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Review Paper

Does adherence to the Mediterranean diet have a protective effect against active and passive smoking?

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SUMMARY

Objective: To investigate the existing evidence about whether adherence to the Mediterranean diet may have a role as an effect modifier of active and passive smoking on human health.
Study design: Review.
Methods: An overview of emerging evidence and published studies that cover the interaction between the Mediterranean diet and smoking.
Results: Both epidemiological and laboratory studies have shown that the Mediterranean diet has a protective effect against biochemical and molecular processes that lead to cancer, cardiovascular disease and respiratory illness. Based on the high daily intake of vitamins and antioxidants, the Mediterranean diet is comprised of a number of compounds that could alter certain outcomes related to smoking. Studies have indicated that certain diseases attributable to smoking, such as lung cancer, asthma and cardiovascular disease, are inversely associated with certain antioxidants and lipids.
Conclusions: The literature indicates that the existence of a partial interaction between adherence to the Mediterranean diet and the health effects of smoking is possible. Further research is needed to lead to a conclusive statement on this hypothesis.

Introduction

Detrimental effects of active and passive smoking

Smoking is one of the largest causes of preventable death, and is expected to kill 1 billion people prematurely this century. Second-hand smoke (SHS) is another serious threat to public health, subsequent to tobacco use, and is a potent mixture of carcinogens, volatile toxins and chemicals.[1–3] It has been estimated that, worldwide, at least 1 billion adults are smokers and at least 700 million children breathe air polluted by tobacco smoke at home.[4] SHS exposure is related to the ever-increasing frequency of diseases among children and adults, such as respiratory illness, asthma, otitis media, sudden infant death syndrome and vascular dysfunction, and predisposition towards cardiovascular disease and cancer.[5–8]

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Moreover, although cardiovascular disease and chronic lung disease are generally the result of long-term processes, recent evidence shows that even brief SHS exposure appears to initiate mechanisms that contribute to their development.[9,10]

Cigarette smoke contains free radicals and other oxidants in abundance. It has been estimated that each puff of a cigarette exposes the smoker to 10^{15} oxidative free radicals, a severe source of oxidative stress.[11] Additionally, the production of reactive oxygen species is further mediated through inflammatory processes induced by the toxins inhaled and absorbed during active and passive smoking.[12] The first line of response is that of antioxidant enzymes such as superoxide dismutase, catalase and glutathione peroxidase, which take advantage of the circulating levels of dietary antioxidants, a second line of defence against oxidative stress. These antioxidants are digested and enter the circulation, acting as a buffer against oxidative stress, and therefore could have a protective effect against antioxidant depletion.

An important issue for public health is whether or not the marked changes in the subjects' health are solely due to the harmful effects of cigarette smoke or to a combined effect of both the oxidative properties of cigarette smoke and the habitual dietary profile of smokers, which is generally lower in fruit and vegetable intake, and higher in alcohol and meat consumption compared with non-smokers.[13–15] Moreover, it is likely that the cumulative effect of both the elevated oxidative stress and lower dietary intake of antioxidants is partially responsible for the negative impact of smoking on human health.

The Mediterranean diet and the smoking paradox

The Mediterranean diet became world renowned in the early 1960s through the Seven Countries Study, an epidemiological study with 16 cohorts in seven countries (Greece, Finland, Japan, former Yugoslavia, Italy, Holland, USA), which aimed to investigate the dietary and lifestyle factors related to the development of cardiovascular disease.[16] As corroborated during the subsequent 10-, 25- and 40-year follow-up of the Seven Countries Study, the rural population of Crete was found to have among the lowest mortality rates for coronary heart disease and cancer, and this was attributed to their dietary and lifestyle habits.[17,18] The traditional diet of Crete (i.e. the typical 'Mediterranean diet') is based on high intake of vitamins, fibre and antioxidants through the consumption of olive oil, wild greens, fruits, wholewheat bread, legumes, walnuts, almonds and snails, supplemented with rare to moderate consumption of red meat, fish and dairy products.[19] In addition, monounsaturated fat (through the extensive consumption of olive oil) accounted for 29% of the daily calorie intake, while saturated fat accounted for 8% of total energy intake.[20]

Furthermore, after following up the 12,763 men of the Seven Countries Study for 25 years, lung cancer mortality was found to be higher in Northern European and Northern American cohorts compared with Southern European and Japanese cohorts,[21] while absolute lung cancer mortality was positively associated with average dietary intake of saturated fat, which was lowest in both the Mediterranean and the Japanese diet, both known for their high antioxidant and low saturated fat profile.[22,23] Specifically, the researchers hypothesized that saturated fat may play a role in the cross-cultural variation in lung cancer mortality, either independently or by effect modification, despite the fact that smoking habits were similar across countries and regions.

Aims and scope

Currently, one of the emerging issues in environmental toxicology is evidence which suggests that antioxidant micronutrients and related bioactive compounds common in fruit and vegetables may ameliorate the toxicity of environmental chemicals and impact disease development, and it has been hypothesized that adherence to the Mediterranean diet may function in such a way.[23,24]

Taking the above scientific facts and epidemiological findings into account, the authors aimed to investigate the existing evidence that could indicate whether adherence to the Mediterranean diet may have a role as an effect modifier of active and passive smoking on human health.

Active/passive smoking, cardiovascular disease and the Mediterranean diet

Active and passive smoking and the risk of cardiovascular disease

Active cigarette smoking and exposure to SHS are strongly associated with vascular dysfunction and atherosclerosis, and impact all phases of atherosclerosis from endothelial dysfunction to acute clinical events.[25,26] Cigarette smoke can promote atherosclerosis, in part, by its effects on the lipid profile of active and passive smokers. Smoking decreases plasma high-density lipoprotein (HDL) levels, and alters HDL:low-density lipoprotein (LDL), HDL:triglycerides and HDL:total cholesterol in both animal models and humans.[25,27] It is interesting to note that lipid peroxidation among young smokers is noted, even after controlling for dietary intake. Cigarette smoking also increases the oxidative modification of LDL, with circulating products of lipid peroxidation and levels of oxidized LDL found to be significantly increased in both active and passive smokers.[27–29] This oxidized LDL may enter the arterial endothelial wall, leading to the attraction of macrophages, lymphocytes and, subsequently, paracrine factors that cause platelet accumulation and initiation of foam cells. This is the first step in developing an atherosclerotic plaque.[30] Additionally, it has been hypothesized that cigarette smoke alters catecholamine release and thus fatty acid release, which in turn increases LDL and very-low-density lipoprotein (VLDL) concentrations, and also contributes to lowering circulating HDL levels.[31]

Interaction between adherence to the Mediterranean diet and the cardiovascular factors influenced by active and passive smoking

In contrast to the above, randomized controlled trials have shown that adherence to the Mediterranean diet has a beneficial effect on circulating oxidized LDL levels, a factor that