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## Cross-comparison of diet quality scores in relation to cardiometabolic health, cognitive function, and ecological sustainability parameters: Results from the Rhineland Study

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Food systems significantly influence both human health and the environment. In 2019, the EATLancet Commission introduced a universal, healthy reference diet aimed at enhancing environmental sustainability and preventing non-communicable diseases.<sup>(1)</sup> This diet, known as the EAT-Lancet reference diet (ELR-diet), has been associated with reduced risks of cardiometabolic diseases and mortality,<sup>(2,3)</sup> as well as a diminished environmental impact.<sup>(4)</sup> However, the distinctions between the ELR-diet and other dietary patterns—traditionally defined solely by their health benefits—remain less examined, particularly in the context of both health outcomes and environmental sustainability. This study evaluates hypothesis-driven diet quality scores—Alternate Healthy Eating Index (AHEI), Mediterranean-style Diet Score (MDS), Dietary Approaches to Stop Hypertension (DASH), Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet, Nordic Diet Score, healthful Plant-Based Diet Index (hPDI), and the ELR-diet—across their effects on cardiometabolic health, cognitive function, and ecological sustainability.

We based our analyses on participants from the Rhineland study with available nutritional assessment, cardiometabolic markers, and cognitive function data at baseline ( $n = 6473$ , age  $56.1 \pm 13.4$  years, 56% women). Based on dietary data collected through a semi-quantitative food frequency questionnaire, we estimated and compared adherence to seven diet quality scores, including the ELR-diet. Cardiometabolic risk markers included adiposity indicators, lipoprotein levels, and blood pressure. Cognitive performance was measured in multiple domains and averaged into a global cognitive function score. Diet-related greenhouse-gas emissions (GHGEs) and land use (LU) were calculated per participant's food intake, expressed as kgCO<sub>2</sub> equivalents and m<sup>2</sup>×year, respectively.<sup>(5)</sup> Correlations between diet quality scores were quantified using Spearman correlation, and associations with outcomes were analyzed using multivariate linear models.

All diet quality scores were positively correlated with each other. The EAT-Lancet diet was most strongly correlated with the hPDI ( $r = 0.43$ ;  $p < 0.001$ ), and least with the Nordic diet ( $r = 0.16$ ;  $p < 0.001$ ). Higher ELR-diet adherence was associated with reductions in various adiposity markers, lipoprotein levels, and blood pressure although these reductions were generally smaller than those observed with the DASH and AHEI diets. ELR-diet adherence was also associated with better global cognitive performance ( $\beta = 0.03$ , 95%CI = 0.02;0.05), closely matching the MIND diet ( $\beta = 0.04$ , 95%CI = 0.03;0.05). Moreover, the ELR-diet was inversely associated with GHGE ( $\beta = -0.3$ , 95%CI = -0.33;-0.27) and LU ( $\beta = -0.37$ , 95%CI = -0.41;-0.33), yet the hPDI diet, was associated with the greatest decrease in both markers (GHGE  $\beta = -0.48$ , 95%CI = -0.51;-0.45; LU  $\beta = -0.58$ , 95%CI = -0.62;-0.54). Conversely, the Nordic diet was associated with increases in both GHGE and LU.

Our study provides evidence that higher diet quality, measured through different scores, is associated with favorable cardiometabolic health, better cognitive performance and reduced environmental impact. These findings support the generalizability of the beneficial effects of adherence to a healthy diet across both health-related and sustainability outcomes.

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