Optimization of personalized dietary recommendations

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Introduction: Consumption patterns in a population often vary greatly and national dietary guidelines may differ too much from individual preferences to be realistic. Providing personalized recommended intakes may be a step forward to increase adherence to dietary guidelines.
Purpose: We developed a method for modelling achievable individual dietary recommendations based on personal preferences. 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, fulfilling criteria on nutrients and contaminants, while simultaneously deviating as little as possible from observed individual intake. Model constraints ensured that modelled fish intake levels met the recommendations for EPA, DHA, and vitamin D without violating the tolerable intake recommendations for methyl mercury, dioxins, and dl-PCBs. Recommended intakes for eleven species were generated for each individual in a group of 3,016 Danes (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.
Results: Our results on the fish intake case suggest that 2 % of the 3,016 Danes should be recommended to decrease their fish intake, 55 % should increase their fish intake with up to 184 g/wk to and 24 % should increase their fish intake with more than 100 g/wk. These recommendations were different from the observed intakes ($P<0.05$) according to the Wilcoxon matched-pairs signed-rank test. The results appeared to be specifically sensitive to the uncertainty on vitamin D levels due to the effect of exposure from the sun.
Significance: Mathematical optimization methods could be used to provide more realistic, achievable dietary guidelines that use data from nutrition science and account for personal preference.