The effect of fiscal policy on diet, obesity and chronic disease: a systematic review

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Objective To assess the effect of food taxes and subsidies on diet, body weight and health through a systematic review of the literature.
Methods We searched the English-language published and grey literature for empirical and modelling studies on the effects of monetary subsidies or taxes levied on specific food products on consumption habits, body weight and chronic conditions. Empirical studies were dealing with an actual tax, while modelling studies predicted outcomes based on a hypothetical tax or subsidy.
Findings Twenty-four studies met the inclusion criteria: 13 were from the peer-reviewed literature and 11 were published on line. There were 8 empirical and 16 modelling studies. Nine studies assessed the impact of taxes on food consumption only, 5 on consumption and body weight, 4 on consumption and disease and 6 on body weight only. In general, taxes and subsidies influenced consumption in the desired direction, with larger taxes being associated with more significant changes in consumption, body weight and disease incidence. However, studies that focused on a single target food or nutrient may have overestimated the impact of taxes by failing to take into account shifts in consumption to other foods. The quality of the evidence was generally low. Almost all studies were conducted in high-income countries.
Conclusion Food taxes and subsidies have the potential to contribute to healthy consumption patterns at the population level. However, current evidence is generally of low quality and the empirical evaluation of existing taxes is a research priority, along with research into the effectiveness and differential impact of food taxes in developing countries.

Une traduction en français de ce résumé figure à la fin de l'article. *Al final del artículo se facilita una traducción al español.* الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

Introduction

The World Health Organization (WHO) has recommended the use of fiscal policy to influence food prices "in ways that encourage healthy eating".[1,2] Although this is consistent with growing worldwide interest in the effect of fiscal policy on diet,[3–5] evidence supporting the use of taxes is weak. This review considers international evidence on the impact of food taxes and subsidies.

The current obesity epidemic reflects an increasingly "obesogenic" food environment and long-term changes in activity levels and energy expenditure.[6] Currently, financial incentives favour the consumption of highly processed, energy-dense foods since it is consistently cheaper, in terms of energy content for a given price, than less energy-dense and often more nutrient-rich foods.[7,8] Taxing less healthy foods could create a financial incentive for consumers to avoid them. Studies on the effect of manipulating food prices show that both individual consumers [9,10] and population groups[11–14] do respond as predicted.

The poor health outcomes associated with the consumption of energy-dense food[8,15] may justify levying taxes on such food to pay for health care and to decrease consumption, a measure that has proved effective for tobacco control.[16] However, taxation structures that worked for tobacco (i.e. an excise tax on a single provenly harmful substance) may not be readily transferable to food, which is essential for life and involves far more complex choices.

Very little evidence about the use of food taxes as a public health strategy is available. Cash & Lacanilao[17] examined pricing and taxation studies on food and concluded that more evidence is needed on the efficacy of taxation as a health intervention to support taking action. In a more recent review, Powell and Chaloupka[18] predicted that a small change in food prices would have little effect on body weight in the United States of America (USA), whereas a "non-trivial" change in food prices would affect body weight. They suggested that a combination of taxes and subsidies would have the greatest effect on body weight.

This review extends previous work on the effects of fiscal policy on food consumption patterns, obesity and chronic disease by updating evidence from the peer-reviewed literature and by incorporating carefully selected evidence from the non-peer-reviewed or grey literature, including modelling studies, all of which act as sources of evidence for policy-makers.

Methods

The Medline, ProQuest and Business Source Premier academic databases and Google Scholar were searched using the term "tax" or "subsidy" with the terms "food", "soft drink", "obesity", "diet", "nutrition", "consumption" and "fat", or their equivalent Medical Subject Heading terms, as appropriate. The first 150 articles identified from each search using Google Scholar were examined. Only English-language literature was included.

The criteria for including a study in this systematic review were that it: (i) was either an empirical or modelling study, (ii) examined a tax or subsidy on a specific food product (i.e. general agricultural subsidies or food taxes were excluded), and (iii) assessed the effect of the tax on a health outcome such as food consumption, body weight or disease. Empirical studies were defined as those that assessed the effect of an actual tax, while modelling studies were those that predicted rather than measured outcomes.

Articles were initially selected on the basis of their titles. Those whose abstracts were deemed irrelevant were then excluded, leaving 24 articles from Medline, 13 from ProQuest and

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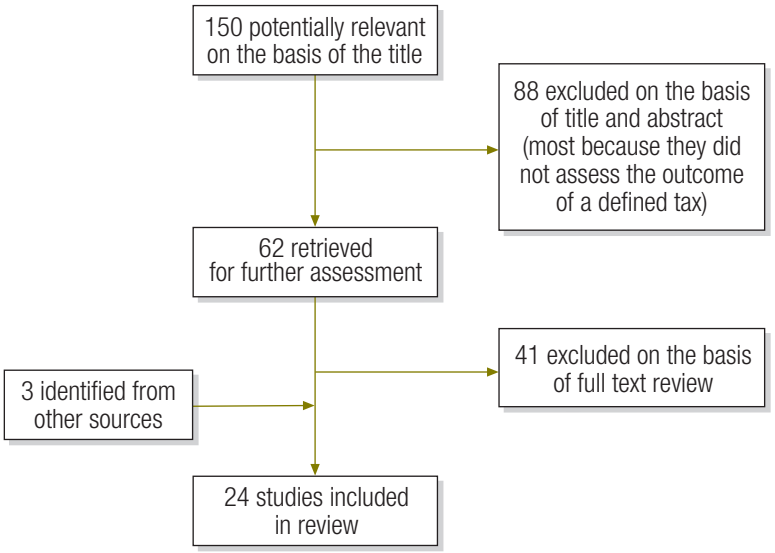
Fig. 1. **Selection of manuscripts for systematic review of studies on the effects of fiscal policy on food consumption**



2 from Business Source Premier. In addition, 55 papers from Google Scholar were judged relevant. Once duplicate references were removed, 62 remained. Thereafter, 41 papers were excluded following a full text review, leaving 21. The reference lists from three recent reviews[17–19] were also examined, yielding two further publications, and the details of one recently published study were obtained directly from a co-author.[20] Finally, 24 studies were included in the current review (Fig. 1).

Analysis

For the purposes of the analysis, studies were classified according to: (i) the outcome assessed, such as the effect on food consumption or expenditure, body weight or health, (ii) whether they were modelling or empirical studies, and (iii) whether or not they were peer-reviewed.

Results

Of the 24 studies reviewed, 13 were from the peer-reviewed literature, including one published in an edited book, and 11 were published online, as summarized in Table 1 (available at: http://www.who.int/bulletin/volumes/88/8/09-070987). All were published between 2000 and 2009, and mostly since 2006. All studies but one were set in high-income countries, and more than half were in the USA.

The majority of studies used predictive models to assess the effect of a proposed tax on consumption. Only 6 studies used observational data and 4 of these used data at the population rather than the individual level to look for associations between taxes and body weight.

Nine studies assessed the effect of taxes on food consumption or expenditure alone, five on consumption and body weight, four on consumption and disease, and six on body weight only. Studies on soft drink taxes were the most common: there were 10 such studies, 2 of which also included "snack" taxes. Thereafter, 7 studies examined food taxation based on nutrient content, most commonly fat. Three studies assessed fruit and vegetable subsidies, and another assessed three taxes on a variety of "unhealthy" foods.

Effect on consumption

Peer-reviewed studies

The four peer-reviewed studies on food consumption all found that a subsidy, tax or change to a tax altered consumption in the expected direction. In an empirical study in Ireland, Bahl et al.[21] found that a 20% reduction in a soft drink tax resulted in a 6.8% increase in average soft drink consumption. However, had all of the tax reduction been passed on, consumption would actually have risen by 15%.

Three studies modelled the effect of proposed taxation strategies on the whole diet. Smed et al.[24] examined seven scenarios for taxing unhealthy and subsidizing healthy foods and nutrients in Denmark. Each involved the equivalent of halving value added tax (VAT) on fruit and vegetables. They concluded that subsidizing specific nutrients was more effective than subsidizing food groups. Their best revenue-neutral scenario decreased average consumption of sugar by 6.5%, fat by 2.5% and saturated fat by 3.6%, and increased consumption of fibre by 6.5%.

In a similar study, Jensen & Smed[22] found that younger consumers and lower-income groups changed their consumption most in response to taxes. Their best taxation scenario reduced average sugar and saturated fat consumption by 16% and 8%, respectively, and increased average fibre consumption by 15%. Santarossa & Mainland[23] modelled the level of tax required to reduce average energy and fat consumption to the recommended level in Scotland: reductions of 17.5% and 20%, respectively. The tax would have to increase the price of meat by 1%, dairy products by 4%, eggs by 11%, and fats and oils by 24%.

Grey literature

In one study from the grey literature, Tefft[37] found that an actual increase of 10% in soft drink taxes in one state in the USA decreased average expenditure by 0.7%. However, the study monitored aggregate expenditure only and consumers may have reduced expenditure by buying cheaper drinks rather than by reducing the volume they consumed.

In contrast, Gabe[34] modelled a proposed 10% soft drink tax in the USA using sales data and predicted that it would reduce sales by 4.8%. In addition, Gustavsen[35] predicted that increasing soft drink prices in Norway by 27%, by doubling production taxes and VAT, would reduce average consumption by 44% in heavy soft drink consumers and by 17% in light consumers. In Sweden, Nordström & Thunström[36] predicted that a 50% subsidy for healthy grain products bearing the healthy food certification keyhole symbol of the Swedish Food Administration, as judged by fat, sugar, fibre and calorie content, would be required to increase average fibre intake to the recommended level (i.e. by 38%). They proposed a 114% tax on bakery and ready-to-eat products, to be used to fund the subsidy and also to prevent unwanted increases in fat, salt and sugar consumption associated with the subsidy alone. A smaller subsidy on fruit and vegetables for people with low incomes modelled by Dong & Lin[33] predicted an increase in average consumption of around 2–5%.

Effect on consumption and body weight

Peer-reviewed studies

Two peer-reviewed studies modelled the effect of taxes on consumption and body

weight. Chouinard et al.[25] predicted that an extremely high tax on dairy fat would be needed to reduce average fat consumption and body weight in the USA because a 50% tax lowered fat intake from dairy products by only 3%, approximately 2–3 g/day, and thus had no effect on body weight.

Kuchler et al.[27] predicted that a 20% tax on salty snack foods in the USA would reduce consumption by only 115–170 g per person per year, equivalent to an average reduction in energy intake of approximately 830 calories, with no effect on body weight. However, in an earlier, unpublished study, Kuchler et al.[26] showed that, if price elasticity (i.e. the change in consumption in response to a given change in price) was greater than assumed in their later published study (i.e. −0.7 rather than −0.45), then a 30% tax might reduce consumption by nearly 1.4 kg per person per year, or 7000 calories on average, with a corresponding drop in average body weight of 0.9 kg annually.

Grey literature

One study in the grey literature by Allais et al.[38] modelled how a 10% tax on cheese and butter products, sugar and fat products and ready-made meals in France would affect diet as a whole. They predicted reductions in average total energy intake of 3.5%, in saturated fat intake of 4.5% and in average weight of 1.3 kg/person per year. They also predicted the unintended side effect that sodium, vitamin B and good fat intake would decrease.

In the USA, Fantuzzi[39] modelled the effects of both a 20% tax and a tax of US$ 0.10 per calorie on soft drinks and predicted that they would not affect consumption or body weight. This study was limited, however, by the fact that a tax of US$ 0.10 per calorie is equivalent to a tax of US$ 9 on a standard can containing 90 calories. Farra et al.[40] modelled the impact of a 10% excise tax on soft drinks in the USA and predicted that per capita consumption would be reduced by 23 litres per year, equivalent to a 1.4 kg decrease in body weight.

Effect on food consumption and health

Peer-reviewed studies

Three studies investigated effects on cardiovascular disease. Marshall modelled extending the VAT at 17.5% in the United Kingdom of Great Britain and Northern Ireland to food products that were the main sources of saturated fat.[29] He calculated that saturated fat consumption would decrease sufficiently to reduce deaths from ischaemic heart disease by 1.8–2.6%, or 1800–2500 deaths per year in the country.

Mytton et al.[30] examined the effect of a similar tax change but considered the whole diet. Extending VAT to products high in saturated fat increased the number of deaths from cardiovascular disease because of a predicted compensatory increase in the consumption of products containing higher levels of salt. In contrast, extending VAT to unhealthy products, as identified by a nutrient scoring system, reduced cardiovascular disease deaths by around 1.2% per annum. The best possible outcome predicted was a 1.7% reduction. A similar study by Nnoaham et al.,[20]which included an analysis of differential population effects, predicted that the most effective strategy was taxation of less healthy foods combined with subsidies for fruit and vegetables.

Cash et al.[28] modelled a fruit and vegetable subsidy in the USA that would lead to a lasting price reduction of 1%. They predicted that 6733 cases of coronary heart disease and 2946 cases of ischaemic stroke would be prevented in the country at an average cost of US$ 1.29 million per life saved.

Effect on body weight

Peer-reviewed studies

Asfaw[31] assessed the direct effects of taxes and subsidies on body weight using historical data on price and consumption changes. The findings indicated that government subsidies for bread and sugar may have contributed to an obesity epidemic in Egypt and that reducing subsidies to create a 1% increase in bread and sugar prices per 100 calories would reduce the average body mass index (BMI) of mothers in the country by 0.12% and 0.11%, respectively.

In an empirical analysis of the relationship between obesity prevalence and state soft drink or junk food taxes in the USA, Kim & Kawachi[15] found no association. However, states with no taxes and those that repealed taxes had higher relative increases in obesity prevalence than those with taxes.

Schroeter et al.[32] found that a 10% tax on food eaten away from home in the USA would slightly increase average body weight by disproportionately increasing food consumption at home, whereas a 10% tax on soft drinks would decrease average body weight by around 0.1%, or 0.09 kg/capita per day. A 10% subsidy for fruit and vegetables would increase average body weight by around 0.2% per day and a 10% subsidy for diet soft drinks would decrease it by 0.07% per day.

Grey literature

Fletcher et al.[41] analysed the relationship between soft drink taxes in states in the USA, which averaged 3%, and population BMI between 1990 and 2006 and found that even relatively large tax increases had little effect. Similarly, Oaks[43] found no relationship between obesity prevalence and a snack and soft drink tax of 5.5% in Maine, USA, on comparing the obesity rate over 15 years with that in New Hampshire, a state with no tax.

Gelbach et al.[42] used data on the effect of food price changes on obesity prevalence between 1982 and 1996 in the USA to model the impact of a 100% tax on "unhealthy" foods. He predicted that a 100% tax would decrease the average BMI by approximately 1% and the incidence of overweight and obesity by 2% and 1%, respectively. However, the study did not include sweets among "unhealthy" foods because pricing data were not available.

Quality of the evidence

Detailed comments on the quality of the studies, which varied widely, are listed in Table 2 (available at: http://www.who.int/bulletin/volumes/88/8/09-070987). Generally, empirical studies should provide more robust results than predictive studies, which involve assumptions about consumer responses to price changes. For example, Cash & Lacanilao[17] cautioned against using price elasticity estimates to simulate substantial price changes in modelling studies, as values have to be extrapolated well outside observed data ranges. However, empirical studies that used regression analysis to assess the link between taxes and obesity were also methodologically weak because consumption of the taxed foods was not measured, making it difficult to determine whether taxes caused the observed weight changes.

There were also inconsistencies in measures of exposure and outcomes between modelling studies. Several studies examined consumption of the taxed food only, while others considered the whole diet. For example, Marshall's study[29] focused solely on the effect of a tax on saturated fat consumption and assumed that decreased fat consumption would lead to a decrease in heart disease, while Mytton et al.'s revision of the study pre-

dicted an increase in heart disease due to the increased salt consumption that inadvertently resulted from the tax on products high in saturated fat. Also, studies expressed weight change differently. Some reported weight change per day or year as if any change would continue for many years.[27,32,40] This is clearly not possible physiologically. It could be corrected by assessing the change from one steady-state to another that would occur in response to a change in energy intake.[44,45]

Discussion

This review was broader in scope than previous reviews in that the majority of studies came from the grey literature or were modelling studies.[17,18] The studies showed that taxes and subsidies on food have the potential to influence consumption considerably and improve health, particularly when they are large.[18] Santarossa & Mainland[23] and Gustavsen[35] proposed taxes that raised the price of unhealthy foods by about 25%, Nordström & Thunström's healthy grain subsidy was 50%,[36] and Marshall[29] and Mytton et al.[30] both considered a VAT rate of 17.5%. In contrast, Chouinard et al.[25] and Kuchler et al.[27] found that taxes of 50% and 20%, respectively, had little or no effect on consumption or body weight. However, Chouinard et al. modelled a tax on only fat from dairy products, which form a core food group in the USA and may be less price elastic than fat from other food groups. Kuchler et al. emphasized that the price elasticity estimates used in modelling substantially changed consumption and body weight outcomes.[26]

Taxes may also reinforce efforts to educate consumers. Being aware that a product has been taxed because it is unhealthy may discourage purchases. Cash & Lacanilao[46] observed this effect when warning labels were placed on products that were taxed because of their high fat content.

One argument against fat taxes is their potential regressivity: they impose a larger burden on the poor than the rich.[47] Farra et al.[40] found that a soft drink tax would impose a disproportionate burden on low-income families who did not reduce consumption, and Nnoaham et al.[20] found that taxes on unhealthy food had a regressive effect that was not counterbalanced by greater health gains, although they may have underestimated gains in poor people. In addition, Leicester & Windmeijer[48] estimated that the rich would spend less than 0.1% of their income on a fat tax in the United Kingdom compared to 0.7% for the poor. However, Smed et al.[24] found that food taxes were only slightly regressive and that lower-income households reduced their consumption proportionately more than wealthier households, as has been observed with tobacco taxes.[49] Combining food taxes with subsidies could help alleviate potential regressivity by enabling consumers to switch to more healthy products without incurring additional costs.

This review highlights the inadequate evidence available for informing policy-making. In particular, the review's findings are limited by the high proportion of modelling studies, which are based on assumptions and subject to data limitations. Moreover, many modelling studies analysed only target food consumption and overlooked shifts in consumption within or across food categories. No experimental studies were available, which probably reflects the difficulty of designing such studies of interventions at a population level, and the empirical studies included had limited sensitivity. Wide variations in data sources and analytical methods also made it difficult to compare the effectiveness of the taxes assessed. Other limitations are that only English-language studies were included and that the majority of the evidence came from high-income countries.

Finally, the administrative aspects of policy implementation, such as selecting a taxation mechanism, will be important for ensuring that taxes are acceptable. The administrative costs involved and the use of revenue either as a source of funds for health programmes or as an alternative income stream were not considered in any of the studies in this review, although in several the estimated revenue gained or lost with a tax or subsidy was reported. These factors may be critical for ensuring the political acceptability of a tax.

Conclusion

This review indicates that food taxes and subsidies can influence consumption in high-income countries and that imposing substantial taxes on fattening foods may improve health outcomes such as body weight and chronic disease risk. The findings support current recommendations that taxes and subsidies should be included as part of a comprehensive strategy to prevent obesity.

Further research is recommended in four areas. First, experimental studies are needed to document actual responses of both prices and consumers to changes in food taxation. These will predominantly involve the evaluation of natural experiments. Second, future modelling studies should examine changes in the entire diet resulting from price changes rather than in single food items to take account of shifts in food consumption within or across food categories. These studies will require the standardization of models for converting energy imbalances to weight changes, thereby avoiding simple, arithmetic equations that imply that weight changes indefinitely. Third, there is a need for research into consumer responses to food taxes in developing countries where differential population effects may be greater. Finally, implementation and administrative costs need to be examined as they represent potential barriers to the feasibility of these interventions. ■

Competing interests: None declared.

الملخص

تأثير السياسات المالية على النظام الغذائي، والسمنة، والأمراض المزمنة: مراجعة منهجية

الغرض: تقييم تأثير الضرائب المفروضة على الأغذية والدعم النقدي للأغذية على النظام الغذائي، والوزن، والصحة من خلال مراجعة منهجية للبحوث المنشورة.

الطرق: أجرى الباحثون بحثاً في الدراسات المنشورة باللغة الإنكليزية والمنشورات غير الرسمية للدراسات التجريبية ودراسات الطراز حول تأثيرات الدعم النقدي أو الضرائب المفروضة على منتجات غذائية محددة على العادات الاستهلاكية، ووزن الجسم، والحالات المزمنة. وكانت الدراسات التجريبية معنية بالضرائب الفعلية، بينما تنبأت دراسات الطراز بالنتائج استناداً إلى الضرائب الافتراضية أو الدعم الافتراضي.

النتائج: تلاءمت أربع وعشرون دراسة مع معايير الإدراج في هذه الدراسة منها: 13 دراسة من أبحاث منشورة خضعت لمراجعة الزملاء، و 16 دراسة للطراز. قيّمت تسع دراسات تأثير الضرائب على استهلاك الأغذية فقط، وقيمت خمس دراسات التأثير على الاستهلاك ووزن الجسم، وأربع دراسات قيمت التأثير على الاستهلاك والأمراض، وقيمت ست دراسات التأثير على

وزن الجسم فقط. وعلى نحو عام، أثرت الضرائب وأثر الدعم على الاستهلاك في الاتجاه المرجو، وارتبطت الضرائب المرتفعة مع أكبر التغيرات الملموسة في الاستهلاك، ووزن الجسم، ومعدلات وقوع الأمراض. إلا أن الدراسات التي ركزت على غذاء واحد أو مادة مغذية واحدة قد تكون بالغت في تقدير تأثير الضرائب نظراً لفشلها في مراعاة التغيرات في استهلاك سائر الأغذية. وكانت جودة البينات منخفضة على وجه العموم. وقد أجريت جميع الدراسات تقريباً في البلدان المرتفعة الدخل.

الاستنتاج: يمكن للضرائب والدعم المفروض على الأغذية أن يساهم في أنماط الاستهلاك الصحي على مستوى السكان. إلا أن جودة البينات الحالية منخفضة على وجه العموم، ويُعد التقييم التجريبي للضرائب الموجودة أولوية بحثية، وكذلك بحوث الفعالية والتأثير المتباين للضرائب المفروضة على الأغذية في البلدان النامية.

Résumé

Effet des politiques fiscales sur l'alimentation, l'obésité et les maladies chroniques : une révision systématique

Objectif Évaluer les effets des taxes alimentaires et des subventions sur l'alimentation, le poids corporel et la santé au travers d'une analyse systématique de la littérature.

Méthodes Il a été procédé à une recherche de la littérature en langue anglaise et des ressources en ligne en matière d'études empiriques et de modélisation sur les effets des subventions monétaires ou des taxes prélevées sur des produits alimentaires spécifiques sur les habitudes de consommation, le poids corporel et les maladies chroniques. Les études empiriques traitaient d'une taxe réelle, alors que les études de modélisation envisageaient les résultats d'une taxe ou d'une subvention hypothétique.

Résultats Vingt-quatre études présentaient les critères l'inclusion. Treize provenaient de littérature revue par des pairs et onze de publications en ligne. Il a été dénombré 8 études empiriques et 16 études de modélisation. Neuf études évaluaient uniquement l'impact des taxes à la consommation alimentaire, cinq, la consommation et le poids corporel, quatre, la consommation et les maladies et six, le seul poids corporel. En général, les taxes et les subventions ont influé sur la consommation dans la direction désirée, les taxes majeures étant associées avec les changements les plus significatifs sur la consommation, le poids corporel et l'incidence de maladies. Cependant, les études axées sur un produit alimentaire ou un nutriment unique peuvent avoir surestimé l'impact des taxes dans la mesure où elles ne prennent pas en considération le déplacement de la consommation vers d'autres aliments. La qualité des éléments probants était généralement basse. Les études ont pratiquement toutes été conduites dans des pays à revenu élevé.

Conclusion Les taxes alimentaires et les subventions ont le potentiel de contribuer à des schémas de consommation sains au niveau de la population. Cependant, les éléments probants dont nous disposons actuellement sont généralement de basse qualité et l'évaluation empirique des taxes existantes est une priorité de recherche, de même que la recherche liée à l'efficacité et à l'impact différentiel des taxes alimentaires dans les pays en développement.

Resumen

Efecto de la política fiscal en la dieta, la obesidad y las enfermedades crónicas: revisión sistemática

Objetivo Evaluar el efecto de los impuestos y las subvenciones sobre los alimentos en la dieta, el peso corporal y la salud mediante una revisión sistemática de la bibliografía.

Métodos Se realizaron búsquedas de bibliografía en lengua inglesa (obras publicadas y bibliografía invisible) que tratara sobre estudios empíricos y de modelización de los efectos que tienen las subvenciones económicas o los impuestos aplicados a ciertos productos alimentarios sobre los hábitos de consumo, el peso corporal y las enfermedades crónicas. Los estudios empíricos manejaron un impuesto real, mientras que los estudios de modelización se basaron en un impuesto o subvención hipotéticos.

Resultados Veinticuatro estudios cumplían los criterios de inclusión: 13 procedían de bibliografía de revisión externa y 11 se publicaron en línea. Se incluyeron ocho estudios empíricos y 16 estudios de modelización. Nueve estudios valoraron el impacto de los impuestos únicamente sobre el consumo de los alimentos, cinco, sobre el consumo y el peso corporal, cuatro, sobre el consumo y las enfermedades y seis únicamente sobre el peso corporal. En general, los impuestos y las subvenciones influyeron sobre el consumo en la dirección deseada, en la que unos impuestos más elevados estaban relacionados con cambios más significativos en el consumo, el peso y la incidencia de enfermedades. Sin embargo, los estudios que se centraron en un solo alimento o nutriente en concreto pueden haber sobrestimado el impacto de los impuestos al no tener en cuenta los cambios en el consumo de otros alimentos. La calidad de los datos fue en general baja. Casi todos los estudios se llevaron a cabo en países ricos.

Conclusión Los impuestos y las subvenciones sobre los alimentos pueden contribuir a la adquisición de pautas de consumo saludables en la población. Sin embargo, la calidad de los datos actuales suele ser baja y la valoración empírica de los impuestos existentes es una investigación prioritaria, junto con los estudios de la eficacia y el impacto diferencial de los impuestos sobre los alimentos en los países en desarrollo.

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Table 1. **Studies on the effects of fiscal policy on food consumption included in systematic literature review**

Study and year	Study focus	Study type[a] and country	Data	Taxation change	Effect on target	Other effects
Peer-reviewed studies						
Outcome assessed: consumption						
Bahl et al. 2003[21]	Soft drink demand	Empirical–ecological, Ireland	Sales data	Excise tax on soft drinks decreased from IR£ 0.37/gallon to IR£ 0.29/gallon	Consumption increase was 6.8%. If whole tax reduction had been passed on, increase would have been 15%	Revenue loss approximately IR£ 2 million/year
Jensen & Smed 2007[22]	Food and nutrient consumption	Modelling, Denmark	Aggregate consumption	VAT on fruit and vegetables halved. The following taxes and subsidies were scaled to be equivalent to this reduction: fibre subsidy; taxes on fat, saturated fat and sugar; and revenue-neutral combination	Small changes in targeted nutrient and food consumption. Best scenario: revenue-neutral subsidy on fibre and tax on saturated fats and sugar. Sugar consumption decreased 6.5%, fat consumption decreased 2.5%, saturated fat consumption decreased 3.6%, and fibre consumption increased 6.5%	None noted
Santarossa & Mainland 2003[23]	Nutrient consumption	Modelling, Scotland	Household consumption	Tax rates needed to change nutrient consumption to meet recommendations; taxes increased the price of meat by 1%, of dairy products by 4%, of eggs by 11%, and of fats and oils by 24%	Energy consumption decreased 17.5%; fat consumption decreased 20%	None noted
Smed et al. 2007[24]	Food and nutrient consumption	Modelling, Denmark	Household purchases	Price of meat, butter and fat increased by 5%; VAT on fruit and vegetables halved. The following modelling scenarios were all scaled to have an equivalent effect on consumers as the above VAT reduction: fibre subsidy; taxes on fat, saturated fat and sugar; and revenue-neutral combinations	More effective to target nutrients than foods. Best scenario: saturated fat and sugar tax plus fibre subsidy resulted in a sugar consumption decrease of 16%, saturated fat consumption decrease of 8%, and increased fibre consumption of 15%	Younger consumers and lower income groups responded more, especially in saturated fat consumption
Outcome assessed: consumption and body weight						
Chouinard et al. 2007[25]	Dairy product demand	Modelling, USA	Household purchases	10% and 50% tax on dairy products by fat content	Daily fat intake decreased by 2–3 g with 50% tax; no noticeable effect on weight	Highly regressive
Kuchler et al. 2004,[26] 2005[27]	Snack food consumption and body weight	Modelling, USA	Household purchases	Salty snack food excise taxes: 1 US cent/pound weight (i.e. 0.4%), 1% and 20%	1 US cent/pound weight and 1% tax had no effect on consumption or body weight; 20% tax decreased body weight by 115–170 g/person per year, equivalent to a reduction in energy intake of around 830 calories.	1 US cent/pound weight gave US$ 40 million revenue; 1% tax gave US$ 100 million; 20% gave US$ 500–700 million
Outcome assessed: consumption and disease						
Cash et al. 2005[28]	Fruit and vegetable demand and heart disease risk	Modelling, USA	Individual consumption	Subsidy to decrease fruit and vegetable prices by 1%	Prevented 6733 cases of coronary heart disease and 2946 cases of ischaemic stroke	Average cost per life saved was US$ 1.29 million

Study and year	Study focus	Study type[a] and country	Data	Taxation change	Effect on target	Other effects
Marshall 2000[29]	Saturated fat consumption and heart disease risk	Modelling, United Kingdom	Individual consumption	Extend 17.5% VAT to main sources of saturated fat	Decreased ischaemic heart disease by 1.8–2.6%, equivalent to 1800–2500 deaths/year, with 900–1000 deaths/year in people under 75 years	None noted
Mytton et al. 2007[30]	Nutrient consumption and heart disease risk	Modelling, United Kingdom	Individual consumption	Extend 17.5% VAT to: (i) sources of saturated fat, and (ii) unhealthy foods; (iii) modification of the above for the best health outcome	(i) increased CVD deaths due to increased salt intake; (ii) decreased CVD deaths by 1.2%; (iii) decreased CVD deaths by 1.7%	Best scenario increased food expenditure by 4.6%.
Nnoaham et al. 2009[20]	Nutrient consumption and CVD and cancer mortality	Modelling, United Kingdom	Individual consumption	Extend 17.5% VAT to: (i) sources of saturated fat; (ii) unhealthy foods (nutrient profiling); (iii) unhealthy foods, with 17.5% fruit and vegetable subsidy; (iv) unhealthy foods, with all tax revenue going to a fruit and vegetable subsidy	(i) no mortality reduction; (ii) CVD and cancer deaths increased by 35–1300 per year; (iii) up to 2900 CVD and cancer deaths averted per year; (iv) up to 6400 CVD and cancer deaths averted per year	All policies would be economically regressive and positive health effects would not necessarily be greater in lower income groups
Outcome assessed: body weight						
Asfaw 2007[31]	Subsidized food and mothers' BMI	Empirical–ecological, Egypt	Household consumption	Food subsidy programme: 57% for bread; 42–62% for sugar	1% price increase in bread decreased BMI by 0.12%; 1% price increase in sugar decreased BMI by 0.11%; 1% price decrease in fruit and vegetables decreased BMI by 0.09%; 1% price decrease in eggs and milk decreased BMI by 0.14%	Cost US$ 1.1 billion in 1997 values
Kim & Kawachi 2006[15]	State taxes and obesity	Empirical–ecological, USA	Obesity prevalence	State taxes on soft drinks or snack foods	No association with obesity point prevalence; states with no tax were more than 4 times as likely to experience a high relative increase in obesity prevalence; those that repealed a tax were more than 13 times as likely	None noted
Schroeter et al. 2008[32]	Body weight	Modelling, USA	Individual consumption	10% tax or subsidy: (i) tax on food away from home; (ii) tax on soft drinks; (iii) subsidy for fruit and vegetables; (iv) subsidy for diet soft drinks	Daily weight change: (i) 0.196% increase; (ii) 0.099% (0.086 kg) decrease in men and 0.122% (0.091 kg) decrease in women; (iii) 0.222% increase: 0.193 kg in men and 0.166 kg in women; (iv) 0.071% decrease	None noted
Grey literature						
Outcome assessed: consumption						
Dong & Lin 2009[33]	Fruit and vegetable demand	Modelling, USA	Household purchase	10% subsidy for fruit and vegetables for people on low incomes	Household fruit consumption increased by 2.1–5.2% and vegetable consumption, by 2.1–4.9%	Cost: US$ 308 million for fruit subsidy, US$ 274 million for vegetable subsidy
Gabe 2008[34]	Soft drink consumption and economy	Modelling, USA	Sales data	Excise tax: US$ 0.42/gallon of bottled drinks and US$ 4.00/gallon of soft drink syrup; equivalent to around a 10% tax	Soft drink sales volume decreased by 4.8% and sports drink volume decreased by 3.2%	Revenue: US$ 31.4 million; jobs lost with decreased production
Gustavsen 2005[35]	Soft drink consumption	Modelling, Norway	Household purchases	Doubling of production tax and VAT on soft drinks; price increased by 27%	Top 5% of soft drink consumers decreased consumption by around 44%, or 74 l/year; lowest soft drink consumers decreased consumption by 17%, or 2 l/year	None noted

Study and year	Study focus	Study type[a] and country	Data	Taxation change	Effect on target	Other effects
Nordström & Thunström 2007[36]	Nutrient consumption	Modelling, Sweden	Household purchases	Removal of VAT plus subsidy for healthy grain products	50% subsidy required to increased fibre intake to recommended level; 114% tax on bakery and ready-to-eat products could fund this subsidy	Increased fat, salt and sugar intake
Tefft 2008[37]	Soft drink expenditure	Empirical–ecological, USA	Household purchases	State soft drink tax	Soft drink tax increase of 10% decreased probability of soft drink expenditure by 0.7%	None noted
Outcome assessed: consumption and body weight						
Allais et al. 2008[38]	Complete food demand system	Modelling, France	Household purchases	10% VAT increase for cheese and butter products, sugar and fat products, and ready-made meals	All tax rises decreased total energy and saturated fat intake; taxing both sugar and fat products and cheese and butter products increased polyunsaturated fat use; taxing all three food groups gave weight decrease of 1.3 kg/year	Ready-made meal tax increased fat-soluble vitamin intake and decreased sodium, vitamin B and good fat intake; government revenue increased by 16%
Fantuzzi 2008[39]	Soft drink consumption and body weight	Modelling, USA	Household purchases	20% *ad valorem* tax and 10 US cent/calorie tax on soft drinks	Insignificant impact: e.g. for Pepsi, 20% tax decreased energy intake by 4 258 calories/year and body weight by 1.22 lb/year; 10 US cent/calorie tax decreased energy intake by 3002 calories/year and body weight by 0.89 lb/year	10 US cent/calorie tax would result in US$ 9 tax on an average can of soft drink containing 90 calories
Farra et al. 2005[40]	Soft drink consumption and body weight	Modelling, USA	Obesity prevalence	10% excise tax on sugared soft drinks	Per capita consumption decreased by 23 l (6 gallons)/year, equivalent to a weight loss of 1.4 kg (3 lb); 4% decrease in obesity prevalence	Regressive tax
Outcome assessed: consumption and disease						
No studies found.						
Outcome assessed: body weight						
Fletcher et al. 2008[41]	State taxes and obesity	Empirical–ecological, USA	Population BMI data from the BRFSS	State soft drink taxes; average 3%	1% tax increase decreased BMI by 0.003 points	Largest impacts in low and high income earners at the tails of the distribution and in Hispanic–Americans
Gelbach et al. 2007[42]	Food consumption and body weight	Modelling, USA	Individual BMI, price data	100% tax on unhealthy foods	Decreased average BMI by around 1% and decreased incidence of overweight by 2% and obesity by 1%	Very small differences in price sensitivity with education, race and gender
Oaks 2005[43]	State snack tax and obesity	Empirical–ecological, USA	Obesity prevalence data from the BRFSS	State tax of 5.5% on soft drinks and snacks	No relationship between obesity and state tax	None noted

BMI, body mass index; BRFSS, Behavioural Risk Factor Surveillance Survey; CVD, cardiovascular disease; IR£, Irish pounds; USA, United States of America; VAT, value added tax.

[a] Empirical–ecological studies are based on observed outcomes; modelling studies are based on predicted outcomes.

Table 2. **Quality of the evidence in studies on the effects of fiscal policy on food consumption included in systematic literature review**

Study type	Individual study findings[a]	Notes on study quality
Experimental case-controlled study based on consumption data	No studies	Not applicable
Observational study based on individual consumption or household or sales data that investigated effects on the whole diet	No studies	Not applicable
Observational study based on individual consumption or household or sales data that investigated effects on the target food only	Bahl et al.[21] – tax decrease resulted in increased consumption	Detailed model based on price and consumption data; included other influences on consumption; evaluated actual change in tax
	Asfaw[31] – subsidy decrease decreased obesity	Simulation based on prices and price elasticity from historical survey data
Observational study based on population data	Kim & Kawachi[15] – states without a tax were more likely to have a higher relative increase in obesity	Used BRFSS data; did not measure changes in consumption of taxed foods or beverages
	Fletcher et al.[41] *– state tax increases had minimal effect*	Used BRFSS data; did not measure changes in consumption of taxed foods or beverages
	Oaks[43] *– no relationship between tax and obesity rate*	Used BRFSS data; did not measure changes in consumption of taxed foods or beverages
	Tefft[37] *– soft drink tax increase decreased consumption by a small amount*	*Used aggregate expenditure data from a consumer expenditure survey and not the volume of consumption; did not measure changes in consumption of taxed foods or beverages*
Predictive model based on individual consumption data that investigated effects on the whole diet	Jensen & Smed[22] – tax–subsidy combination improved diet	Used annual aggregate consumption survey data
	Mytton et al.[30] – fat tax increased salt consumption; tax on less healthy foods improved diet and reduced CVD	Used National Food Survey data and meta-analyses of the effect of dietary change on health.
	Nnoaham et al.[20] – tax alone increased CVD and cancer deaths, tax plus subsidy decreased deaths	Used National Food Survey and Expenditure and Food Survey data and meta-analyses of the effect of dietary change on health.
	Santarossa & Mainland[23] – large fat tax decreased consumption	Used food survey data; calculated tax rate based on dietary change desired
Predictive model based on household expenditure or food sales data that investigated effects on the whole diet	Smed et al.[24] – tax–subsidy combination improved diets; greatest effects in young people and those with a low socioeconomic status	Used household purchase data
	Allais et al.[38] *– tax on fatty foods decreased consumption and weight*	Used household purchase data
Predictive model based on individual consumption data that investigated effects on target foods only	Cash et al.[28] – fruit and vegetable subsidy decreased coronary heart disease	Used consumption data from 1994–1998; relative disease risk based on panel surveys; 1999 and 2001 data were from different cohorts
	Marshall[29] – saturated fat tax decreased CVD deaths	Used consumption data from dietary survey; price elasticity estimates not based on data
	Farra et al.[40] *– soft drink tax reduced consumption and weight*	Simple calculation based on Irish price elasticity and USA sales data

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Study type	Individual study findings[a]	Notes on study quality
Predictive model based on household expenditure or sales data that investigated effects on target foods only	Chouinard et al.[25] – high tax on dairy products resulted in minor decrease in fat consumption	Used supermarket scanner data
	Kuchler et al.[26,27] – large taxes needed to decrease consumption	Used household purchase data; used price elasticity estimates to simulate substantial price changes
	Schroeter et al.[32] – taxes and subsidies resulted in weight changes	Used price elasticity data from the literature; no discussion of time over which apparent daily weight change is sustained
	Dong & Lin[33] – subsidy increased fruit and vegetable consumption	Used household purchase data and NHANES data; only considered low-income Americans
	Fantuzzi[89] – tax had no effect on consumption	Used supermarket scanner data; very high tax of US$ 9 per soft drink can
	Gabe[34] – soft drink tax reduced sales substantially	Used sales and revenue data; only included two brands of soft drink and two sports drinks; assessed impact on the economy of Maine, USA
	Gustavsen[35] – large soft drink tax gave large decrease among heavy consumers	Used consumption data from annual household survey; considered difference in price elasticity with consumption volume
	Nordström & Thunström[36] – large subsidy plus tax improved diet	Used household expenditure data; used price elasticity estimates to simulate substantial price changes
Predictive model based on the association between observed price data and BMI	*Gelbach[42] – large tax on unhealthy foods reduced overweight and obesity*	Used National Health Interview Survey and price data; used price elasticity estimates to simulate substantial price changes

BMI body mass index; BRFSS, Behavioural Risk Factor Surveillance Survey; CVD, cardiovascular disease; NHANES, National Health and Nutrition Examination Survey; USA, United States of America; US$, United States dollar.

[a] Unpublished studies are shown in italics.