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Commission

Health Equity Pilot Project (HEPP)

Evidence Review

*The impact of interventions and policies on SES
differentials in obesity and diet*



Health

A report on literature reviews and scientific evidence relating to the impact of interventions and policies on the socio-economic gradient in diet and obesity.

Prepared for the Health Equalities Pilot Project
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Overview

This report summarises the evidence base for interventions and policies that affect certain aspects of diet and obesity and which show differential effects on different socio-economic groups.

Methods

A rapid review was undertaken using standard scientific journal databases, grey literature searches, and snowballing from the papers' references and from circulating drafts of the current report to experts with specialist knowledge. Papers were included if they were systematic reviews, literature or narrative reviews, or were recently published studies of interventions conducted in the European region after 2005.

PRISMA data

Search	Total from peer-reviewed database	Total from grey literature	Total combined before de-duplication	Total combined after de-duplication	Additions from Scopus after de-duplication	Paper titles reviewed	Paper abstracts reviewed	Paper full text examined	Papers reported
Obesity and SES (2006-current)	1549	2472	4021	3719	33	3752	821	46	8 adult 15 child
Sugar sweetened beverages and SES (2006-current)	2777	57	2834	2581	780	3361	884	35	10
Fruit and veg and SES (2006-current).	3493	1343	4836	3157	650	3807	1411	14	14
Trans fat and SES (2006-current)	3208	13	3221	3065	902	3967	944	6	3
Salt consumption and SES (2006 - current)	1176	350	1526	1346	19	1365	427	18	4
Dietary patterns general						(extracted from above)	3666	53	17
Marketing						(extracted from above)	801	34	18

Summary results

The results indicated a remarkable lack of detailed evidence. Despite the fact that many studies of interventions collect data about the participants' economic, educational or occupational status, many such studies report their data after controlling or adjusting for SES, thus preventing assessment of differential effects. Recently a few reviews have re-analysed earlier data to assess such differential effects ^{1,2} but much more could be undertaken to make use of past projects, and lessons learned for the design of future interventions.

It should also be noted that targeted interventions which are undertaken only with lower SES groups may have an impact which the authors interpret as reducing the SES health gap or the SES health gradient. On their own this may be true, but if the same intervention was available to higher SES groups their response may have been equal or greater than the response found in the lower SES groups, which would widen the gap or increase the gradient. Thus targeted interventions may indicate the responsiveness among low SES participants but cannot claim to reduce the SES differentials on a population-wide basis.

In brief, the following results were found:

Child obesity interventions

The evidence suggests that school- or pre-school interventions in younger children with parental/family involvement and sustained over several years may have a benefit for lower SES groups. For older children this is not the case, and the benefit of school-based interventions may rather be found among higher SES groups. Changes to environmental and social barriers may have benefits for low SES groups, while there was evidence of no benefit for children from family-targeted social media campaigns.

Adult obesity interventions

A weak evidence base suggests that environmental and fiscal measures may reduce SES health inequalities, while informational interventions may be less effective, although the UK '5-a-day' campaign may be an exception (it included social marketing and food labelling measures). Targeted interventions may be effective at improving health behaviour in the targeted group, including weight-loss programmes targeting low SES women.

Sugar-sweetened beverages

A weak evidence base suggests that multicomponent school- and family-based interventions may achieve a short-term narrowing of the SES gap in consumption

among children. SSB taxation was more effective in real-life situations although unintended consequences, such as substitution with other unhealthy products, should be considered.

Dietary patterns

A weak evidence base suggests that a narrowing of the SES gap in dietary behaviour may be achieved through price adjustments, for example combined taxation and subsidies to encourage switching to healthier products, or the provision of free healthier foods at schools. Informational approaches including computer-based material and social marketing appears either ineffective or widens the gap for older children and adults.

Fruit and vegetables

A weak evidence base suggests that the provision of free fruit in schools may achieve a short-term narrowing of the SES gap in fruit and vegetable consumption among children, while a decline in family income (effectively increasing the price of many food products) may widen the SES gap in consumption, at least in adults.

Trans fats (TFA)

A weak evidence base suggests that reformulation may achieve a narrowing of the SES gap in TFA consumption, but that labelling of ITFA or total TFA content on packaging may widen the SES gap in consumption.

Salt

A weak evidence base suggests that the reformulation can have a population-wide effect and can narrow SES differentials in consumption. Informational interventions – labelling and social marketing – did not reduce differentials.

Marketing

A weak evidence base indicates small differences in impact, indicating that interventions in marketing would benefit all groups without widening or narrowing SES health-related differentials. Furthermore, interventions to reduce TV advertising should have greater impact in lower SES groups, as their exposure is highest and their responsiveness to advertising of unhealthy foods is highest. Colour-coded packaged food labelling may also benefit lower-income purchasers. There is additional evidence (not reviewed here) that colour coded 'traffic light' labelling is superior to numerical coding among people with lower educational status and lower literacy and numeracy.

Child obesity

Summary

Nine systematic and literature reviews were found (see tables below). A Cochrane review⁴ found few qualifying studies with SES data, and concluded that interventions appeared not to widen SES health differentials. Several reviews found weak or absent effects on lower SES groups for informational interventions, but stronger effects with environmental or social/community interventions that helped overcome barriers to behaviour change. Interventions targeting children from lower SES backgrounds were more likely to be effective if they were aimed at pre-school children and included a high level of parental engagement, skill-building and links to community resources.*

The lack of further evidence led us to consider individual studies conducted in the European region and noted in a review provided to the European Commission by Health Equity Action in 2015³. Five studies reported in six papers were included. A study in the UK¹² of a social marketing campaign aimed at families and encouraging healthier diets, physical activity, and less sedentary behaviour found a low level of impact on low SES families, and a worsening of health behaviour among high SES families (a paradoxical reduction in the SES health gap).

A 2-year school-based multi-component intervention among infants 3-6y in Belgium¹³ showed an improvement in BMI among children from lower SES communities, as did a 2-year intervention among kindergarten children in France¹⁵ but a 20-week school intervention among older children in the UK [14] showed improvements only for higher SES children. Lastly, the large-scale, longitudinal study in Kiel, Germany (the KOPS project)^{16,17} found no overall effect of a series of interventions, but within the higher SES groups there were significant favourable effects.

Conclusion

The evidence suggests that school- or pre-school interventions in younger children with parental/family involvement and sustained over several years may have a benefit for lower SES groups. For older children this is not the case, and the benefit of school-based interventions may rather be found among higher SES groups. Changes to environmental and social barriers may have benefits for low SES groups, while there was evidence of no benefit for children from family-targeted social media campaigns.

** Interventions that target low SES and have an effect on that group are described by some reviewers as 'narrowing the gap'. This may be true if the intervention is not*

available to high SES groups. However, if the intervention had been available to both low and high SES groups then it may be equally effective in both groups, or be even more effective in the high SES group.

Table: Interventions to reduce the risk of obesity in children, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Cochrane Reviews search: 17 records found, of which 8 relevant and one with information on equalities (Waters 2011).							
Waters 2011 ⁴ Interventions for preventing obesity in children (Cochrane Review)	Systematic review, 55 studies	Various ages 0-18y	Various formats	Various	Various	Various: change in BMI etc.	<i>"Interventions did not appear to increase health inequalities"</i> but the number of studies was limited.
Beauchamp 2014 ⁵ The effect of obesity prevention interventions according to socioeconomic position: a systematic review	Systematic review, 14 studies (5 adult, 9 children) (8 in EU)	Various	Various formats	Various	SES various	Various, including change in BMI	Of the 9 child studies, 1 no effect on any SES group, 3 greater effect in higher SES group, 2 effect equal in both groups, 2 effect stronger in low SES groups, 1 effect in low SES but no comparator.
Boelsen-Robinson 2015 ⁶ A systematic review of the effectiveness of whole-of-community interventions by socioeconomic position	Systematic review, 13 studies (8 adults, 5 children) (5 in EU)	Various	Various formats	Various	SES various	Various weight-related	Of the 5 child studies, 1 greater effect on higher SES group. 3 equal effects in both high and low SES groups, 1 greater effect on low SES group.
Hillier-Brown 2014 ⁷ (NB – same data as Bambra 2015) A systematic review of the effectiveness of individual, community and societal level interventions at reducing socioeconomic inequalities in obesity among children.	Systematic review, 23 studies (4 in EU)	Various	Various formats	Various	SES various	Various weight-related	At individual level (4 studies), one targeted had an effect (but no comparator), one had no effect, and two showed reduced inequalities. At community level (17), 13 were targeted, of which 4

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
							had an effect (no comparator) and 4 compared groups and showed no reduced inequalities. At societal level (1), no reduction in inequalities. A multilevel study showed a slight reduction in inequalities.
Bambra 2015 ⁸ (NB – same data as Hillier-Brown 2014) How effective are interventions at reducing socioeconomic inequalities in obesity among children and adults? Two systematic reviews	Systematic review, Children: 76 studies (25 universal, 51 targeted) (17 in EU)	Various	Various formats	Various	Various	Various weight-related	Generally “...only limited evidence of interventions with the potential to reduce SES inequalities in obesity.” Acknowledges that targeted interventions “have little effect on the wider social gradient”.
Laws 2014 ⁹ The impact of interventions to prevent obesity or to improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families: a systematic review	Systematic review, 32 studies 6 in EU)	Various under 5y	Various formats	Various	SES various	Various weight-related or dietary behaviour or physical activity	Of 32 studies, 20 measured weight-related effects, of which seven showed a positive effect of the intervention. No SES comparator groups.
Olstad 2016 ¹⁰ Can policy ameliorate socioeconomic inequities in obesity and obesity-related behaviors? A systematic review of the impact of universal policies	Systematic review, 36 studies (14 in EU) (25 of children, 10 of adults, 1 of both)	Various	Various formats	Various	SES various	Various weight-related or dietary behaviour or	“Majority of the universal policies examined had neutral impacts on inequities in obesity and obesity-related behaviour, regardless of whether they

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
on adults and children.						physical activity	<i>are more agentic or structural in nature... Fiscal measures had consistently neutral or positive impacts on inequities."</i>
Golubovic 2014 ¹¹ Can school-based nutrition interventions contribute to a reduction in the socioeconomic inequalities in childhood diet and obesity? A systematic literature review.	Systematic review, 21 studies (11 in EU)	School children	Various formats	Various	SES various	Various weight and diet related	11 targeted studies of which 7 showed a positive effect but no comparator. 10 studies with comparator groups of which 3 showed positive effects and one a negative effect.
Magnee 2013 ² Equity-Specific Effects of 26 Dutch Obesity-Related Lifestyle Interventions	Narrative review, Children: 7 studies (all EU – The Netherlands)	Various	School, health care. community, individual	Higher vs lower SES	Various	Weight, diet, PA	All studies showed intervention effects, of which 2 decreased inequalities, 3 increased them, 2 showed no differential effects.
Studies based in EU and included in the Health Equity Audit review [3].							
Croker 2012 ¹² Cluster randomized trial to evaluate the 'Change for Life' mass media / social marketing campaign in the UK	Social media campaign evaluated in schools with and without active promotion of C4L material. (UK)	Parents of children 5-11y	Active promotion of printed and personalised information	Matching schools	Education: university vs non-U	Diets, attitudes, PA, sedentary TV time,	Low level of effect, with some measures showing the intervention had no impact on low SES and a negative impact on higher SES (a paradoxical reduction in gradient).
De Coen 2012 ¹³ Effects of a 2-year healthy eating and physical activity intervention	Cluster randomized control (Belgium)	Children 3-6y	School-based multi-component	Control schools	Community deprivation scores	BMI, diet, PA, screen	Most outcomes showed no SES differential, but BMI showed improvement in

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
for 3-6-year-olds in communities of high and low economic status: the POP project.			intervention over 2 years			time	low SES communities.
Fairclough 2013 ¹⁴ Promoting healthy weight in primary school children through physical activity and nutrition education: a pragmatic evaluation of the CHANGE! randomised intervention study.	Cluster randomised intervention (UK)	Children 10-11y	School-based PA and diet intervention over 20 weeks	Control schools	School-based (free meals)	Weight measures, diet and PA	Most outcomes showed no significant effects or differential effects, but some dietary effects shown in higher SES group: <i>"CHANGE! was most effective among girls, overweight/obese, and high SES participants"</i> .
Jouret 2009 ¹⁵ Prevention of overweight in preschool children: results of kindergarten-based interventions	Cluster randomized intervention	Pre-school kindergarten children	Educational materials for parents, plus lessons, posters etc for children, over 2 years	Intervention vs control	Local area deprivation	BMI	Significant intervention effect among children in low SES schools only.
Plachta-Danielzik 2011a ^{1b} 15 years of the Kiel Obesity Prevention Study (KOPS). Results and its importance for obesity prevention in children and adolescents.	Cross-sectional and longitudinal cohort study Germany (Kiel)	15,000 children 5-15y (KOPS programme)	School and family interventions	Control schools	Neighbourhood deprivation factors	BMI	Effect for high SES children, not low. "Even with this individual [family] approach children of low SES could not be reached."
Plachta-Danielzik 2011b ^{1r} Eight-year follow-up of school-based intervention on childhood overweight--the Kiel Obesity Prevention	Quasi-RCT Germany (Kiel)	1290 children 6-14y (KOPS)	School intervention, 8-year follow-up	Control children	Parental educational status (low, middle,	BMI	No overall effect of intervention, but a significant improvement for children of high SES. <i>"School-based health</i>

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Study.					high)		<i>promotion has some favourable and sustained effects on 8-year changes in BMI-SDS, which are most pronounced in students of high SES families."</i>
(NB: several studies with SES measures, but results reported only after controlling for SES.)							

Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

Waters 2011 ⁴ Interventions for preventing obesity in children (Cochrane Review)	No studies found showing differentiated results
Beauchamp 2014 ⁵ The effect of obesity prevention interventions according to socioeconomic position: a systematic review	The most common characteristic of interventions that were ineffective in lower SES groups was a focus on information delivery. Interventions shown to be effective in lower SES groups included a wide reach, a long duration, and included changes to the environment or social factors that may be barriers to healthy behaviour.
Boelsen-Robinson 2015 ⁶ A systematic review of the effectiveness of whole-of-community interventions by socioeconomic position	One study appeared to narrow the SES gap: it included changes to the environment, used more than three settings, and community engagement. Three studies were effective in both low and high SES groups: all three included changes to the environment and used more than three settings, and two included community engagement. One study was effective in high SES groups only: it included changes to the environment, more than three settings, and community engagement.

<p>Hillier-Brown 2014⁷ (NB – same data as Bambra 2015) A systematic review of the effectiveness of individual, community and societal level interventions at reducing socioeconomic inequalities in obesity among children.</p>	<p>At individual level, there was some evidence that screen-time reduction and mentoring health promotion may reduce inequalities. Only very limited evidence that individual or community/school interventions <i>may</i> be effective in reducing socioeconomic inequalities in obesity.</p>
<p>Bambra 2015⁸ (NB – same data as Hillier-Brown 2014). How effective are interventions at reducing socioeconomic inequalities in obesity among children and adults? Two systematic reviews</p>	<p>Children: School-based and environmental interventions targeted at low-SES children appear to have evidence of effectiveness – and over the longer term – in primary school-age. Multi-level interventions that use community empowerment mechanisms may also be effective in reducing the widening of inequalities.</p>
<p>Laws 2014⁹ The impact of interventions to prevent obesity or to improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families: a systematic review</p>	<p>Focus on targeted interventions: Those involving infants under 2y improved diet quality, those involving infants 3-5y had mixed results, with more successful interventions requiring high levels of parental engagement, use of behaviour change techniques, a focus on skill building and links to community resources.</p>
<p>Olstad 2016¹⁰ Can policy ameliorate socioeconomic inequities in obesity and obesity-related behaviours? A systematic review of the impact of universal policies on adults and children.</p>	<p>EU countries: No policies showed a reduction of inequalities on children. Policies with neutral impact were A school-based PA interventions (Denmark), the French national nutrition programme, the free fruit and veg scheme (Netherlands, UK), free breakfast initiative (Wales). Policies with negative impact were a national healthy school standard (UK) and a local school wellness intervention (Cambridge, UK).</p>
<p>Golubovic 2014¹¹ Can school-based nutrition interventions contribute to a reduction in the socioeconomic inequalities in childhood diet and obesity? A systematic literature review.</p>	<p>There is a tendency for a reduction in socioeconomic inequalities in diet and overweight when school-based interventions employ an environmental component. However, the improvements do not seem to outlast the intervention.</p>

Magnee 2013 ² Equity-Specific Effects of 26 Dutch Obesity-Related Lifestyle Interventions	Decreased SES inequalities were found in two studies: one involved school vending machine promotion, the other free fruit and vegetable distribution in school. SES differentials increased with a computer-based intervention, a primary school intervention encouraging more PA with after-school activities, and a free fruit and vegetable programme.
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Adult obesity

Summary

Seven systematic and literature reviews were found. Beauchamp et al⁵ found a common lack of effectiveness among lower SES groups for interventions focusing on information delivery, whereas lower SES groups responded positively to interventions that were of long duration and included changes to environmental or social barriers to healthy behaviour. Targeted workplace interventions have shown poor results and in one study appeared to widen inequalities¹⁸. In the European region, taxes on unhealthy food (Hungary)¹⁰ and the UK 5-a-day programme reduced SES inequalities. A 5-year community intervention appeared to reduce SES inequalities, but an internet-based intervention and a distance counselling intervention appeared to widen SES inequalities². Weight loss programmes targeted at lower SES women through primary care or community programmes appeared to show some effectiveness.*

The lack of further evidence led us to consider individual studies conducted in the European region and noted in the review provided to the Commission by Health Equity Audit in 2014³. Only one study met the criteria: a controlled trial encouraging physical activity in older people showed improvements in both low and high SES groups in terms of behaviour, and no effect for either group on body weight.

Conclusion

A weak evidence base suggests that environmental and fiscal measures may reduce SES inequalities in obesity levels, while informational interventions may be less effective, although the UK '5-a-day' campaign may be an exception (it included social marketing and food labelling measures). Targeted interventions may be effective at improving health behaviour in the targeted group, including weight-loss programmes targeting low SES women.

** Interventions that target low SES and have an effect on that group are described by some reviewers as 'narrowing the gap'. This may be true if the intervention is not available to high SES groups. However, if the intervention had been available to both low and high SES groups then it may be equally effective in both groups, or be even more effective in the high SES group.*

Table: Interventions to reduce the risk of obesity in adults, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Cochrane Reviews search: 31 records found, of which 11 relevant and none with information on equalities.							
Beauchamp 2014 ⁵ The effect of obesity prevention interventions according to socioeconomic position: a systematic review	Systematic review, 14 studies (5 adult, 9 children) (8 in EU)	Various	Various formats	Various	Various	Various, change in BMI etc.	Of the 5 adult studies, 2 no effect on any SES group, 2 stronger effect in high SES, 1 effect equal in both high and low SES groups.
Boelsen-Robinson 2015 ⁶ A systematic review of the effectiveness of whole-of-community interventions by socioeconomic position	Systematic review, 13 studies (8 adults, 5 children) (5 in EU)	Various	Various formats	Various	Various	Various weight-related	Of the 8 adult studies, 3 showed no effect on any SES group, 4 showed equal effects in both high and low SES groups, 1 had an effect on low SES group but no comparator.
Hillier-Brown 2014 ⁷ A systematic review of the effectiveness of individual, community and societal level interventions at reducing socioeconomic inequalities in obesity among adults.	Systematic review, 20 studies (2 in EU)	Various	Various formats	Various	Various	Various weight-related	At individual level (5 studies), 4 studies were targeted of which 2 showed an effect, the fifth compared SES groups and found no effect in any group. At community level (13 studies), 11 were targeted, of which 3 had an effect, 2 compared groups and showed no effect in any group. At societal level (3), 2 were targeted and showed no effect, one compared groups, and showed no reduction in inequality.
Bambra 2015 ⁸ How effective	Systematic review,	Various	Various formats	Various	Various	Various	Targeted interventions are able

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
are interventions at reducing socioeconomic inequalities in obesity among children and adults? Two systematic reviews	Adults: 33 studies (13 universal, 20 targeted) (15 in EU)					weight-related	to show benefits (but no high SES comparator). Generally <i>"...only limited evidence of interventions with the potential to reduce SES inequalities in obesity."</i> Acknowledges that targeted interventions "have little effect on the wider social gradient".
Olstad 2016 ¹⁰ Can policy ameliorate socioeconomic inequities in obesity and obesity-related behaviors? A systematic review of the impact of universal policies on adults and children.	Systematic review, 36 studies (14 in EU) (25 of children, 10 of adults, 1 of both)	Various	Various formats	Various	Various	Various weight-related or dietary behaviour or physical activity	<i>"Majority of the universal policies examined had neutral impacts on inequities in obesity and obesity-related behaviour, regardless of whether they are more agentic or structural in nature... Fiscal measures had consistently neutral or positive impacts on inequities."</i>
Cairns 2014 ¹⁸ Weighing up the evidence: a systematic review of the effectiveness of workplace interventions to tackle socio-economic inequalities in obesity.	Systematic review, 18 studies (1 in EU)	Workplace adults	Various formats	Various	Various	Various weight-related	11 counselling studies had no effect on adiposity. Two targeted PA interventions had a small effect (no comparator). A universal PA intervention increased inequalities. Other studies were inconclusive.
Magnee 2013 ² Equity-Specific Effects of 26 Dutch Obesity-Related Lifestyle Interventions	Narrative review, Adults: 19 studies (all EU – The Netherlands)	Various	Social media, workplace, health care, community, individual	Higher vs lower SES	Various	Weight, diet, PA	12 studies showed intervention effects, of which 2 decreased inequalities, 3 increased them, 7 showed no differential effects.
Studies based in EU and included in the Health Equity Audit review [3]							

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Van Stralen 2010 ¹⁹ Exploring the efficacy and moderators of two computer-tailored physical activity interventions for older adults: a randomized controlled trial	RCT individual level	Older adults	Information by post, including local greenspace details	3 levels of intervention	Education low vs high	Weight and PA	Small effect on PA behaviour, equal for low and high SES. No effects on weight.
<i>(NB: several studies with SES measures, but results reported only after controlling for SES.)</i>							

Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

Beauchamp 2014 ⁵ The effect of obesity prevention interventions according to socioeconomic position: a systematic review	The most common characteristic of interventions that were ineffective in lower SES groups was a focus on information delivery. Interventions shown to be effective in lower SES groups included a wide reach, a long duration, and included changes to the environment or social factors that may be barriers to healthy behaviour.
Boelsen-Robinson 2015 ⁶ A systematic review of the effectiveness of whole-of-community interventions by socioeconomic position	One study appeared to narrow the SES gap: it included changes to the environment, with more than three settings, and community engagement. Four studies were effective in both low and high SES groups: three included changes to the environment, two included more than three settings, and two included community engagement.
Hillier-Brown 2014 ⁷ <i>(NB – same data as Bambra 2015)</i> A systematic review of the effectiveness of individual, community and societal level interventions at reducing socioeconomic inequalities in	Primary care-delivered tailored weight loss programmes targeted at individuals, and community-based behavioural weight loss programmes and community diet clubs appear to have evidence of effectiveness – at least in the short term – among low-income women.

obesity among adults.	
Bambra 2015 ⁸ (NB – same data as Hillier-Brown 2014). How effective are interventions at reducing socioeconomic inequalities in obesity among children and adults? Two systematic reviews	Adults: Targeted interventions in low SES groups that have some effectiveness – at least in the short term, and for women – include (i) primary care-delivered tailored weight loss programmes, and (ii) community-based weight loss programmes (diet clubs, commercial and behavioural programmes).
Olstad 2016 ¹⁰ Can policy ameliorate socioeconomic inequities in obesity and obesity-related behaviours? A systematic review of the impact of universal policies on adults and children.	EU countries: Policies with a positive impact (reduction) on inequalities: Taxes on unhealthy food (Hungary) and 5-a-day information campaign (UK). Policies with neutral impact: National nutrition programme (France), national diabetes prevention (Finland). Policies with negative impact: None listed. <i>“The majority of the universal policies examined had neutral impacts on inequities in obesity and obesity-related behaviours, regardless of whether they were agentic or structural in nature... Fiscal measures had consistently neutral or positive impacts on inequities.”</i>
Cairns 2014 ¹⁸ Weighing up the evidence: a systematic review of the effectiveness of workplace interventions to tackle socioeconomic inequalities in obesity.	<i>“The evidence reviewed here suggests that workplace counselling or advice-based interventions – whether targeted or universally delivered – are ineffective in reducing inequalities in obesity, with none of the 11 studies of these finding any effects on BMI or weight. However, two RCTs (strong/moderate quality) found that physical activity interventions targeted at low income workers could be effective in reducing inequalities in obesity with small weight reductions (2kg) detected in both evaluations. However, an observational study (moderate quality) of a universally delivered physical activity intervention found that it increased educational inequalities in waist circumference.”</i>
Magnee 2013 ² Equity-Specific Effects of 26 Dutch Obesity-Related Lifestyle Interventions	Decreased SES inequalities were found in a five-year community intervention, and in a PA intervention among older people. Increased SES inequalities were found in an internet-based intervention, and a distance counselling/email intervention. No differential impact was found in four internet-delivered interventions, an elderly PA intervention, and a workplace intervention.

Sugar-sweetened beverages

Summary

Three systematic reviews and one rapid review were found. One systematic review²² considered targeted school and family interventions in children and showed evidence that targeted interventions in low SES groups appeared to be effective at reducing consumption. The three other reviews focused on fiscal measures, primarily taxes on SSBs. One²⁰ found reduced consumption was similar on all SES groups or was greater in lower SES groups (the higher consumers). Another review²¹ found that taxation reduced the SES gradient in consumption in a real-life taxation intervention, but increased the gradient in a controlled trial using a virtual supermarket. The final review²³ found taxation reduced consumption among those who consumed most.

The lack of further evidence led us to consider individual studies. A US-based modelling study²⁴ found that taxation would reduce purchases of SSBs among middle income families most, while higher income families would continue purchasing, and lower income families would reduce consumption but substitute with other high-calorie products. A multi-component school-based intervention with adolescents²⁵ achieved a reduction in SSB consumption, with greatest effect among children from lower income households. Two school-based studies found no differential effects.

A survey²⁸ found children's SSB consumption among lower income families was explained by a few significant variables: SSB availability in the home, SSBs routinely served at meals, and parental permissiveness. Lastly, a survey of adults' attitudes following the imposition of a beverages tax in France²⁹ found general approval, but with an SES gradient: higher approval was found among more educated adults.

Conclusion

A weak evidence base suggests that multicomponent school- and family-based interventions may achieve a short-term narrowing of the SES gap in consumption among children, and SSB taxation was more effective in real-life situations although unintended consequences, such as substitution with other unhealthy products, should be considered.

Table: Interventions to reduce sugar-sweetened beverage consumption, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Backholer 2016 ²⁰ The impact of a tax on sugar-sweetened beverages according to socio-economic position: a systematic review of the evidence.	Systematic review, 11 studies (2 in EU)	Whole population	Taxation	Various	Income, education	SSB intake, BMI	Studies show similar weight benefits across SES groups or greater benefit in lower groups.
Public Health England 2015 ²¹ Sugar Reduction: The evidence for action – Annexe 2: fiscal measures	Rapid review	Whole population	Taxes and subsidies	Various	Two studies gave data on income groups	Consumption	Mexico data showed impact greatest for lower income, so reducing inequalities. French study in artificial supermarket showed all income groups reduced consumption, but gradient increased.
Avery 2014 ²² A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness	Systematic review, 8 studies (5 in EU)	Children (8-15y)	School education, school practices, home delivery substitution	RCTs	Some studies targeted lower income schools	SSB intake, BMI/ adiposity	Targeted interventions are effective in low socio-economic groups. No quantitative analysis of SES subgroups or change in gradients.
Escobar 2013 ²³ Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis	Systematic review, 12 studies (1 in EU)	Whole population	Taxation	Before - after	Not SES, but higher vs lower consumption groups	Prices, sales, BMI	Tax reduces consumption, especially for higher consumers. No quantitative analysis of SES subgroups or changes in gradient, but taxation policy recommended as improving diet and health among those

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
							who need it most.
Finkelstein 2010 ²⁴ Impact of targeted beverage taxes on higher- and lower-income households	Economic modelling (USA database)	Nielsen Homescan panel database	Taxation	Elasticities	Income levels	Purchases, BMI	Tax had greatest effect on reducing consumption among middle-income groups. Lower-income groups substitute with other high-calorie products. High-income groups continue purchasing.
Bjelland 2015 ²⁵ Changes in adolescents' and parents' intakes of sugar-sweetened beverages, fruit and vegetables after 20 months: results from the HEIA study -- a comprehensive, multi-component school-based randomized trial	RCT, Norway	1418 children (11-13y), 849 mothers, 680 fathers	Multicomponent school-based	RCT	Education of parents	Reported intake	Consumption reduced across all groups, with greatest reduction among children of parents with low and medium educational level, reducing the gradient.
Griffin 2015 ²⁶ A brief educational intervention increases knowledge of the sugar content of foods and drinks but does not decrease intakes in Scottish children aged 10–12 years	RCT, UK	Children (10-12y) in 14 schools	Interactive classroom sessions	RCT	Some schools more deprived	Knowledge and intake	A higher proportion of children in the control group were from less deprived areas. Results showed intervention group improved knowledge but no difference in intake.
De Gaar 2014 ²⁷ Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a	Targeted RCT, The Netherlands	1288 children (6-12y)	Water promotion campaign	RCT	Deprived and ethnic minority area schools	Reported intake	Small effect, but not significant in lowest-educated groups.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
controlled trial							
De Coen 2012 ²⁸ Parental socioeconomic status and soft drink consumption of the child. The mediating proportion of parenting practices.	Survey, Belgium	1639 parents of children (2-7y)	Analysis of parental practices	Sub-groups	High vs low mothers educational level	Child intake, parental practices	Children of low educated parents had higher intake, entirely explained by variables e.g. SSBs at home, SSBs served at meals, parental permissiveness.
Julia 2015 ²⁹ Public perception and characteristics related to acceptance of the sugar-sweetened beverage taxation launched in France in 2012	Policy impact assessment France	National sample of adults	Beverage tax (7c per litre) on all sweetened drinks, Jan 2012	Sub-groups	3 education and 3 income levels	Attitudes	General approval (especially if linked to health promotion) but participants with lower educational levels were less likely to support the tax.
<i>(NB several studies with SES measures, but results reported only after controlling for SES.)</i>							

Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

Backholer 2016 ²⁰ The impact of a tax on sugar-sweetened beverages according to socio-economic position: a systematic review of the evidence.	Based on the available evidence, a tax on SSBs will deliver similar population weight benefits across socioeconomic strata or greater benefits for lower SES groups.
Public Health England 2015 ²¹ Sugar Reduction: The evidence for action – Annexe	A lack of real-life evidence indicates the need for any new tax to be accompanied by a robust evaluation that examines the long-term effects of any price increases, specifically assessing

2: fiscal measures	compensatory behaviours and whether price increases would exacerbate health inequalities within certain population subgroups.
Avery 2014 ²² A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness	A number of studies were effective amongst children in low socioeconomic groups and therefore could offer an opportunity for helping to reduce current health inequalities amongst children.
Escobar 2013 ²³ Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis	To the extent that low-income individuals are more price-sensitive, they will be more likely to cut back on the intake of taxed SSBs, often from a higher consumption level and with a higher BMI, and thus experience greater health gain. This gives ground to consider a simultaneous subsidy of healthy foods such as fruit and vegetables.

Dietary patterns

Summary

Five systematic and three literature reviews were examined. McGill et al³⁰ considered a wide range of approaches to changing dietary patterns, and the SES differential responses in terms of diet, nutrition, and health. The authors conclude that use of pricing mechanisms and interventions affecting accessibility/availability decreased SES inequalities, while individualised approaches (such as dietary counselling) increased SES inequalities. A second study³¹ considered multi-component school-based interventions and found some evidence for improvements in diet and BMI in interventions that targeted children from lower income backgrounds.*

A Cochrane review³³ of adherence to dietary advice found lower SES groups tended to show reduced compliance. A review of controlled trials³⁴ found lower SES groups showed less response to interventions than higher SES groups, widening the gap. A similar review by De Bourdeaudhuij³⁵ reached a similar conclusion: controlled interventions tended to widen SES differentials in dietary quality. Lastly, a review by Lien et al¹ reanalysed three interventions and found that school-based free breakfasts or free fruit improved dietary patterns for all children and especially those from lower SES backgrounds, while classroom interventions had equal effects in both SES groups, and computer-based informational interventions were effective with lower SES girls.

The lack of further evidence led us to consider individual studies conducted in the European region. Ten studies were included (see table below). One general study of price elasticities found that lower SES households were more price-sensitive, especially for meat and fish, than higher SES households. Two modelling studies were conducted using UK Kantar household data: one found that low income families increased fruit and vegetable purchases through targeted economic incentives rather than 'nudges'; the other found that price incentives for healthy foods tended to be effective for higher SES groups more than lower, while all groups responded to incentives for unhealthy foods, but especially lower SES consumers.

A further econometric study in the UK estimated that there would be no widening of SES dietary consumption patterns if taxation of less healthy foods was combined with subsidies for healthier foods. Similarly, a controlled trial of simulated taxation of breakfast cereals and soft drinks reduced purchases equally across SES groups in the UK. A study of low income families in the Netherlands found that reduced prices of healthier foods was preferred over increased prices of unhealthy foods.

A three-year multi-component school-based intervention among young children in Denmark showed improved diets among all children and especially those of lower SES mothers. A computer-aided intervention among older children showed

improvements in diet, especially for children from higher SES backgrounds. A school intervention with sports mentors targeted in low income areas in Belgium had no effect on dietary intake, while a multi-media social marketing intervention among adults in a low-income region of the Netherlands had only minor effects despite reaching a large proportion of participants.

Conclusion

A weak evidence base suggests that a narrowing of the SES gap may be achieved through price adjustments such as combined taxation and subsidies favouring healthier products, or the provision of free healthier foods at schools. Informational approaches including computer-based material and social marketing appear either ineffective or widen the gap for older children and adults.

** Interventions that target low SES and have an effect on that group are described by some reviewers as 'narrowing the gap'. This may be true if the intervention is not available to high SES groups. However, if the intervention had been available to both low and high SES groups then it may be equally effective in both groups, or be even more effective in the high SES group.*

Table: Interventions to improve dietary patterns, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
McGill 2015 ³⁰ Are interventions to promote healthy eating equally effective for all? Systematic review of socioeconomic inequalities in impact	Systematic review, 36 studies (20 EU)	Various	Price (18), place (6), product (1), prescription (0) promotion (4), person (18)	Differential impacts on SES	Various	Purchases, reported diet, weight change, blood nutrient indicators, CHD incidence	'Price' and 'Place' decreased inequalities, 'Person' (especially dietary counselling) increased inequalities. 'Product', 'Promotion' and 'Prescriptive' not enough data. Authors note large number of papers failing to report sub-group analyses.
Van Cauwenberghe 2010 ³¹ Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and 'grey' literature.	Systematic review, 42 studies (36 in EU)	Children and adolescents	Multi-component school-based	Various	12 studies targeted low SES backgrounds	Dietary behaviour, BMI	Limited evidence for improvements in targeted groups of children, inconclusive for adolescents.
Brambila-Macias 2011 ³² Policy interventions to promote healthy eating: A review of what works, what does not, and what is promising	Non-systematic review (EATWELL project)	Various	Level of nutrition knowledge	Various	Educational level, occupational level	Dietary behaviour	Notes that nutritional knowledge is linked to behaviour and is independent of SES. But reference cited contradicts this: showing close link between SES and nutritional knowledge and dietary behaviour (see Wardle 2000 [66]).
Desroches 2013 ³³ Interventions to enhance adherence to dietary advice	Cochrane review, 38 studies	Adults	Various RCTs	Control groups	Not specified	Dietary changes	Only one paper identified to show SES differences in adherence to dietary advice: "a

for preventing and managing chronic diseases in adults (Cochrane Review)							<i>low level of education, low socio-economic group... were associated with reduced compliance".</i>
Oldroyd 2008 ³⁴ The effectiveness of nutrition interventions on dietary outcomes by relative social disadvantage: a systematic review	Systematic review, 6 studies (2 in EU)	Children (4 studies), adults (2)	Various RCTs	Control groups	Income, deprivation area, or ethnic group	Dietary changes	Most studies found effects were smaller in low SES groups (e.g. smaller increases in fruit and vegetable consumption in low-income children) and a widening of inequalities despite some benefits in the low SES groups.
De Bourdeaudhuij 2010 ³⁵ School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project	Systematic review, 11 studies	Children (6 studies), adolescents (5)	Various	Control groups or pre-post	1 study (KOPS, Germany) reported for SES	Dietary changes	Greater effects in children of higher SES families.
Lien 2014 ¹ Exploring subgroup effects by socioeconomic position of three effective school-based dietary interventions: the European TEENAGE project	Review / re-analysis of three interventions	Children of various ages	Various	Comparison of intakes	'SEP' = Parental education, school deprivation	Intake measures	Providing a school breakfast or fruit without parental payment seemed equally effective in both high and low SEP groups or even more effective in low SEP groups. The general multi-component classroom-centred intervention also had equal effect on FV in both SEP groups, whereas computer-based tailored interventions seemed more effective in the low SEP girls.
Griffith 2014 ³⁶ Getting a healthy start? Nudge versus economic incentives.	Targeted, econometric, UK	Kantar 256 low income households	Introduction of Healthy Start Scheme	'Nudge' vs voucher scheme	'on benefits'	Fruit and vegetable purchases	Targeted benefits are effective in increasing purchases of fruit and vegetables. The scheme

		purchase data					worked through economic incentives rather than through a “nudge”.
Nakamura 2015 ³⁷ Price promotions on healthier compared with less healthy foods: a hierarchical regression analysis of the impact on sales and social patterning of responses to promotions in Great Britain	Modelling with Kantar Worldpanel, 11,000 products, 27,000 households, UK	UK households	Effect of price manipulation	Healthy vs unhealthy food price promotions	Occupational classes	Sales	Higher-SES groups were more responsive than lower SES groups to promotions for both healthier and less-healthy foods. All groups were more responsive to unhealthy foods, especially lower SES groups.
Zizzo 2016 ³⁸ The impact of taxation and signposting on diet: an online field study with breakfast cereals and soft drinks	RCT, UK	1000 adults using online supermarket	Taxation of breakfast cereals and soft drinks	Level of tax, signposting of tax	Education level, gross income	Purchases	Both 20% tax and 40% tax reduced purchases, especially if signposted. Effects were similar across SES groups.
Waterlander 2010 ³⁹ Perceptions on the use of pricing strategies to stimulate healthy eating among residents of deprived neighbourhoods: a focus group study.	Targeted focus group survey, Netherlands	59 residents of deprived neighbourhood	Price variation, information	Tax vs subsidies	Combined index (SCP)	Attitudes and perceptions	Price is an effective tool, especially if combined with information. Reduced prices to promote healthier foods were preferred over taxes on unhealthy foods.
Jensen 2015 ⁴⁰ Intervention effects on dietary intake among children by maternal education level: results of the Copenhagen School Child Intervention Study (CoSCIS)	Non-random, 3-year control trial, Denmark	Children (5-7y) 10 intervention schools in one suburb, 8 control schools in another.	Multi-component PA, diet, classroom, canteen, parents	No intervention	Maternal education low, medium, high	Change in child’s reported diet	Slight improvements generally and children of low-educated mothers showed more improvement (but their diets were initially worse).
Green 2013 ⁴¹ The effect of rising food prices on food consumption: systematic review with meta-regression	Econometric, various	International and national subgroups	Price elasticities	Consumption levels	Household incomes	Differential response to price changes	Low income households showed highest elasticities for meat, fish and ‘other’; high income households showed smallest elasticities for cereals,

							sweets, and fruit and veg.
Nnoaham 2009 ⁴² Modelling income group differences in the health and economic impacts of targeted food taxes and subsidies	Econometric, UK	Household survey	Price elasticities, taxes, subsidies	Consumption levels	Household incomes	Differential response to price changes	All modelled taxation and taxation/subsidy regimens will be regressive. Health gains are maximized and the economic effect ameliorated if taxes to less-healthy foods are combined with subsidies of fruit and vegetables. No clear income group gradients exist in the health gains produced by the combined tax-subsidy regimens.
Ezendam 2015 ⁴³ Differential effects of the computer-tailored FATaintPHAT programme on dietary behaviours according to sociodemographic, cognitive and home environmental factors	RCT The Netherlands	School (23 schools) 883 children (12-13y)	Computer-aided health education	Consumption of sugar-sweetened beverages, snacks, fruit, vegetables	Educational level (vocational vs academic)	Self-reported consumption	For sugar-sweetened beverages, a reduction among higher educated, not lower. No difference for fruit. For vegetables, increase among those who reported high availability at home, independent of education level.
Dubuy 2014 ⁴⁴ Evaluation of a real world intervention using professional football players to promote a healthy diet and physical activity in children and adolescents from a lower socio-economic background: a controlled pretest-posttest design	RCT Belgium	Schools and football clubs 605 boys (10-14y)	'Health Scores!' school programme involving professional football club	Control schools with no programme	Schools with higher levels of socially deprived children	Self-reported dietary intake	No effects on diets (including breakfast, fruit, soft drinks or sweet and savoury snacks. Some improvements in attitudes and self-efficacy statements.
Luten 2016 ⁴⁵ Reach and effectiveness of an integrated community-based intervention on physical	RCT The Netherlands	Adults (>55y) in town of Veendam	Multi media (posters, radio, leaflets etc)	Neighbouring town	Low-SES region of country	Self-reported dietary intake of fruit and vegetables	<i>"We reached a relatively large proportion of the participants with our intervention but found that the intervention had only</i>

activity and healthy eating of older adults in a socioeconomically disadvantaged community							<i>minor effects.”</i>
<i>(NB several studies with SES measures, but reported only after controlling for SES.)</i>							

Systematic reviews: authors’ summaries of characteristics of studies that had SES-differentiated effects

McGill 2015 ³⁰ Are interventions to promote healthy eating equally effective for all? Systematic review of socioeconomic inequalities in impact	Policy makers should be aware that some healthy eating interventions targeted at healthy populations may have greater benefits for individuals of higher SEP (and subsequently increase inequalities), notably personalised nutritional education and dietary counselling interventions. On the other hand a combination of taxes and subsidies may preferentially improve healthy eating outcomes for people of lower SEP (potentially reducing inequalities). As noted, the majority of identified studies did not explore differential effects by SEP. When considering implementing a food policy at any level, those involved should consider the potential differential impact of these on health inequalities.
Van Cauwenberghe 2010 ³¹ Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and ‘grey’ literature.	Adolescents: There is inconclusive evidence that interventions in adolescents with low socio-economic backgrounds can change dietary behaviour positively. Younger children: There is limited evidence that interventions targeted at children with a low socio-economic status are effective in changing dietary behaviour.
Brambila-Macias 2011 ³² Policy interventions to promote healthy eating: A review of what works, what does not, and what is promising	Policy interventions are classified into two broad categories: information measures and measures targeting the market environment. Of the information measures, policy interventions aimed at reducing or banning unhealthy food advertisements generally have had a weak positive effect on improving diets, while public information campaigns have been successful in raising awareness of unhealthy eating but have failed to translate the message into action. Interventions targeting the market environment, such as fiscal measures and nutrient, food, and diet standards, are rarer and generally more effective, though more intrusive. Overall, we conclude that measures to support informed choice have a mixed and limited record of success. On the

	other hand, measures to target the market environment are more intrusive but may be more effective.
Desroches 2013 ³³ Interventions to enhance adherence to dietary advice for preventing and managing chronic diseases in adults (Cochrane Review)	Notes the possibility of SES differentials but provides no evidence or comment.
Oldroyd 2008 ³⁴ The effectiveness of nutrition interventions on dietary outcomes by relative social disadvantage: a systematic review	We found six studies that met the inclusion criteria. The studies showed that nutrition interventions have differential effects by SES, but they provided only limited evidence for widening of inequalities. This may be an absence of evidence rather than evidence of an absence of an effect. Owing to the small number of studies in this review, the possibility that nutrition interventions widen inequalities cannot be excluded.
De Bourdeaudhuij 2010 ³⁵ School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project	Refers to one study (KOPS) which showed no overall effect but improvements in subgroups, including high SES groups.
Lien 2014 ¹ Exploring subgroup effects by socioeconomic position of three effective school-based dietary interventions: the European TEENAGE project	Computer-tailored advice affected fat intake among low, but not high SES girls after 1 year. A multicomponent intervention affected the total fruit and vegetable intake in both SES groups, vegetable intake in low SES, and fruit intake in high SES across three countries after 1 year. Free fruit affected total fruit and vegetable intake as well as fruit intake equally in both SES groups in one country after 2 years. Providing a free healthy breakfast increased consumption of healthy food items only in the low SES group.

Fruit and vegetables

Summary

Of four systematic reviews examined, two mentioned but did not assess SES differential effects. Of the remaining two, one looked at SES in relation to fruit and vegetable promotion in pre-school settings⁴⁹ and the second assessed the potential for the European Union School Fruit and Vegetable Scheme to influence children's diets.⁴⁸

In pre-school settings, targeted interventions (all in the USA) increased fruit and vegetable intake, from which the authors concluded that the interventions had the potential to reduce the SES gap.*

The assessment of the potential of the EU School Fruit and Vegetable Scheme to increase children's fruit and vegetable consumption considered 30 studies and found only one with SES-differentiated outcomes: in Norway children's fruit intake in lower SES groups increased and thus narrowed the gap with higher SES groups if the fruit was provided without charge, but if a charge was made (even if subsidised) then higher SES groups showed a greater response.

The lack of further evidence led us to consider individual studies. Of the ten found in systematic searching, five found no intervention effect or an effect equally distributed across SES groups. A controlled trial in Germany found a widening of the gap following food preparation lessons among pre-school children. A cross-sectional survey in the Netherlands indicated a benefit may be obtained from targeted interventions for children in lower SES groups which reduce takeaway food consumption, increase meals eaten at tables and involve children in cooking. A school-based family intervention in Norway found a benefit for fathers with lower education. An analysis of the UK free fruit scheme for children found an initial benefit for children in both SES groups but the response declined after a year, especially for lower SES children. A study in Greece showed that the financial crisis 2008-2011 led to a reduction of fruit and vegetable intake by adults in lower SES groups.

Conclusion

A weak evidence base suggests that the provision of free fruit in schools may achieve a short-term narrowing of the SES gap in fruit and vegetable consumption among children, while a decline in family income (effectively increasing the price of many food products) may widen the SES gap in consumption, at least in adults.

** Interventions that target low SES and have an effect on that group are described by some reviewers as 'narrowing the gap'. This may be true if the intervention is not available to high SES groups. However, if the intervention had been available to both low and high SES groups then it may be equally effective in both groups, or be even more effective in the high SES group.*

Table: Interventions to promote fruit and vegetable consumption, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Delgado-Noguera 2011 ⁴⁶ Primary school interventions to promote fruit and vegetable consumption: A systematic review and meta-analysis	Systematic review, 19 studies						<i>No subgroup analysis for socioeconomic status</i>
Wolfenden 2012 ⁴⁷ Interventions for increasing fruit and vegetable consumption in children aged 5 years and under	Systematic review (Cochrane Review), 5 studies						<i>No subgroup analysis for socioeconomic status</i>
Sa and Lock 2008 ⁴⁸ Will European agricultural policy for school fruit and vegetables improve public health? A review of school fruit and vegetable programmes	Systematic review, 30 studies	School-age children receiving subsidized fruit	Effect of fruit schemes on intake	Before-after fruit scheme	Sub-group analysis	Intake	Of 30 studies, one (in Norway) reported increased fruit intake among lower SES children (narrowing the SES intake gap) if the fruit was free, but not if there was a (subsidised) charge.
Mikkelsen 2014 ⁴⁹ A systematic review of types of healthy eating interventions in preschools	Systematic review, 26 studies (3 in Europe)	Pre-school and childcare settings	Multicomponent interventions	various	Included targeted studies of low income families	Intake	16 studies targeted lower income or non-Caucasian children, of which 3 (all USA) showed increased fruit and veg intake.
Moor 2008 ⁵⁰ The impact of school fruit tuck shops and school food policies on children's fruit consumption: a cluster randomised trial of schools in deprived areas	Targeted RCT, UK	43 primary schools, 1976 children (9-11y)	Fruit sold in school-run tuck-shops for 1 year	Control schools	Target: above average free school meals	Reported intake	No effect on intake. Some improvement in schools with already-existing policies controlling snacks in schools.

De Bock 2011 ⁵¹ Positive impact of a pre-school-based nutritional intervention on children's fruit and vegetable intake: results of a cluster-randomized trial	Stratified RCT (control group received intervention 6 months later), Germany	348 children (3-6y), plus some parental involvement	Pre-school children food preparation lessons	Delayed control group	Parental education L, M, H (ISCED)	Reported intake	Small increase in vegetable intakes, which widen SES gaps (more increase for higher educated than middle, and middle than low).
Hughes 2012 ⁵² Childhood consumption of fruit and vegetables across England: a study of 2306 6-7-year-olds in 2007	Survey of School Fruit and Vegetable Scheme uptake, England	138 schools, 2306 children (6-7y)	Take-up and use of SFV Scheme	Schools not participating	Deciles of deprivation (IMD04)	Reported intake	SFVS increased consumption in all areas, does not reduce or widen gradient.
De Jong 2014 ⁵³ Home environmental determinants of children's fruit and vegetable consumption across different SES backgrounds	Cross-sectional survey, The Netherlands	4072 children (4-13y)			Parental education L, M, H	Correlates of intake by SES and BMI	Interventions should be targeted at lower SES groups, and include measures to: (i) prevent eating takeaway meals on a weekly basis, (ii) promote eating a home cooked meal at the table, and (iii) involve children in the cooking process.
Bjelland 2014 ²⁵ Changes in adolescents' and parents' intakes of sugar-sweetened beverages, fruit and vegetables after 20 months: results from the HEIA study a comprehensive, multi-component school-based randomized trial	RCT, Norway	1418 adolescents (11-13y), 849 mothers, 680 fathers	Multi-component, school-based	Control group	Parental education L, M, H	Reported consumption, reported knowledge	Small positive effects on lower-educated fathers' vegetable intake.
Adams 2012 ⁵⁴ Increase Retail Access to Fresh Fruit and Vegetables: A Mixed Methods Process Evaluation	Mixed methods UK	87 shops	Process evaluation of Change4Life promotion of FV in stores in deprived areas		Deprived area location (lowest 40% national ranking)	Intervention fidelity; variety, purchase price and quality of FV	Intervention fidelity was low and the intervention is unlikely to have had a substantial or long-term effect on customers' consumption of FV.

Fogarty 2007 ⁵⁵ Does participation in a population-based dietary intervention scheme have a lasting impact on fruit intake in young children?	Intervention vs control regional schools, UK	Young children (4-7y)	National Schools Fruit Scheme	Control areas	Above vs below median Townsend deprivation score	Parental report of intake pre-, during and a year after leaving scheme	Intervention effective for both groups, potentially narrowing differentials. Effect deteriorated after a year, especially in lower SES areas.
Luten 2016 ⁴⁵ Reach and effectiveness of an integrated community-based intervention on physical activity and healthy eating of older adults in a socioeconomically disadvantaged community	RCT The Netherlands	Adults (>55y) in town of Veendam	Multi-media (posters, radio, leaflets etc)	Neighbouring town	Low-SES region of country	Self-reported dietary intake of fruit and vegetables	<i>"We reached a relatively large proportion of the participants with our intervention but found that the intervention had only minor effects."</i>
Filippidis 2014 ⁵⁶ Trends in cardiovascular risk factors in Greece before and during the financial crisis: the impact of social disparities	Pre-post survey Greece	National sample of adults	Economic crisis	Trend over time	Education and economic status ESOMAR	Self-reported dietary intake of fruit and vegetables	The consumption of at least five portions of fruit and vegetables per day significantly decreased during the crisis among those of lower SES.
Mantziki 2016 ⁵⁷ Inequalities in energy-balance related behaviours and family environmental determinants in European children: changes and sustainability within the EPHE evaluation study	Uncontrolled prospective intervention in 7 countries	Children (6-8y)	EPODE school and community interventions	Change at 1 and 2 years	Education level of the mother (2 levels)	Parental report	Six countries showed no narrowing of inequality. One showed a narrowing of inequality of fruit intake (but not veg, nor other dietary indicators and with a high drop-out rate).

Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

<p>Sa and Lock (2008)⁴⁸ Will European agricultural policy for school fruit and vegetables improve public health? A review of school fruit and vegetable programmes</p>	<p>A free fruit scheme was used by all groups whereas a subsidised (subscription) scheme was mainly used by families with high SES. Compared to the subscription scheme, the free scheme reduced differences in fruit and vegetable intake between socioeconomic groups, with increased intake sustained 3 years after the free programme.</p>
<p>Mikkelsen 2014⁴⁹ A systematic review of types of healthy eating interventions in preschools</p>	<p>Several educational and multicomponent interventions were targeted towards institutions with children of low-income families and several of them had positive results especially on the consumption of fruits and vegetables that supports the notion of early education establishments as a potential setting to decrease inequalities in health.</p>

Trans fats

Summary

We found no systematic reviews of interventions to reduce trans fatty acids (TFA) intake, differentiated by SES. A literature review by the European Commission⁵⁸ concluded that mandatory iTFA labelling would lead to a widening of SES health inequalities with higher SES groups benefiting the most.

The lack of reviews led us to consider individual studies. Of the two studies found, one⁶⁰ provided modelling evidence to demonstrate that a total ban on iTFAs in the food supply would have a beneficial effect on health: the assumption would be made that consumers would benefit in proportion to their consumption level and that lower income consumers tend to consume greater quantities of iTFAs, thereby narrowing health inequalities. The other study⁶¹ did not show evidence but made a statement to the effect that mandatory labelling would benefit higher income groups more than lower, unless the labelling was accompanied by significant reformulation.

Conclusion

A weak evidence base suggests that reformulation may achieve a narrowing of the SES gap in TFA consumption, and that labelling of iTFA content on packaging may widen the SES gap in consumption.

Table: Interventions to reduce non-dairy, industrially-produced trans-fatty acid (iTFA) consumption, with SES assessment.

Reference	Study design	Popula tion	Intervention	Comparator	SES	Outcome measure	SES-relevant results
No systematic reviews found							
European Commission 2015 ⁵⁸ Report From The Commission To The European Parliament And The Council regarding trans fats in foods and in the overall diet of the Union population	Literature review and report by JRC	Various	Labelling, voluntary reformulation	No intervention	Not stated	Assumed consumption	TFA labelling “would allow the marketing of products with different TFA content on the same market. Consumers' choices would be affected not only by the information provided by the label but also by the possible price differences between reformulated products and cheaper alternatives. Low income populations would be more likely to consume the cheaper products (with high TFA contents); this could widen health inequalities (but not worsen health effects for the most vulnerable compared to a no policy change scenario).” (p12)
Allen 2015 ⁶⁰ Potential of trans fats policies to reduce socioeconomic inequalities in mortality from coronary heart disease in England: cost effectiveness modelling study	Epidemiologi cal modelling, England UK	Adults >25y	Total ban on trans fatty acids in processed foods; improved labelling of trans fatty acids; bans on trans fatty acids in restaurants and takeaways.	No intervention	Index of Multiple Deprivati on quintiles	CHD deaths, QALYs, costs and savings	A total ban on iTFAs in processed foods in England would reduce inequality in mortality from coronary heart disease by 15% and give the greatest net cost savings. Improved labelling and bans in restaurants would be at best half as effective in terms of reducing both mortality and inequalities, but still be cost-saving. Relying on voluntary reformulation

							will have negative health and economic outcomes.
Backholer & Peeters 2012 ⁶¹ JAMA letters	Comment						<p><i>“However, research has revealed that individuals who have healthier diets and who are from higher socioeconomic backgrounds are more likely to seek out and use food labels to make healthier choices.* Therefore, unless mandatory dietary labelling of TFAs leads to significant industry product reformulation to essentially eliminate dietary consumption of TFAs, it is unlikely that intake of TFAs among more socioeconomically disadvantaged individuals will markedly change following labelling regulations.”</i></p> <p><small>* Hess R, Visschers VH, Siegrist M. The role of health-related, motivational and sociodemographic aspects in predicting food label use: a comprehensive study. <i>Public Health Nutr.</i> 2012;15(3):407-414.</small></p>

Salt

Summary

We found no systematic reviews of interventions to reduce salt intake, differentiated by SES.

The lack of reviews led us to consider individual studies. Of the four studies found, two^{62,64} compared national dietary intakes before and after a national salt reduction campaign (in England) and found that consumption declined but without evidence for a differential effect between SES groups, despite some elements of the campaign being targeted at lower income groups. A modelling study based on the same intervention⁶⁵ found that reformulation would reduce SES salt consumption differentials, while labelling and social marketing would not. Lastly, a study of Kantar consumer data⁶³ during the same national campaign showed that overall salt intake levels reduced due to reformulation, not changes in product purchases, and this effect was greatest for lower occupational classes.

Conclusion

A weak evidence base suggests that the reformulation can have a population-wide effect and can narrow SES differentials in consumption. Informational interventions – labelling and social marketing – did not reduce differentials.

Table: Interventions to reduce salt consumption, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
No systematic reviews found							
Millett 2012 ⁶² Impacts of a national strategy to reduce population salt intake in England: Serial cross-sectional study	Serial surveys 2003 and 2007, England	HSE population samples 8621 and 6281 adults	National salt reduction strategy – reformulation, social marketing, targeted campaigns	Before - after	Occupation classes	Reported salt use and urine samples	Intake levels reduced uniformly across sub-groups (c 14%), i.e. gradient remained despite lower class groups being targeted within the campaign.
Griffith 2014 ⁶³ The importance of product reformulation versus consumer choice in improving diet quality	Serial surveys of purchase data and nutrient profiles, 2005 and 2011, Britain	Kantar World panel samples of 25,000 households and 50,000-60,000 products	National salt reduction strategy – reformulation, social marketing, targeted campaigns	Before - after	Occupation classes	Product purchases with salt content	Intake levels reduced due to reformulation, not product switching by shoppers. Intake levels reduced more for lower occupational classes: 17% (DE) 16% (C12), 11% (AB).
Ji and Cappuccio 2014 ⁶⁴ Socioeconomic inequality in salt intake in Britain 10 years after a national salt reduction programme	Serial surveys of dietary data 2000-2001, and 2008-2011, Britain	NDNS survey populations (c1200)	National salt reduction strategy – reformulation, social marketing, targeted campaigns	Before - after	Education groups, occupation groups	Reported dietary data	Intake levels reduced but gradient remained.
Gillespie 2015 ⁶⁵ The health equity and effectiveness of policy options to reduce dietary salt intake in England:	Modelling	England, adults	Mandatory and voluntary product reformulation,	Differential forecast CHD events	Index of Multiple Deprivation (quintiles)	CHD mortality	Mandatory reformulation most effective overall and in reducing SES differentials, Voluntary labelling next effective.

policy forecast			nutrition labelling, social marketing				Labelling and social marketing did not reduce inequalities.
<i>(NB several studies with SES measures, but results reported only after controlling for SES.)</i>							

Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

None found		
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Marketing

Summary

Four reviews were found which included relevance to various aspects of marketing (price, promotion, labelling, etc) and having a statement on SES differentials.

The most recent⁷⁰ concerned menu labelling in out-of-home catering, reviewed 18 studies and found poor quality of studies. Of two studies showing a differential response, both showed more response (healthier purchasing patterns) in higher-income neighbourhoods.

A European Commission study⁶⁹ using mixed methods including a literature review, noted a lack of definitive evidence. A review by Public Health England⁶⁸ found insufficient evidence but noted the potential for differential responses to marketing interventions. Lastly, Mills⁶⁷ noted the lack of evidence, reporting that 'important details such as socioeconomic position and ethnicity were rarely provided'.

The lack of results from these reviews led us to examine recent single-study papers (see table below). A US study⁷¹ found companies were promoting less healthy fast food outlets including in-store marketing in low-income neighbourhoods, and advertised their products more intensively in African-American TV programming. A controlled trial in the USA⁷³ found low-income students to be more responsive to unhealthy advertising than higher-income students.

In the UK, magazine advertising for food products tended to have less healthy products in magazines targeting a lower-income, female readership⁷⁵. Analysis of outdoor advertising in the UK found lower-income neighbourhoods had a greater number of food adverts, and specifically a greater number of adverts for unhealthy foods⁷⁷. A similar finding was made for UK broadcast advertising: TV audiences in low-SES households were more exposed to food advertising and specifically to unhealthy food advertising⁷⁸. A similar finding was made for children watching TV in Norway⁸⁰.

An analysis of TV viewers in Finland, Germany, and Romania⁷⁹ found that those who viewed most unhealthy food advertising also consumed more unhealthy diets (but no sub-group analysis was reported). A study in Ireland⁸¹ found children's recognition of TV ads for unhealthy foods was greatest among families that viewed more TV, had a poorer diet, and had lower levels of maternal education.

Data in the HBSC study of children aged 11-15y across Europe⁸² found higher TV viewing in lower-SES households, and this was associated with higher consumption of unhealthy foods and lower consumption of healthier foods. A PHE study of Kantar World panel data⁷² found that 'Everyone takes advantage of

price promotions, not just low-income consumers', implying no significant differential between SES groups. A second study using Kantar data (also in the UK)³⁷ found lower-SES groups tended to be more responsive to price promotions for unhealthy foods, but generally it was the higher-SES groups who were more responsive to price promotions for foods of all types.

Lastly, a study in the UK of colour-coded labelling of the fat content of packaged foods⁸³ found that the response was greatest among lower-SES participants, but affected higher-SES differentially according to a participant's concerns with their weight.

Conclusion

There is a significant lack of evidence on which to base a firm conclusion. Many studies found only small differences, indicating that interventions in marketing would benefit all groups without widening or narrowing SES differentials in health behaviour. Interventions to reduce TV advertising should have greater impact in lower SES groups, as both exposure and responsiveness to advertising of unhealthy foods are highest in lower SES groups. Colour-coded packaged food labelling may also benefit lower-income purchasers. There is additional evidence (not reviewed here) that colour-coded 'traffic light' labelling is superior to numerical coding among people with lower educational status and lower literacy and numeracy.

Table: Effects of marketing, with SES assessment.

Reference	Study design	Population	Intervention	Comparator	SES	Outcome measure	SES-relevant results
Mills 2013 ⁶⁷ Systematic literature review of the effects of food and drink advertising on food and drink-related behaviour, attitudes and beliefs in adult populations	Systematic review, 9 studies	Various adults	Exposure to advertising	Various	Subgroups	Behaviour, attitudes, beliefs	Noted the lack of relevant evidence (<i>"important details such as socioeconomic position and ethnicity were rarely provided"</i>)
Sarink 2016 ⁷⁰ The impact of menu energy labelling across socioeconomic groups: A systematic review	Systematic review, 18 studies	Populations eating away from home	Menu labelling (nutrition, energy content)	Various	Education, income, neighbourhood	Awareness, use, purchase behaviour	Data quality poor: of 2 studies reporting benefit of menu labelling, both indicated improved purchase patterns in higher SES neighbourhoods.
Public Health England 2015 ⁶⁸ Sugar Reduction: The evidence for action – Annexe 3: marketing strategies	Rapid review, 45 studies, 3 with SES analyses	Various, including targeted	Place, price, branding, labelling, promotion	various	Low income area	Response to marketing	No sub-group analysis but recognition of differential response potential
European Commission 2016 ⁶⁹ Study on the impact of marketing through social media, online games and mobile applications on children's behaviour.	Mixed methods: survey, focus groups, literature review.	Children	Exposure to digital media	various	SES and education	various	Commentary notes very few robust studies to show SES differences, few definitive findings.
Harris 2010 ⁷¹ Evaluating fast food nutrition and marketing to youth	Mixed methods: Literature review and database analyses, USA	Children and adolescents	Exposure to various marketing methods	various	Income and ethnicity groups	Exposure prevalence	<i>"Fast food ads appear more frequently during African American-targeted TV programming than during general</i>

							<i>audience programming... Billboards for fast food restaurants appear significantly more often in low-income African American and Latino neighbourhoods. Fast food restaurants located in poorer African American neighbourhoods also promote less-healthy foods and have more in-store advertisements compared to restaurants in more affluent, predominantly white neighbourhoods."</i>
Public Health England 2015 ⁷² Sugar Reduction: The evidence for action – Annexe 4: price promotions	Kantar World panel, 30,000 households, UK	Whole population	Promotional offers in retailers	Various	No quantified sub-group analyses	Purchase behaviour	<i>"Everyone takes advantage of price promotions, not just low-income consumers"</i>
Zimmerman 2014 ⁷³ The effects of food advertising and cognitive load on food choices	RCT, USA	351 college students	Effect of advertising	SES level, induced stress (cognitive load) level	Home neighbourhood median income	Healthy / unhealthy food consumption	Low-income students ate more unhealthy snacks (and more total kcalories) after advertising exposure
Nakamura 2015 ³⁷ Price promotions on healthier compared with less healthy foods: a hierarchical regression analysis of the impact on sales and social patterning of responses to promotions in Great Britain	Modelling with Kantar World panel, 11,000 products, 27,000 households, UK	UK households	Effect of price manipulation	Healthy vs unhealthy food price promotions	Occupational classes	Sales	Higher-SES groups were more responsive than lower-SES groups to promotions for both healthier and less-healthy foods. All groups were more responsive to unhealthy foods, especially lower SES groups.
Duffey 2010 ⁷⁴ Food price and diet and health outcomes: 20 years of the CARDIA Study	Food price database and young adult survey, USA	5,000 adults aged 18-30y	Price	Pre-post change in price	Income	Food intake	<i>"In our sample, income did not modify the relationship between price and consumption"</i>

Adams 2009b ⁷⁵ Socio-economic and gender differences in nutritional content of foods advertised in popular UK weekly magazines	Content analysis, UK	UK adult readers of magazines	Publication of advertisements	Types of magazine, types of advertisement	Occupational classes and income tertiles of National Readership Profiles	Advertisements for less healthy products	A greater readership in social classes C2DE was associated with advertisements for foods with more protein, fat, saturated fat, carbohydrate and total sugars, and higher sodium density.
Adams 2011c ⁷⁶ Variations in food and drink advertising in UK monthly women's magazines according to season, magazine type and socio-economic profile of readers: a descriptive study of publications over 12 months	Content analysis, UK	UK adult readers of magazines targeting women	Publication of advertisements	Types of magazine, types of advertisement	Occupational classes and income tertiles of National Readership Profiles	Advertisements for less healthy products	<i>"Non-significant trend for advertisements for 'food and drinks high in fat and/or sugar' to be more prevalent in magazines with less affluent readerships."</i>
Adams 2011b ⁷⁷ Socio-economic differences in outdoor food advertising in a city in Northern England	Content analysis, UK city	UK local population	Display of advertisements	Types of food	Local area deprivation index in tertiles	Advertisements for less healthy products	Least affluent had greater number and square-metres of advertising for all products and for HFSS products. Gradient across tertiles.
Adams 2011a ⁷⁸ Socio-economic differences in exposure to television food advertisements in the UK: a cross-sectional study of advertisements broadcast in one television region	Content analysis UK regional TV	UK region TV viewers	Broadcast of advertisements	Types of food	Social class of main earner in household	Advertisements for less healthy products	<i>"...the overall volume of advertising, food advertising and 'less healthy' food advertising seen by viewers progressively increased as affluence decreased, with those in the least affluent social grade viewing more than twice the volume of all three types of advertising than those in the most affluent social grade."</i>
Giese 2015 ⁷⁹ Exploring the association between	Content analysis TV commercials,	TV viewers in Finland,	Broadcast of advertisements	Types of food	Household affluence	Advertisements for	Exposure levels closely associated with consumption

television advertising of healthy and unhealthy foods, self-control, and food intake in three European countries	diet surveys.	Germany and Romania			(Wossman index of book ownership)	less healthy products, dietary patterns	levels: healthy with healthy, unhealthy with unhealthy. Results presented 'control for affluence'. Affluence subgroups not separately reported.
Klepp 2007 ⁸⁰ Television viewing and exposure to food-related commercials among European school children, associations with fruit and vegetable intake: a cross sectional study	Content analysis TV commercials, diet survey	13305 children (10-11y) in 9 European countries (7 in EU)	Broadcast of advertisements	Total exposure, types of food,	Household social class in two strata	Advertisements for less healthy products, dietary patterns	Lower class children watch more TV, greater exposure to both healthy and unhealthy foods. Children exposed to healthier food ads ate more fruit and vegetables.
Tatlow-Golden 2014 ⁸¹ Young children's food brand knowledge. Early development and associations with television viewing and parent's diet	Survey	172 preschool children (3-6y) Ireland	Exposure to brand promotion	Healthy and unhealthy food brands	Mothers' education level (three levels)	Brand familiarity	No SES differences in children's recognition of <i>healthy</i> brands, but recognition of <i>unhealthy</i> brands was associated with more TV viewing, poorer child's diet, poorer mother's diet, and lower maternal education.
Vereecken 2005 ⁸² Television viewing behaviour and associations with food habits in different countries	Survey (WHO-HBSC)	162000 children (11-15y) in 32 countries (25 in EU)	TV viewing,	Correlational	Head of household occupation, 3 classes	TV viewing, diet	Higher TV viewing in lower class households. Higher viewing significantly associated with greater consumption of confectionery, snacks and lower consumption of fruit, vegetables (controlled for SES).
Crockett 2014 ⁸³ The impact of nutritional labels and socioeconomic status on energy intake. An experimental field study	RCT	287 adults in London suburb, UK	Snacks labelled 'low fat' (green), 'high fat' (red) or no label	Labelling differences, and subjects' weight concern differences	Index of multiple deprivation	Consumption of snacks	Colour-coded nutritional labelling had significant impact on lower SES participants, nuanced effect on higher-SES participants according to their weight concerns.

(NB several studies with SES measures, but results reported only after controlling for SES.)							
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Systematic reviews: authors' summaries of characteristics of studies that had SES-differentiated effects

Sarink 2016 ⁷⁰ The impact of menu energy labelling across socioeconomic groups: A systematic review	Of the two studies that reported a benefit of menu energy labelling overall, both identified a greater effect on fast food purchases among consumers visiting stores located in high compared to low-SES neighbourhoods. It is difficult to know whether the paucity of evidence of effectiveness reported in low-SES populations represents a truly limited impact in such populations, or is a result of a more general lack of policy effectiveness or the limited quality of the reviewed studies.	
Public Health England 2015 ⁶⁸ Sugar Reduction: The evidence for action – Annexe 3: marketing strategies	Several of the studies indicate that impact may differ by population subgroup. (No further comment.)	
European Commission 2016 ⁶⁹ Study on the impact of marketing through social media, online games and mobile applications on children's behaviour.	Commentary notes that parents of higher socio-economic status tended to use active mediation strategies, including talking about the Internet and sharing online activities, while parents of lower socio-economic status, or lower Internet use or digital confidence, tended to rely more on restrictive mediation	

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