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Letter to the Editor

No nutritional lessons can be learned from a misspecified and over-restricted model with no sensitivity analysis.

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Dear Editor:

In an article published recently in *The Journal of Nutrition*, Vieux *et al.* used a diet optimization model to conclude that nutritionally adequate diets need to contain approximately >50% animal protein (1).

We have many concerns about this work.

Diet modeling using optimization can be used for two purposes: to identify which is the “best” diet in a well-established context, which is useful to inform food-based dietary guidelines (2), or to analyze a nutritional question, which is useful to characterize and understand nutrient issues and dietary levers. In this latter case, which is that addressed by Vieux *et al.*, because diet modeling results depend on the data used and the constraints applied (3, 4), a sensitivity analysis must be conducted to explore how the chosen constraints influence or restrict the solutions identified (5). This is critical to establish the overall significance of the results. Here, unfortunately, the authors provided hardly any indications regarding the influence of their chosen constraints, while they drastically narrowed the domain of feasible dietary solutions, all combined with a flawed research strategy, as we will argue below.

Regarding the constraints chosen, the greatest possible consumption of each food item and group was set at the 95th percentile of intake in the old survey used by the authors, for reasons of theoretical “acceptability”. It is difficult to agree that intakes higher than the 95th percentile consumption observed 16 years ago are simply unattainable in our current context of marked food transition. The food repertoire was also very short, especially regarding plant protein (n=2 for legumes; n=2 for plant-based meat substitutes, vs n=19 for meat) (1). In particular, while legumes are acknowledged as a cornerstone of nutrient-rich healthy plant-based diets, it is striking that they remained embedded in the “starchy food” group and restricted to two food items (boiled beans and lentils). Furthermore, no information was given about the dietary constraints (on the consumption of food items or groups) that were active and therefore limiting for the identification of more plant-based dietary solutions. It is not reasonable to study potentially major changes to the share of animal/plant protein based on the premise of such conservative – and indeed outdated – dietary patterns, and capping the consumption of likely dietary levers at binding values. Indeed, such a constraint on legume consumption has been waived in the modelling scenarios that underpin food-based dietary guidelines for French women (2). Current dietary guidelines advocating several servings of legumes per week (6) would be considered impossible according to the authors’ model.

The authors also chose to limit the deviation in food mass and number of food items from the observed diet to arbitrary values, while it was precisely identified as increasing in line with the potential share of plant protein. It was also unusually restrictive to constraint at the same or lower

cost, as this simply discarded all dietary solutions at even a 1% higher cost. This constraint was systematically binding, as recognized by the authors, but they did not investigate the effects of its relaxation. Furthermore, the costs of the food items studied dated from 16 years ago. Given the food price fluctuations seen since then and cruelly illustrated today, such a constraint is inappropriate when trying to study a long-term dietary transition. Indeed, current diets would be considered impossible using their model.

Lastly, the authors applied a research strategy that was conceptually flawed in modelling terms. After determining modelled diets containing an increasing share of plant protein under an initial set of constraints, the authors discarded some of the most plant-based solutions using a second set of constraints as *a posteriori* criteria, such as protein intake adequacy. However, they were unable to prove that another solution which satisfied these *a posteriori* constraints could not have been found if they had been integrated beforehand. In particular, if a sufficient amount of protein in the modelled diets had logically been required beforehand with other nutritional constraints of the same type, it is possible and indeed likely that a solution would have been found for the share of plant protein rejected by the authors. Diets containing >50% plant protein were thus ruled out due to model misspecification, as a nutritional constraint was omitted. It is certain that an opposite conclusion would have been reached if the authors had omitted the reference values for fiber or saturated fatty acids, rather than protein.

In conclusion, there was no sensitivity analysis of the influence of the restrictive and questionable constraints that prevented greener dietary solutions, combined with the *a priori* omission of a nutritional constraint (sufficient protein intake) that was nevertheless used *a posteriori* to discard the greenest dietary solutions inadequately built because of this misspecification. This invalidates the authors' conclusion that diets containing <50% animal protein are intrinsically unable to ensure nutritional adequacy. This misleading conclusion, as captured unfortunately by the paper's title, is further contradicted by other literature findings (7-9). In particular, we recently modelled fully nutritionally adequate diets containing only 20% animal protein (9). Diets with a lower share of animal protein are also better for long-term health and the environment (8-10). Finally, because it did not identify critical nutrients or analyze the influence of the many non-nutritional constraints chosen, this work offers no information on what should be considered an obstacle to reducing the share of animal products, which is the question at issue (5).

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The authors' responsibilities were as follows: FM drafted the paper and all authors participated actively in critically reviewing of this draft and its revision and read and approved the final manuscript.

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