What works to improve school lunch nutritional quality - legislation or self-audit? Medium-term results from Sweden

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Research Article

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Abstract

Background

Poor monitoring and evaluation leads to a lack of evidence regarding what works in terms of improving school meal quality. Sweden has a long-standing policy of universal free school meals but updated legislation regarding nutritional quality came into effect in 2011. To coincide with this, we built a fully automated web-based self-audit tool for schools, called School Food Sweden, in order to i) establish a national database on overall meal quality, covering six domains, and ii) help schools and municipalities improve, based on the implementation strategy of audit and feedback. We have previously examined the pre- and post-legislation period. In this paper we describe changes in one domain – nutritional quality – in the years since the new legislation and examine if repeated use of the tool was associated with improvements.

Methods

Primary schools in Sweden self-selected to use the tool between March 2012 and July 2019 and audited a four-week lunch menu. Date of audit, number of audits per school (1-9), how often schools accessed their feedback (% of times) and school characteristics were noted. Factors associated with meeting nutritional criteria were examined using variance weighted least squares regression and logistic regression, using both repeated cross-sectional and longitudinal design.

Results

Almost half of all ca 4800 primary schools in Sweden signed up to the tool. Nutritional quality was audited by 1500 schools at least once. Repeated cross-sectional analyses showed the proportion of all schools meeting the criteria increased significantly between 2012/13 and 2018/19 (from 11% to 34%). For all schools, each extra audit completed increased the odds of meeting nutritional criteria by 1.30 (CI 1.20-1.41), controlling for region and time since the introduction of legislation. In a longitudinal analysis (schools with repeat audits, n=774), both number of audits and the frequency of accessing previous feedback reports were predictors of meeting the nutritional criteria (OR 2.02, CI 1.23-3.31), even after adjusting for time since the introduction of legislation and number of days since the previous audit.

Conclusions

Both legislation and self-audit with automatic feedback appear effective in helping schools to improve school meal quality. Self-audit may be an essential complement to legislation, or a promising alternative in settings where regulation is not an option.

Background

The World Health Organisation recognises the importance of school meals and recommends school meal policies as a way to improve public health [1]. While many countries offer school meals, contexts and policies vary greatly [2-6]. However, a common issue is a lack of monitoring and evaluation [5, 7, 8], particularly in high-

income countries [3]. This in turn limits the evidence base for school meal policies, which in turn can hamper the spread of good or improved practice.

Universal policies and long-standing practices are a particular challenge to evaluate [5], which is exemplified by Sweden. School meals have a long history (see Box 1) and Sweden is almost unique in providing school lunches free of charge to all primary school pupils – ages 6-16 – regardless of the economic circumstances of the family, or whether the school is publicly (i.e. municipality) or privately run. Yet according to a recent overview of policies in selected countries in Europe [5], neither Sweden nor Finland, which has a very similar system for school meals [9], would have met core criteria for "good practice", as neither country has an official system for monitoring and evaluation. In Sweden, new legislation came into effect in 2011 explicitly stating that school meals should be "nutritious" (see Box 1). This provided a new opportunity for a policy evaluation, but none was planned. No further clarification of "nutritious" was provided but the School Inspection Agency concluded that meals should be in line with Swedish (now Nordic) nutritional recommendations [10].

Box 1 Selected major developments in Swedish school lunch policy

Late 19th century: School lunches are provided piecemeal, as a way of counteracting poverty
1946: National policy is introduced to subsidise meals if local authorities chose to provide them
1970s: Implementation of school lunches is now widespread
1998: Education Act 1997 comes into force; school meals to be provided to all, "free of charge"
2011: Education Act 2010 comes into force, and adds that school meals should be "nutritious"

For a more detailed history, see Lundborg et al [11].

As no official monitoring or evaluation was planned, in 2010 we started to develop a tool that would let schools complete a self-assessment (audit) of their full school meal situation. One aim of the tool was to build up a database and to evaluate any change in nutritional quality after the new policy. Another aim was to support schools and municipalities in their attempts to improve overall school meal quality, by providing them with automatic tailored feedback [12]. Audit and feedback is an implementation strategy defined as "a summary of […] performance over a specified period of time, given […] in a written, electronic or verbal format. The summary may include recommendations for […] action"[13]. Self-evaluation is seen as a useful tool in the field of school effectiveness [14], and a Cochrane review found evidence for the effectiveness of audit and feedback for improving practice in the healthcare setting [15]. However, another Cochrane review of strategies used to enhance implementation of school-based policies or practices - targeting risk factors such as nutrition, physical activity or tobacco - found that audit and feedback was rarely utilised in this setting [16].

Using a pre/post-study design between the spring of 2011 and of 2013 we evaluated the initial effects of the policy in a randomly selected, nationally representative sample of schools. We found significant but modest improvements in nutritional quality [17]. In the present study, using the same outcome, we wanted to re-examine the effects of the policy, as well as, for the first time, evaluate the effect of repeatedly using the tool. The aims of this study were therefore to describe the changes in nutritional quality of school lunches offered in Swedish

primary schools in the eight years following a change to national legislation, (Study A) and to compare changes in schools that used this self-audit tool more often with those that used it less often (Study B).

Methods

The School Food Sweden tool

The development and validation of the tool is described in more detail elsewhere [12]. Briefly, a stakeholder group helped identify six important domains of school meal quality, and a web-based tool to measure provision/choice, nutritional quality, food safety issues, service and pedagogy, environmental and organisational aspects was developed. Following pilot-testing, validation studies and further improvements including automatic feedback reports, the tool was made freely available for all primary schools in March 2012. The tool consists of two parts: questionnaires – one per domain – plus feedback in the form of a tailored report. The questionnaires are free-standing and can be answered in any order; all are optional, but the domain "provision/choice" is required in order to generate the report. The report includes all domains, even if not yet completed. It is a pedagogically designed PDF-document, about 20 pages long. It includes summary statistics and clear explanations of why each domain and sub-domain is important. The score for each question is shown using a traffic-light colour system to indicate what is currently good and what could be improved. Schools can contact the administrator of the tool by email or phone if they have questions, but no support, follow-up or other feedback is offered as standard. Schools can use any part of the tool as often as they wish, without limitations. Any member of staff can complete any questionnaire, but most commonly the nutritional quality domain is completed by the school kitchen manager. When the school is ready, they click a button to create and download their tailored feedback.

Setting, recruitment and study design

Guidelines for school meals are produced by the Swedish Food Agency, a government agency. Guidelines were first issued in 2007; a major revision was published in 2013 [18]. The guidelines state that meals are expected to meet nutritional recommendations over a four-week period, and include general information about foods to promote, and but no standards or rules. In fact, in the most recent revision 2018 [19], suggestions of food servings were toned down even more, in order to emphasise the importance of schools taking a common-sense and holistic approach. This non-prescriptive approach is possible in part because of the long tradition of school meals – even today a school lunch consists of a cooked meal, a salad buffet and crispbread with spread, and milk/water. Fried foods have never been a feature, nor have desserts or soft drinks. In the majority of schools, a choice of two or more warm meals is offered. Food is prepared freshly, either on-site (by municipal or private catering), at a nearby school or at a central municipal kitchen. School cafeterias are common, but while the offering is generally less healthy it is not free of charge, and vending machines are very rare. The guidelines also emphasise the need to consider other aspects of meal quality, such as the importance of a pleasant meal environment, adequate time to eat, and the potential for school meals to be well-integrated in the school's educational activities. Pupils generally serve themselves and eat in a canteen; teachers are usually present and are encouraged to use the meal as an opportunity to interact with pupils, the "pedagogical lunch" [20].

The study population was all primary schools that used the tool between the launch date 29th March 2012 and 31 July 2019. Schools self-select to use the tool, although some public schools may be directed to do so by their municipality. They are not invited, and any contact with them prior to sign up is usually indirect – e.g., the tool is mentioned in guidelines, we have had contact with their municipalities and regions, or with organisations and government agencies working with public meals, or we have participated in relevant meetings/conferences etc. A municipality-level account function that can create municipality-level reports and get an overview of school accounts was added in 2016.

To examine changes over time (Study A), we used a repeated cross-sectional design. If a school performed more than one audit of nutritional quality during a school year (defined here as 1 August-31 July), only the most recent was included when reporting that school year's results at group level. To compare the results of repeated audits (Study B), we used an open cohort design. Due to pilot-testing and the pre/post study, some schools had used the tool before the launch date, when automatic feedback was not yet in place. We restricted this analysis to schools that had only ever been exposed to the complete version of the tool so all schools who had first completed an audit of nutritional quality after the launch date were included, and all their audits were included.

Data collection

Nutritional quality

The nutritional quality questionnaire assesses the adequacy of a school's four-week lunch menu in terms of four nutritional aspects: iron, fibre, vitamin D and fat quality. These four were chosen to focus on nutrients of importance for children that are not easily met [21], including in school lunches [22, 23], while keeping the questionnaire as brief as possible. The questionnaire includes questions about the serving frequency of both rich and/or common food sources of these nutrients over a four-week period. All data is self-reported by schools. The answers are scored and compared to validated criteria for the four nutrients [12]. If the criteria for all four are met, the school menu is classified as "likely to meet nutritional recommendations", in this study referred to as "meeting nutritional criteria", the primary outcome. All other results are combined as "not meeting nutritional criteria". Where two audits had been conducted very close together (within 28 days), the later was excluded, on the assumption that this was unlikely to reflect meaningful changes and could signal that the school was testing the effect of alternative answers.

Other data

We extracted data on when and how often the school had performed the audit(s) of nutritional quality, as well as the number of days that had elapsed since any previous audit, and whether feedback (a report with results) had been generated. Some reports are never generated, due to lack of awareness, lack of interest or perhaps technical difficulties, and we cannot see if reports have been opened/read. We calculated the proportion of times a school had generated reports and categorised this as *sometimes* (0-50% of occasions), *mostly* (51-89% of occasions) and *almost always* (90-100% of occasions). For public schools we also noted if and when the municipality had created an account. This variable was included as a proxy for how engaged the municipality

was with the tool, which could either be signal that schools had extra support, or that they were under external pressure to do so.

School characteristics

Data on schools was extracted from a national database [24], namely: the number of pupils, the owner of the school (municipality or private), and the location of the school. As measures of the school's socioeconomic position, we used the proportion of students with parents with longer education (>12 years), as well as the proportion with a foreign background (pupil or both parents born outside Sweden). Occasionally data was missing, or if less than 10 pupils in a category, not published. In the latter case we imputed it as 5. School size was categorised into three categories (≤200 pupils, 201-400 pupils, ≥400 pupils. Geographical location in Sweden was coded as east, south or north, according to one of the definitions used by Statistics Sweden.

Statistical analysis

For the cross-sectional study (Study A), the proportion of schools meeting the criteria for nutritional quality each school year was compared and a binary logistic regression was performed to see if school year was a significant predictor. For study B, to investigate whether schools with more audits were more likely to meet the nutritional criteria than those with fewer, three analyses were performed. Firstly, we grouped audits from all schools by audit order (i.e., all 1st audits, all 2nd audits etc) and compared the proportion of schools meeting the criteria across all groups, calculating the average results and the average change from the preceding audit. As selection bias was a potential concern, i.e., schools which went on to use this tool many times might differ from ones that only used the tool once, we repeated this analysis, stratifying schools according to the number of audits in total that each performed, to see if the pattern held. Schools with more than nine audits were excluded due to very small numbers (N=13, 1%).

Secondly, we extended this subgroup analysis in a way that allowed us to control for potential confounders, using variance weighted least squares (VWLS) regression. This model, sometimes referred to as meta-regression, extends the simple linear regression to consider the outcome as an estimated quantity that can be averaged rather than a simple observation. For each subgroup (schools grouped by audit order), the variances of the outcome variable are estimated and assumed independent of the other subgroups. Then the model treats each subgroup as one observation, weighted with the estimated variance. In general, the outcome variable can be seen as an estimate and the explanatory variables as confounders observed at subgroup level that might influence the average of the "intervention" effect. Here, we estimated the continued effect of total number of answers of the audit order with and without the potential confounders included in the models. The confounders controlled for in the models were distribution of region, proportion of private schools and average size of the schools.

Thirdly, as the tool consists of two components – an audit component plus a feedback component - we wanted to consider both as independent predictors. Two logistic regressions were performed to test if the number of occasions a school evaluated its nutritional quality or if the proportion of occasions a school generated its previous feedback was associated with the odds of meeting the nutritional criteria. (We first checked there was no evidence of a correlation between number of audits performed and percent of all feedback generated;

Spearman's rho 0.019). Potential confounding factors in both regression models were audit date (expressed as months since March 2012), school characteristics, and for public schools, whether the municipality had an account by the time of the school's final audit. Statistical significance was set to a level of 0.05. Analysis was performed in IBM SPSS Statistics for Windows (version 26), except for the VWLS which was performed in Stata Statistical software (version 16.1).

Results

Use of the tool

By July 2019, 2,206 primary schools had created an account, corresponding to 45% of all primary schools in Sweden that year (ca 4,800) (Table 1). Additionally, 50% of the country's 290 municipalities had created a municipal-level account. During the 7-year period from launch spring 2012 to end of school year 2018/19, 1,500 schools audited nutritional quality at least once. These schools came from 223 of the country's 290 municipalities. In total, 4,141 audits of nutritional quality were made during this period; 894 schools (57%) performed two or more audits. For Study B, 190 schools were excluded as they had first used the tool before the report function was available and 1,310 schools remained. Schools using the tool were not representative of all schools nationally. They tended to be larger, were more likely to be publicly run, and more likely to be from the eastern region of Sweden (Table 1). This pattern remained relatively stable, making it reasonable to compare trends over time.

Table 1 Description of all schools, schools with accounts and with completed audits

	All schools[1]		Schools with accounts		Schools that have evaluated nutritional quality			
					All		Post-launch[2]	
	N = 4823		N = 2206		N = 1500		N = 1310	
	N[4]		N	%	N	%	N	%
Schools (% of all schools)		100		45.0		31.0		27.1
Municipal schools (%)		82.7		88.4		91.9		91.5
Number of pupils (median)		208		285		300		286
Region (%)								
- East		32.7		40.6		44.7		42.3
- South		45.7		42.1		37.9		39.5
- North		21.5		17.4		17.3		18.2
Municipality has created account (%)[3]		n/a	1951	78.2	1378	85.1	1198	77.6
Parents with higher education (%)	4644	54.0		-	1380[5]	51.0	1216	50.1
Parents with foreign background (%)	1153	15.0		-	1085[6]	13.0	1180	13.0

[1]Operating in 2017/18

[2]Excluding schools which began to use the tool prior to March 2012

[3]For municipally-run schools only

[4]N can vary due to e.g. missing data so the N for which data is available is given if different from the N in the header.

[5]Missing data for higher education: 120 of 1500 (of which 91 due to difficulties locating data, 9 lacked data, 20 had less than 10 pupils with this characteristic and so data is not made public (imputed as 5)).

[6]Missing data for foreign background: 415 of 1500 (of which 91 due to difficulties locating data, 50 lacked data, 274 had less than 10 pupils with this characteristic and so data is not made public (imputed as 5)).

Changes over time

Many schools had difficulty meeting the nutritional criteria for school meals (Table 2). However, the cross-sectional results showed the proportion increased significantly with each passing school year, from 11% in the first full school year of operation 2012/13 to 34% in 2018/19 (Table 2). Of the four nutrients included in the tool, schools had most difficulty reaching the requirements for vitamin D and fat quality, while requirements for fibre

and iron were met by most (data not shown). As schools included in these yearly cross-sectional datasets included both schools performing an audit for the first time and those that were repeat users, we examined if this positive trend was also present among first-time users only, who could not have been affected by previous experience with the tool. No such clear trend was seen, and the variation from year-to-year was high (Table 2).

Table 2 Proportion of schools meeting all four nutritional criteria per school year

	ST 2012	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Number of schools with audits	64	554[1]	604	519	635	547	464	451
	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)
Meeting all four nutritional criteria (%)[2]	9.4 (6)	10.6 (59)	26.5 (160)*	27.0 (140)*	28.5 (181)*	33.1 (181)*	32.3 (150)*	33.9 (153)*
Number of schools using tool for first time[3]	55	430	343	123	177	85	53	44
	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)
Meeting all four nutritional criteria (%)	7.3 (4)	8.8 (38)	16.9 (58)*	19.5 (24)*	7.3 (13)	10.6 (9)	7.5 (4)	25.0 (11)*

ST = spring term

[1]Includes 94 schools participating in the pre/post study from 2011 and 2013 (i.e. not self-selected).

[2]Based on a school's final audit for that school year

[3]Schools who had completed an audit prior to launch date were excluded.

* Significantly different from reference year 2012/13, the first complete school year, P≤0.00

Changes following use of the tool

This longitudinal analysis was restricted to the schools that only ever had access to the complete tool, i.e. first used it March 2012 or later (N=1,310). Over half audited nutritional quality more than once (59%, N=774). The median length of time between all audits was 367 days (inter-quartile range: 267-502 days). For schools with more than one audit, the proportion meeting all four nutritional criteria on the first audit was 24.5%, while the proportion meeting the criteria at their final (most recent) audit was 31.6%.

To investigate whether schools with more audits were more likely to meet the nutritional criteria than those with fewer, three analyses were performed. Firstly, the proportion meeting all criteria at each audit, grouped by audit order, is presented. The bars in Figure 1 show an overall trend towards improved outcomes by higher audit order. Because schools that went on to use the tool repeatedly were more likely to have had better results on the first audit (14.3% met the criteria) than schools only ever performed one audit (9.3%), we stratified schools according to the total number of audits conducted, plotted as lines in Figure 1. The lines also suggest an overall trend towards improved results, regardless of stratum, although there is a lot of variation, particularly in the strata with most audits, due to small numbers.

Secondly, the results of the variance weighted least squares regression, extending the subgroup analysis to adjust for confounders (distribution of region, proportion of private schools and average size of the schools), showed similar patterns as the results presented in Figure 1. The estimates showed an increase in average proportion meeting nutritional criteria with increasing number of total audits (data not shown). When comparing the models with and without the potential confounders of school characteristics, no strong indication of confounding effect was observed.

Finally, the results of the logistic regression show the relationship between i) the total number of audits a school had completed, and ii) how often (% of times) the school had generated their prior reports, on the likelihood of the school meeting nutritional quality at its final audit. In a simple logistic regression (Model 1), with schools with just one audit in total as the reference category, for each increasing number of total audits completed, schools increased their odds of meeting nutritional criteria at their final – most recent – audit by 1.38 (CI 1.30-1.48) (Table 3). After controlling for geographical region and audit date, it was 1.30 (CI 1.20-1.41, Model 2). Among schools with repeated uses, results from Models 1 and 2 were similar to those for all schools. Model 3 included a variable relevant only to schools with repeated audits, namely the number of days (≥28) that had elapsed since the previous audit. The OR for the final Model 3 was 1.26 (CI 1.12-1.41). Neither the owner of the school nor the proportion of pupils with foreign background nor parents with a longer education were significant predictors in the models. For municipal schools, whether the municipality had an account by the time of the school's final audit was also considered, but this was not significant either and was therefore excluded so results could be presented for all schools.

Table 3 Results of logistic regression with the total number of audits completed as the predictor, showing odds of meeting the nutritional criteria at the final (most recent) audit.

	All schools				All repeat users		
	N=1310				N=774		
	OR	(95% CI)			OR	(95% CI)	
Model 1	1.38	1.30	1.48	Model 1	1.34	1.23	1.45
Model 2	1.30	1.20	1.41	Model 2	1.32	1.20	1.46
				Model 3	1.26	1.12	1.41

Model 1: unadjusted

Model 2: Model 1, adjusted for region and time since launch
Model 3: Model 2 adjusted for days passed since previous audit (repeat users only)

Table 4 shows that, compared to schools that accessed their previous audit results (i.e. generated their report) only *sometimes*, schools that accessed their prior results *almost always* were more likely to meet the nutritional criteria: the odds ratio ranged from unadjusted 2.40 (1.48-3.88) to adjusted 2.02 (1.23-3.31, Model 3 as before).

Table 4 Results of logistic regression with the predictor "proportion of previous audit results generated", showing odds of meeting the nutritional criteria at the final (most recent) audit.

	All repeat users		
	N=774		
Model 1			
S*ometimes* (0-50%)	ref.		
Mostly (51-89%)	3.31	1.89	5.79
Almost always (90-100%)	2.40	1.48	3.88
Model 2			
S*ometimes* (0-50%)	ref.		
Mostly (51-89%)	2.46	1.38	4.41
Almost always (90-100%)	2.04	1.25	3.34
Model 3			
S*ometimes* (0-50%)	ref.		
Mostly (51-89%)	1.97	1.09	3.57
Almost always (90-100%)	2.02	1.23	3.31

Model 1: unadjusted

Model 2: Model 1, adjusted for region and time since launch

Model 3: Model 2 adjusted for days passed since previous audit

Discussion

The findings suggest that both time elapsed since the adoption of a legal requirement for nutritious school lunches and repeated use of The School Food Sweden tool, a self-administered audit and feedback tool, exerted an influence on meal quality in Sweden between 2012 and 2019. Disentangling the two instruments is however a challenge due to their universal nature.

Evidence for an effect of the 2011 policy includes the fact that in repeated cross-sectional analyses, the proportion of all schools meeting nutritional criteria increased with each passing year, from 11% in 2012/13 to

34% in 2018/19. This extends the results of our previous work, where using a pre/post study design, but where no feedback was provided, we found modest improvements in nutritional quality two years after the legislation [17]. Legislation is one of the more powerful instruments available to promote behavioural changes [25] and can often give rise to ripple effects - activities and initiatives by other important stakeholders. Some early examples have been described [17], such as the founding of the National Centre for Public Meals (NCPM) at the Swedish Food Agency in 2011. The NCPM overhauled guidelines for school meals in 2013 [18] and since then, the guidelines have been disseminated widely. The centre has also undertaken surveys that show that the proportion of municipalities with an official policy document adopted by local politicians for school meals has risen from 45% in 2011, to 74% in 2016, and 85% in 2018 [26], and that the vast majority refer to the national guidelines.

However, the repeated cross-sectional analyses that showed improvements in quality over time included both schools using the tool for the first time as well as repeat users, so if the tool had an effect it would influence this observation. The proportion of schools meeting nutritional criteria with each passing year did not increase as clearly for schools who were using the tool for the first time, something which would have been expected if time since introduction of the policy was the only factor. Either schools that started using the tool later are different in some way, perhaps with greater needs (a form of selection bias), or the policy effect is smaller than expected, or maybe even waning. Further evidence for the effect of the tool includes the fact that we also saw a dose-response effect where schools that had used the tool more often had better results than those that used it less often, and furthermore achieved better results when they used both components of the tool – audit together with feedback. In our analysis of factors associated with both improvement in and meeting nutritional criteria, repeated use of the tool stood out as a predictor, even when controlling for other important variables known to be associated with nutritional quality, including time since introduction of the policy. These point to the effectiveness of the tool to improve nutritional quality, rather than the policy alone.

This is not to say that the policy had little effect. As mentioned, the policy led to initiatives and increased attention on school food quality, so the take-up of the tool would likely have been lower if not for the policy. On the other hand, if a policy is not carefully evaluated, it is difficult to be sure of its effects. And without follow-up or consequences for non-compliance, effects may be limited. At school level, the inclusion of school meals in internal quality management systems, as also required by the new law, is quite low. By 2016 only half of schools surveyed by Olsson and Waling had done so [27]. Of municipalities with local policy documents, only 58% had followed these up within the previous three years [26]. Poor evaluation and monitoring is a common and persistent problem in the field of school meal policy [5, 7, 28], and means that good practice and/or lessons learned may be missed. Evaluations of the effects of truly universal meal policies are particularly challenging and are, unsurprisingly, rare [5]. A recent systematic review of “universal” school meals – both breakfast and lunch – has been conducted by Cohen et al [6]. They identified studies that predominantly utilised pre- and post-designs, or where “universal” was limited to a group of schools in a country (not all schools as in the present study), or in the one case where it was universal - Japan - analysis was cross-sectional. Long-term evaluations are even rarer. For example, the longest follow-up by far in a systematic review of the impact of school food environment policies on actual dietary intakes was 60 months [29]. One noteworthy exception is a Swedish study where economists found that adults who had attended school at a time when free school lunches were becoming widespread in the 50s and 60s and received them during all nine primary school years benefited from a 3% increase in lifetime earnings, and this effect was greater for those who had come from poorer households

[11]. That analysis could not take quality into account, and the effects of meals in well-nourished populations is probably less dramatic [30], but the finding that inequalities can be dampened via school meals is relevant even today [23, 31].

The implementation strategy of audit and feedback is considered very effective to support change, at least in the healthcare setting [15]. It appears to be less commonly used to enhance implementation of school-based health-related policies [16]. Evaluation of the effectiveness of such tools, and providing feedback remotely – fully automated, without in-person follow-up, as in our study – is rare. One school canteen-based audit and feedback randomised controlled trial has been conducted, in Australia [32]. Compared to our tool, this was a relatively intensive intervention; the main component being a menu audit, with initial face-to-face contact, and subsequent provision of feedback via a written report and telephone call up to four times over a 12-month period. Although no evidence was found for an improvement in the primary outcomes (proportion of schools with a menu that did not include discouraged foods/beverages, and the proportion where encouraged items made up the majority of the menu), intervention schools offered fewer discouraged items. The intervention has been modified and tested again at scale with positive results [33]. In the Netherlands, the Canteen Scan tool [34] has been developed with the aim of assessing compliance with the Dutch Guidelines for Healthier Canteens. This also provides automatic and tailored feedback. In a six-month quasi-experimental controlled trial, improvements in the food environment were noted, but not in pupil purchasing behaviour [35]. Again, feedback was not provided remotely, as it was in our case. Otherwise there appear to be few other tools similar to the School Food Sweden tool in terms of function and level of automation, but this may be partly because of difficulties in identifying tools that are not well described in the scientific literature. Two relevant systematic reviews have recently been published. Cupertino et al [36] identified 16 instruments (including ours) that have been developed to evaluate school menus. The authors did not assess validity and/or reliability. The majority were not published in English and only one [37] briefly mentioned that software had been developed to automate checklists and provide a PDF of results. O'Halloran et al [38] reviewed 38 measurement methods which have been used to assess school food environments, of which one third measured data self-reported at school level. Of these, none of these methods appeared to be designed for use in an ongoing manner, several focused on attitudes and beliefs, and vanishingly few had investigated validity and/or reliability.

Strengths and limitations

This dataset is unique and the long period of time covered is a strength. Although the time period presented here begins after the legislation became active, we had previously examined the pre- and post-period [17]. The tool appears unusual in its degree of automation, requiring little contact with schools, increasing feasibility. The validity and reliability of the tool and the criteria used to assess the nutritional quality have also been described [12]. Schools using the tool were not representative of all schools nationally, however this remained relatively stable, making it reasonable to compare trends over time. The biggest limitations of the study are the self-reported data, and the lack of control schools. There is no real incentive for schools not to report accurately as there are no clear consequences for poor results, and the tool is clearly presented as an aid to improvement rather than as a means of control. Still, desirability bias is a common phenomenon and cannot be ruled out. As the policy was national it was not possible to have control schools that were unexposed to it. As regards schools that were "unexposed" to the tool, we know that they differ with regards to structural factors (e.g. size, owner, region), but we cannot know if the nutritional quality is different. Are schools that decide to use the tool in greater need of help (but maybe less engaged), or do they have better resources (and maybe more engaged), or

a mixture? This introduces self-selection bias and unbalanced confounders in estimating the effect of the tool. The effect of using the tool may overstate or understate the true effect. To try to compensate we explored the question from numerous angles, both at audit level and school level. On the assumption that schools that use it more frequently are more willing and able to improve already from day one, we have, where possible, presented results separately according to frequency of usage (we found evidence of improvement at all levels of usage). In effect, we used schools with one audit only and before receiving feedback as “control” – this may in fact be better than using schools that don’t use the tool at all, as those with one audit are more likely to be similar to other schools using the tool more often. We therefore believe that the comparison with these groups may actually be less subject to residual confounding. Whether similar improvements are seen in the other five domains of the tool – to give a fuller picture of changes in school meal quality – are not yet evaluated but are planned.

Long-term evaluations always face the risk of confounding due to other external factors changing over time, likely to be a mixture of positive and negative, which are difficult to account for. For example, we know that challenges for the public meal sector today include replacing the many staff approaching retirement age and the increasing demands on quality, including requests from parents for special dietary requirements [26], changes to budgets and staff training etc.

Conclusion

The improvement in nutritional quality of lunches offered in Swedish schools that was first seen two years after the introduction of legislation in 2011 appears to have continued in the subsequent six years. This positive result appears to be at least in part due to repeated use of The School Food Sweden tool. The more schools used the tool, the more likely the lunch menu was to meet nutritional criteria. Self-audit with automatic feedback appears effective in helping schools to improve school meal quality and an essential complement to legislation, or a promising alternative in settings where regulation is not an option.

Declarations

Ethics approval and consent to participate

Not applicable as the study does not involve data on humans.

Consent for publication

Not applicable.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

EP and LSE conceived of the study. EP managed the tool and the data collected, designed and performed the initial analysis, and drafted and revised the manuscript. LSE made substantial contributions to the manuscript. FA designed and performed additional statistical analysis, and interpreted the results together with EP, and contributed to the manuscript. All authors read and approved the final version.

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Abbreviations

VWLS variance weighted least squares (regression)

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Figures

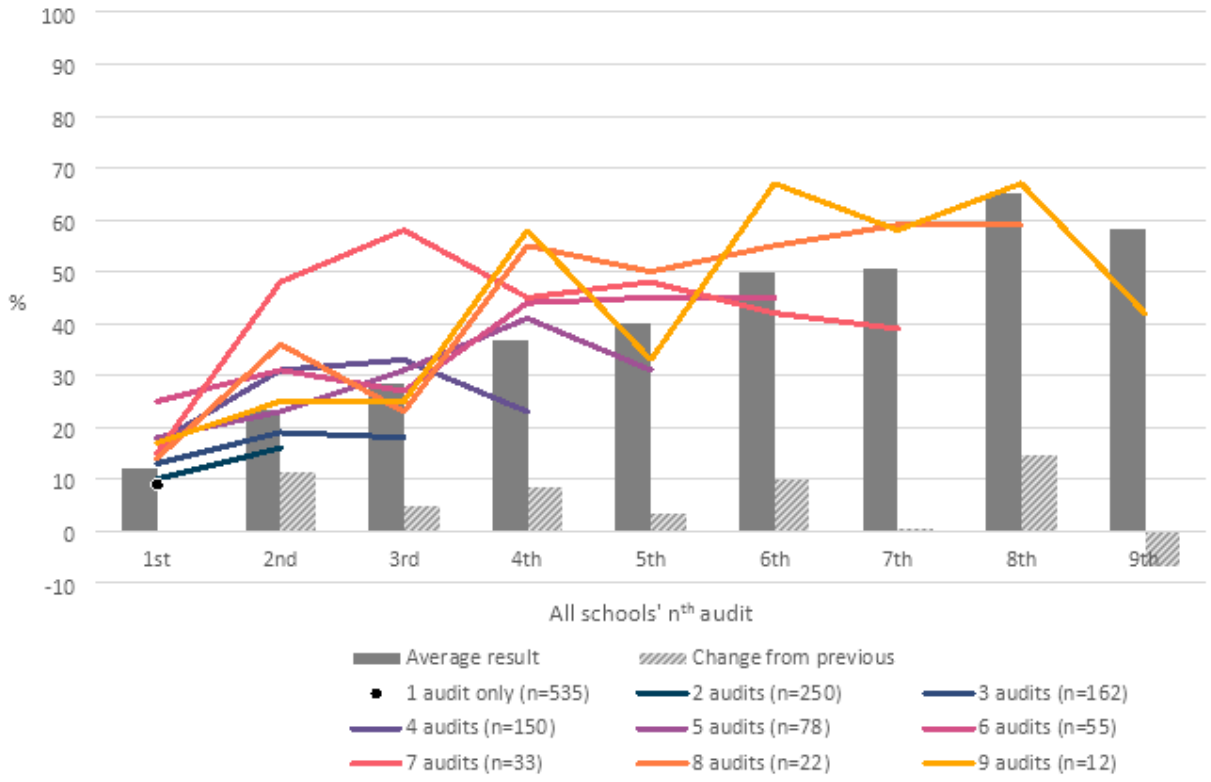

Figure 1

The percentage of schools meeting the nutritional criteria grouped by audit order. Bars show the average results at each audit for all schools combined. Lines show the same data but separately for nine groups of schools: those with only one audit in total (n=535 schools), 2 audits in total (n=250 schools), etc.