatory biomarker such as complement pathway that involves C3 and C4 protein and high sensitivity CRP (hs-CRP). These biomarkers are the first one to rise in acute inflammation process and become new interest area in investigating CVD [9]. Study by Andersen et al (2010) found that in CRP associated with metabolic risk factors in children such as fitness, fatness and CVD risk score [10]. In that study, the researcher also found that complement factors C3 and C4 were associated with high cardiometabolic score in both male and female teenager, making it one of the components that should be investigated in assessing CVD risk in the younger population [9].

Most authors agreed that assessment of CVD risk should focus on multiple risk factors instead of individual risk. This is aligned with previous study that suggest multifactorial risk assessment can predict CVD event in adulthood more accurately [12]. Early identification of CVD risk factors is important since all these risk factors are modifiable, indicate that with early intervention the risks are able to manage the outcome. Two studies suggest increase physical activities among moderate-to-high risk group can reduce the obesity in children. Moreover, physical fitness also associated increase insulin sensitivity in body cells, that lead to decrease blood glucose levels. Centre for Disease Control and Prevention (CDC) recommend all children aged 6 to 17 years to exercise at least 60 minutes of moderate-to-vigorous intensity physical activity, three times per week, as part of healthy lifestyle to prevent of getting non-communicable disease in adulthood [13].

Moreover, another study recommended family-based intervention to prevent CVD risk factors particularly obesity [14]. Although family history usually links to genetic inheritance from parents, the parents' diet are also inherited by the children [15]. As children are unable to choose their own diet, most of their dietary

intake depended on the food provided by their parents. Thus, change in family dietary intake would likely to change the risk of get CVD in the future [16-19].

Limitation

The limitation of this study is that we were unable to explore in detail the topic as most of articles are selected from open-source journal. Therefore, limited resources were available. However, this limitation can be overcome with budget to review the paid article as well. Despite of the limitation given this study is believed to open the pathway of developing concise and comprehensive risk score that helps the clinician to use in predicting the CVD events from childhood. Our recommendation for further research should be focused on different type of study that can prove causality such as cohort study, longer duration of study as well as the study that also analyse the risk of smoking in children.

Risk of bias

There were six studies with low risk of bias. Methodologically, these studies were conducted cross sectionally or in a cohort study. Majority of the studies have low selection bias as the study population and eligibility criteria were clearly mentioned. However, one study by Sobrinho et al, 2017 has high selection bias as the study selected five secondary schools which already had collaboration agreements already established with the research centres [9]. Overall, this study can be considered low to moderate bias as other categories of bias assessment were considered low.

In terms of confounding factors, they are present in the form of background of the patients recruited. For example, study conducted by Stavnsbo et al in 2018; the age group was not homogenous among different countries involved which may influence the study outcomes [19]. Furthermore, the study conducted by Sobrinho et al in 2017 has high cofounder bias in which only the presumed healthy adolescents were included in the study [9].

In the form of data collection, the study by Lewit and Baker in 2018 has high risk of bias as the information were gathered from parents in which can lead to recall bias and cannot be verified. Overall, five studies have low risk in all categories of bias risks.

Conclusion

Cardiovascular risk scoring had been assessed even in adolescents. The risk stratification is based on the presence of metabolic risk and behaviours including family history which are present regardless of their age. These early assessments have made the public aware of the presence of the modifiable risk factors since childhood in which end up with recommendations for healthy lifestyle and weight reduction program, beginning at home and school.

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