Review article

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The role of dietary and physical activity assessment in the predictive ability of cardiovascular disease risk scores: A narrative review

Christina Vafia, Demosthenes Panagiotakos

Department of Nutrition and Dietetics, School of Health Sciences and Education, Harokopio University, Athens, Greece

ABSTRACT

Due to the increased burden of cardiovascular disease (CVD) around the world, country specific risk prediction models (or scores) of future CVD events have been developed and recommended as screening tools for primary prevention, as well as treatment management. Most of these risk scores include basic demographic characteristics, like age and sex, smoking habits, as well as some clinical and biochemical factors, like blood pressure, cholesterol, and glucose levels. Dietary habits and physical activity status of individuals have consistently shown in many studies during the past years a strong, and independent association with CVD risk. However, their integration in CVD risk scores is rare, even though when used for the assessment of overall CVD risk, the models showed improved classification ability. In this review paper, and in the light of the recent SCORE 2 (2021) tool presented by the European Society of Cardiology, we discuss the benefits from the incorporation of dietary and physical activity assessment in the predictive ability of CVD risk prediction tools.

KEY WORDS: *Risk prediction, diet, physical activity, cardiovascular disease*

INTRODUCTION

Cardiovascular diseases (CVD) are the most common, fatal, non-communicable diseases worldwide, responsible for an estimated 18.6 million deaths in 2019[1,2]. The increased burden of CVD during the last half of the previous century, together with need for effective, prevention measures for the public health, led to the development of several risk prediction models (or scores or tools) to enhance healthcare and primary prevention[3]. There are several risk scores, which predict future CVD events, using different methodologies, but almost a common set of risk factors, i.e., basic demographic characteristics, like age and sex, smoking habits, as well as some clinical and biochemical factors, like blood pressure, cholesterol, and glucose levels. All these models have been calibrated in different geographical regions and in diverse patient and population cohorts. Among the most common CVD

Corresponding author:

Christina Vafia, MSc
School of Health Sciences & Education
Department of Nutrition and Dietetics
Harokopio University, Athens, Greece
70 Eleftheriou Venizelou Ave.
Kallithea, Athens, 176 76 Greece
Tel.: 6951668482, E-mail: dp4422115@hua.gr

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scores are Framingham Risk Score, Prospective Cardiovascular Munster (PROCAM) study risk score, and European Society of Cardiology (ESC) SCORE[4], which has recently been updated to SCORE2[5]. The Framingham Heart Study Risk Score (FRS) is one of the first risk prediction model, focused on the US population, but during the years there was a widespread of its use throughout the western world. FRS predicts 10-year risk of developing angina pectoris, or myocardial infarction, or coronary heart disease death, for individuals without heart disease. In Europe, PROCAM study was one of the first presented a CVD risk score in early 2000s; the score estimated the risk for acute coronary events (i.e., myocardial infarction, sudden cardiac death) over the course of 10 years[4]. At the same period, two risk charts, for men and women, were developed by the European Society of Cardiology (ESC), the Systematic Coronary Risk Estimation (SCORE) model, to reflect the large variation in CVD mortality in European countries, using data from 12 cohort studies. In mid 2021, the SCORE2 has been presented which is a new algorithm, calibrated and validated to estimate 10-year fatal and non-fatal CVD risk in individuals in Europe without previous CVD or diabetes, aged 40-69 years[5]. In the latest European guidelines for CVD prevention, risk estimation through SCORE2 is strongly recommended for apparently healthy individuals[6].

In any of the abovementioned prediction risk scores, accuracy of classification is a cornerstone. In order accuracy to be achieved all the determinants, i.e., influential factors, should be integrated in the algorithm, including those related to behaviors. As already declared by the World Health Organization (WHO) in the 1990s, most CVD events can be prevented by addressing behavioral risk factors, such as smoking, diet, and physical activity[7]. However, to the best of our knowledge, there is a lack of dietary and physical activity assessment in CVD risk prediction models up to date and thus, the predictive ability of these two factors on the risk scores needs to be evaluated.

Dietary habits assessment in relation to CVD risk

The risk of developing CVD is determined by several factors. The dietary habits and level of physical activity (PA) have been shown to play a significant role in the development and progression of the disease. According to the most recent 2021 ESC Guidelines[6], there is an inverse relationship between moderate-to-vigorous PA and CVD morbidity and mortality. The reduction in risk remains across the full range of PA levels and is smaller for the least active individuals. Regarding nutrition, ESC states that dietary habits influence CVD risk, mainly through risk factors such as lipids, blood pressure, body weight and diabetes mellitus. The American Heart Association (AHA) Guidelines[8], in aspects of a healthy diet that reduces CVD risk, emphasize on the intake of specific food choices/groups (i.e., vegetables, fruits, nuts, whole grains, fish) and minimize the intake of other ones (e.g., trans fats, processed red meats, refined carbohydrates). A recent meta-analysis[9] of prospective cohort studies found a decreased incidence of CVD in individuals with the highest number of combined healthy lifestyle habits. In this meta-analysis, CVD was defined as myocardial infarction, coronary heart disease, ischemic stroke, and heart failure. The combined healthy lifestyle habits included a healthy diet, moderate alcohol consumption, physical activity, and optimal weight. It was shown that younger participants (aged 37.1-49.9 years) experienced more benefits from healthy lifestyle behaviors in terms of reduction of CVD risk than older adults (aged 60.0- 72.9 years). This concludes to the importance of establishing a healthy diet and a physical activity pattern earlier in life to have a better preventive effect regarding CVD risk.

Physical activity assessment in relation to CVD risk

It has already been underlined that physical inactivity, together with unhealthy diet, have an unfavourable effect on CVD risk[6]. Physical inactivity enhances the development of high blood pressure, increases blood cholesterol and triglycerides levels which then increase the risk of developing CVD. Thus, a sedentary lifestyle is considered by various national and international organizations to be one of the most important modifiable risk factors for cardiovascular morbidity and mortality[6,10]. Fortunately, a moderate level of occupational or recreational activity appears to confer a significant protective effect.

Dietary and Physical activity assessment for the prediction of CVD risk

Thus, the question that arises now is whether dietary and PA assessment need to be integrated into the algorithms predicting CVD risk. To answer this question, more insight is needed on how diet and physical activity affect CVD risk independently, through distinct mechanisms and pathways. Mediterranean diet is a widely studied, healthy dietary pattern, which evidently offers protection against CVD, with the exact underlying mechanisms of this protection not been fully explored. The oxidative stress and the inflammation are both crucial points in the pathogenesis of endothelial dysfunction, which is the precursor to the pathogenesis of atherosclerosis. In alignment with this scientific fact, studies have shown that the protective effect could be attributed to the richness of Mediterranean foods in antioxidant[11] and anti-inflammatory[12] molecules.

A randomized clinical trial showed a significant reduction in circulating oxidized LDL and inflammation markers achieved by implementing a Mediterranean diet[11,13]. Another study by Esposito et al., showed that, after two-year follow up of exposure to this dietary pattern, there was an improvement in high sensitivity-CRP concentrations and endothelial function[14]. It should also be underlined that there are very recent nutrigenomic studies which revealed that Mediterranean diet could modulate the expression of several proatherosclerotic genes, responsible for vascular inflammation, thrombosis, and foam cell formation[15,16]. For instance, in a recent study it has been indicated that Mediterranean diet and olive oil favorably induce gene expression changes if constantly taken[17].

Regarding physical activity, it has been revealed that the positive impact of exercise on classical CVD risk factors does not entirely explain its protective effect against CVD onset[18]. Another important mechanism that could possibly explain the protective influence of exercise against CVD development is the restoring of vascular homeostasis through enhancement in shear stress-induced NO bioavailability[19,20]. Moreover, the American Heart Association emphasized the importance of cardiorespiratory fitness (CRF) to reduce the incidence and prevalence of CVD. CRF is considered an essential marker that should be evaluated and intervened on to reduce all cause and cardiovascular mortality[21]. Several large (retrospective and prospective) epidemiological studies have investigated the association and effect of physical activity and higher CRF on coronary heart disease. They concluded that there is an inverse relationship developing gradually between CRF and CVD risk[22–24]. All these information highlight the importance of including diet and physical activity in CVD risk estimation scores, since they affect CVD development independently of the traditional risk factors. In Figure 1, a biological model based on the common knowledge regarding the mechanisms and paths by which diet and physical activity may influence CVD risk, is presented.

Risk classification based on dietary and physical activity assessment

A vital query that remains to be answered is how much the predictive ability of CVD risk scores is improved by dietary and physical activity assessment being incorporated as components of the CVD risk prediction algorithms.

In the 10-year follow-up of the ATTICA Study, one of the research hypotheses that were evaluated was the role of including dietary assessment in a CVD risk prediction model. The results showed that the inclusion of dietary assessment in the HellenicSCORE (a CVD risk prediction tool that has been developed based on the ESC SCORE and on national prevalence data), through the integration of MedDietScore (a diet score that evaluates the level of adherence to the Mediterranean diet), the predictivity ability of the HellenicSCORE was improved by 37% and its correct classification ability by 56%[25-27]. In line with these findings, the INTERHEART study[28], a case-control study involving 5,671 myocardial infarction cases and 10,646 age, sex and region matched control subjects without known heart disease, from 52 countries, through a specific attributable risk analysis[29], demonstrated that an unhealthy dietary intake (i.e., lower consumption of fruits and vegetables and increased alcohol intake), increases the risk of acute myocardial infarction (AMI) globally and accounts for 30% (95% Confidence Interval- CI 26% to 35%) of the population- attributable risk. In other words, 30 out of 100 cases of acute myocardial infraction would have been prevented if the entire population adopted healthier

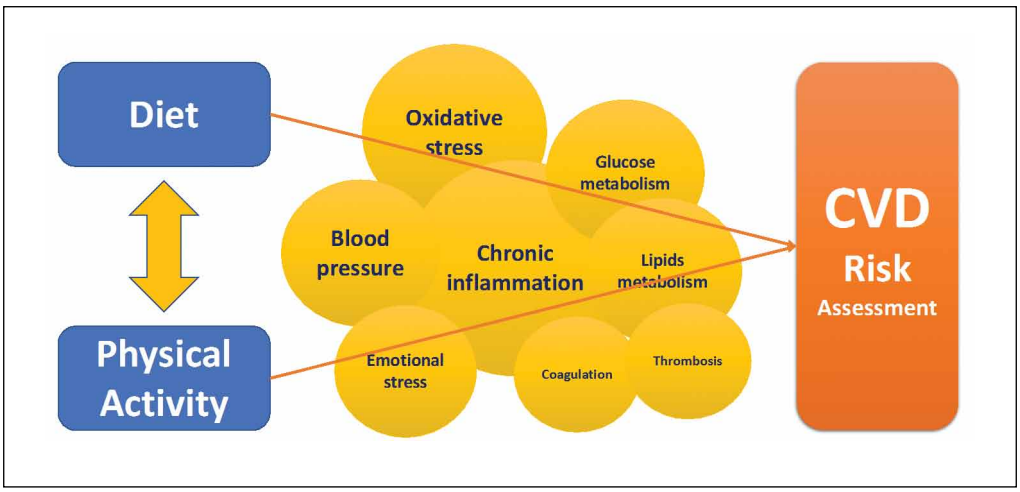

FIGURE 1. The synergistic effect of diet and physical activity on CVD risk, through various biological mechanisms.

dietary habits. It should be underlined that INTERHEART study's final model evaluated only specific food groups and that may under-estimate the overall effect of the diet.

As regards PA, data from the 10-year follow up of the ATTICA study were used to examine whether inclusion of PA status in a CVD risk model improves its predictive accuracy[30]. The results showed that both HellenicSCORE and PA status were predictors of future CVD events ($p<0.05$). Nonetheless, the misclassification of the true CVD cases of the model that involved only the HellenicSCORE was significantly reduced when PA assessment was included, even when adjusted for diabetes mellitus and dietary habits.

Feasibility of the dietary and physical activity assessment in the routine clinical practice

There are several health metrics regarding dietary and physical activity assessment that are widely used in research. E.g., the Mediterranean Dietary Score (MDS) proposed by Trichopoulou et al.[31,32] in mid 1990s, the Mediterranean Adequacy Index proposed by Prof. Adalberta Alberti-Fidanza and Prof. Flaminio Fidanza[33], and more recently the MedDietScore proposed by Panagiotakos et al.,[34] are some of the dietary assessment methods developed to evaluate the level of adherence to the traditional Mediterranean diet. The majority of these metrics are feasible during daily clinical evaluation, e.g., the MedDietScore consists of 11 semi-quantitative questions concerning the frequency of consumption of the main components of the Mediterranean dietary pattern, and can be self-completed in less than 5 minutes[34]. Regarding physical activity assessment, there are also several short indexes evaluating physical activity level; e.g., the International Physical Activity Questionnaire (IPAQ) has been extensively used to estimate the total physical activity in MET-min/week and time spent sitting/week[35]. All the above-mentioned health metrics are well established in research and can make the dietary and PA assessment needed to be integrated in CVD scores feasible.

Conclusive remarks

Despite the very few studies that have incorporated in CVD risk prediction tools, dietary and PA assessment, the presented findings in this review, may underline the importance of integrating dietary and PA information in a CVD risk prediction model. Both diet and PA affect CVD risk independently of the classical risk factors (lipids levels, blood pressure, body weight). Consequently, the emphasis should be given on updating future CVD risk prediction models to be more effective by incorporating information concerning dietary habits and physical activity status, especially since this information can be easily obtained.

ΠΕΡΙΛΗΨΗ

Ο ρόλος της αξιολόγησης των διατροφικών συνηθειών και της σωματικής δραστηριότητας στην προβλεπτική ικανότητα των σκορ καρδιαγγειακού κινδύνου: Ανασκόπηση

Χριστίνα Βαφία, Δημοσθένης Παναγιωτάκος

Τμήμα Επιστήμης Διαιτολογίας-Διατροφής, Σχολή Επιστημών Υγείας και Αγωγής, Χαροκόπειο Πανεπιστήμιο, Αθήνα, Ελλάδα

Εξαιτίας του αυξημένου καρδιαγγειακού νοσολογικού φορτίου παγκοσμίως, έχουν αναπτυχθεί μοντέλα πρόβλεψης κινδύνου (ή σκορ) για μελλοντικά καρδιαγγειακά συμβάντα. Τα μοντέλα αυτά συστήνονται ως εργαλεία ανίχνευσης κινδύνου και αξιοποιούνται τόσο για την πρωτοβάθμια πρόληψη, όσο και για τη θεραπευτική διαχείριση της νόσου. Η πλειοψηφία των σκορ κινδύνου περιλαμβάνει βασικά δημογραφικά χαρακτηριστικά, όπως η ηλικία και το φύλο, οι καπνιστικές συνήθειες, καθώς και κάποιους κλινικούς και βιοχημικούς δείκτες, όπως η αρτηριακή πίεση, η χοληστερόλη, και τα επίπεδα γλυκόζης. Οι διατροφικές συνήθειες αλλά και η σωματική δραστηριότητα των ατόμων έχουν παρουσιάσει, με συνέπεια τα τελευταία έτη, μια ισχυρή και ανεξάρτητη συσχέτιση με τον καρδιαγγειακό κίνδυνο. Ωστόσο, η ενσωμάτωση τους στα σκορ πρόβλεψης είναι σπάνια, παρόλο που όταν χρησιμοποιούνται για την εκτίμηση του συνολικού καρδιαγγειακού κινδύνου, τα μοντέλα παρουσιάζουν βελτιωμένη ταξινομητική ικανότητα. Σε αυτό το άρθρο ανασκόπησης, και με αφορμή την πρόσφατη ανάπτυξη ενός αναθεωρημένου εργαλείου από την Ευρωπαϊκή Καρδιολογική Εταιρεία, του SCORE2

(2021), συζητούνται τα οφέλη, από την ενσωμάτωση της αξιολόγησης των διατροφικών συνηθειών και της σωματικής δραστηριότητας, στην προβλεπτική ικανότητα των εργαλείων πρόβλεψης καρδιαγγειακού κινδύνου.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: *Πρόβλεψη κινδύνου, διατροφή, σωματική δραστηριότητα, καρδιαγγειακή νόσος*

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