Targeting Early Antecedents to Prevent Tobacco Smoking: Findings From an Epidemiologically Based Randomized Field Trial

Sheppard G. Kellam, MD, and James C. Anthony, PhD

Abstract

Objectives. This study examined whether interventions aimed at aggressive/disruptive classroom behavior and poor academic achievement would reduce the incidence of initiation of smoking.

Methods. An epidemiologically based, universal randomized preventive trial involved 2311 children in 2 classroom-based preventive interventions or controls. Each intervention was directed at 1 of the aforementioned 2 antecedents over first and second grades in 19 urban schools.

Results. Smoking initiation was reduced in both cohorts for boys assigned to the behavioral intervention.

Conclusions. Targeting early risk antecedents such as aggressive behavior appears to be an important smoking prevention strategy. (Am J Public Health. 1998;88:1490–1495)

Methods

Interventions

The Good Behavior Game, a behavior management strategy designed to improve aggressive/disruptive classroom behavior, is led by the teacher during regular class periods. After baseline assessments of target behaviors, teachers assign all students to 1 of 3 teams, balancing teams for sex and levels of aggressive behavior. The teacher defines and posts undesirable behaviors. Examples are fighting, shouting out of turn, and teasing. Teams are rewarded when no member exhibits the proscribed behaviors during game sessions. If a child misbehaves, the team loses points. At first, tangible prizes are used, such as colorful stickers and erasers. Later in the school year, teachers use less tangible rewards. At first, the game was played for 10 minutes 3 times per week during the regular curriculum, with the frequency and length of sessions increasing over first and second grades. Rewards were given weekly; if each child behaved well, all teams could win.

Mastery Learning, an enriched curriculum, was directed at raising reading achievement scores. Key elements were high expectations, small instructional units, use of formative testing, and individualized corrective methods. Students did not proceed to the next unit until 80% had achieved 80% to 85% of the learning objectives (instead of the usual 50%).

These classroom-based interventions were implemented for 2 years, in the first and second grades. We have previously reported evidence of Good Behavior Game impact on aggressive/disruptive behavior through sixth grade for boys who, at baseline, were above the median in terms of aggressive behavior. Improvements in reading scores with Mastery Learning were followed by reduced depressive symptoms over first grade, particularly among girls. Raising achievement scores accounted for reduced aggressive behavior, particularly among boys.

Study Population and Research Design

Five urban areas were defined with socioeconomic levels ranging from very poor to middle class. In each area, 3 to 4 public elementary schools with similar socioeconomic and racial/ethnic profiles were selected. Within each area, the Good Behavior Game

The authors are with the Prevention Research Center, Department of Mental Hygiene, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

Requests for reprints should be sent to Sheppard G. Kellam, MD, Prevention Research Center, Mason F. Lord Bldg, Suite 500, 5200 Eastern Ave, Baltimore MD 21224.

This article was accepted March 5, 1998.
was randomly assigned to 1 school and Mas- 
tery Learning to another; 1 or 2 schools were 
controls. Control classrooms received cus-
tomary school programs. Within each inter-
vention school, 1 first-grade classroom and 
teacher were assigned randomly to the inter-
vention, and at least 1 classroom served as a 
within-school control. Within each school, all 
entering first graders were assigned in alpha-
betic sequence to classrooms. Over the 2 
intervention years (first and second grades), 
classroom composition was kept intact. 
Transfers from one intervention to the other 
or from control to either intervention were 
rare, but in this study we adopted an intent 
to treat strategy, using initial assignment at ba-
eline to define the intervention and control 
children. Protocols for this school-based 
investigation were approved by the Johns 
Hopkins School of Public Health institutional 
review board. Each child’s parent/guardian 
was asked to give informed consent. During 
the first year of recruitment, only 5% declined 
to participate.23

Two consecutive cohorts of first-grade 
children were recruited (total n = 2311), 1196 
in cohort 1 (1985) and 1115 in cohort 2 
(1986). A few children reported starting to 
smoke cigarettes prior to entry into first 
grade. Because they no longer were at risk 
for initiation, these children were excluded 
from the analytic sample. A total of 1604 
children (cohort 1, n = 818 [68%]; cohort 2, 
n = 786 [70%]) initially still at risk remained 
in the Baltimore City Public Schools and 
completed an assessment of tobacco and 
other drug experiences on at least 1 occasion 
after intervention from 1989 until 1994. Ten 
students withdrew consent for follow-up 
assessments.24 When attrition occurred, it was 
unrelated to intervention status (P > .25).

Among the 1604 children, 808 were 
boys and 796 were girls, and more than 90% 
had been born in either 1979 or 1980. About 
22% were assigned to Good Behavior Game 
classrooms (n = 352), 22% were assigned to 
Mastery Learning classrooms (n = 348), and 
the rest were assigned to control classrooms 
(n = 904). A total of 502 youths (31.3% of 
the follow-up sample) were found to have 
initiated tobacco smoking when last assessed 
(Table 1).

**Assessment Procedures**

At the end of the first quarter of first 
grade, prior to implementation of the inter-
ventions, each teacher rated each child in 
the classroom in a standardized 2-hour interview 
using the Teacher Observation of Classroom 
Adaptation–Revised.23,25 This instrument’s 
Authority Acceptance subscale gauges each 
child’s level of aggressive/disruptive behav-
ior and includes items such as “fights,” 
“breaks rules,” and “harms property,” each 
rated from 1 to 6 depending on frequency. 
The subscale’s reliability has been adequate 
(Cronbach α > .85 in the studies cited here); a 
robust association between first-grade rats 
and adolescent drug use over 10 years has 
been reported.8 Research staff monitored 
 fidelity of intervention implementation; no 
control classroom teachers used behavior 
management methods such as the Good 
Behavior Game or the Mastery Learning 
curriculum. Forty hours of instruction and 
support were provided to all teachers, includ-
ing control classroom teachers.

Periodic meetings with school officials, 
community leaders, and parents led to com-
community support for learning about children’s 
drug experiences, but there was concern 
about saliva, breath, or urine testing. 
The accepted solution was annual face-to-face 
interviews 40 to 70 minutes in duration. 
These interviews were administered during 
the spring of each year from ages 8 and 9 
through age 14. The interview was conducted 
in a private room in the school by a 
trained young adult interviewer. The inter-
viewer first worked through issues of trust 
and rapport and read a disclosure statement 
that provided students with an opportunity to 
decline participation. The interviewer then 
read each standardized question and marked 
the student’s responses. Each year, students 
were asked whether they had tried tobacco 
and their age at first use.6,24,27

**Statistical Analysis**

We used standard life table and survival 
analysis methods to compare risk of initi-
ating tobacco use for 2 interventions and all 
internal and external control classrooms. 
Kaplan-Meier25 survival curves for each 
group were compared via log-rank statistics 
as an aid to interpretation. Adjusted esti-
mates for the relative risk of tobacco 
smoking also were obtained via conditional forms 
of Cox proportional hazards modeling; 
EGRET26 was used in calculating estimates. 
To accommodate clustering of students 
within initial elementary schools, this analy-
isis involved presorting of students into strata 
defined by school attended in first grade. 
Beyond accommodating the clustering of 
students, the Cox model23 provided 
safeguards against the possibility that observed 
variations in smoking might be attributable 
to imbalances in the distribution of covari-
ates (e.g., age, sex, level of aggression in 
first grade).

**Results**

Descriptive information about combined 
cohorts is provided in Table 1. Of the 1604 
children who had not smoked at baseline, 502 
had tried smoking by 14 years of age. Boys 
and girls were analyzed separately, consider-
ing the stronger attributable risk of aggressive 
behavior among boys. In each cohort, boys in 
Good Behavior Game classrooms were less 
likely than boys in control classrooms to initi-
ate tobacco smoking (log rank P = .03). This 
was most apparent after 10 years of age. 
Figures 1 and 2 are plots of the male cohorts’ 
cumulative incidence of tobacco smoking 
from 6 through 14 years of age. Girls in Good 
Behavior Game classrooms were not at lower 
risk (log rank P = .53). Estimates from the Cox 
proportional hazards analyses were consistent 
with life table results. When grouped into risk 
sets defined at first-grade entry, boys in Good 
Behavior Game classrooms had a lower risk 
of starting to smoke than boys in control
classrooms (estimated relative risk \( RR = 0.62, 95\% \text{ confidence interval} \ [CI] = 0.40, 0.97; P = .04 \)). The estimated risks for girls in Good Behavior Game and control classrooms were essentially the same (\( RR = 0.9, 95\% \text{ CI} = 0.57, 1.42; P = .66 \)).

For girls in both cohorts, the Good Behavior Game appeared not to have affected risk of starting to smoke. In contrast, the relative risk estimates for boys in Good Behavior Game classrooms vs boys in control classrooms were 0.58 (95% CI = 0.33, 1.00) in cohort 1 and 0.62 (95% CI = 0.29, 1.31) in cohort 2. For boys in cohort 1 only, there was a statistically significant inverse association between assignment to Mastery Learning and risk of tobacco smoking (\( RR = 0.46, 95\% \text{ CI} = 0.24, 0.87; P = .017 \)), although there was a similar trend in cohort 1.

In exploratory analyses of subgroup variation, both cohorts were grouped by gender and classified into tertiles by first-grade teacher’s rating of aggressive/disruptive behavior; these analyses used the Cox models (Table 2). Boys in the best behaving tertile showed more impact, being much less likely to start smoking than control boys (\( RR = 0.13, 95\% \text{ CI} = 0.03, 0.62; P = .01 \)). A congruent result emerged from corresponding comparative life table analyses of this subgroup of boys (log rank \( P = .003 \)). We found no Good Behavior Game impact at any level of aggressive/disruptive behavior among girls.

**Discussion**

In 2 consecutive cohorts, the estimated risk of initiating tobacco use was lower than expected for boys assigned to the Good Behavior Game intervention. The lack of impact of the Good Behavior Game for girls in these classrooms is consistent with the much lower risk for later drug use associated with aggressive/disruptive classroom behavior among girls. This result also supports the importance of early risk behaviors, which occur much more frequently among boys, in the etiology of teenage tobacco use.\(^8,13-15,31\)

Several caveats merit attention. First, this study focused on young people who remained in Baltimore public schools, an important and definable epidemiologic population and a majority of the original children. It did not include children who moved to other areas or transferred to private schools; these participants are now being followed up at 19 or 20 years of age. Out-migration from the school system was unrelated to intervention assignment. Second, our assessment of the youths’ tobacco experiences depended on self-report interview assessments made annually. Some researchers prefer to use bioassays to limit methodological problems associated with self report. However, we found that most youths recalled their first tobacco smoking experiences clearly. Furthermore, bioassays have questionable utility for assessing tobacco smoking across spans of 1 year or more. Self-report assessments have been central in basic studies linking early ratings of aggressive/disruptive behavior to later teenage smoking.\(^8\)

Appearance of subgroup variation in response to interventions deserves attention, as discussed recently by Hatch.\(^{12}\) We have already commented on gender differences. We also found that boys at lower levels of aggressive/disruptive behavior in first grade seemed to benefit more, even though the Good Behavior Game had an impact among more aggressive boys in terms of later teenage aggressive behavior.\(^{21}\) This suggests that better-behaved children in Good Behavior Game classrooms were more able to withstand later exposure to tobacco and peer pressure than were their better-behaved control counterparts or their more aggressive Good Behavior Game classmates. These are issues for examination in follow-up studies involving smokers vs nonsmokers within...
subgroups defined by sex, early aggressive/disruptive behavior, other mediators and moderators, and intervention assignment.

The Mastery Learning results are important for 2 reasons. The first is the specificity of the Good Behavior Game; if the game’s impact was a nonspecific benefit of special attention, then the impact of Mastery Learning should have been comparable to that for the Good Behavior Game. Second, mixed results with respect to Mastery Learning should not lead to dismissal of possible smoking prevention via improving school achievement. In both cohorts, the age 14 cumulative risk estimates for Mastery


<table>
<thead>
<tr>
<th>Designated Subgroup</th>
<th>Intervention/Control Status</th>
<th>Estimated Relative Risk</th>
<th>95% Confidence Interval</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boys in grade 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower aggressive/disruptive (n = 253)</td>
<td>Good Behavior Game (n = 41)</td>
<td>0.13</td>
<td>0.03, 0.62</td>
<td>.011</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 58)</td>
<td>0.60</td>
<td>0.31, 1.18</td>
<td>.137</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 154)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Middle aggressive/disruptive (n = 285)</td>
<td>Good Behavior Game (n = 52)</td>
<td>0.62</td>
<td>0.38, 1.77</td>
<td>.618</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 75)</td>
<td>0.96</td>
<td>0.46, 2.01</td>
<td>.918</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 158)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Higher aggressive/disruptive (n = 270)</td>
<td>Good Behavior Game (n = 84)</td>
<td>0.57</td>
<td>0.25, 1.28</td>
<td>.172</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 41)</td>
<td>0.77</td>
<td>0.33, 1.77</td>
<td>.540</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 145)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Girls in grade 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower aggressive/disruptive (n = 262)</td>
<td>Good Behavior Game (n = 63)</td>
<td>1.00</td>
<td>0.30, 3.38</td>
<td>.997</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 51)</td>
<td>1.09</td>
<td>0.57, 2.10</td>
<td>.786</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 148)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Middle aggressive/disruptive (n = 263)</td>
<td>Good Behavior Game (n = 49)</td>
<td>0.63</td>
<td>0.28, 1.43</td>
<td>.273</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 67)</td>
<td>2.21</td>
<td>0.78, 6.29</td>
<td>.137</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 147)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Higher aggressive/disruptive (n = 271)</td>
<td>Good Behavior Game (n = 59)</td>
<td>1.13</td>
<td>0.48, 2.67</td>
<td>.773</td>
</tr>
<tr>
<td></td>
<td>Mastery Learning (n = 60)</td>
<td>1.35</td>
<td>0.60, 3.05</td>
<td>.472</td>
</tr>
<tr>
<td></td>
<td>Control (reference) (n = 152)</td>
<td>1.00</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Note.* Estimates were derived from the conditional form of the Cox proportional hazards model, with risk set stratification by school at entry into first grade.
Learning boys were intermediate, above levels observed for Good Behavior Game boys but below expected values in control classrooms. In cohort 2, reductions associated with Mastery Learning were statistically significant ($P < .05$). With continued follow-up, these cohorts may show more substantial evidence of Mastery Learning impact.

The Good Behavior Game and Mastery Learning are “universal” interventions received by all children in classrooms, not merely those at higher risk. They are implemented by regular classroom teachers during the regular school day. They are economical in terms of time and money, reducing teacher burden rather than increasing it. In contrast to smoking prevention efforts that focus on the unpleasant or harmful effects of tobacco or promote teenagers’ resistance to peer pressure to smoke, the Good Behavior Game targeted a much earlier developmental antecedent for teenage smoking. Our results support a general prevention research strategy of targeting early risk factors as complements to effective interventions in later years. Prevention studies can identify new, potentially malleable developmental antecedents of smoking, later targeting them as antecedents for change.  

Acknowledgments

This work was supported primarily by National Institute of Mental Health grants R01MH38725 and R01MH42968 (Sheppard G. Kellam, principal investigator) and by National Institute on Drug Abuse grant R01DA04392 (James C. Anthony, principal investigator).

The contributions of the city of Baltimore, its families and children, and the administration of the Baltimore City Public Schools continue to be enormous. The work of the prevention program would not have been possible without the participation and support of the leadership, faculty, and staff of the school district. Dr. Walter Amprey, former superintendent of Baltimore City Public Schools, and former director Dr. Juanita Lewis have overseen and guided the current follow-up and the new work on the next stages of intervention development and evaluation. Alice Pinderhughes, former superintendent of the Baltimore City Public Schools, originally worked out the collaborative arrangement with Drs. Kellam, Anthony, and other faculty at the Prevention Research Center. The assistance and support of Dr. Leonard Wheeler, former assistant superintendent for elementary school, and Dr. Carla Ford, former supervisor, Office of Early Childhood Education, have been vital to our program.

The original search for a behavioral intervention to address the social adaptational process between teacher and children was led by Dr. Alan Harris, and the implementer and supervisor was Dr. Jaylan Turkhan. Dr. Lawrence Dolan developed and implemented the Mastery Learning intervention based on the work of Benjamin Bloom and was the first field supervisor. Dr. Lisa Wertheram followed Dr. Dolan, and she and Dr. Nicholas Ialongo have made important contributions. Dr. C. Hendrickson Brown continues to play a key biostatistical and methodological role. The leadership of Elva Edwards in community building and evaluation is gratefully acknowledged. Natalie Keegan produced both the manuscript and the graphic illustrations.

References


NEW!
Case Studies in Public Health Ethics
Steven S. Coughlin, PhD, Colin L. Soskolne, PhD,
and Kenneth W. Goodman, PhD

Suitable for classroom discussions and professional workshops. Topics covered include: moral reasoning, issues of privacy and confidentiality protection, informed consent in public health research, ethics of randomized trials, institutional review board system, scientific misconduct, conflicting interests, and intellectual property and data sharing, publication and interpretation of research findings, communication responsibilities of public health professionals, studies of vulnerable populations, cross-cultural research, genetic discrimination, HIV/AIDS prevention and treatment, health care reform and the allocation of scarce resources. An instructor’s guide is also provided at the end.

- $37 for nonmembers  • $26 for APHA members*
  (add shipping and handling costs to all prices.)
To order: 301/893-1894  • To fax: 301/843-0159

* Members may purchase up to 2 copies of the book at this price

American Public Health Association
Publications Sales  • P.O. Box 753
Waldorf, MD 20604-0753

32. Hatch M. What can we infer from findings in subgroups? Epidemiology. 1993;6:473–475