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Original Investigation

Reducing Smoking in Adolescents: Cost-Effectiveness Results From the Cluster Randomized ASSIST (A Stop Smoking In Schools Trial)

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Abstract

Introduction: School-based smoking prevention programmes can be effective, but evidence on cost-effectiveness is lacking. We conducted a cost-effectiveness analysis of a school-based "peer-led" intervention.

Methods: We evaluated the ASSIST (A Stop Smoking In Schools Trial) programme in a cluster randomized controlled trial. The ASSIST programme trained students to act as peer supporters during informal interactions to encourage their peers not to smoke. Fifty-nine secondary schools in England and Wales were randomized to receive the ASSIST programme or usual smoking education. Ten thousand seven hundred and thirty students aged 12–13 years attended participating schools. Previous work has demonstrated that the ASSIST programme achieved a 2.1% (95% *CI* = 0%–4.2%) reduction in smoking prevalence. We evaluated the public sector cost, prevalence of weekly smoking, and cost per additional student not smoking at 24 months.

Results: The ASSIST programme cost of £32 (95% *CI* = £29.70–£33.80) per student. The incremental cost per student not smoking at 2 years was £1,500 (95% *CI* = £669–£9,947). Students in intervention schools were less likely to believe that they would be a smoker at age 16 years (odds ratio [*OR*] = 0.80; 95% *CI* = 0.66–0.96).

Conclusions: A peer-led intervention reduced smoking among adolescents at a modest cost. The intervention is cost-effective under realistic assumptions regarding the extent to which reductions in adolescent smoking lead to lower smoking prevalence and/or earlier smoking cessation in adulthood. The annual cost of extending the intervention to Year 8 students in all U.K. schools would be in the region of £38 million and could result in 20,400 fewer adolescent smokers.

Introduction

Globally, tobacco is thought to kill 5.4 million people per annum, a figure expected to rise to 8 million by 2030 unless there is concerted international action on tobacco control (World Health Organization, 2008). In the Global Youth Tobacco Survey, 17.3% of children aged 13–15 years reported current tobacco use (Warren, Jones, Eriksen, & Asma, 2006). In England and Wales, self-reported smoking is rare (<2%) at age 11 years, but by age 15 years, more than 12% of boys and 18% of girls report weekly smoking (Currie et al., 2008). More than two thirds of adult smokers report starting before the age of 18 years (Robinson & Lader, 2007). Younger age at initiation is associated with a decreased probability of quitting in later life (Jit, Aveyard, Barton, & Meads, 2010). These factors emphasize that preventing smoking initiation among adolescents remains a public health priority. A central theme of U.S. and U.K. government policy is "to stop the inflow of young people recruited as smokers" (Centers for Disease Control and Prevention, 2007; Department of Health, 2010; National Institute for Health and Clinical Excellence [NICE], 2010).

School-based smoking prevention programmes can be effective in preventing or at least delaying smoking among adolescents (Thomas & Perera, 2006). However, a review of economic evaluations in health promotion concluded that "Little is known about the cost-effectiveness of social interventions in schools, despite the importance of school climate on child and adolescent health . . . " (Rush, Shiell, & Hawe, 2004). A recent review by Jit et al. (2009a) identified just six cost-effectiveness analyses of interventions, including peer-led education (Vijgen, van Baal, Hoogenveen, de Wit, & Feenstra, 2008), class competitions with prizes to discourage smoking (Hoeflmayr & Hanewinkel, 2008), and additional education about the physical and social consequences of smoking (Dino, Horn, Abdulkadri, Kalsekar, &

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Branstetter, 2008; Wang, Crossett, Lowry, Sussman, & Dent, 2001). Only two were based on randomized controlled trials (RCTs) and neither collected resource use data prospectively.

In this paper, we report a cost-effectiveness analysis of a school-based "peer-led" intervention aimed at reducing adolescent smoking conducted alongside the previously published ASSIST (A Stop Smoking In Schools Trial) RCT (Campbell et al., 2008).

Methods

Study Design

ASSIST was a cluster RCT, which, at baseline, included 10,730 Year 8 (12–13 years old) students in 59 schools in South East Wales and the West of England. Participants were followed up for 2 years in 29 control schools (5,372 students) and 30 intervention schools (5,358 students). Schools were stratified block randomized either to their usual smoking prevention education (control) or to receive the ASSIST programme in addition to their usual smoking prevention education. Details of the trial design and the primary outcomes have been previously reported (Campbell et al., 2008; Starkey, Moore, Campbell, Sidaway, & Bloor, 2005).

The ASSIST Programme

The ASSIST programme consisted of the identification of influential students (peer supporters) who were trained to have informal conversations with their peers about the effects of smoking and the benefits of not smoking (Audrey, Cordall, Moore, Cohen, & Campbell, 2004). The intervention entailed eight stages (Table 1). Health trainers (experienced in youth work, health promotion, and education) and health promotion specialists were familiarized with the ASSIST programme during a 2-day training, the trainer session. Some trainers were employed by the project team, while others were privately contracted at a daily rate. Influential students were selected using a questionnaire that asked students to provide up to five names in response to questions such as, "Who do you respect in Year 8 at your school?" The selection of peer supporters was designed to be inclusive to all students, regardless of their current smoking behavior (Starkey, Audrey, Holliday, Moore, & Campbell, 2009). Peer supporters attended a 2-day training session during which they learned about the negative effects of smoking and the benefits of remaining smoke free using a variety of methods, including role-play, small group work, and games. Training took place outside of school but during school hours. Following training, the 835 peer supporters who consented to undertake the intervention were asked to undertake informal conversations about smoking with other Year 8 students over a 10-week period and to record details of these conversations in a diary (Audrey, Holliday, & Campbell, 2006). At the end of the 10 weeks, those students who returned a completed diary received a £10 gift voucher. Additional details of the intervention and trial methods have been published previously (Starkey et al., 2005).

Costing Methods

A public sector perspective was taken in the analysis, including costs to Local Authorities and the National Health Service (NHS). ASSIST trainers and project researchers completed time sheets and intervention-related expense claims. Teachers who facilitated intervention delivery (e.g., attended the training day with peer supporters) also documented their contribution. All staff time included travel time. The study coordinators collated timesheet and expense information (including training materials, venue costs, bus hire, and peer supporter vouchers), stratifying resource use by school and stage of the intervention. Student time for peer nomination (Stage 1) was estimated assuming that the questionnaire took 15 min per student to complete. Peer supporter time at later stages was estimated by multiplying the number of peer supporters by an assumed hourly input at each stage (11 hr at Stage 3 and 1 hr at other stages). We did not estimate student time taken in smoking-related conversations as a result of the intervention.

The intervention was implemented during 2001/2002. Personnel costs were estimated by selecting the equivalent staff grade on 2008 pay scales, including approximately 23% for employer costs. Although some ASSIST trainers were employed by the university during the trial, we assumed that they would

Table 1. Description of the Resources Used At Each Stage of the Peer Supporter Intervention

Stage	Description	Resources used	Timing
0	Two-day "Training the Trainers" meeting to introduce trainers to the ASSIST intervention	Health trainers and health promotion specialists' time, travel, and refreshment costs	Prerandomization
1	Nomination of peer supporters by student questionnaire	Health promotion trainer/specialist time, teacher time, study coordinator time, researcher time, administrator time, casual staff time, training material, and travel time	Week 1
2	Meeting with nominees to recruit the peer supporters	Health promotion trainer/specialist time, teacher time, training materials, and travel time.	Week 2
3	Two-day training of the peer supporters	Venue and refreshments, health promotion trainer/specialist time, teacher time, privately contracted trainer time, training materials, bus rental, and travel costs	Week 4
4–7	Four follow-up sessions. In school visits by trainers to check the progress of peer supporters	Health promotion trainer/specialist time, teacher time, privately contracted trainer time, and travel time	Weeks 5, 8, 11, and 14.

be NHS employees in practice. The grade of teacher supporting ASSIST varied, most often being the head of Personal and Social Education. We estimated teacher unit costs using spine point U2 on the 2008 national salary scale (Department for Children Schools and Families, 2008). Costs for road travel were estimated at 44 pence per mile (The Automobile Association, 2008). Privately contracted trainers were paid up to £200 per training day. All expenses were recorded in 2001/2002 values and inflated to 2008 values using the consumer price index (Office for National Statistics, 2009). As our analysis took a public sector decision maker viewpoint, we did not cost peer supporter time. The intervention occurred during one school year, and costs were not discounted.

The ASSIST programme was explicitly an addition to (as opposed to a substitute for) the smoking prevention education currently provided by schools. The costs of other smoking prevention education were assumed to be similar in intervention and control schools and excluded from the analysis.

Outcome Assessment

Smoking behavior of students in both arms of the trial was collected at baseline and at 1- and 2-year follow-up. Respondent smoking behavior was assessed using a question with six possible responses ranging from "I have never smoked" to "I usually smoke more than six cigarettes a week." The primary outcome measure was prevalence of weekly smoking (defined as usually smoking at least one cigarette per week). Saliva samples were collected from participants at baseline and follow-up to minimize misreporting. Analysis was based on intention-to-treat, and thus, the outcome of students who changed schools was attributed to the school they were in at the start of the trial. Parents/carers of Year 8 students received information letters and a reply slip to return if they did not want their child to participate. Students were given the option to refuse some or all the intervention activities. The Multi-Centre Research Ethics Committee for Wales reviewed the trial protocol and judged it as meeting ethically acceptable standards.

Effectiveness

The primary effectiveness finding of the RCT, based on a multilevel model using data from all trial follow-up timepoints, was that the odds ratio (*OR*) for being a smoker in an intervention school when compared with a control was 0.78 (95% *CI* = 0.64–0.96) as previously reported (Campbell et al., 2008). At the 1- and 2-year follow-up, the adjusted *OR* were 0.77 (95% *CI* = 0.59–0.99 [n = 9,147]) and 0.85 (95% *CI* = 0.72–1.01 [n = 8,756]), respectively(Campbell et al., 2008). In the control schools, the prevalence of weekly smokers increased from 6.59% at baseline to 15.13% at 1 year and 21.74% at 2 years. By comparison, the prevalence in the intervention schools was 4.78% (baseline), 12.49% (1 year), and 18.95% (2 years; Campbell et al., 2008) We used smoking prevalence at the 2-year follow-up, adjusted for baseline smoking status, as the primary outcome measure for the cost-effectiveness analysis. This timepoint was thought most likely to be indicative of long-term smoking behavior and health outcomes.

Cost-Effectiveness Methods

Cost per student within each school was calculated by dividing the costs of the peer-supporter programme at that school by the total number of students in the school year at study initiation. The incremental cost effectiveness ratio (ICER) was calculated by dividing the mean cost per student of the intervention (weighted by year group size) by the difference in the proportion of students smoking in the intervention and control arms. These proportions were calculated using random-effects logistic regression models adjusted for baseline smoking status, country, independent/state school, English or Welsh medium, size of school, and level of entitlement to free school meals, which were centered at their mean values. The ICER represents the cost per additional student not smoking at the 2-year follow-up.

We also collected information about students' perceptions of smoking prevalence among people of their age whether they believed they would be smoking at age 16 years and among smokers whether they would like to give up smoking. These data provide an indication about whether differences in smoking prevalence will be maintained beyond 2 years.

Statistical Analysis

Teacher information was not returned at eight schools; we used simple random imputation within intervention schools to impute missing teacher hours. The *CI*s for the ICER were calculated using bootstrap sampling at the school level and independently within strata defined by trial arm with 10,000 replications. We used a bootstrap imputation procedure to compute *SE*s that accounts for uncertainty of the imputed values (Little & Rubin, 2002). This procedure entails bootstrapping the original incomplete dataset, applying the imputation procedure to each bootstrap dataset and then computing the ICER from each imputed bootstrap dataset. Based on these replications, bias-corrected accelerated 95% *CI*s are calculated for the ICER (Efron & Tibshirani, 1993). Analyses were conducted in Stata Version 11.0, StataCorp, College Station, TX.

We conducted four sensitivity analyses. ASSIST used a mix of researchers, privately contracted and employed ASSIST trainers. Arguably, health and educational authorities could save money by using only employed ASSIST trainers, provided that there was sufficient demand for their services from schools (Sensitivity analysis 1). Equally, authorities might choose to implement ASSIST using solely privately contracted trainers to provide more flexibility to expand or reduce training to meet demand (Sensitivity analysis 2). Travel costs observed during the trial were higher than could be achieved in other settings. Privately contracted trainers were based in Wales, incurring high travel costs for follow-up visits in English schools. We recalculated costs excluding the travel time and expenses of privately contracted trainers on the assumption that local trainers could be hired (Sensitivity analysis 3). In most schools, senior teachers supported the intervention. As the intervention becomes established within a school, some tasks might be delegated to more junior teaching staff (e.g., "classroom teacher" M3; Department for Children Schools and Families, 2008; Sensitivity analysis 4).

Results

The intervention used 17,909 hr of human resources over the 30 intervention schools (Table 2). As a peer-led intervention, it is not surprising that most of this input was from the peer

Table 2. Resources and Costs of the Intervention

Resources	Stage 0, hr	Stage 1, hr	Stage 2, hr	Stage 3, hr	Stage 4–7, hr	Total input, hr	Unit cost	Total cost	*M* (*SD*) cost per school ($n = 30$)
Peer supporter[a]	0	1,340	873	9,262	2,949	14,424	Not estimated	Not estimated	Not estimated
Senior health promotion specialists	55	9	26	351	85	524	£25.99	£13,615	£454 (£167)
Employed ASSIST trainers	77	27	57	671	217	1,047	£14.58	£15,268	£509 (£108)
Privately contracted ASSIST trainers	69	2	2	621	349	1,043	Variable	£40,808	£1,360 (£760)
Casual staff	0	34	0	49	0	83	£7.26	£599	£20 (£41)
Teachers	0	58	31	430	91	610	£32.61	£19,894	£663 (£117)
Study coordinators	0	50	1	13	1	64	£24.95	£1,590	£53 (£72)
Senior lecturer	0	6	0	0	0	6	£36.65	£206	£7 (£37)
Research staff	0	50	0	0	0	50	£22.84	£1,134	£38 (£36)
Administrators	0	60	0	0	0	60	£13.08	£782	£26 (£24)
Travel expenses								£26,531	£884 (£305)
Training materials								£2,525	£84 (£25)
Bus								£7,323	£244 (£60)
Venue and refreshments								£27,291	£910 (£248)
Vouchers								£7,449	£248 (£94)
Planning and administration								£4,828	£161 (£61)
Total cost								£169,865	£5,662 (£1,226)

Note. [a]5,358 students participated in peer nomination, 873 students attended peer recruitment meetings, 842 students completed peer training, and between 715 and 756 peer supporters attended follow-up sessions.

Table 3. Cost Per Student Not Smoking at 2 Years

	Control group	Intervention group
Nonsmoking prevalence at 24-month follow-up[a] (%)	83.5	85.6
Difference between intervention and control groups, % (95% *CI*)	2.1–4.2	
Cost of intervention, per student (95% *CI*)	£32 (£29.7–£33.8)	
Incremental cost per student not smoking[b] (95% bias-corrected accelerated *CI*)	£1,500 (£669–£9,947)[c]	

Note. [a]Adjusted for baseline smoking status, country, independent/state school, English or Welsh medium, size of school, and level of entitlement to free school meals.

[b]This is the cost of the intervention divided by the difference in smoking prevalence between the intervention and control groups.

[c]As the lower confidence limit for the effect size is very close to zero, the upper confidence limit for the cost-effectiveness analysis is not stable and tends toward infinity.

supporters (14,424 [81%] of total hours). Health promotion specialists, employed ASSIST trainers, and privately contracted trainers contributed a further 2,614 hr. The intervention also required substantial input from teachers, predominantly accompanying peer supporters during their training (Table 2).

The mean cost per intervention school was £5,662 (*SD* = £1,226), equivalent to £32 per student. The major contributors to total cost were health promotion specialists and ASSIST trainers (£2,323 per school), bus, venue and refreshments costs (£1,154), travel expenses (£884), and teacher's time to accompany peer supporters during training (£663). Cost per student ranged among schools from £23 to £59, primarily due to the economies of scale of conducting peer training in schools with a larger number of students.

After adjusting for baseline smoking prevalence and other covariates, 85.6% of the intervention group and 83.5% of the control group were not smoking at the 2-year follow-up (Table 3). ASSIST resulted in a 2.1% reduction in smoking prevalence at a cost of £32 per student; therefore, the incremental cost per student not smoking at 2 years was £1,500 with a relatively wide *CI* (95% *CI* = £669–£9,947; Table 3).

Students in the intervention schools were less likely to think that they would be a smoker at age 16 years than those in the control group (Table 4). There was a nonsignificant trend for students in intervention schools to, correctly, estimate that less than 50% of people of their age smoked. More smokers in intervention schools reported a desire to give up smoking completely, but the difference between intervention and control schools was not statistically significant.

Sensitivity Analyses

If research staff and employed ASSIST trainers were replaced by privately contracted trainers, the mean cost per student increased to £38 (Table 5). Conversely, if the intervention was delivered solely by employed ASSIST trainers, the average cost per student fell by £6. Excluding the travel time and expenses of privately contracted trainers or using more junior teachers to supervise the peer supporters reduced costs by a similar amount.

Discussion

The mean cost per school of the ASSIST programme was £5,662, equivalent to £32 per student. The ASSIST programme resulted in a 2.1% reduction in smoking prevalence at 2 years, and the incremental cost per student not smoking was £1,500.

The intervention also affected students' beliefs about longer term smoking behavior, with a lower proportion of students in the intervention schools believing that they would be a smoker at age 16 years.

There is good evidence that a wide variety of school-based interventions can be effective in reducing the prevalence of smoking, but the evidence is less clear cut on which models of intervention work best. The intervention effect found in ASSIST is very similar to the pooled effect observed in 27 RCTs of school-based interventions to prevent the uptake of smoking (Uthman et al., 2009). However, our study is the first prospective economic evaluation conducted alongside a rigorous RCT. A review of cost-effectiveness analyses of school-based smoking prevention identified two studies based on RCTs (Jit et al.,

Table 4. Potential Markers of Future Smoking Habits

	OR (intervention group/control group)[a]	95% *CI*
Want to give up smoking completely (current smokers only)	1.17	0.85–1.61
Think they will be smoking when 16 years old (all students)	0.80	0.66– 0.96**
Think ≤50% of people their age smoke (all students)	1.24	0.98–1.56

Note. OR = odds ratio.

[a]Adjusted for baseline smoking status, country, independent/state school, English or Welsh speaking, size of school, and level of entitlement to free school meals. An *OR* of greater than 1 indicates that the statement was more likely to be endorsed by students in the intervention schools.

$^{**}p < .05$.

Table 5. Sensitivity Analyses

	Description	Cost per student
1	All research staff and privately contracted ASSIST trainers replaced by employed ASSIST trainers.	£26
2	All research staff and employed ASSIST trainers replaced by privately contracted ASSIST trainers.	£38
3	All privately contracted trainer travel time and expenses excluded.	£28
4	Teaching staff replaced by more junior teaching grades.	£27

2009a; Vijgen et al., 2008; Wang et al., 2001). Both trials were categorized as being of lower methodological quality by a recent systematic review, which also noted that effect sizes tended to be largest in trials of lower quality (Uthman et al., 2009). Furthermore, both economic evaluations were based on retrospective reconstruction of the intervention costs rather than prospective recording of resource use.

If our results were extrapolated to the 730,000 students aged 12 years in the 6,736 secondary schools in the United Kingdom in 2007/2008 (Department for Children Schools and Families, 2010), the annual cost would be in the region of £38.1 million, and the investment would result in 20,400 (based on unadjusted analyses) fewer adolescent smokers at age 14 years. Placing these results in a broader context, NHS expenditure on treating lung cancer in 2009/2010 was £260.8 million in England alone (Department of Health, 2011), and NICE estimates that providing Varenicline for an additional 125,000 adult smokers attempting to quit in England and Wales would have annual prescription costs of £6.25 million (NICE, 2007). Successful tobacco control policy requires both effective prevention and cessation interventions. Our results indicate that peer-led school-based smoking prevention programmes should be an important element of government tobacco control policy.

The key uncertainty, which will determine the cost-effectiveness of any school-based smoking prevention strategy, is the degree to which reductions in adolescent smoking can be prolonged into adulthood. The results of ASSIST (Campbell et al., 2008) demonstrated a decline in effect size from 1 to 2 years, a trend that is confirmed in the few studies of other interventions that have followed participants after leaving school (Peterson, Kealey, Mann, Marek, & Sarason, 2000). Our finding that ASSIST influenced student beliefs about their likelihood of smoking at age 16 years is encouraging; however, attitudes toward smoking do not necessarily predict future smoking behavior (de Leeuw, Engels, Vermulst, & Scholte, 2008). Even so, merely delaying smoking initiation would be beneficial if, as has been found to be the case, it then increases the likelihood of successful smoking cessation later in life (Jit et al., 2009b, 2010). In a simulation study, Jit et al. estimated that a hypothetical school-based smoking prevention intervention costing £38.50 per student with an *OR* for smoking prevalence in intervention groups of 0.83 after 2 years would be cost-effective at current thresholds, resulting in a cost effectiveness ratio of £12,700 per quality-adjusted life year even if it only succeeded in delaying smoking initiation. Applying these findings to our analysis would indicate that ASSIST is a cost-effective intervention at conventional thresholds. However, there remains the need for caution in presuming that effective school-based programmes will cause lifetime reductions in smoking-related morbidity and resource use.

There are a number of limitations to our study design. The opportunity cost of peer supporter's time was not quantified. As peer training was provided during school hours, it was at the expense of other education. It is difficult to assign a monetary value to these lost opportunities. School curricula are already under pressure. With increasing awareness of the early origins of many diseases, it is likely that school-based health promotion will continue to add to that pressure. Furthermore, recent changes to the school inspection system in England now require that schools are assessed according to the extent to which students adopt healthy lifestyles. This underlines the importance of thoroughly evaluating the effectiveness and affordability of school-based health promotion initiatives rather than assuming that they are beneficial on the basis of little more than good intention. Our study estimates the additional impact of a peer-led intervention over and above the existing smoking prevention education, which varied from school to school. Future research should explore whether these benefits can be replicated when ASSIST is implemented in other settings and its relative effectiveness compared with other school-based smoking prevention programmes.

While the evidence suggests that the ASSIST programme is both effective and cost effective, implementing the programme more widely presents a number of challenges. First, there is a need to alert potential funders to the evidence in an intelligible format. Second, ensuring that the intervention being delivered is of high quality, true to the evaluated intervention, and therefore has the potential to achieve the positive results obtained in the trial is a further challenge (Holliday, Audrey, Moore, Parry-Langdon, & Campbell, 2009). For those implementing ASSIST, it may be tempting to make changes in order to cut costs or in an attempt to improve effectiveness, for example, by running the peer supporter training in school with more than 1-year group or providing more intensive follow-up. Such reformulation, however, would mean that its cost-effectiveness in preventing smoking uptake could no longer be presumed. Fidelity of implementation will require that robust quality control procedures are included in the roll out of the ASSIST programme. Third, obtaining access to an appropriate (and diversely skilled) pool of people who can be trained as ASSIST trainers also presents a challenge, but evidence from early adopters of the ASSIST programme suggests that this can be achieved. Finally, in order to achieve government targets of 8% or less of 16- to 17-year-olds smoking by 2020, school-based interventions increasing awareness of the benefits of not smoking will have to be complemented with other strategies, such as reducing affordability and availability of tobacco products (Department of Health, 2010).

At a cost of approximately £5,600 per school or £32 per student, intervention schools in the ASSIST trial implemented a peer-led intervention with the aim of discouraging smoking uptake among 12- to 13-year-olds. The intervention was effective in reducing smoking prevalence, costing approximately £1,500 per child not smoking at 2 years. The intervention is cost-effective under realistic assumptions regarding the extent to which these reductions in adolescent smoking lead to lower smoking prevalence and/or earlier smoking cessation in adulthood.

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Declaration of Interests

RC and LARM are directors of a not-for-profit company, DECIPHer Impact Limited, set up to enable organizations to obtain a license to use the ASSIST programme and to receive training, support, and quality assurance to ensure fidelity of programme implementation. All other authors declare that they have no conflict of interest.

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