

## Diet and environmental impact



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Christian's research examines the economic and environmental impacts of food consumption with focus upon sustainable, healthy and affordable diets, food waste, and the how to shift towards sustainable diets and cookery.

Christian was formerly employed as a Public Health Research Fellow at the Rowett Institute of Nutrition and Health, University of Aberdeen, where he looked at healthy sustainable diets for high and low income groups using linear programming and agent based modelling.

From 2017-2020 Christian Reynolds was on secondment to WRAP as Technical Specialist in international food sustainability. In this role Christian worked on integrating healthy sustainable eating and food waste reduction messages.

With COP26 coming to a close, we have been reminded of the potential of dietary change to reduce environmental impact. This November edition of the Global Fruit and Vegetable Newsletter provides three different perspectives on our diet's environmental impact, and shows innovative modelling that answers some much-needed questions.

- Kovacs *et al.* compares the **carbon footprint** of adhering to the **food based dietary guidelines** of Germany, India, the Netherlands, Oman, Thailand, Uruguay, and the United States. They examine how the different recommendations contribute to the embodied **greenhouse gas emissions** associated with **each country's dietary guideline**, and how cultural preferences (such as preferences for beef as a protein source) play a role in the resulting carbon emissions. In a comparison of the seven countries with the EAT-Lancet guidelines, only adhering to India's recommendations lead to a lower carbon footprint.
- Colombo *et al.* modelled **four pathways** where the **total fruit and vegetable** consumption per person in the UK increases from current levels to **5 portions a day**. Pathways included increasing UK grown vegetable (and fruit), or increasing global vegetable (and fruit) consumption. They found that **health impacts were positive** across all four pathways, with an **increase in life expectancy** by 7-8 months.
- Torstensson *et al.* gives another viewpoint this issue, identifying **commonly prepared dishes** in Swedish households using retail sales data - some really interesting analysis! They explore how the dishes can be adjusted to reach **nutritional and climate impact guidelines**. They highlight the importance of **protein choice**, and methods for retailers to offer foods with lower-climate impact and higher nutritional value.

# Carbon footprints of dietary guidelines in seven countries modeling health and environmental impacts

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*Food-based dietary guidelines (FBDG) are developed on a national level by more than 90 countries. They provide brief science-based messages to promote nutritious diets (FAO, 2018). Recent global dietary changes have been observed as urbanizing populations are shifting to diets higher in animal products and lower in legumes, grains, and vegetables. This presents a dual burden on health and the environment (Tilman, 2014; Swinburn, 2019). A shift to diets that are both nutritious and sustainable is one solution to address both health and environmental concerns. Although many countries have already developed FBDG to promote a culturally relevant and nutritious diet, more work is needed on incorporating environmental sustainability such as dietary impacts on greenhouse gas emissions (GHGE) into countries' FBDG (Rose, 2019).*

*Studies suggest that carbon footprints of dietary guidelines differ among countries, with the footprint of the US guidelines being higher than other countries (Springmann, 2020). Unfortunately, it is not clear from previous work whether this difference in footprints is due to the guidelines themselves or to the eating patterns of countries.*

Thus, this study aims to address this gap by modeling the carbon footprint of the dietary guidelines from seven countries, developing a method to compare carbon footprints of FBDG using food supply data and a database of global warming impacts, and examining differences in global warming impacts of the recommended diets by controlling for consumption differences between countries.

## The recommended daily amounts of food groups vary widely

All FBDG were organized into six major food groups – protein foods, dairy, grains, fruits, vegetables, and oils/fats. The daily recommended amount and composition for each food group varied widely across countries' FBDG (figure 1). For example, the United States had the highest recommendation for dairy foods, more than three times that of the EAT-Lancet recommendation, an international guideline that incorporates nutrition, health, and environmental sustainability goals (Willett, 2019).

Table 1: Daily recommended amounts of each food group by country (for a 2000-kcal diet).

	PROTEIN FOODS (G)	DAIRY (ML)	GRAINS (G)	FRUIT (G)	VEG (G)	OILS/FATS (G)
GERMANY	99	524	362	250	512	35
INDIA	75	300	330	100	500	25
OMAN	168	118	662	686	420	56
THE NETHERLANDS	150	415	428	200	250	40
THAILAND	135	237	600	784	200	
UNITED STATES	156	710	170	392	350	27
US VEGETARIAN	97	710	184	392	350	27
URUGUAY	91	455	227	455		25
EAT-LANCET	167	194	186	160	280	42

## KEY MESSAGES

- FBDG as well as their associated carbon footprints vary among countries.
- India recommendations had the lowest greenhouse gas emissions while US recommendations had the highest.
- GHGE levels are mainly associated with the recommended amounts of dairy and protein-rich foods.
- The GHGE attributed to the protein-rich food recommendations ranged from 0.03 kg CO<sub>2</sub>-eq/d in India to 1.84 kg CO<sub>2</sub>-eq/d in the US, for recommended amounts of 75 g/d and 156 g/d, respectively.
- After controlling for country-level consumption patterns by applying the US consumption pattern to all countries, US recommendations were still the highest.

Based on: Kovacs B, et al. The carbon footprint of dietary guidelines around the world: a seven country modeling study. *Nutr J.* 2021;20(1):15.

## References:

- Food and Agriculture Organization of the United Nations (2018) Food-based dietary guidelines. <http://www.fao.org/nutrition/education/food-dietary-guidelines/home/en/>.
- Tilman D, Clark M. Global diets link environmental sustainability and human health. *Nature.* 2014;515(7528):518–22.
- Swinburn BA, et al. The global Syndemic of obesity, Undernutrition, and climate change: the lancet commission report. *Lancet.* 2019;393(10173):791–846.
- Springmann M, et al. The healthiness and sustainability of national and global food based dietary guidelines: modelling study. *BMJ.* 2020;370:m2322.
- Rose D, et al. Position of the Society for Nutrition Education and Behavior: The importance of including environmental sustainability in dietary guidance. *Journal of Nutrition Education and Behavior* 2019;51(1):3-16.
- Willett W, et al. Food in the Anthropocene: the EAT-lancet commission on healthy diets from sustainable food systems. *Lancet.* 2019;393(10170):447–92.
- Heller MC, et al. Greenhouse gas emissions and energy use associated with production of US self-selected diets. *Environmental Research Letters* 2018;13 044004.
- Rose D, et al. Carbon footprint of self-selected US diets: nutritional, demographic, and behavioral correlates, *American Journal of Clinical Nutrition* 2019;109:526-534.

## Greenhouse gas emissions associated with FBDG

The daily recommended amounts of each food group influence the greenhouse gas emissions of a country's recommended diet. This concerns particularly the protein and dairy food groups, as animal foods have larger carbon footprints than plant-based foods.

Overall, India's recommendations had the lowest greenhouse gas emissions with 0.74 kg CO<sub>2</sub>-eq/day, mainly because India's guidelines for proteins only includes plant proteins while other countries include a mixture of animal and plant proteins. The country with the highest total GHGE attributed to eating the country's recommended diet is the US at 3.83 kg CO<sub>2</sub>-eq/day, which is 4.5 times higher than the GHGE of India's recommended diet. Also, the EAT-Lancet recommends a greater amount of protein foods than that of the US but over half of these protein foods are from plant, which explains the lower GHGE from proteins foods in the EAT-Lancet guidelines compared to the US (about half lower) (figure 2).

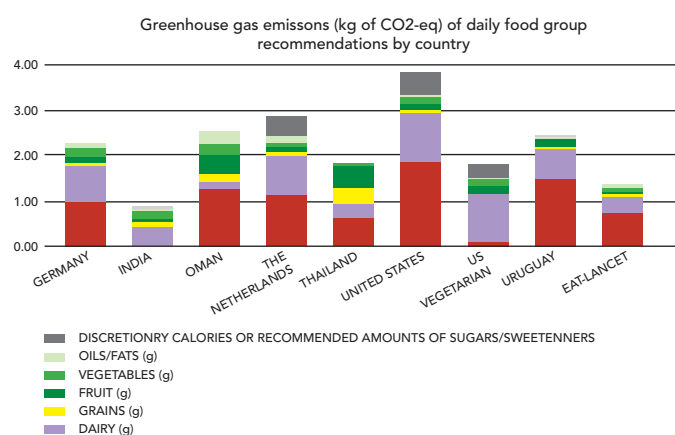


Figure 2: Greenhouse gas emissions (kg of CO<sub>2</sub>-eq) of daily food group recommendations for a 2000-kcal diet pattern by country. (\*fruit and vegetables form one group in Uruguay, so the GHGE of fruit refers to the emissions for the combined group).

After controlling for country-level consumption patterns by applying the US consumption pattern to all countries, carbon footprints of US recommendations were still the highest. They were 19% and 47% higher than those of the Netherlands and Germany, respectively.

## METHODOLOGY

- A purposive sampling was used to include FBDG from national sources:
  - the United States;
  - two European countries (Germany and the Netherlands) for which earlier research had shown that diet shifts towards their guidelines would lower GHGE;
  - India, to seek maximum variation in GHGE; and
  - Oman, Thailand, and Uruguay for diverse geographic representation.
- All FBDG were classified into six major food groups: protein foods, dairy, grains, fruits, vegetables, and oils/fats. All guidelines were scaled to a 2000-kcal diet.
- To determine specific quantities of individual foods within these groups, data on food supplies available for human consumption for each country was used from the UN Food and Agriculture Organization's food balance sheets.
- Data on the GHGE for the production of different foods come from the database of Food Impacts on the Environment for Linking to Diets (dataFIELD), which is based on an exhaustive review of the life cycle assessment literature (Heller, 2018; Rose, 2019b).

# Meeting the United Kingdom « 5-a-day » of fruit and vegetable recommendation: modeling health and environmental impacts

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According to the United Kingdom's Eatwell Guide and national « 5-a-day » campaign, the consumption of 5 servings of fruit and vegetables (including legumes) as fresh, canned, or frozen is recommended everyday (NHS, 2018). Ten years after the launch of the campaign, fruit and vegetable consumption has increased by approximately half a portion daily (Castiglione, 2019). However, mean fruit and vegetable consumption remains well below the recommendation in the United Kingdom across all age and sex groups (Food Standards Agency and Public Health England, 2019). In addition, United Kingdom has committed to reduce its carbon emissions to net zero by 2050 (UK Government, 2019). This transition is likely to involve shifts towards plant-based diets (Reynolds, 2019).

The aim of this diet-modeling study is to quantify the potential effects on health (changes to life years gained, life expectancy at birth), environmental footprints (greenhouse gas emissions (GHGE) and blue water footprints), and dietary costs that could be expected from four hypothetical consumption pathways to reach the « 5-a-day » recommendation.

## An increased consumption of fruit and vegetable following the four pathways to 5-a-day

In this study, four hypothetical pathways were modelled in which total fruit and vegetable consumption per person was increased from current levels to 5 portions (400 g) per day (figure 1).

In the United Kingdom, diet of individuals aged more than 12 years old contained an average of 88 g of fruit (~1 portion) and 144 g of vegetables per day.

In all four pathways, vegetable consumption increased from baseline to between 246 g (a 76% increase) and 312 g (a 123% increase) per day. The greatest increase in vegetable consumption was in the VEG-ALL and VEG-UK pathways.

In the F&V-ALL pathway, fruit consumption increased from baseline by 75% (to 154 g/d), while in the F&V-UK pathway, it increased by 52% (to 134 g/d). However, it remained the same in both « vegetable only » pathways.

## Achieving the 5-a-day target could increase average life expectancy at birth by 7 to 8 months

In all four pathways, health effects were positive, with an increase in life expectancy by 8 months for the F&V-ALL, and 7 months for the F&V-UK and VEG-UK models.

Approximately, 80% of these health benefits were attributable to health improvements from increased consumption of fruit and vegetables. The remainder was attributable to a decreased intake of red and processed meat.

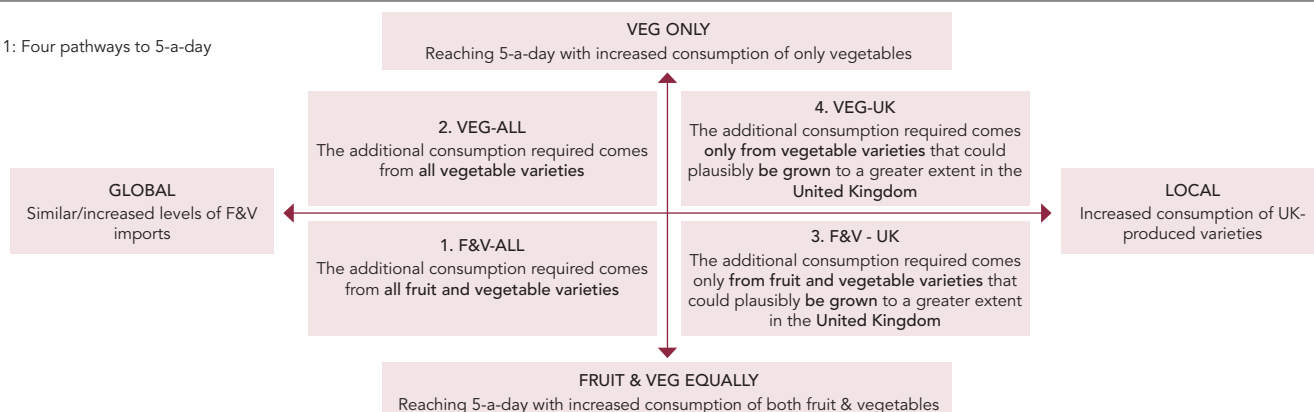
## Achieving the 5-a-day target could reduce diet-related GHGEs and blue water footprint

All four of the pathways modelled to achieve the 5-a-day reduced total GHGEs from total diet, compared with the current average diets in the United Kingdom. The VEG-ALL pathway showed the greatest reduction with an 8.2% reduction, followed by the VEG-UK pathway (7% reduction).

These reductions could reduce diet-related GHGEs by 6.6 to 12.2 mt CO<sub>2</sub>eq/year, depending on the pathway. This could be translated to a ~0.8 to 1.6% reduction of annual GHGEs.

Greater reductions in water use were observed for pathways that prioritized fruit and vegetables produced in the United Kingdom rather than imported varieties. In fact, blue water footprint was reduced by 1% in the VEG-UK pathway and by 0.9% in F&V-UK pathway, while it was increased by 0.5% in the F&V-ALL pathway (+0.07 km<sup>3</sup>/year).

Figure 1: Four pathways to 5-a-day



## KEY MESSAGES

- Achieving the 5-a-day target in the United Kingdom could:
  - increase average life expectancy at birth by 7–8 months;
  - reduce diet-related GHGEs by 6.1 to 12.2 Mt carbon dioxide equivalents/year.
- Greater reductions in GHGEs were achieved by prioritizing increased vegetable consumption over fruit.
- The greatest reduction in water footprints was obtained by prioritizing vegetable varieties produced in the United Kingdom.
- Health and environmental benefits could be expected from consumption pathways that meet the 5-a-day recommendation.

## METHODOLOGY

- Baseline diet was estimated using 18,006 food diaries from 4,528 individuals participating in the UK National Diet and Nutrition Survey (2012/13–2016/17).
- Linear programming was used to model the 4 pathways.
- Increases in fruit and vegetable consumption were substituted for consumption of sweet snacks and meat, respectively.
- Changes in life expectancy were assessed using the IOMLIFET life table model.
- The overall GHGEs and blue water footprints of the current mean UK diet and the four 5-a-day pathways were calculated as the sum of the corresponding reported food weights multiplied by their specific carbon dioxide equivalents (CO<sub>2</sub>eq) and water footprint values as recorded in the literature.

Based on: Patricia Eustachio Colombo, et al. Pathways to “5-a-day”: modeling the health impacts and environmental footprints of meeting the target for fruit and vegetable intake in the United Kingdom. *The American Journal of Clinical Nutrition* 2021; 114(2): 530–539.

## References:

- National Health Service. Why 5 a day? <https://www.nhs.uk/live-well/eat-well/why-5-a-day/>.
- Castiglione C, Mazzocchi M. Ten years of five-a-day policy in the UK: nutritional outcomes and environmental effects. *Ecol Econ* 2019;157:185–94.
- Food Standards Agency and Public Health England. NDNS: time trend and income analyses for Years 1 to 9. 2019: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/943114/NDNS\\_UK\\_Y9-11\\_report.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943114/NDNS_UK_Y9-11_report.pdf).
- UK Government. UK becomes first major economy to pass net zero emissions law: <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law>.
- Reynolds CJ, et al. Healthy and sustainable diets that meet greenhouse gas emission reduction targets and are affordable for different income groups in the UK. *Public Health Nutr* 2019;22:1503–17.

# Food Dishes for Sustainable Development

## A Swedish food retailer perspective

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Global food production is the single largest driver in environmental degradation. It threatens our ecosystems and climate stability. To overcome this urgent crisis, substantial dietary shifts to healthy and sustainable diets will be required (Willett, 2019). The food retailers can play an important role to influence the consumer to make more sustainable food choices by integrating sustainability related aspects in their corporate portfolio decisions. There is a great need for more guidance and communication towards the consumer on how to make food choices with lower climate impact. To enhance sustainable and healthy food choices, the retailers need to increase and improve their communication.

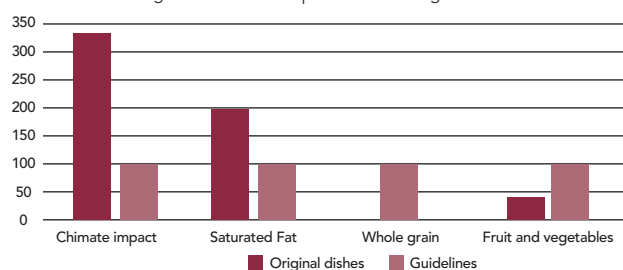
In this study retailers are given a role to influence consumer behavior towards more sustainable and healthy diets. The ten most commonly prepared dishes in a home setting among customers of a major food retailer in Sweden were identified through sales statistics. The dishes were altered to reach nutritional and climate impact guidelines. As a final step, the selected dishes were analyzed from a nutritional and climate impact perspective, to enable comparison with established guidelines.

### Commonly prepared dishes exceeded nutrition and climate impact guidelines

The ten most popular dishes in order were: chicken tikka masala with rice, chicken wok with noodles, spaghetti Bolognese, curry chicken leg with rice, hot dogs, lasagna, sausage stroganoff, pork fillet with potato wedges and salmon with lemon and dill sauce. These dishes are lacking in fruit, vegetables, and whole grain, and they also contain too much saturated fat. All the dishes had higher climate impact than the maximum recommended CO<sub>2</sub>e per meal and had to be altered. World Wildlife Fund (WWF) has concluded that the climate impact of food must

be reduced by 75% (WWF, 2020). In numbers, this equates to 11 kg CO<sub>2</sub> equivalents per week, or 1.6 kg per day, or relevant in this case: 0.5 kg per meal. Clearly, alterations are required in order to meet the nutritional and climate impact guidelines (figure 1).

Figure 1. Average nutritional content and climate impact (kg CO<sub>2</sub>e) of the original dishes in comparison with the guidelines.



### Plant-based protein sources, a key possibility for a lower-climate impact and higher nutritional value diet

Incorporation of sustainability offers great possibilities for competitive advantage, which can be attained through green product portfolio management (Wever, 2008). Plant-based protein sources present a key possibility in the needed transformation to a diet with lower climate impact and higher nutritional value. Thus, the expansion of plant-based alternatives could be valuable for future product development but this challenges current strategic management and sales policy of Swedish food retailers. The meat category is crucial from a financial aspect (Tjärnemo, 2015). Meanwhile, the consumers are increasingly aware of sustainability and expect the corporations to act which creates an important incentive.



### KEY MESSAGES

- Commonly prepared food dishes in Sweden exceeded goals for climate boundaries and were not in line with nutritional guidelines (saturated fat content is too high while vegetables, fruits, wholegrains and fiber need to be increased) and had higher higher climate impact than the maximum recommended CO<sub>2</sub>e per meal.
- To reduce climate impact and increase nutritional value, the amount of animal-based product need to be reduced and/or exchanged to healthy plant-based alternatives.

### METHODOLOGY

- The data included all purchases during 2019 from a major food retailer store.
- Definitions and components of the dishes were further identified through major Swedish food recipe databases.
- Climate impact data from Mat.se's climate database, a collaboration with the Research Institutes of Sweden, were used to calculate climate impact of the dishes.
- Data from the Swedish food composition database and the program Dietist net provided the nutritional data underlay.
- The reference energy intake values in this study is based on both men and women in all adult age categories and all physical activity level values (Nordic Council of Ministers, 2014).
- The dietary components included are energy intake, protein, fat, saturated fatty acids, whole grain, dietary fiber and fruit and vegetables.

Based on: Torstensson L, et al. Food Dishes for Sustainable Development: A Swedish Food Retail Perspective. Foods. 2021;10(5):932.

### References:

- Nordic Council of Ministers. Nordic Nutrition Recommendations 2012-Integrating Nutrition and Physical Activity; Nordic Council of Ministers: Ved Stranden, Copenhagen, 2014.
- Tjärnemo H., et al. Swedish food retailers promoting climate smarter food choices-Trapped between visions and reality? J. of Retailing and Consumer Services. 2015;24;130-139.
- Willett W, et al. Food in the Anthropocene: The EAT-Lancet Commission on Healthy Diets from Sustainable Food Systems. Lancet 2019; 393: 447-492.
- Wever R., et al. Sustainable Innovation 08 Conference. 2008.
- WWF. One Planet Plate. Available online: <https://www.wwf.se/mat-och-jordbruk/one-planet-plate/#klimat-och-biologisk-mangfald>

### Cross-sectional associations of schoolchildren's fruit and vegetable consumption, and meal choices, with their mental well-being: a cross-sectional study



A team of English researchers studied the association between food choices and mental well-being in more than 7,500 secondary school and 1,000 primary school children. According to this study, there is a significant association between nutritional variables and well-being scores: scores were 3.73 units higher in children consuming five or more servings of fruit and vegetables compared with none. When comparing those consuming a conventional breakfast type (e.g. toast, cereal, yogurt, fruit, etc.) and those not having breakfast or consuming only a snack or a breakfast bar or an energy/non energy drink, results showed that the type of breakfast and lunch consumed would also be associated with mental well-being, with a higher score for those who ate a conventional breakfast type. Likewise, eating breakfast was significantly associated with well-being. Therefore, promoting a healthy diet among children seems essential for their mental well-being.

Hayhoe R, et al. *BMJ Nutrition, Prevention & Health* 2021;e000205.

### Lifestyle and Life Satisfaction: The Role of Delayed Gratification



Currently, an increasing shift towards veganism and vegetarianism and physical activity by favoring walking or the use of the bicycle is largely observed because of environmental concerns. Therefore, this paper aims to evaluate the potential impact of these lifestyle trends, fruit and vegetable consumption and the level of physical activity being the main lifestyle indicators, on individual wellbeing and life satisfaction. Researchers used data from UK Understanding Society Database which covers 40,000 UK households over time. Findings shows that fruit and vegetable consumption and physical activity significantly improve wellbeing, regardless of gender, income, region, education, and age

Gschwandtner, et al. *J Happiness Stud* 2021.

### Fathers' daily intake of fruit and vegetables is positively associated with children's fruit and vegetable consumption patterns in Europe: The Feel4Diabetes Study



A study investigated the relationship between fathers' and children's fruit and vegetable intake. 10,038 fathers and 12,041 school children from six European countries participated to the study. Overall, European children have low fruit and vegetable intake, especially in Southern European countries. Results also highlighted a positive association between fathers' and children's fruit and vegetable consumption. Children with fathers consuming fruit and vegetables daily were more likely to consume fruit and vegetables 1-2 times per day. Implementation of future strategies promoting fruit and vegetable consumption not only in mothers, but also in fathers could be an effective public health initiative to increase their intake in children.

Papamichael MM, et al. *J Hum Nutr Diet.* 2021.

### Nutrient and Food Tax and Subsidies: A Modeling Efficacy Study on Health-Related Consumption and Mortality



A modelled study aimed to evaluate the effects of taxes and subsidies on foods and nutrients on Swedish public health, specifically on mortality (averted and postponed). Findings show that such policy instruments improve dietary habits and reduce mortality, with a greater efficacy when combining both taxes and subsidies. In fact, the combination of a 34.4% VAT on products rich in saturated fat and a -10.4% VAT (i.e., subsidy) on fruit and vegetables would result in almost 2,100 deaths averted or postponed.

Saha S et al. *Soc Sci Med.* 2021;287:114388.

### Making sense of adolescent-targeted social media food marketing: A qualitative study of expert views on key definitions, priorities and challenges



International experts in the fields of public health, nutrition, behavioral sciences, etc. (n=17) were interviewed to have their insights on factors involved in the association between social media food marketing and adolescents' dietary behaviors. Experts agreed that there is limited scientific evidence on adolescent-targeted social media food marketing. Also, strict regulations are lacking to protect adolescents from unhealthy social media food marketing, while adolescents are active on social media and are cognitively to implicit marketing techniques. Therefore, social media food marketing targeting adolescents should be controlled by encouraging healthy food marketing and limiting junk food marketing.

Van der Bend D et al. *Appetite* 2021;168:105691.