SHORT COMMUNICATION

Fostering sustainable dietary habits through optimized school meals in Sweden – OPTIMAT

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ABSTRACT

The fulfilment of commitments to international agreements that relate to sustainable development requires fundamental changes in food consumption. This project aims to promote healthy and sustainable dietary habits in Sweden through optimized school meals.

Several studies are planned. The first is an analysis of children's dietary intake in relation to school meal quality. The second is a modelling study where nutritious, affordable and theoretically acceptable food baskets, optimized for low emissions of greenhouse gases, are developed. Menus based on these baskets will be developed and tested for acceptability in schools. Lastly, challenges in the implementation of climate-friendlier school meals will be studied. Currently, the collection of data on dietary habits and school meal quality has been finalized. Preliminary optimization analyses have also been performed.

This project has the potential to contribute to more sustainable procurement and consumption patterns, a more efficient use of public resources, and to fulfilment of the 2030 Agenda for Sustainable Development.

Keywords: NUTRITION, CHILDREN, PUBLIC SECTOR MEALS, GREENHOUSE GAS EMISSIONS, LINEAR PROGRAMMING

INTRODUCTION

The OPTIMAT – or the optimization of food – project commenced in 2016 and focuses on improving future diets in Sweden; one of the biggest contemporary challenges to both human health and the environment. Poor dietary habits are the number one contributor to the loss of Disability-Adjusted Life Years (DALYs) globally and in Sweden, increasing the risks for cardiovascular diseases, diabetes and cancer *(1)*. In addition, our food choices drive food production systems that impose a heavy environmental burden *(2)*. The global food system contributes to approximately 25% of all anthropogenic greenhouse gas emissions (GHGE) – a major driver of climate change – and contributes to deforestation, the exploitation of land and freshwater, nitrogen cycle disruption, and the loss of biodiversity *(3)*. As populations grow and become wealthier and increasingly urbanized, food choices shift towards resource-intensive and greenhouse gas-emitting foods of animal origin *(4)*. Hence, a commitment to international agreements related to sustainable development, such as the 2030 Agenda for Sustainable Development *(5)*, will necessitate fundamental changes in both what and how food is produced and consumed.

WHAT ARE SUSTAINABLE DIETS?

In 2012, the Food and Agriculture Organization (FAO) (re-)established the concept of sustainable diets and described it as: *"[…] those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective*

and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimising natural and human resources" (6). Although the definition suggests that these different dimensions of a sustainable diet are synergistic, this is often, but not always, the case; for example, sugar is good for the climate but not for health *(7, 8)*. Hence, trade-offs are unavoidable when aiming for healthy and environmentally sustainable diets.

HOW DO WE GET THERE?

Most previous studies investigating the relationship between people's food consumption patterns and environmental parameters have evaluated the impact of current diets *(9–14)*, while others have made attempts to model and discuss the trade-offs between nutritional adequacy and environmental sustainability *(15–18)*.

Transforming people's diets will require future consumers to be both well-informed and responsible, as well as having better access to affordable, nutritious and health-promoting foods that are also sustainable. As concluded by the European Live Well for Life project, consumers can be guided towards more sustainable consumption patterns by national dietary guidelines reflecting sustainability, green public procurement policies, and information campaigns *(19)*. Neto et al. have recently reviewed 23 green public procurement schemes from different regions of Europe *(20)*, and the EU has established non-binding procurement criteria for food and catering which are currently being revised *(21)*.

THE POTENTIAL OF SCHOOL MEALS

Improving the school food environment may be effective in improving children's eating behaviours *(22)*, and eating a balanced school lunch has been shown to contribute to healthier overall eating patterns outside school *(23)*. By introducing children to healthy and environmentally sustainable school meals from an early age it is possible to improve children's understanding of sustainable development and to adapt their diets in the short and long term, to their benefit and that of the planet. A study from England has suggested that a change to school meals, defined by a low level of salt, free sugars and saturated fat, could lower GHGE by as much as 24% *(24)*.

Due to their reach and scale, Swedish school meals hold great potential to positively influence children's dietary patterns as well as a significant portion of the food procured by the public sector. Each day, all 1.3 million primary school children are served a fully subsidized school lunch. School meals are generally of high quality in Sweden *(25)*. However, there is still room for improvement: when it comes to certain nutrients, with respect to how the school meal is served and integrated within teaching, and how schools limit environmental impact *(26)*.

OPTIMIZING SCHOOL MEALS WITH LINEAR PROGRAMMING

It is clear that there are many benefits to be gained if school meals, like other public meals, could be optimized simultaneously for environmental impact and nutritional quality. In addition, school meals must adhere to strict budget limitations and ultimately be acceptable to students. One method of approaching this challenge is through linear programming which is an algorithm for maximizing or minimizing a given linear objective function subjected to a set of linear constraints *(27)*. Using this algorithm, school meals can be optimized for minimal environmental impact while constraints such as nutritional adequacy, cost and acceptability are still met. A number of studies have included multiple constraints in an attempt to identify healthy diets with low environmental impact *(15–18)*, but to the best of the authors' knowledge, none have studied children's diets in particular nor attempted to optimize school food, and none have, so far, attempted to test the adoption of such diets by consumers in practice.

AIM AND METHODS OF THE OPTIMAT PROJECT

The aim of the OPTIMAT project, running from 2016–2021, is to optimize the composition of school meals in Sweden. The project aims to answer the research question: to what extent can school meals be improved from a nutritional and environmental perspective while still being acceptable to students and affordable to schools? Four related studies are planned. The first is an analysis of children's current dietary intake, performed as part of the *Riksmaten Ungdom* national survey carried out by the Swedish National Food Agency and involving a representative sample of more than 3000 adolescents *(29)*. The importance of school meal quality for children's overall diets will be examined. Quality will be assessed using our web-based tool *SkolmatSverige*, covering six domains: choice, nutritional quality, safe food practice, service aspects and pedagogical integration, environmental impact, and organisation/policy issues *(30)*. The second study will utilise linear programming

(31) to develop nutritious, affordable and acceptable so-called food baskets, optimized for low GHGE. Although GHGE are just one aspect of environmental sustainability, they are used here because this is the parameter for which the most complete data is available. In addition, we will use a GHGE database specific to the Swedish context, developed by the Swedish Research Institute (RISE). We will use actual procurement data from schools containing information on current food volumes, cost and seasonality, and couple this to the national nutritional database and the GHGE database. Four-week school meal plans will be developed in collaboration with chefs and municipalities, based on the optimized food baskets. In the third study, these meal plans will be tested in schools in a quasi-experimental intervention study and evaluated with regard to nutrient intake and acceptability by students, measuring food waste and other outcomes. The fourth study is a qualitative study including interviews with the students and school kitchen managers in order to identify barriers and facilitators for the implementation of climate-friendlier school meals.

CURRENT STATUS

Several international experts in the field have agreed to join a reference group for the project and will advise throughout the project.

At the time of writing, the dietary assessment has been completed and school meal quality has been assessed in a number of schools. A method for measuring plate waste and lunch consumption is available for all schools *(32)*. A list of foods procured by three typical schools over one entire school year has been collected and the linear programming methodology has been applied. Preliminary results indicate that only a few nutrient demands are actively constraining the reduction of GHGE from the school meals, and that reductions in GHGE of up to 50% are achievable without compromising nutritional value. Linear programming seems to be a suitable tool to minimize GHGE while observing multiple constraints.

ASPIRATIONS

Once the resulting food baskets have been converted into school meals acceptable to students and schools, this project will contribute to reducing GHGE from school meals without compromising nutritional quality, foster environmental consciousness in the next generation, and result in more sustainable school meals. The results from this project should be of interest and relevance to other countries facing comparable challenges and help Sweden to achieve the European Union's 40% target for GHGE reductions by 2030 *(32)*.

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REFERENCES

1. GBD Compare | IHME Viz Hub [website] (http://vizhub.healthdata.org/gbd-compare, accessed on 28 September 2017).
2. Meybeck A, Gitz V. Sustainable diets within sustainable food systems. Proc Nutr Soc. 2017 Feb; 76(1):1–11.
3. Mason P, Lang T. Sustainable diets: how ecological nutrition can transform consumption and the food system. London and New York: Routledge, Taylor & Francis Group; 2017:353.
4. Garnett T. Three perspectives on sustainable food security: efficiency, demand restraint, food system transformation. What role for life cycle assessment? J Clean Prod. 2014 Jun 15; 73(Supplement C):10–8.
5. Transforming our world: the 2030 Agenda for Sustainable Development. In: Sustainable Development Knowledge Platform [website]. United Nations Department of Economic and Social Affairs (https://sustainabledevelopment.un.org/post2015/transformingourworld, accessed 29 May 2017).
6. Sustainable Diets and Biodiversity – Directions and solutions for policy, research and actions [website]. Rome: Food and Agriculture Organization of the UN; 2012 (http://www.fao.org/docrep/016/i3004e/i3004e00.htm, accessed 12 April 2017).
7. Scarborough P, Allender S, Clarke D, Wickramasinghe K, Rayner M. Modelling the health impact of environmentally sustainable dietary scenarios in the UK. Eur J Clin Nutr. 2012 Jun; 66(6):710–5.
8. Vieux F, Soler LG, Touazi D, Darmon N. High nutritional quality is not associated with low greenhouse gas emissions in self-selected diets of French adults. Am J Clin Nutr. 2013 Mar 1; ajcn.035105.
9. Davis J, Sonesson U, Baumgartner DU, Nemecek T. Environmental impact of four meals with different protein sources: Case studies in Spain and Sweden. Food Res Int. 2010 Aug; 43(7):1874–84.

10. Carlsson-Kanyama A, González AD. Potential contributions of food consumption patterns to climate change. Am J Clin Nutr. 2009 May 1; 89(5):1704S–1709S.

11. Meier T, Christen O. Environmental impacts of dietary recommendations and dietary styles: Germany as an example. Environ Sci Technol. 2013 Jan 15; 47(2):877–88.

12. Xue X, Landis AE. Eutrophication potential of food consumption patterns. Environ Sci Technol. 2010 Aug 15; 44(16):6450–6.

13. Stehfest E, Bouwman L, van Vuuren DP, den Elzen MGJ, Eickhout B, Kabat P. Climate benefits of changing diet. Clim Change. 2009 Jul; 95(1–2):83–102.

14. Pairotti MB, Cerutti AK, Martini F, Vesce E, Padovan D, Beltramo R. Energy consumption and GHG emission of the Mediterranean diet: a systemic assessment using a hybrid LCA-IO method. J Clean Prod. 2015 Sep 15; 103:507–16.

15. Macdiarmid JI, Kyle J, Horgan GW, Loe J, Fyfe C, Johnstone A et al. Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? Am J Clin Nutr. 2012 Sep; 96(3):632–9.

16. Donati M, Menozzi D, Zighetti C, Rosi A, Zinetti A, Scazzina F. Towards a sustainable diet combining economic, environmental and nutritional objectives. Appetite. 2016 Nov 1; 106:48–57.

17. Perignon M, Masset G, Ferrari G, Barré T, Vieux F, Maillot M et al. How low can dietary greenhouse gas emissions be reduced without impairing nutritional adequacy, affordability and acceptability of the diet? A modelling study to guide sustainable food choices. Public Health Nutr. 2016 Oct; 19(14):2662–74.

18. van Dooren C, Aiking H. Defining a nutritionally healthy, environmentally friendly, and culturally acceptable Low Lands Diet. Int J Life Cycle Assess. 2016 May; 21(5):688–700.

19. Pathways and policies. In: LiveWell for Life [website]. LiveWell for Life (http://livewellforlife.eu/key-recommendations, accessed 25 September 2017).

20. Neto B, Gama Caldas M. The use of green criteria in the public procurement of food products and catering services: a review of EU schemes. Environ Dev Sustain [website]. Springer Netherlands; 2017 (http://link.springer.com/10.1007/s10668-017-9992-y, accessed 21 June 2017).

21. EU GPP criteria. In: European Commission/Environment [website]. European Commission; 2017 (http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm, accessed 28 September 2017).

22. Driessen CE, Cameron AJ, Thornton LE, Lai SK, Barnett LM. Effect of changes to the school food environment on eating behaviours and/or body weight in children: a systematic review. Obes Rev Off J Int Assoc Study Obes. 2014 Dec; 15(12):968–82.

23. Tilles-Tirkkonen T, Pentikäinen S, Lappi J, Karhunen L, Poutanen K, Mykkänen H. The quality of school lunch consumed reflects overall eating patterns in 11–16-year-old schoolchildren in Finland. Public Health Nutr. 2011 Dec; 14(12):2092–8.

24. Wickramasinghe KK, Rayner M, Goldacre M, Townsend N, Scarborough P. Contribution of healthy and unhealthy primary school meals to greenhouse gas emissions in England: linking nutritional data and greenhouse gas emission data of diets. Eur J Clin Nutr. 2016 Oct; 70(10):1162–7.

25. Patterson E, Elinder LS. Improvements in school meal quality in Sweden after the introduction of new legislation – a 2-year follow-up. Eur J Public Health. 2015 Aug; 25(4):655–60.

26. Patterson E, Schäfer Elinder L, Regnander M. School Food Sweden's survey of school meal quality. 2014-15. Stockholm: Center for Epidemiology and Community Medicine, Stockholm County Council; 2015.

27. Dantzig GB. 1947. Maximization of a linear function of variables subject to linear inequality. In: Koopmans TC, ed. Activity analysis of production and allocation. New York-London: Wiley & Chapman-Hall; 1951. pp. 339-347.

28. Dooren C van, Aiking H. Defining a nutritionally healthy, environmentally friendly, and culturally acceptable Low Lands Diet. Int J Life Cycle Assess. 2016 May 1; 21(5):688–700.

29. Riksmaten Ungdom (National Food Survey Youth). In: Livsmedelsverket [website]. National Food Agency Sweden; 2016 (https://www.livsmedelsverket.se/riksmatenungdom, accessed 29 May 2017); in Swedish.

30. Patterson E, Quetel AK, Lilja K, Simma M, Olsson L, Elinder LS. Design, testing and validation of an innovative web-based instrument to evaluate school meal quality. Public Health Nutr. 2013 Jun; 16(6):1028–36.

31. Parlesak A, Tetens I, Jensen JD, Smed S, Blenkuš MG, Rayner M et al. Use of linear programming to develop cost-minimized nutritionally adequate health promoting food baskets. PLOS ONE. 2016 Oct; 11(10):e0163411.

32. Ny funktion! Hur ser lunchkonsumtionen ut i din kommun? [New feature! What does lunch consumption look like in your municipality?] In: SkolmatSverige.se [website] (http://www.skolmatsverige.se/nyhet/2017/kommun-konsumtion, accessed 29 May 2017; in Swedish).

33. 2030 climate and energy framework. Brussels: European Commission; 2014. ■