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Commentary

Fruit and vegetables and cardiovascular disease: epidemiological evidence from the non-Western world

Observational studies have shown a more favourable cardiovascular risk profile in consumers of fruit and vegetables than in non-consumers. Fruit and vegetable intake is usually associated with lower levels of serum cholesterol[1] and lower blood pressure[2]. Furthermore, the increase in cardiovascular risk factors with ageing tends to be slower in fruit and vegetable consumers[3,4] resulting in less coronary and cerebrovascular events[5–8].

In most instances, these observations were obtained in developed countries, mostly in North America, where nutritional habits may differ substantially from those in other parts of the world. Fruit and vegetable consumption is usually associated with healthy behaviours in high-income countries; consumers of fruit and vegetables tend to smoke less, to exercise more frequently and are usually better educated than non-consumers[9], resulting in complex interactions. Although statistical adjustment for lifestyle factors has been performed, residual effects and additional confounders that might have not been anticipated may still explain the association between fruit and vegetable intake and CVD. Finally, high intakes of fruit and vegetables are usually consumed as part of a prudent diet further complicating the assessment of the relationships between a particular food and chronic diseases[10,11]. For these reasons, the assessment of the true contribution of fruit and vegetables to cardiovascular event occurrence remains uncertain in observational epidemiological studies.

Randomised controlled trials increasing fruit and vegetable intake are another strategy to analyse the relationship between fruit and vegetables and CVD. The results of intervention studies support the concept of a genuine effect of fruit and vegetables on blood pressure. In the DASH study 459 adults were enrolled for an 8-week strictly controlled dietary intervention. In the pre-randomisation phase, the subjects were fed for 3 weeks a control diet that was low in fruit, vegetables and dairy products, with a fat content typical of the average diet in the USA. They were then randomly assigned to receive for 8 weeks a control diet, a diet rich in fruit and vegetables or a 'combination' diet rich in fruit, vegetables and low-fat dairy products and with reduced saturated and total fat. Sodium intake and body weight were maintained at constant levels. The fruit-and-vegetables diet reduced systolic blood pressure by 2·8 mm Hg more ($P<0·001$) and diastolic blood pressure by 1·1 mm Hg more than the control diet ($P=0·07$). The combination diet reduced systolic and diastolic blood pressure by 5·5 and 3·0 mm Hg more, respectively, than the control diet ($P<0·001$ for each)[12]. In contrast, the LDL-cholesterol level was non-significantly decreased by 0·05 mmol/l[13]. Like observational studies, nutritional intervention trials present some limitations that hamper their interpretation. Firstly, true double-blind controlled trials are not feasible in the context of interventions with food items, leaving the possibility for biases in the assessment of end-points. Secondly, increased consumption of fruit and vegetables might induce changes in other components of the diet. For instance, in the DASH trial, fruit and vegetables were substituted by snacks to achieve equivalence of energy intake in the control and experimental diet. Thirdly, results of highly controlled intervention trials cannot easily be extrapolated to the general population or to draw public health policies. Finally, the difficulty of achieving great modification of diet in long-term studies hampers the interpretation of the results. For example, in the 'Women's Health Initiative Randomized Controlled Dietary Modification Trial'[14], intensive behaviour modifications were designed to reduce total fat intake and increase intakes of vegetables, fruits and grains. During the follow-up fruit and vegetable consumption remained higher in the intervention group, but was actually only slightly more than one portion per day more than in the control group. Therefore, no significant differences in CHD, stroke and CVD rates were observed between groups. Thus, until now there is no definitive evidence from intervention trials that fruit and vegetable consumption decreases CVD incidence.

Analyses of association of fruit and vegetable intake with cardiovascular risk factors in non-Western countries are necessary to understand the complexity of the relations between fruit and vegetable and occurrence of chronic diseases and also to explore the consistency of these associations across countries. The later point represents an important criterion in the appraisal of the causal relationship between nutritional factors and chronic diseases.

In this issue of the *British Journal of Nutrition*, Radhika *et al.*[15] analysed the relation between fruit and vegetable intake and cardiovascular risk factors (blood pressure, obesity, cholesterol) in a cross-sectional sample of Southern India inhabitants. Their results showed a strong inverse correlation between fruit and vegetable consumption and CVD risk factors, consistent with earlier studies from the Western world. As mentioned earlier, our understanding of the possible effect of fruit and vegetable consumption and CVD occurrence is based mainly on observational cohort data from Western countries where specific combinations of confounders may contribute to the association. Therefore, the consistent findings of Radhika *et al.*[15] in subjects with different dietary and lifestyle habits and thus with different confounder background may be interpreted as additional evidence of a possible causal relation. In conclusion, analyses of cohort studies in

non-Western populations should help to improve our understanding of the relation between fruit and vegetable intake and chronic diseases.

Luc Dauchet and Jean Dallongeville

INSERM U557, Bobigny, INRA, U1125, Bobigny
CNAM, EA3200, Bobigny; Univ Paris 13, Bobigny
CRNH IdF, Unité de Recherche en Epidémiologie Nutritionnelle
Bobigny, F-93017
France
Department of Epidemiology and Public Health
Rouen University Hospital
1 rue Germont
Rouen, F-7600
France
and
Institut Pasteur de Lille
INSERM U744
1 rue du professeur Calmette
Lille, F-59009
France
l.dauchet@uren.smbh.univ-paris13.fr

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