only 29 133 were recruited (ATBC Cancer Prevention Study Group, 1994).

Continuing our previous research (Vartiainen *et al*, 1994) and analysing random population samples of Finnish subjects, we prospectively monitored mortality of 18 344 men (aged 25–64 years) through the National Death Register for a mean of 14.6 years. There were 91 suicides among 7649 smokers and 53 suicides among 10 695 non-smokers. In order to replicate the findings of Partonen *et al*, we classified cholesterol into the same three categories. Using the Cox model the relative risks were adjusted for identical variables except for carbohydrate intake. Among smokers the unadjusted risks (with 95% CIs) of suicide increased from 1.00 to 1.48 (0.63–3.47), and to 1.80 (0.75–4.31) with increasing cholesterol level. The relative hazards changed clearly after adjustment for covariates (1.00, 1.38, 1.62, respectively), but remained non-significant. In the report by Partonen *et al*, the relative risks did not change at all after adjustment for covariates, which we find surprising. We found no association between cholesterol and suicide in non-smokers.

Inconsistent findings between these two large longitudinal studies may have resulted from several confounding effects. First, 75% of the participants in the ATBC study were treated with alpha-tocopherol alone, beta-carotene alone, or both. It is possible, theoretically, that these antioxidants possess some unknown central nervous system effects. Second, the method of suicide may influence the cholesterol–suicide association. Our own findings implicate that very high serum total cholesterol is associated with the increased risk of violent, but not with non-violent suicide (Tanskanen *et al*, 2000). Third, it has been suggested that cholesterol is only a surrogate marker of changes in dietary polyunsaturated fatty acids, which have been linked to depression (Hibbeln & Salem, 1995) – one of the strongest risk factors for suicide. Probably various other factors also confound this controversial relationship.

ATBC Cancer Prevention Study Group (1994) The alpha-tocopherol, beta-carotene lung cancer prevention study: design, methods, participant characteristics, and compliance. *Annals of Epidemiology*, **4**, 1–10.

Hibbeln, J. R. & Salem, N., Jr. (1995) Dietary polyunsaturated fatty acids and depression: when cholesterol does not satisfy. *American Journal of Clinical Nutrition*, **62**, 1–9.

Partonen, T., Haukka, J., Virtamo, J., *et al* (1999) Association of low serum total cholesterol with major depression and suicide. *British Journal of Psychiatry*, **175**, 259–262.

Tanskanen, A., Vartiainen, E., Tuomilehto, J., *et al* (2000) High serum cholesterol and risk of suicide. *American Journal of Psychiatry*, in press.

Vartiainen, E., Puska, P., Pekkanen, J., *et al* (1994) Serum cholesterol concentration and mortality from accidents, suicide, and other violent causes. *British Medical Journal*, **309**, 445–447.

A. Tanskanen Research and Development Unit, Department of Psychiatry, Kuopio University Hospital, PO Box 1777, 70211 Kuopio, Finland
J. Tuomilehto National Public Health Institute, Helsinki, Finland
H. Viinamäki Department of Psychiatry, University of Kuopio, Kuopio, Finland

We read with interest the excellent large-scale prospective study reported by Partonen *et al* (1999). They found that low serum total cholesterol appears to be associated with low mood and suicide. However, others have reported conflicting results (McCallum *et al*, 1994). Weidner *et al* (1992) found that patients on a cholesterol-lowering diet were associated with reductions in depression if they were instructed to increase fish consumption. This implied that differences in the composition of polyunsaturated fatty acids (PUFAs) might explain the conflicting finding. The PUFAs are classified into two main groups: omega-3 (or n-3) of which the parent essential fatty acid is alpha-linolenic acid (C18:3n-3), and n-6, of which the parent essential acid is linoleic acid (C18:2n-6). Maes *et al* (1999) found that major depression is associated with: significantly decreased total n-3 fatty acids; increased monounsaturated fatty acids and C22:5n3 proportions and increased C20:4n6/C20:5n3 and C22:5n6/C22:6n3 ratios; lower C22:4n6, C20:5n3 and C22:5n3 fractions in phospholipids; lower C18:3n3, C20:5n3 and total n3 fatty acids, and higher C20:4n6/C20:5n3 and n6/n3 ratios in cholesteryl esters; and lower serum concentrations of phospholipids and cholesteryl esters. These findings are consistent and have shown well-established positive correlation between depression and coronary artery disease. Many studies have documented evidence of hypothalamic–pituitary–adrenocortical axis hyperactivity within medication-free patients with major depression, including hypercortisolaemia (Raadsheer *et al*, 1994). Hypercortisolaemia can induce hypercholesterolaemia, hypertriglyceridaemia and hypertension. These are well known to be predisposing factors of cardiovascular disease. If low serum cholesterol concentrations were linked to increased depression, it would be difficult to interpret the correlation between depression and coronary artery disease. The relationship between cholesterol and depression may not be specific enough.

Maes, M., Christophe, A., Delanghe, J., *et al* (1999) Lowered omega-3 polyunsaturated fatty acids in serum phospholipids and cholesteryl esters of depressed patients. *Psychiatry Research*, **85**, 275–291.

McCallum, J., Simons, L., Simons, J., *et al* (1994) Low serum cholesterol is not associated with depression in the elderly: data from an Australian community study. *Australian and New Zealand Journal of Medicine*, **24**, 561–564.

Partonen, T., Haukka, J., Virtamo, J., *et al* (1999) Association of low serum total cholesterol with major depression and suicide. *British Journal of Psychiatry*, **175**, 259–262.

Raadsheer, F. C., Hoogendijk, W. J. G., Stam, F. C., *et al* (1994) Increased numbers of corticotropin-releasing hormone expressing neurons in the hypothalamic paraventricular nucleus of depressed patients. *Neuroendocrinology*, **60**, 436–444.

Weidner, G., Connor, S. L., Hollis, J. F., *et al* (1992) Improvements in hostility and depression in relation to dietary change and cholesterol lowering. *Annals of Internal Medicine*, **117**, 820–823.

K.-P. Su, S.-Y. Tsai Department of Psychiatry, Taipei Medical College-Affiliated Wan Fang Hospital, No. 111, Hsing-Lung Road Sec. 3, Taipei 116, Taiwan
S.-Y. Huang Graduate Institute of Nutrition and Health Science, Taipei Medical College, Taipei, Taiwan

Authors' reply: We analysed data from the ATBC Cancer Prevention Study, which was a primary prevention trial to test whether alpha-tocopherol and beta-carotene supplements would reduce the incidence of lung and other cancers (ATBC Cancer Prevention Study Group, 1994). Smokers were recruited from the total population of elderly men and assessed for eligibility. A previous diagnosis of cancer, current severe angina with exertion, chronic renal insufficiency, cirrhosis of the liver, alcohol dependence, or a disorder limiting participation in the long-term trial were grounds for exclusion.

We concluded that low serum total cholesterol appeared to be associated with low mood. We also found that low serum total cholesterol predicted, after adjusting for risk factors, the occurrence of conditions indicative of poor outcome, such as hospitalisation owing to major depressive disorder and death from suicide. Findings were similar for violent deaths exclusive of suicide. Trial supplementation had no effect

https://doi.org/10.1192/bjp.176.4.399 Published online by Cambridge University Press