Deriving Personalized Recommendations for Fish Intake Using Mathematical Optimization Methods

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Objectives: As an alternative to generic dietary guidelines for the whole population, we developed a method for modelling individual dietary recommendations based on personal preference. The method is applied in a model on fish intake in Denmark.

Methods: A mathematical optimization model that applies quadratic programming was developed to model personalized recommendations for fish intake that deviate as little as possible from observed individual fish intake. Model constraints ensured that modelled fish intake levels met the general recommendations for eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and vitamin D without violating the tolerable intake recommendations for methyl mercury, dioxins, and dioxin-like polychlorinated biphenyls (dl-PCBs). Recommended intakes for eleven species were generated for each individual in a group of 3,016 Danish adults (1,552 women and 1,464 men, aged 18-75 y), whose fish intakes and body weights were recorded from a national dietary survey. Background intakes of the nutrients and contaminants in question from other foods than fish, supplements and environmental exposure were analyzed. Modelled intakes with different background exposures were compared with the Wilcoxon matched-pairs signed-rank test. Modelled intakes were also compared with the observed intakes.

Results: Our results on the fish intake case suggest that 55 % of the study population should be recommended to increase their fish intake with up to 184 g/wk and that 24 % of the study population should increase their fish intake with more than 100 g/wk. Only 2 % of the population should be recommended to decrease their intake of fish. These modelled recommendations were different from the observed intakes for all fish species ($P<0.05$). The results appeared to be specifically sensitive to the uncertainty on vitamin D levels due to the effect of exposure from the sun.

Conclusions: The quadratic programming model was appropriate for translating recommendations for nutrients and contaminates into individual fish intake recommendations, thanks to its multidimensional property. Mathematical optimization methods could be used to provide more realistic and achievable dietary guidelines that account for personal preference.