

## Editorial

# Increasing fruit and vegetable intake: where are we at and how do we reach recommendations?

As rich sources of micronutrients, dietary fibre and other favourable substances, such as antioxidants, fruit and vegetables (F&V) are important elements of a healthy and balanced diet. However, population consumption of F&V remains inadequate<sup>(1)</sup>, independently increasing the risk of non-communicable diseases such as cardiovascular diseases (CVD), diabetes and several cancers<sup>(2–8)</sup>. Low F&V consumption is among the top contributors to global death and disability, and estimated to be responsible for approximately 6.7 million deaths worldwide in 2010, compared with 5.1 million in 1990<sup>(9)</sup>.

### Fruit and vegetable intake and supply

As part of a healthy diet, the WHO suggests consuming a minimum of 400 g or five servings of F&V per day to improve overall health and reduce the risk of certain non-communicable diseases<sup>(10)</sup>. Recent evidence suggests that a higher number of servings might increase health benefits even further<sup>(11)</sup>. Increasing individual F&V consumption to up to 600 g/d could reduce the global burden of disease by 1.8%<sup>(12)</sup>. The majority of adults globally would have to at least double their current F&V consumption to meet the WHO's minimum recommendation<sup>(13)</sup>. A study using data from 2003 showed that 77.6% of men and 78.4% of women from fifty-two mainly low- and middle-income countries consumed less than the minimum recommended five daily servings of F&V<sup>(1)</sup>. The determinants of low F&V intake vary and include a strong social gradient<sup>(14)</sup> and local access and availability<sup>(14)</sup>. Wolnicka *et al.*<sup>(15)</sup> show in this issue that factors within the family environment such as parents' dietary habits and F&V availability have a great influence on children's F&V consumption.

A study using data from 2009 found that the global supply of F&V falls, on average, 22% (34% when considering food wastage) short of population needs, and this varies from 58% to 13% across low- and upper-middle-income countries. High-income countries appear to have sufficient F&V supply<sup>(16)</sup>. These large differences between countries may be due to a range of factors, such as producer-end subsidies for other crops, adequacy of distribution systems (increasing F&V wastage), increasing population size, international trade, and the exclusion of subsistence farming and food production from the aforementioned figures.

An estimated F&V supply gap of 34% and 43% has been projected for years 2025 and 2050, respectively, with widening

gaps between high-/middle-income and low-income countries, if current production levels remain constant<sup>(16)</sup>.

### Strategies to increase fruit and vegetable intake: what works?

The World Cancer Research Fund's 'NOURISHING' framework of food policies to promote a healthy diet<sup>(17)</sup> provides a useful structure to identify where action is most needed to increase F&V consumption. The NOURISHING framework focuses on policy efforts to improve the healthiness of food environments. These efforts include offering healthy foods and setting nutrition standards in key settings such as schools, food pricing strategies, food labelling regulations and tougher restrictions on junk food marketing to kids. Policy efforts focusing on food environments hinge upon harnessing supply chains and actions across sectors. Indeed, there is a tension between the need to consume more, on the one hand, and making reasonably priced F&V sufficiently available, on the other.

A lot of countries globally have F&V programmes or schemes in place in schools, some of them for lower socio-economic students only<sup>(18)</sup>. There is evidence that these programmes or schemes work to increase fruit consumption<sup>(19,20)</sup> and to restrain the consumption of junk food among wealthier children<sup>(21)</sup>. Some countries use targeted subsidies for healthy foods, including F&V<sup>(18)</sup>. Australia has implemented a Goods and Services Tax exemption for fresh F&V. Fiji has removed original import and excise duty (set at 5–32%) on F&V that are not locally grown to promote F&V consumption.

This issue of *Public Health Nutrition* includes an example at the local level. The New York City Health Department District Public Health Offices distribute 'Health Bucks' to farmers' markets in low-income neighbourhoods. When customers use income support (e.g. Food Stamps) to purchase food at farmers' markets, they receive one Health Buck worth \$US 2 for each \$US 5 spent, which can then be used to purchase fresh F&V. According to Olsho *et al.*<sup>(22)</sup>, greater exposure to Health Bucks was associated with greater awareness of farmers' markets; increased frequency and amount of farmers' market purchases; and greater likelihood of a self-reported year-over-year increase in F&V consumption.

Reducing junk food marketing to kids also has potential to improve diets<sup>(23)</sup>. Team FNV (<http://www.fnv.com/>) is a recent innovative campaign in the USA to market F&V

and have F&V taking over the billboards from junk food. F&V claims on food packages are often not regulated under existing regulations or standards. Heller *et al.*<sup>(24)</sup> show in this issue that labels and advertisements for sham fruit foods mislead children with regard to the food's real fruit content. Wellard *et al.*<sup>(25)</sup> further suggest that F&V claims should be regulated using nutrient profiling. They found that many products in Australia carried F&V claims and were significantly higher in energy, saturated fat, sugar and sodium than fresh F&V. Marketing these products as a way of meeting F&V intake is misleading.

Moreover, it may contribute to increasing the already important social gradient in nutritional health literacy<sup>(26)</sup> and the intake of ultra-processed foods that are high in fat, sugar and/or sodium. There are considerable and widening inequalities<sup>(27,28)</sup> both in the consumption of healthy diets<sup>(29)</sup> and in nutrition-related diseases<sup>(30–33)</sup>. It can be argued that health claims are an effective form of marketing, which is a well-established way of influencing consumer food purchasing and consumption behaviour<sup>(34)</sup>.

The NOURISHING framework also recommends policy areas focusing on population- and individual-level behaviour change and communication, including information, nutrition advice and counselling. There is mixed evidence that F&V promotion campaigns are useful, with some reviews concluding that 5-a-day and other campaigns are somewhat effective at improving knowledge and awareness of recommended F&V portions as well as purchasing behaviour<sup>(35,36)</sup> and others finding modest evidence that campaigns aimed to promote an increase in F&V intake<sup>(37)</sup> are effective. Intensive long-term campaigns that communicate simple, unambiguous messages through many different channels and involve the whole family in an interactive way have been found to be most effective.

Nudging to increase F&V consumption has been trialled. Van Kleef *et al.*<sup>(38)</sup> suggest in this issue that children's vegetable intake can be improved by serving larger portions in smaller-sized pieces. In addition, a study from Peru<sup>(39)</sup> found that promoting fruit consumption by product placement close to the point of purchase, adding health information and price reduction had a positive effect on fruit purchasing in a university cafeteria, especially in males and non-student adults. Yi *et al.*<sup>(40)</sup>, however, show that the perception of specific vegetables on taste, healthiness, ease of preparation and cost varies significantly across different consumer segments. This has implications for the development of new approaches to promoting different vegetables.

Grier *et al.*<sup>(41)</sup> evaluated the feasibility of a 10-week gardening and nutrition education programme for young people and their communities living in a low-income area of Virginia (USA). They found potential for the programme in that it significantly improved self-efficacy around F&V, gardening knowledge and familiarity with food-based dietary guidelines. Grier *et al.*'s study contributes to strengthening the evidence base on urban gardening programmes<sup>(42)</sup>. Gudzone *et al.*<sup>(43)</sup> also tested opportunities to

improve F&V consumption in a low-income urban setting: they paired urban farms with corner stores for produce distribution, which may be feasible as a new model to increase access to F&V among low-income urban neighbourhoods. This echoes the findings of reviews which highlight the importance of multifaceted approaches to F&V<sup>(44–46)</sup>, including active participation of the wider community and hands-on exposure to F&V.

Overall, promising strategies for increasing F&V consumption include community-based multi-component interventions to maximise exposure to F&V, interventions in supermarkets and canteens to make F&V more visible and accessible, F&V programmes in schools, reducing junk food marketing to kids and reducing the price of F&V<sup>(35,45,47,48)</sup>.

### Future directions

Existing interventions have led to only small to medium increases in the actual consumption of F&V, which is not sufficient to meet the WHO recommendations. In addition, the supply of F&V is currently not sufficient for everyone to meet existing recommendations. The global nutrition and agricultural communities need to find innovative strategies to increase both the supply of and the demand for F&V to meet population health needs.

Some of the strategies to increase demand for F&V may include: providing fresh F&V for low-income students; creating healthier school food environments; farm-to-institution programmes in schools, hospitals and workplaces; taxes on foods of low nutritional value and subsidies on F&V; stricter controls on marketing for unhealthy foods; supporting community gardens; and providing vouchers to help low-income pregnant women and their infants/young children purchase more F&V. Increasing the supply of F&V needs further consideration and could potentially be achieved through: tackling food loss and waste across the supply chain; adequate distribution systems in low-income countries; reducing producer-end subsidies for other crops; and optimizing international trade. Notably, these strategies range across multiple levels, from local to global, and they will have their best chance at success if there is a shared vision of what needs to be achieved and some coordinated effort towards that end.

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### References

1. Hall JN, Moore S, Harper SB *et al.* (2009) Global variability in fruit and vegetable consumption. *Am J Prev Med* **36**, 402–409. e5.

2. Zhan J, Liu YJ, Cai LB *et al.* (2015) Fruit and vegetable consumption and risk of cardiovascular disease: a meta-analysis of prospective cohort studies. *Crit Rev Food Sci Nutr*, (Epublication ahead of print version).
3. Li M, Fan Y, Zhang X *et al.* (2014) Fruit and vegetable intake and risk of type 2 diabetes mellitus: meta-analysis of prospective cohort studies. *BMJ Open* **4**, e005497.
4. Hartley L, Igbinedion E, Holmes J *et al.* (2013) Increased consumption of fruit and vegetables for the primary prevention of cardiovascular diseases. *Cochrane Database Syst Rev* **6**, CD009874.
5. He FJ, Nowson CA, Lucas M *et al.* (2007) Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies. *J Hum Hypertens* **21**, 717–728.
6. Dauchet L, Amouyel P, Hercberg S *et al.* (2006) Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. *J Nutr* **136**, 2588–2593.
7. Turati F, Rossi M, Pelucchi C *et al.* (2015) Fruit and vegetables and cancer risk: a review of southern European studies. *Br J Nutr* **113**, Suppl. 2, S102–S110.
8. Hung HC, Josphipura KJ, Jiang R *et al.* (2004) Fruit and vegetable intake and risk of major chronic disease. *J Natl Cancer Inst* **96**, 1577–1584.
9. Lim SS, Vos T, Flaxman AD *et al.* (2013) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380**, 2224–2260.
10. World Health Organization (2004) *Global Strategy on Diet, Physical Activity and Health*. Geneva: WHO.
11. Oyebo O, Gordon-Dseagu V, Walker A *et al.* (2014) Fruit and vegetable consumption and all-cause, cancer and CVD mortality: analysis of Health Survey for England data. *J Epidemiol Community Health* **68**, 856–862.
12. Lock K, Pomerleau J, Caser L *et al.* (2004) Low fruit and vegetable consumption. In *Comparative Quantification of Health Risks: Global and Regional Burden of Diseases Attributable to Selected Major Risk Factors*, pp. 597–728 [M Ezzati, AD Lopez, A Rodgers *et al.*, editors]. Geneva: WHO.
13. Murphy MM, Barraj LM, Spungen JH *et al.* (2014) Global assessment of select phytonutrient intakes by level of fruit and vegetable consumption. *Br J Nutr* **112**, 1004–1018.
14. Kamphuis CB, Giskes K, de Bruijn GJ *et al.* (2006) Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *Br J Nutr* **96**, 620–635.
15. Wolnicka K, Taraszewska AM, Jaczewska-Schuetz J *et al.* (2015) Factors within the family environment such as parents' dietary habits and fruit and vegetable availability have the greatest influence on fruit and vegetable consumption by Polish children. *Public Health Nutr* **18**, 2705–2711.
16. Siegel KR, Ali MK, Srinivasiah A *et al.* (2014) Do we produce enough fruits and vegetables to meet global health need? *PLoS One* **9**, e104059.
17. Hawkes C, Jewell J & Allen K (2013) A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the NOURISHING framework. *Obes Rev* **14**, 159–168.
18. World Cancer Research Fund (2014) WCRF International Food Policy Framework for Healthy Diets: NOURISHING 2014. <http://www.wcrf.org/int/policy/nourishing-framework/offer-healthy-foods> (accessed June 2014).
19. Schwartz MB, Henderson KE, Read M *et al.* (2015) New school meal regulations increase fruit consumption and do not increase total plate waste. *Child Obes* **11**, 242–247.
20. Ovrum A & Bere E (2014) Evaluating free school fruit: results from a natural experiment in Norway with representative data. *Public Health Nutr* **17**, 1224–1231.
21. Brunello G, De Paola M & Labartino G (2014) More apples fewer chips? The effect of school fruit schemes on the consumption of junk food. *Health Policy* **118**, 114–126.
22. Olsho LE, Payne GH, Walker DK *et al.* (2015) Impacts of a farmers' market incentive programme on fruit and vegetable access, purchase and consumption. *Public Health Nutr* **18**, 2712–2721.
23. Boyland EJ & Whalen R (2015) Food advertising to children and its effects on diet: a review of recent prevalence and impact data. *Pediatr Diabetes* **16**, 331–337.
24. Heller R, Martin-Biggers J, Berhaupt-Glickstein A *et al.* (2015) Fruit-related terms and images on food packages and advertisements affect children's perceptions of foods' fruit content. *Public Health Nutr* **18**, 2722–2728.
25. Wellard L, Hughes C, Tsang YW *et al.* (2015) Investigating fruit and vegetable claims on Australian food packages. *Public Health Nutr* **18**, 2729–2735.
26. Cowburn G & Stockley L (2005) Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutr* **8**, 21–28.
27. World Health Organization, Commission on Social Determinants of Health (2008) *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health. Final Report of the Commission on Social Determinants of Health*. Geneva: WHO.
28. Bell D & Slater E (2012) In poor health: London's shocking disparity in men's life expectancy. *The Bureau of Investigative Journalism*, 25 June; available at <https://www.thebureauinvestigates.com/2012/06/25/in-poor-health-shocking-disparity-across-capital-in-male-life-expectancy-rates/>.
29. Mathieson A & Koller T (2006) *Addressing the Socio-economic Determinants of Healthy Eating Habits and Physical Activity Levels among Adolescents. WHO/HBSC FORUM 2006*. Copenhagen: WHO Regional Office for Europe.
30. Stamatakis E, Wardle J & Cole TJ (2010) Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *Int J Obes (Lond)* **34**, 41–47.
31. Dinsdale H, Ridler C & Rutter H (2012) *National Child Measurement Programme: Changes in Children's Body Mass Index between 2006/07 and 2010/11*. Oxford: National Obesity Observatory.
32. van Rossem L, Silva LM, Hokken-Koelega A *et al.* (2010) Socioeconomic status is not inversely associated with overweight in preschool children. *J Pediatr* **157**, 929–935. e1.
33. Howe LD, Tilling K, Galobardes B *et al.* (2011) Socioeconomic disparities in trajectories of adiposity across childhood. *Int J Pediatr Obes* **6**, e144–e153.
34. Cairns G, Angus K & Hastings G (2009) *The Extent, Nature and Effects of Food Promotion to Children: A Review of the Evidence to December 2008*. Geneva: WHO.
35. Mozaffarian D, Afshin A, Benowitz NL *et al.* (2012) Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation* **126**, 1514–1563.
36. Hawkes C (2013) *Promoting Healthy Diets through Nutrition Education and Changes in the Food Environment: An International Review of Actions and Their Effectiveness. Background Paper for the International Conference on Nutrition (ICN2)*. Rome: FAO.
37. Rekhly R & McConchie R (2014) Promoting consumption of fruit and vegetables for better health. Have campaigns delivered on the goals? *Appetite* **79**, 113–123.
38. van Kleef E, Bruggers I & de Vet E (2015) Encouraging vegetable intake as a snack among children: the influence of portion and unit size. *Public Health Nutr* **18**, 2736–2741.
39. Cardenas MK, Benziger CP, Pillay TD *et al.* (2015) The effect of changes in visibility and price on fruit purchasing at a

- university cafeteria in Lima, Peru. *Public Health Nutr* **18**, 2742–2749.
40. Yi S, Kanetkar V & Brauer P (2015) Assessment of heterogeneity in types of vegetables served by main household food preparers and food decision influencers. *Public Health Nutr* **18**, 2750–2758.
  41. Grier K, Hill JL, Reese F *et al.* (2015) Feasibility of an experiential community garden and nutrition programme for youth living in public housing. *Public Health Nutr* **18**, 2759–2769.
  42. Warren E, Hawkesworth S & Knai C (2015) Investigating the association between urban agriculture and food security, dietary diversity, and nutritional status: a systematic literature review. *Food Policy* **53**, 54–66.
  43. Gudzone KA, Welsh C, Lane E *et al.* (2015) Increasing access to fresh produce by pairing urban farms with corner stores: a case study in a low-income urban setting. *Public Health Nutr* **18**, 2770–2774.
  44. Knai C, Petticrew M, Durand M *et al.* (2015) Has a public-private partnership resulted in action on healthier diets in England? An analysis of the Public Health Responsibility Deal food pledges. *Food Policy* (Epublication ahead of print version).
  45. Pomerleau J, Lock K, Knai C *et al.* (2005) Interventions designed to increase adult fruit and vegetable intake can be effective: a systematic review of the literature. *J Nutr* **135**, 2486–2495.
  46. Knai C, Pomerleau J, Lock K *et al.* (2006) Getting children to eat more fruit and vegetables: a systematic review. *Prev Med* **42**, 85–95.
  47. Escaron AL, Meinen AM, Nitzke SA *et al.* (2013) Supermarket and grocery store-based interventions to promote healthful food choices and eating practices: a systematic review. *Prev Chronic Dis* **10**, E50.
  48. Glanz K, Bader MD & Iyer S (2012) Retail grocery store marketing strategies and obesity: an integrative review. *Am J Prev Med* **42**, 503–512.