



Smart food policies for obesity prevention

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For an [infographic on food policy](#) see <http://www.thelancet.com/infographics/obesity-food-policy>

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Prevention of obesity requires policies that work. In this Series paper, we propose a new way to understand how food policies could be made to work more effectively for obesity prevention. Our approach draws on evidence from a range of disciplines (psychology, economics, and public health nutrition) to develop a theory of change to understand how food policies work. We focus on one of the key determinants of obesity: diet. The evidence we review suggests that the interaction between human food preferences and the environment in which those preferences are learned, expressed, and reassessed has a central role. We identify four mechanisms through which food policies can affect diet: providing an enabling environment for learning of healthy preferences, overcoming barriers to the expression of healthy preferences, encouraging people to reassess existing unhealthy preferences at the point-of-purchase, and stimulating a food-systems response. We explore how actions in three specific policy areas (school settings, economic instruments, and nutrition labelling) work through these mechanisms, and draw implications for more effective policy design. We find that effective food-policy actions are those that lead to positive changes to food, social, and information environments and the systems that underpin them. Effective food-policy actions are tailored to the preference, behavioural, socioeconomic, and demographic characteristics of the people they seek to support, are designed to work through the mechanisms through which they have greatest effect, and are implemented as part of a combination of mutually reinforcing actions. Moving forward, priorities should include comprehensive policy actions that create an enabling environment for infants and children to learn healthy food preferences and targeted actions that enable disadvantaged populations to overcome barriers to meeting healthy preferences. Policy assessments should be carefully designed on the basis of a theory of change, using indicators of progress along the various pathways towards the long-term goal of reducing obesity rates.

Introduction

What works to prevent obesity? This question is often asked by policy makers and politicians, and in this Series paper, we address it in the realm of food policy. To do so, we explore how food-policy actions work. Our objective is to identify how such policies can be designed to be more effective. For the purposes of this paper, food policies are defined as actions that aim to improve the human diet. We focus on policies at the consumer-end of the food system, recognising that they have the potential to influence both supply and demand. We define effective food policies as those that successfully influence one of the key determinants of obesity: diet.

We start by reviewing the relevant evidence from psychology, economics, and public health nutrition to develop a theory of change through which food-policy actions could be expected to affect diet. We find that the interactions between people's environments and their food preferences are key in the identification of the mechanisms through which food policies work. We explore how actions in three specific policy areas (school settings, economic instruments, and nutrition labelling) work through these mechanisms. We use the theory of change and the evidence reviewed to provide guidance for the design, prioritisation, and assessment of effective food policies.

How food-policy actions work

The theory of change

Theories of change are a useful method to understand complex problems such as obesity because they

highlight the mechanisms through which interventions are expected to lead to specific changes, and how these changes might interact.^{1,2} In this paper, we develop a theory of change to identify the key mechanisms through which food-policy actions work (figure). Four pieces of evidence were especially important in the formulation of the theory: first, the importance of food preferences in the determination of what people eat, and the influence of food, social, and information environments in the shaping of these food preferences (panel 1); second, the barriers that people face, especially people of low socioeconomic status, in accessing, preparing, and eating healthy diets; third, the effect of food prices and presentation on people's purchase and consumption choices; and finally, the evidence that activities in the food system, eg, in production, distribution, processing, and marketing, affect food environments, and are affected by food policies.

On the basis of this evidence, people's environments emerge as central in the theory of change, as a mediator between learned food preferences and eating behaviours (figure). We identify four mechanisms through which food-policy actions could be expected to work: by providing enabling food, social, and information environments for healthy preference learning; by overcoming barriers to the expression of healthy preferences in these environments; by encouraging people to reassess existing unhealthy preferences when they are choosing and purchasing food; and by stimulating a food-systems

response. We now discuss the evidence base for each of the mechanisms in turn.

Mechanism 1: to provide an enabling environment for healthy preference learning

The first mechanism is based on the evidence that although some aspects of human food preferences are innate, they are mostly learned (panel 1). Food preferences refer to whether someone likes a food and how much and how often they want to eat it. The evidence shows that these preferences are influenced by exposure to the eating behaviours of parents, caregivers, peers, and role models, to foods that are available inside and outside the home, and to cultures and social norms around food more broadly (panel 1). Preferences can also change in response to new information and marketing. Repeated exposure to the conditions in which consumption occurs can also lead to the development of habits, which then become default preferences.

This process of preference learning begins in the early stages of life (panel 1). Although preferences can be modified over time, they are often persistent and resistant to change. A potentially powerful role for policy is therefore to support an environment that encourages healthy preference learning early in life and by young children.

Mechanism 2: to overcome barriers to the expression of healthy preferences

The second mechanism is based on the evidence that the ability to access and consume a healthy diet is compromised by many barriers, even when people have a preference to eat well. This problem is particularly important for groups of low socioeconomic status. Many of these barriers are underpinned by the structure of the food system.³⁵ Barriers to availability of nutritious foods are widespread in rural areas.³⁶ They are also present in urban areas where the quality and quantity of available foods varies substantially between neighbourhoods.³⁷ Evidence suggests that healthy foods are typically more expensive than less healthy alternatives,³⁸ and healthy, culturally acceptable diets are often beyond the reach of low-income families.^{39,40} Lack of time, physical resources, information, skills, mobility, and social support are additional barriers to the preparation and consumption of healthy diets,^{41–45} and can affect all income groups. A second role for policy is therefore to lift these barriers to enable people to express healthy preferences.

Mechanism 3: to encourage people to reassess existing unhealthy preferences

The third mechanism is based on evidence that people who have already developed unhealthy preferences struggle to make healthier choices,^{46–48} but that these choices can be shifted through changes in the way food

is priced and presented. According to the nudge theory developed in behavioural economics, the way food is priced and presented in retail and food service

Key messages

- Food policies have an essential role in curbing the global obesity epidemic, but they need to be well designed to effectively attain their goal of healthier diets for all
- To design effective food policies that prevent obesity, a better understanding of how they work is needed
- The interaction between people's food preferences and the environments and systems in which these preferences are learned, expressed, and reassessed provides a novel perspective from which to understand how food policies work
- Four of the key mechanisms through which food policies can work are by 1) providing an enabling environment for healthy preference learning, 2) overcoming barriers to the expression of healthy preferences, 3) encouraging people to reassess existing unhealthy preferences, and 4) stimulating a positive food-systems response
- To have a sustained and equitable effect over the long term, the top policy priority should be to implement comprehensive policies that create food, information, and social environments that enable infants and young children to learn healthy preferences; food policies should aim not just to make the healthy choice the easy choice, but the healthy choice the preferred choice
- Food-policy actions that enable disadvantaged populations to overcome barriers, such as poor access, skills, and social support, to the expression of healthy preferences would be a relatively quick way to address inequalities
- How quickly food policies work and how effective they are, will vary depending on people's pre-existing preferences and other behavioural, socioeconomic, and demographic characteristics; population-level policies should be better tailored to the population's characteristics
- A combination of actions is needed to support effective, mutually reinforcing, and systemic change; modelling can be used to identify what combination of policies may work most effectively and for which groups
- The design and assessment of population-based food policies can be enriched by the joining and combining of insights from behavioural research, economics, and public health
- Smart food policies can be expected to have a substantial and sustained effect on obesity over the long term; over the short term, policy makers and researchers need to manage the expectations of politicians by developing indicators of early progress towards a longer-term goal

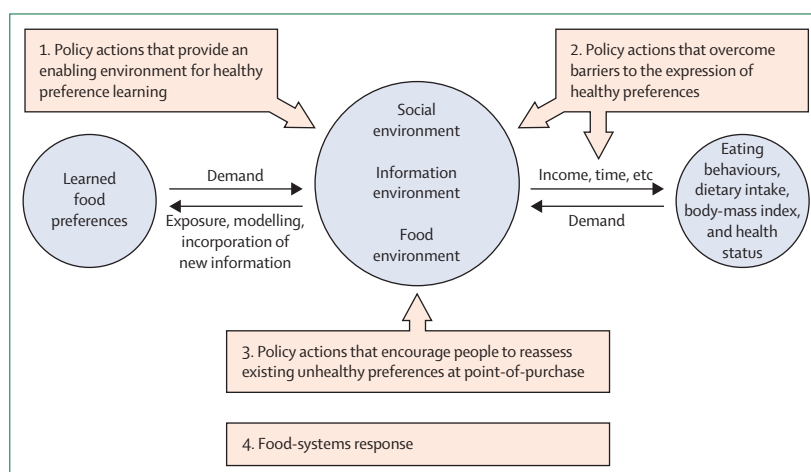


Figure: Framework of the theory of change and the four mechanisms through which food-policy actions could be expected to work

Panel 1: What are food preferences and how are they learned?

Food preferences are well established as important determinants of food intake.³⁻⁵ In psychology, the term food preferences is sometimes used narrowly to refer to liking for a food, or more specifically for a taste (taste preferences), but it can also be used more broadly to encompass what people say they want to eat, and in what quantities and frequency. Food preferences are thus defined in this Series as what people would select to eat at any one time from available options in a free choice environment.

Some aspects of food preferences are innate; for example, human infants have a liking for sweetness.⁶ But most aspects of food preferences are malleable and learned over time. This flexibility probably indicates an evolved capacity to learn which of the available foods provide adequate energy and are non-toxic.^{7,8}

Preference learning (and unlearning) is a lifelong process. It starts before birth and is influenced by early feeding practices.⁹ A major determinant of food preferences is the familiarity of the taste, which goes alongside the experience of the consequences of consumption (eg, post-ingestional nausea results in dislike for the food). Familiarity, in turn, is a result of exposure to the taste of a food. Numerous laboratory and naturalistic studies show that repeated exposure to the taste of a food results in children liking it more and eating more.^{10,11} Preference learning can involve reinforcing innate preferences (eg, for sweetness) or unlearning innate dislikes (eg, coffee) and less favoured foods such as vegetables.^{4,7}

Parents and caregivers potentially exert a key influence on their children's food preferences through the foods that they provide in the home as well as their feeding practices, which may be conducive to, or hinder, the development of healthy eating patterns.^{12,13} The home environment has been shown to be particularly important in the influencing of preferences for energy-dense foods.¹⁴ Social and cultural norms also play a role in preference learning.^{15,16} Modelling via social and cultural norms around food influences preferences,^{17,18} including through peer groups and social networks.^{19,20}

Recurring exposure to the same food environment can lead to routine or habitual behaviour, which might be non-cognitive, but nevertheless leads to preferences for some actions and choices.^{21,22} The more often an action (eg, an eating behaviour) is taken under stable circumstances, the more behaviour is determined by the habit.^{23,24} Past consumption can thus predict future behaviour.²⁵

Information can also influence food preferences. Advertising has a direct effect on preferences by creating familiar and positive associations.^{26,27} Children who habitually watch more television display an enhanced preference after exposure to food advertising,²⁸ and prefer the taste of branded foods and drinks over identical products in plain packages.^{29,30} Consumer preferences for brands can persist over time and space.³¹

Actions taken by food market actors aim to mobilise, enhance, and sometimes even create food preferences. For example, snack foods and confectionery are formulated to exploit innate preferences for sweetness and energy density.³² Sizing up of portions by food companies encourages children to eat beyond the level at which their appetite is satisfied, which can then become normalised and preferred.³³ In low-income and middle-income countries, companies have worked to make their products as available and affordable as possible to create new preferences and habits.³⁴

environments can encourage people to make choices that satisfy long-term preferences for health rather than following unhealthy preferences for short-term gratification.⁴⁹ This theory is supported by empirical evidence, which shows that food availability and presentation at point-of-purchase shapes people's food choices.^{21,50} Conventional economic theory also posits that high prices encourage people to shift away from the food they might have otherwise chosen.⁵¹ This shift

is supported by empirical evidence that people are less likely to choose foods when their prices rise, and even less so when acceptable alternative foods are available.^{52,53} A third role for food policy is thus to influence the prices, availability, and presentation (choice architecture) of healthier options to encourage consumers to reassess their preferences and make alternative choices.

Mechanism 4: to stimulate a food-systems response

The fourth mechanism is based on the evidence that food policies designed to affect consumer choices can also stimulate interdependent actions elsewhere in the food system. For example, mandatory labelling of trans fats in the USA is reported to have incentivised the food industry to reduce the level of trans fats in foods through reformulation.⁵⁴ Actions taken further upstream in the food system, such as interventions by governments to overcome bottlenecks in the supply of healthy foods and enhance the nutritional quality of available foods, can also affect food environments.⁵⁵ A fourth role of policy is thus to induce systemic dynamic positive feedback responses in the food system.

Testing of the theory: how have policy actions worked?

Can the mechanisms that drive this theory of change further an understanding of how food policies have worked? Here we review the evidence in three specific policy areas (school settings, economic instruments, and nutrition labelling), with the aim of identifying which—if any—of the mechanisms are at work. The review includes evidence from systematic reviews and assessments of implemented policy actions. We use the analysis to provide insights for improved policy design (table).

School settings

Schools are an influential setting for young children. According to the theory of change, actions in schools can be expected to work through different mechanisms, depending on the specific policy action taken and the characteristics of the population.

Specific actions to improve diets in school settings include the provision of fruits and vegetables, food-based and nutrient-based standards on the foods and meals available in schools, changes to presentation and financial incentives for food choices at point-of-purchase, and nutrition education.

Programmes that provide fruits and vegetables have been shown to enhance attitudes and consumption both inside and outside schools by providing opportunities for repeated exposure.⁵⁶⁻⁶¹ Several systematic reviews conclude that such programmes are generally more effective when they combine distribution of fruits and vegetables with various other actions.^{57,61,62,63} These findings suggest that preference learning is a primary mechanism through which the programmes work, since exposure, reinforced

	Core policy objectives*	Core elements	Examples of additional complementary and mutually reinforcing elements
School settings			
Fruit and vegetable programmes	Healthy preference learning; overcome barriers to meeting healthy preferences caused by lack of financial or physical access	Provide repeated and sustained exposure to fruit and vegetables; focus on products that appeal to taste preferences; provide free where barriers to access are significant	Actions to change knowledge, awareness, attitudes, and behaviours (eg, nutrition education, school gardens) towards fruits and vegetables in children, teachers, parents, caregivers, and community members; leverage incentives created by increased market access for fruit and vegetable producers and retailers
School food standards	Healthy preference learning	Apply to all venues and purchasing channels within and near the school setting; apply to all potential close unhealthy substitutes (eg, all sugar-sweetened beverages); supply healthy substitutes for popular foods and drinks (eg, water or low calorie drinks); engage with staff involved in food delivery, teachers, parents and caregivers	Choice architecture interventions to encourage children to reassess pre-existing unhealthy preferences; actions to change knowledge, awareness, attitudes, and behaviours towards healthy school meals and snacks (eg, nutrition education) in children, teachers, parents, caregivers, and community members; provide incentives for a food-systems response through school food procurement (eg, farm-to-school programmes, procurement standards)
Nutrition education	Healthy preference learning; overcome barriers to meeting healthy preferences caused by poor information and skills	Focus on food and nutrition literacy; focus on food skills, including shopping and cooking; initiate in pre-school settings; train teachers and engage parents and caregivers	Actions to improve the school food environment (eg, fruit and vegetable programmes, school food standards, choice architecture interventions)
Economic instruments			
Taxes	Encourage people to reassess pre-existing unhealthy preferences; healthy preference learning	Make the taxes large; give primary consideration to targeting products with healthier close substitutes, taking into account potential substitution effects that would undermine the overall effect on dietary quality; ensure healthy close substitutes are less expensive; prioritise taxes on unhealthy foods that are popular and habit-forming in young people	Provide complementary information to raise awareness at point-of-purchase; prioritise taxes on unhealthy foods likely to encourage a positive food-systems response (eg through reformulation, shift in product portfolios, changes in pricing strategies)
Subsidies	Overcome barriers to meeting healthy preferences caused by poor financial or physical access; healthy preference learning	Focus on foods for which the target population have a preference but for whom access is a barrier to greater consumption; target families with children to provide a healthy preference-learning environment	To encourage consumers to reassess unhealthy preferences, implement in the form of a financial incentive, or with complementary information to raise awareness at point-of-purchase; sustain over the long term to encourage healthy preference learning; leverage incentives created by increased market demand from retailers and producers
Nutrition labelling			
Nutrient information on food label	Induce a food-systems response; overcome barriers to meeting healthy preferences caused by inadequate information	Include nutrients of priority public health concern amenable to reformulation; make labelling mandatory or provide incentives for wide application; make the label visible, easy to understand, and not misleading; target the contexts where, and the foods for which, provision of information will make a difference to consumer choices	Design the label to encourage consumers to reassess their choices at point-of-purchase; accompany with public awareness and education campaigns about the label; engage with food producers to stimulate food product reformulation, with nutrition labelling a tool to further incentivise the development and production of healthier products
*Core objectives will vary depending on the population and context (see panel 3); all policy actions have the potential to induce a food-systems response.			
Table: Elements of smart food-policy design in three policy areas			

by multiple actions, is known to influence preferences (panel 1). The success of free schemes relative to paid schemes suggests that school fruit programmes also operate through the mechanism of overcoming barriers to access for children who already like fruits and vegetables but have inadequate access at home.⁶⁴

School policies to restrict availability and portion size of foods and drinks are a way of removing negative external influences into the process of preference learning. Assessments of implemented policies show that they are effective in reducing caloric intake and increasing healthy food intake inside schools.^{65–67} Nevertheless, pre-existing preferences for these foods mean that policies are prone to be undermined if inadequately designed and implemented.⁶⁸ Analyses

from the USA^{69,70} show that only partial restriction of foods, drinks, and sales channels compromises the effectiveness of the policies because children are still exposed to them. Children also compensate by bringing the restricted foods and drinks from home or consuming more food outside of school. A comprehensive, multifaceted approach tends to lead to more positive results.⁷¹ In the UK, for example, the introduction of comprehensive school food standards in 2008 as part of a whole-school approach, led to substantially improved daily dietary intake among primary school children compared to previous piecemeal changes.^{72,73}

There is also evidence that school food policies can work by encouraging children to reassess their preferences at point-of-purchase: changes to the order of foods presented

in buffets in public and private institutional settings has been shown to encourage a shift towards healthier consumption patterns.^{74,75}

With regard to nutrition education in schools, randomised controlled trials in different countries show that well designed education-only interventions can effectively improve knowledge and shift consumption of a range of foods in children across the socioeconomic range.^{76–80} However, in other contexts, nutrition education alone has been shown to be insufficient to effect change. A series of interventions in Chile showed that nutrition education interventions had minimal effects in improving food habits in schools with a large proportion of children from low-income families.^{81–83} Poor outcomes were attributed to problems with implementation, lack of accompanying changes in the school food environment, and pre-existing unhealthy preferences among children, their parents, and teachers.

These findings are illustrative of a broader evidence base showing that nutrition education is more effective when it aims to stimulate learning, literacy, skills, and action, rather than just providing knowledge.^{84,85} These findings also reflect the evidence that moderating factors, such as pre-existing preferences, attitudes, knowledge, gender, habit strength, and sociodemographic factors play a critical role in influencing effectiveness.^{86,87}

This has important implications for the smart design of actions in school settings (table). Effective policies involve a suite of actions that take the characteristics of the school-population into account. In all schools, actions should be designed to create a healthy preference-learning environment, such as through repeated and sustained exposure to healthy foods, comprehensive and consistent food standards, and skills and literacy-oriented nutrition education for children (including very young children), their teachers, and catering staff.

Targeted food taxes and subsidies

When purchasing foods, consumers have to assess their preference for the food against its cost. Health-related food taxes have the potential to influence this assessment process. Systematic reviews suggest that food taxes have the potential to reduce the purchase of the targeted foods and drinks.^{53,88–92} These findings are supported by evidence from three countries with food taxes. An analysis of the effect of a tax on saturated fat in Denmark (introduced in 2011 and abolished in 2012) showed a 10–15% decrease in consumption of selected targeted products.⁹³ An assessment of the public health product tax in Hungary (introduced in 2011) showed that sales of products subject to taxation decreased by 27%, consistent with a 25–35% decrease in consumption.⁹⁴ Early results of the soft drink tax in Mexico (implemented in 2014) also indicate an effect on purchasing in the intended direction.⁹⁵

The immediacy of the effect supports the theory that taxes work primarily by encouraging consumers to reassess their preferences at the point-of-purchase. The

greater need to consider affordability in this decision explains why people with low incomes are more likely to change their purchasing in response to food taxes.^{52,92,96} The findings of some studies also show the greatest effect on young people.⁹⁷ Although inadequately researched,⁹⁰ evidence from other goods suggests this is because young people's preferences are less well formed, and so their assessment is more affected by price and the response to the tax by parents and peers.⁹⁸ Experimental studies show the provision of information about price changes can enhance effectiveness, which also supports the thesis that reassessment is the key mechanism.⁸⁹

In the long term, there are indications that taxes can work by contributing to healthy preference learning. Results of modelling studies suggest that consumer responses to taxes are larger in the long term than in the short term if habit and preferences shift as a result of reduced exposure.^{99,100} Taxes can also influence actions in the food system. In response to the Hungarian tax, for example, manufacturers have either removed the taxed ingredient entirely or decreased the quantity of the ingredient through reformulation.⁹⁶

Food subsidies are generally implemented as a way of overcoming affordability barriers to healthy foods for people with low incomes. Vouchers, financial incentives, and fruit and vegetable boxes have all been established to have a positive effect on the consumption of the targeted foods among low-income families.^{101–105} In addition, there is some evidence that financial incentives can affect higher income groups, not just people with low incomes. For example, a privately run financial incentives programme led to a shift in expenditure on healthier foods in South Africa.^{106,107} This evidence indicates that subsidies can also work by encouraging people to reassess their choices at the point-of-purchase.

Targeted food subsidies have been shown to feed back to change the actions taken by actors in the food system. For example, changes to the Special Supplemental Nutrition Program for Women, Infants, and Children¹⁰⁸ in the USA stimulated grocery stores to increase the availability and variety of healthy foods, especially in low-income neighbourhoods.

The effectiveness of subsidies, as for taxes, can be hampered by pre-existing unhealthy preferences. In some cases, subsidies have been shown to have small effects on the reduction of unhealthy food consumption relative to the increase of healthy food consumption¹⁰⁶ and fail to reduce total calories purchased.^{109,110} Subsidies implemented only over the short term might also be insufficient to shift preferences; more evidence is needed to test this hypothesis.¹⁰²

This analysis has important implications for more effective design of taxes and subsidies (table). Firstly, taxes would need to be sufficiently large to stimulate consumers to reassess their purchase decisions.⁸⁸ Actions to raise awareness at point-of-purchase could strengthen their effect. Close and healthier substitutes

need to be available and less expensive to avoid substitution of the taxed food with a non-targeted less healthy food.⁸⁸ The potential of food taxes to induce a food-systems response could be more effectively levered by strategically targeting foods that can be reformulated. Subsidies should target populations that face affordability and access barriers to healthy foods that they like. A focus on families with young children would also help provide a healthy preference learning environment at home. To affect people with low preferences for these foods, subsidies need to be implemented in the form of an incentive, encouraging people to reassess their preferences, and sustained for a sufficient time to enable preferences and habits to adjust.

Nutrition labelling

The evidence base on the effects of nutrition labelling is quite complex, both for mandatory nutrient lists and more visible labels that interpret the nutrition content. Overall, the evidence suggests that labels work by filling an information gap for groups of people who already have healthy preferences and an intention to eat healthy foods, but for whom a scarcity of information at the point-of-purchase serves as a barrier to expression of these preferences.

Mandatory nutrient lists can be difficult to understand. In high-income and lower-income countries, nutrient lists are used more by consumers with increased levels of nutrition knowledge, healthy eating behaviours, or high incomes.^{111–115} Calorie labels, labels with more explicit indication of nutrient content (eg, use of words or colours to indicate high, medium, or low nutrient content), or those based on a nutritional rating system have been found to be easier to understand and interpret correctly.^{111,116,117} But even for these labels, the effects on purchasing depend on the food preferences and intentions of the population, their degree of existing knowledge, the purchasing occasion, the foods, the frequency of purchase, the type of labelling, and the setting.^{118–127} This is illustrated by different responses to calorie labels in different contexts and populations.^{118,119,122,125–127} For example, mandatory calorie labelling in a coffee shop chain in New York City had an effect on calories purchased by people with high income, high education, and high calorie-consumption who previously underestimated the amount of calories in the food items.¹¹⁸ A similar label posted in fast-food outlets in Philadelphia and Baltimore had a negligible effect on frequent customers of all educational and income levels.¹¹⁹

There is consistent evidence, however, that mandatory or widely implemented labelling of calories or specific nutrients has an effect through the mechanism of food-systems response. Adoption of the Choices logo in the Netherlands,¹²⁸ mandatory trans fat labelling in South Korea, Canada, and the USA,^{54,129,130} the Pick the Tick logo in New Zealand,¹³¹ and mandatory menu labelling in Washington State¹³² are all reported to have led to reformulations that improved the nutrient profile

of the products on the market. These results indicate that the main mechanism through which labels have worked to affect the diets of wider populations is by creating an incentive for food manufacturers and restaurant chains to change their products.

Smart nutrition labelling policies should therefore first aim to maximise a food-systems response through the creation of incentives for product reformulation. In order for nutrition labels to also have a direct effect on consumer choices, they should target the contexts and foods where specific groups of consumers are likely to respond to new information. To achieve both these goals, labels should be highly visible, understandable, and not misleading. The nutrients listed should be amenable to reformulation and of concern to the target group. Further work is needed to assess if the use of interpretive elements could, with time, broaden the effect of labelling by encouraging consumers to reassess unhealthy preferences.^{133–135}

How to design more effective food policies

Principles and challenges

The analysis presented in this Series paper shows that the learning, expression, and reassessment of food preferences in the context of people's environments are important elements in understanding how food policies work. The evidence indicates that effective policy actions are those which change some aspect of the food, social and information environment around people and

Panel 2: Five principles for effective food-policy actions

People

Effective policies are based on an understanding of the people they seek to support. They take account of people's preferences, behaviours, socioeconomic and demographic characteristics, and the problems they face in eating healthy diets.

Environments

Effective policies change some aspect of the food, social, and information environments around people.

Systems

Effective policies work, directly or indirectly, to change the food, information and social systems that underpin people's environments. They support the creation of dynamic positive feedback mechanisms in those systems.

Mechanisms of change

Effective policies are based on an understanding of the mechanisms through which they can have the greatest effect (panel 4). The most effective policies operate through multiple mechanisms, including a positive food-systems response.

Layering and reinforcement

Effective policies are not implemented as single magic bullets, but as part of a combination of complementary and mutually reinforcing actions.

Panel 3: How to design smart food policies

- First, identify the problem you seek to address, the characteristics of the population you seek to influence (including their preference profile, other behavioural mediators, and their socioeconomic and demographic characteristics); and whether the problem is one of, or a combination of, learned unhealthy preferences, barriers to access to expressing healthy preferences, or an environment that encourages unhealthy food choices at point-of-purchase
- On the basis of this analysis, identify the mechanisms through which the policy would be expected to work and the range of policy options available to work through the identified mechanisms (examples given in panel 4)
- Select one or more policy actions and design them to work through the selected mechanisms; tailor the policy to the characteristics of the population
- Identify complementary and mutually reinforcing actions to directly enhance effectiveness within the target populations and create positive feedbacks in underlying systems; take time to reflect upon the initial effects of the implemented action, and adapt the action as necessary

the systems that underpin them, are tailored to the preference, behavioural, socioeconomic, and demographic characteristics of the people they seek to support, work through the mechanisms likely to have most impact, and are implemented as part of a combination of actions. Five principles can therefore be set out for effective food policy (panel 2). These principles are broadly consistent with findings about how to design behaviour change interventions most effectively.¹³⁶

From the analysis emerge two core challenges for food policies for obesity prevention. First, as a result of variations in pre-learned preferences and other mediators, the effects of food policies can be expected to be heterogeneous. The challenge here is to design policies tailored to these characteristics, while still retaining a population-level focus. Second, unhealthy preference learning leaves a legacy: after people learn unhealthy preferences, they become more resistant to change. The challenge is both technical—change of preferences takes time—and political—government policy proposals may be unpopular if people perceive them to restrict what they want to eat.

Practical steps

The basic steps needed to design effective food policies for obesity prevention are set out in panel 3. The process includes identification of the problem and the population characteristics, design of the policy to work through the appropriate mechanisms, and identification of complementary policy actions. In this process, mathematical or computational modelling can be a useful technique in assisting decision makers,

both in the identification of key mechanisms at work and in the design of policies that can harness the mechanisms effectively.^{137,138} The process of designing smart policies will also be enriched through greater transdisciplinary engagement between public health, behavioural economics, and systems-science expertise.

Selection of policy priorities

A wealth of policy actions have the potential to work through one or more mechanisms of change (panel 4).

Of these policies, priorities should be selected for specific contexts based on the steps needed to design effective policies set out in panel 3. In addition, governments should prioritise two areas of action. A top priority should be policies which create an enabling environment for healthy preference learning among the young. This is essential if dietary improvements are to be equitable and sustained over the long-term. As recommended by Lobstein and colleagues in this Series,¹³⁹ actions must start very early in life, such as through the promotion and protection of breastfeeding, appropriate complementary feeding, and other actions to support the development of healthy preferences during pregnancy. These actions should continue in the first 2 years of life¹⁴⁰ (the first 1000 days) and the pre-school age.¹⁴¹ As illustrated in panel 4, targeting of infants and young children implies a focus on their parents and caregivers so that they are more able and willing to improve the home learning environment.¹⁴² To be effective, actions should be concerted and comprehensive. It is also essential that they act to reduce intrusion by external market actors into the process of healthy preference learning (panel 1), such as by restricting unhealthy food marketing.^{139,143,144}

A second priority is to ensure that people who want to eat well have the opportunity and capability to do so.¹³⁶ Policy actions that overcome the barriers that people face emerge as a relatively quick win for food policy since, where healthy preferences already exist, well designed policies could be expected to have an immediate positive effect. Since barriers tend to be greater for disadvantaged groups, policies also have strong potential to address inequalities. Policies could also be expected to face fewer political challenges. To be effective, however, policies must be based on accurate identification of the specific barriers people face, eg, scarcity of skills, information, time, money, mobility, or social support and the presence of healthy (rather than unhealthy) preferences.

How to design policy assessments

The analysis in this paper presents some important challenges for the measurement and interpretation of the effects of food-policy actions on diets and obesity. First, policy actions will take time to work when unhealthy preferences have already been learned. Second, actions are likely to affect different people in different ways. Third, the failure of an action could be due to poor design, such as the absence of mutually reinforcing actions.

Fourth, the feedback effects of the policy on the systems underlying food, social, and information environments are difficult to identify.

These challenges have consequences for the design of assessments. Assessments should, similar to the policies themselves, be based on a theory of change,² which means basing the assessment on a clear understanding of the mechanisms through which the policy could be expected to work, what the expected outcomes would be, and when these outcomes can be expected to occur.^{145,146} This is particularly important, since in practice there will probably be a time lag, or an indirect relation, between changes in consumption of specific foods, dietary quality, obesity prevalence, and good health.^{65,76,78,107} Clear indicators need to be identified to measure progress along the various pathways of change towards lower obesity rates. Such indicators have a political role—to show early proxies of progress to politicians and policy makers before the long-term goal is attained. Dynamic modelling could play an important part by elucidating pathways of change and expected time horizons.

Since policies can be expected to have different effects on different groups, assessments should also measure the effects of the policy on population subgroups and assess the role of population characteristics in mediating effectiveness. Groups should be differentiated according to their behavioural characteristics (eg, preferences, intentions, habits)^{87,113} in addition to the more conventional socioeconomic and demographic groupings.¹⁴⁷ The use of so-called stated preferences should be more widely considered as an indicator by policy evaluators. For example, to assess the effect of actions that restrict food marketing to children.²⁸ Assessments should attempt to link specific aspects of policy design with the measured indicators in order to identify elements of success and failure and to learn lessons for the improvement of design. Finally, the effect of policies on system-level changes should be considered central to assessment design.

Moving forward

The analysis in this paper provides a more nuanced and sophisticated understanding of the role of food policy in addressing obesity. In essence, we have taken a systems approach^{2,35,55,137,148–151} to addressing obesity by identifying some of the multiple distinct mechanisms at work in the complex system of interdependent interactions between people and their environments. The analysis has enabled us to understand how food policies can be designed more effectively to improve diets. Smart food policies emerge as policies that strategically target food preference formation, expression, and reassessment in the broader context of environments and systems. Smart policies therefore extend beyond making healthy choices the easy choices to making healthy choices the preferred choices. Well designed food policies have substantial potential to meaningfully and sustainably improve diets locally, nationally, and worldwide, including among

Panel 4: Examples of food-policy actions categorised by the mechanisms* through which they can be expected to work

Provide an enabling environment for healthy preference learning

- Protection and promotion of breastfeeding and appropriate complementary foods in infants and young child feeding practices
- Regulation of the marketing of inappropriate complementary foods to parents and caregivers
- National provision of nutrition counselling to pregnant women, new parents and caregivers
- Nutrition education for children, including food skills and food literacy; food skills and literacy education for teachers and catering staff
- Initiatives to make healthy foods available in schools
- Food standards in pre-schools and school settings that make healthy food available and restrict the availability of unhealthy foods
- Reformulation to reduce the sugar content in foods targeted at the child market
- Subsidies that promote affordability of nutritious foods among low-income parents with young children
- Regulation of unhealthy food marketing to children
- Regulation of claims made on unhealthy foods that mislead children and their parents into perceiving them as healthy
- "Zoning out" unhealthy food retail in places where children gather

Overcome barriers to expression of healthy preferences

- Initiatives to make specific healthy foods available in schools
- Community and homestead gardening projects
- Community-based interventions that emphasise social participation and social networks
- Home delivery of healthy foods and meals to the elderly
- Targeted food subsidies
- Incentives to attract retailers of healthy foods into underserved low-income neighbourhoods or to encourage existing retailers to offer healthier products
- Nutrition labels that fill information gaps
- Development of transport and storage infrastructure for nutritious foods in low-income and middle-income countries

Encourage people to reassess existing unhealthy preferences at point-of-purchase

- Health-related food taxes
- Targeted food subsidies implemented in the form of an incentive
- Standards that restrict foods from specific settings
- Redesigning of choice architecture at point-of-purchase
- Nutrition labels with some form of warning symbol or nutritional rating system

*As indicated, the same policy action might work through multiple mechanisms; all can be expected to induce a food-systems response.

disadvantaged groups, and therefore have an essential part to play in curbing the global obesity epidemic.

Contributors

CH conceived the idea for this paper, conducted, supported, and interpreted results of literature reviews, and wrote original drafts of most of the text. TS assisted in the conception of the paper with regard to the economic theory, wrote text, and edited the paper. JJ assisted in the conception of the paper, conducted literature reviews, interpreted the results, contributed to the interpretation of all other aspects of the paper, created tables, wrote text, and edited the paper. JW wrote the behavioural psychology part of the paper and edited the paper. RH contributed to conceptual design and writing of the paper and developed formal models to inform the argument presented in the paper. SF contributed the equity components of the paper and reviewed the paper. AMT contributed to the fiscal policy case study and the

conceptual development of the paper and edited the paper. JK took responsibility for the Chilean examples and nutrition education case study and reviewed the text.

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Declaration of interests

We declare no competing interests.

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