Appendix A: Description of basic DEA models

In this paper we use both the input-oriented and the output oriented Banker, Charnes and Cooper (BCC) models(10). The models are used multiple times i.e. as many times as the number of the evaluated diets in the sample and they compare each diet with all other diets in the sample. In the application presented in this manuscript the sample refers to a sex/age group. The mathematical formulation of the input-oriented DEA model (IO-DEA) is presented below:

|  |  |  |  |
| --- | --- | --- | --- |
| $$min\left\{θ-ε\left(\sum\_{ι}^{}s\_{i}^{in}+\sum\_{j}^{}s\_{j}^{ot}\right)\right\}$$ |  |  | (IO-DEA) |
| *s.t.:*  |  |  |
| $$\sum\_{k}^{}y\_{jk}λ\_{k}- y\_{j}^{0}-s\_{j}^{ot}=0$$ | $$ ∀ j$$ |  |
| $$\sum\_{k}^{}x\_{ik}λ\_{k}-θx\_{i}^{0}+ s\_{i}^{in}=0$$ | $$ ∀ i$$ |  |
| $$\sum\_{k}^{}λ\_{k} =1$$ |  |  |
| $$λ\_{k} , s\_{j}^{ot}, s\_{i}^{in} \geq 0$$ | $$∀ k,j, i$$ |  |

Where $θ \in \left\{0…1\right\}$ is the efficiency score of the evaluated diet calculated with the input-oriented DEA model (efficient diets get the value of 1), *λk* is a decision variable and the weight of diet *k* in the efficient alternative of the evaluated diet, *sjot* is the slack decision variable that captures the deviation between the intake of more-is-better nutrient *j* of the improved diet and the intake of more-is-better nutrient *j* of the current diet, *sjin* is the slack decision variable that captures the deviation between the intake of less-is-better nutrient *i* of the current diet and the intake of less-is-better nutrient i of the improved diet, *ε* is a marginal (i.e. very small) positive number, *xik* is the content of less-is-better nutrient *i* in diet *k*, *yjk* is the content of more-is-better nutrient *j* in diet *k*, *xi0* is the content of less-is-better nutrient *i* in the evaluated diet, and *yj0* is the content of more-is-better nutrient *j* in the evaluated diet.

The mathematical formulation of the output-oriented DEA model (OO-DEA) model is presented below:

|  |  |  |  |
| --- | --- | --- | --- |
| $$max\left\{φ+ε\left(\sum\_{ι}^{}s\_{i}^{in}+\sum\_{j}^{}s\_{j}^{ot}\right)\right\}$$ |  |  | (OO-DEA) |
| *s.t.:*  |  |  |  |
| $$\sum\_{k}^{}y\_{jk}λ\_{k}- φy\_{j}^{0}-s\_{j}^{ot}=0$$ | $$ ∀ j$$ |  |  |
| $$\sum\_{k}^{}x\_{ik}λ\_{k}- x\_{i}^{0}+ s\_{i}^{in} =0$$ | $$ ∀ i$$ |  |  |
| $$\sum\_{k}^{}λ\_{k} =1$$ |  |  |  |
| $$λ\_{k} , s\_{j}^{ot}, s\_{i}^{in} \geq 0$$ | $$∀ k,j, i$$ |  |  |

Where *φ* is the efficiency score of the evaluated diet calculated with the output-oriented DEA model. The higher the value of *φ* the higher the efficiency of the evaluated diet. To normalize the efficiency scores of the OO-DEA to values from 0 (i.e. lowest efficiency) to 1 (i.e. highest efficiency) we report efficiency scores as *φ-1*.

For computational efficiency and to avoid determining an appropriate marginal positive parameter *ε* both the IO-DEA and the OO-DEA models were solved in two stages following Cooper et al. (2017) (10).

Appendix B: Acceptability extensions - the MINDV model.

To identify healthier diets that are as close as possible to current food-item intakes we use the MINDV model. This model minimizes the total absolute deviation between the food item intake of the new calculated diet and the food-item intakes of the current diet. The model makes sure that the new diet contains at least the intake of more-is-better nutrients and at most the intake of less-is-better nutrients of the current diet. Similar to the basic IO-DEA and OO-DEA model this model is also used multiple times; once for each current diet. Diets that have been identified efficient based on the basic DEA models do not have to be evaluated.

|  |  |  |  |
| --- | --- | --- | --- |
| $$min\left\{\sum\_{f}^{}\left(d\_{f}^{+}+d\_{f}^{-}\right)\right\}$$ |  |  | (MINDV) |
| *s.t.:*  |  |  |
| $$\sum\_{k}^{}FI\_{fk}λ\_{k}+d\_{f}^{-}-d\_{f}^{+}=FC\_{f}^{0}$$ | $$ ∀ f$$ |  |
| $$\sum\_{k}^{}y\_{jk}λ\_{k}- y\_{j}^{0} \geq 0$$ | $$ ∀ j$$ |  |
| $$\sum\_{k}^{}x\_{ik}λ\_{k}- x\_{i}^{0} \leq 0$$ | $$ ∀ i$$ |  |
| $$\sum\_{k}^{}λ\_{k} =1$$ |  |  |
| $$λ\_{k} , d\_{f}^{-}, d\_{f}^{+} \geq 0$$ | $$∀ k,f$$ |  |

Where *df+* and *df-* are the positive and negative deviation of the calculated food-item intake from the food-item intake of the current diet, *FIfk* is the intake of food-item *f* of diet *k*, *FCf0* is the intake of food-item *f* of the evaluated diet.

Appendix C: Differences between groups of individuals

The p-values of pairwise t-test comparisons for a set of important variables to identify group differences.

