



Review

Health risks of human exposure to chemical contaminants through egg consumption: A review



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ABSTRACT

It is well known that by a number of reasons such as low cost, general availability, nutritional characteristics, and multiple possibilities of consumption, avian eggs in general, and hen eggs in particular, are an important component of the human diet over the world. Until recently, it was assumed that the egg cholesterol content implied an increased risk for coronary heart disease (CHD). However, recent studies have suggested that a frequent consumption of eggs (up to one egg per day) is not associated with increased risk of CHD or stroke. The nutritional benefits of eggs are due to the content of proteins and several essential nutrients, particularly vitamins D and B12, choline, and selenium among others. However, various studies have also detected the presence of several chemical pollutants in eggs, whose exposure could also mean certain health risks for the consumers. The human health risks derived from exposure to a number of chemical contaminants through the regular consumption of eggs are here reviewed. It is concluded that the health risks derived from exposure to these contaminants must be considered in the context of each specific diet, which besides eggs, includes numerous foodstuffs, and chemical pollutants.

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1. Introduction

The socio-economic status of the general population influences their dietary habits, and consequently the health. A proper balance of the intake of nutrients, concurrently with the avoidance of their excess or

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deficiency, is basic to maintain a good health status, as well as to prevent a number of diseases. There are three basic parameters influencing the socio-economic status: occupation, education, and income (Vlismas, Stavrinou, & Panagiotakos, 2009). Income is likely to mirror the availability of economic and material resources. Therefore, it influences the dietary quality, making healthy food more or less affordable and accessible.

In recent years, a number of studies that focused on the potential association between certain dietary habits and the risks of various diseases have been performed. These are some interesting examples: antioxidant vitamins and coronary heart disease risks; dietary antioxidant nutrients; fruit and vegetable intakes and total mortality; Mediterranean diet and mortality; fruit and vegetable consumption, and renal and breast cancer; meat intake and risk of stomach and esophageal adenocarcinoma; cereal fiber intake and reduced risk of gastric adenocarcinomas; health benefits and risks of regular fish consumption; dairy consumption and risk of prostate cancer; meat, fish and fat intake and risk of colorectal cancer, etc.

On the other hand, it has been demonstrated that certain dietary habits can also contribute to compromised health by being a source of potential exposure to toxic contaminants. Consequently, caution in the consumption of certain foodstuffs, depending on their concentrations of chemical pollutants, is also another nutritional key issue. This paper specifically reviews the potential health risks derived from exposure to a number of chemical contaminants through a regular dietary consumption of hen eggs. Eggs, whose nutritional content is well established, are generally accessible to most individuals over the world, even for populations whose incomes are low.

2. Eggs and diet

In recent decades, a number of studies regarding dietary fat and cholesterol intake have reported a strong and positive correlation with heart disease (Fernandez, 2006; Jones, 2009; Kratz, 2005; Spence, Jenkins, & Davignon, 2010). However, the results of various epidemiological investigations performed in recent years do not support a relationship between cholesterol intake and cardiovascular disease (CVD) (Barona & Fernandez, 2012; Baum et al., 2012; Rong et al., 2013). Even various recent clinical trials assessing the effects of long-term egg consumption (as a vehicle for dietary cholesterol) did not find negative impacts on several indices of cardiovascular health and disease (Barona & Fernandez, 2012; Baum et al., 2012), noting that the existing epidemiological data clearly demonstrate that dietary cholesterol is not correlated with increased risk for coronary heart disease (CHD) (Fernandez, 2012; Rong et al., 2013).

In the human diet, the avian egg is an important source of nutrients, containing proteins, lipids, vitamin D, vitamin B12, selenium and other minerals, choline, and growth factors required by the developing embryo, as well as a number of defense factors to protect against bacterial and viral infection. In addition, eggs contain substances with biological functions beyond basic nutrition (Ruxton, Derbyshire, & Gibson, 2010). A medium-sized egg provides approximately 78 kcal, containing about 6.5 g of protein and 5.8 g of fat, being 2.3 g monounsaturated fat. The lipids are found almost exclusively in the egg yolk, mainly as lipoproteins, while the majority of proteins are found in the egg yolk and the egg white, and only a small proportion in the eggshell and the shell membrane (Kovacs-Nolan, Phillips, & Mine, 2005). Notwithstanding, eggs, as a large number of other food items, are also a source of dietary cholesterol.

On the other hand, it is also important to take into account that eggs are an inexpensive and low calorie source of many other nutrients, including minerals, proteins and unsaturated fatty acids, which could lower the risk of cardiovascular disease (Fernandez, 2012; Rong et al., 2013). Moreover, in populations following a carbohydrate restricted diet, dietary cholesterol from eggs could increase plasma concentrations of HDL cholesterol, which has been suggested to protect against

vascular disease. Consequently, in recent years some health organizations have recommended that reducing egg intake might not be important for healthy people with normal levels of cholesterol in the blood (Better Health Channel-BHC Australia, 2009; Fernandez, 2012; Rong et al., 2013).

Because globally eggs may be a healthful food, it is important that sensible strategies be recommended for inclusions of eggs in a healthy diet. Consequently, the daily consumption of avian eggs is being reconsidered based on the recent recommendations for dietary cholesterol for health populations. Eggs are also a good source of several nutrients, such as high-quality protein, choline, selenium, and lutein. The current American Heart Association (AHA) recommendations are the following: to balance caloric intake and physical activity to achieve and maintain a healthy body weight; consume a diet rich in vegetables and fruits; choose whole-grain, high-fiber foods; consume fish, especially oily fish, at least twice a week; limit intake of saturated fat to <7% of energy, trans fat to <1% of energy, and cholesterol to <300 mg/day by choosing lean meats and vegetable alternatives, fat-free (skim) or low-fat (1% fat) dairy products, and minimize intake of partially hydrogenated fats; minimize intake of beverages and foods with added sugars; choose and prepare foods with little or no salt.

3. Chemical pollutants in eggs

Certain dietary habits can also contribute to compromised health by being a source of exposure to environmental contaminants. Many of these potentially toxic pollutants are fat soluble, and thus, any fatty food (including eggs) often may contain high levels of persistent organic pollutants (POPs). A number of studies have shown that eggs as many other food items, especially those with a high fat content, can be a potential source of human exposure to environmental contaminants, whose potential toxicity is well known. Among these pollutants that stand out are metals, polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), or polycyclic aromatic hydrocarbons (PAHs), but also other organohalogenated contaminants such as polybrominated diphenyl ethers (PBDEs), polychlorinated diphenyl ethers (PCDEs), polychlorinated naphthalenes (PCNs), and perfluorinated compounds (PFCs). Information on exposure and adverse effects for most of these organic pollutants in humans is still relatively limited.

Next, the results of various recent international studies, in which the concentrations of chemical contaminants in eggs were determined, are summarized. In a survey of residues of organochlorine pesticides (OPs) in hen eggs of Uganda (Ejobi, Muller, Opunda-Asibo, & Kruger, 2000), it was concluded that egg contamination with residues of OPs from areas of Uganda included in the study presented a low health risk to the consumers. It was remarked that organochlorine residue levels in hen eggs of Uganda were relatively lower than those previously found in other African countries. Sasamoto et al. (2006) estimated the dietary intake of dioxins (PCDD/Fs and dioxin-like PCBs) through foods retailed in the metropolitan Tokyo area from 1999 to 2004. The study was carried out by the total diet-market basket method on the basis of food classification (14 groups), the data on food consumption in the Tokyo region being obtained from the Japan Nutrition Survey. It was found that more than 90% of the daily intake of dioxins proceeded from the groups of fish and shellfish, meat and eggs, and milk and dairy products. Moreover, high levels of PCDD/Fs in eggs, among other foodstuffs, were also detected in an assessment of the dietary exposure to some POPs in the Republic of Karakalpakstan, Uzbekistan (Muntean et al., 2003). In turn, when the levels of PCDD/Fs and PCBs were determined in the blood of non-occupationally exposed residents living in the vicinity of a chemical plant in the Czech Republic (Cerná et al., 2007), a positive correlation of the PCDD/F and PCB blood levels with age and with consumption of locally produced eggs was found.

Polder et al. (2010) analyzed residues of several POPs in 70 selected food items from Northwest Russia in 1998–2002. The levels of PCBs in eggs ranged from 0.5 to 16 ng/g wet weight (ww). Mean levels in

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