Safety Effects of Drawstring Requirements for Children’s Upper Outerwear Garments

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Objective: To evaluate the effectiveness of the requirements of the voluntary safety standard for drawstrings on children’s upper outerwear garments in preventing child deaths resulting from drawstring entanglement.

Design: An interrupted time series design. Annual estimates of drawstring-related child deaths were developed for the study period of January 1985 to December 2009. A Poisson regression model for rate data was used to evaluate the effectiveness of the drawstring requirements during the postintervention period.

Setting: United States.

Subjects: Children aged 14 years and younger.

Intervention: The application of the drawstring requirements of the voluntary standard that were adopted in 1997.

Main Outcome Measure: The estimated percentage reduction in the drawstring-related child mortality rate associated with the application of the drawstring requirements.

Results: The drawstring requirements of the voluntary standard were associated with a 90.9% (95% CI, 83.8%-96.1%) reduction in the drawstring-related mortality rate. This suggests the prevention of about 50 child deaths from 1997, when the voluntary standard was adopted, through the end of our study period in 2009.

Conclusions: The requirements of the voluntary safety standard for drawstrings have been highly effective in preventing deaths resulting from the entanglement of drawstrings in children’s upper outerwear garments.

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Drawstrings in children’s upper outerwear garments such as jackets and sweatshirts, which are generally worn over other clothing, can result in injury or death when they become entangled with other objects. Drawstrings in the neck and hood areas of outerwear garments present a strangulation hazard when they become caught in gaps or on protuberances from objects such as playground slides.1,4 Additionally, waist-level drawstrings can become entangled in school bus handrails or doors, presenting a hazard to children when buses pull away after a stop.3,7

From January 1985 through September 1995, the US Consumer Product Safety Commission (CPSC) received reports of 17 fatal injuries and 42 cases of nonfatal injuries or potential injuries involving children whose hood or waist-level drawstrings became entangled on playground equipment, school bus handrails, and other common items.7 All reports involved children aged 14 years and younger.

In 1995, after CPSC staff met with industry representatives to discuss drawstring hazards and to develop a voluntary agreement to address the hazards, the CPSC issued a set of voluntary guidelines designed to prevent children from entangling themselves with drawstrings in upper outerwear.1,8 As an alternative to neck-level drawstrings, the CPSC staff recommended the use of other closures such as snaps, buttons, Velcro, or elastic. The CPSC also recommended that the ends of waist-level drawstrings measure no more than 3 inches from where the strings extend from the garment, reasoning that this limitation, among others, would reduce the risk of waist-level drawstring entanglements.9

At about the same time the drawstring guidelines were being developed, the National Highway Traffic Safety Administration (NHTSA) initiated remedial actions to reduce the hazards associated with drawstrings being snagged on school bus handrails and doors.10 These actions included recalls to address the hazards on existing buses, requirements for improved designs on new buses, and increased driver training.

After developing the drawstring guidelines, CPSC staff worked closely with industry to develop a voluntary standard to address the drawstring hazards. In 1997,
ASTM International adopted ASTM F1816-97, a voluntary safety standard for drawstrings on children’s upper outerwear that followed the CPSC’s guidelines. The standard prohibits the use of drawstrings in the neck area of garments sizes 2T to 12. It also requires that nonretractable drawstrings at the waist level of garments sizes 2T to 16 meet the following: (1) be limited to no more than 75 mm (3 in) outside the drawstring channel when the garment is expanded to its fullest width; (2) have no toggles, knots, or other attachments at the free ends; and (3) be bartacked if the drawstring is 1 continuous string. Garments with fully retractable drawstrings are exempt. The standard’s garment size specifications were intended to address the hazards to children believed to be at greatest risk: children aged 18 months to 10 years for neck-level drawstrings and children aged 18 months to 14 years for waist-level drawstrings.

The purpose of this study is to evaluate the effectiveness of the drawstring requirements of the voluntary standard in preventing child deaths.

METHODS

DATA

The analysis is based on reported deaths resulting from drawstring entanglement involving children’s upper outerwear garments compiled by CPSC staff from January 1985 through December 2009. A major source of information was the CPSC’s Injury and Potential Injury Incidents database, which drew on reports of drawstring-related deaths from a number of sources: newspaper and other media accounts, the Medical Examiners’ and Coroners’ Alert Program, state consumer protection agencies, the public (through the CPSC’s telephone hotline or website), and other sources such as the NHTSA. Additional information was collected from the CPSC’s National Electronic Injury Surveillance System, a stratified national probability sample of US hospital emergency departments, and from the CPSC’s death certificates database. The CPSC contracts with each of the 50 states and the District of Columbia to purchase information on unintentional deaths with external causes that have a high probability of being product related.

To ensure the accuracy of the reported deaths, to collect additional information, and to prevent double counting, CPSC staff attempted to conduct follow-up field investigations on the reported drawstring-related deaths. These in-depth investigations included the collection of police and coroners’ reports, discussions with police investigators and medical examiners, and (sometimes) discussions with next of kin. Duplicate cases identified from different sources were eliminated.

STATISTICAL ANALYSIS

The effectiveness of the voluntary standard’s requirements in preventing drawstring-related child deaths is evaluated with a Poisson log-linear regression model for rate data. The Poisson model is well suited for the analysis of data that have counts (ie, nonnegative integers) as possible outcomes, such as the number of deaths during a given period. It can also be used to evaluate mortality rates when the outcome data, measured in deaths, are indexed by a measure of risk exposure. The expected annual number of drawstring-related deaths was assumed to follow a Poisson distribution and was estimated as a function of predictor variables and an offset term. The offset term allows us to adjust the expected value of the response variable for the population of children at risk and has a defined coefficient of 1. For this analysis, the offset term was based on the resident US population of children aged 18 months through 14 years, the children most likely to use the garment sizes cited in the standard.

The effect of the drawstring requirements on child deaths was quantified with a predictor variable, standard, that was intended to represent the proportion of upper outerwear garments in use that were sold after the voluntary standard was adopted or that met the provisions of the CPSC guidelines before the voluntary standard was adopted. For this analysis, we assumed that the variable increased gradually from 0 in 1994 to 1 in 2000 (ie, standard = 0.167 in 1995; standard = 0.333 in 1996;... and standard = 1 in 2000). Although the voluntary standard was not adopted until 1997, our specification accounts for the fact that a number of manufacturers followed the CPSC drawstring guidelines as early as 1995 and that some garments—originally sold with drawstrings before the voluntary standard was adopted—may have remained in use for several years after the standard had been adopted. Additionally, because the remedial actions taken by the NHTSA to address drawstring hazards in school buses were initiated during this same time in the mid 1990s, this variable should implicitly account for any safety improvements that might be associated with those actions.

A dichotomous predictor variable, underreport, was included to adjust for the possibility that deaths were underreported prior to 1994, the year the CPSC began working closely with industry to encourage removing drawstrings from children’s upper outerwear garments. This variable was set to 1 for the years 1985 through 1993, the years when the deaths may have been underreported, and to 0 otherwise. Prior to 1994, the CPSC had not conducted any drawstring-related clothing recalls, and information on drawstring involvement in some deaths may have been underreported because injury prevention efforts tended to focus on the products in which drawstrings had caught rather than on the drawstrings themselves.

Finally, a sensitivity analysis was conducted to measure the sensitivity of the statistical results to variations in the specification of the regression model and changes in the specification of the standard and underreport variables.

RESULTS

DESCRIPTIVE RESULTS

A total of 29 drawstring entanglement deaths were identified from January 1985 through December 2009. Follow-up in-depth investigations were conducted in 22 of the cases. Information on 6 cases was limited to that provided in the CPSC’s Injury and Potential Injury Incidents database; information on 1 case was limited to that provided in the death certificate. Table 1 provides some descriptive results. Twenty-three of the reported deaths occurred before the voluntary standard was adopted in 1997. During the prestandard period, there were about 3.3 deaths/year from 1994 through 1996 but only about 1.4 deaths/year from 1985 through 1993. The lower rate from 1985 through 1993 was probably related to underreporting because there is no evidence that drawstrings were used less frequently during this period. Additionally, the rate of reported drawstring-related deaths appears to have declined substantially after the 1997 adoption of the voluntary standard. The children who died ranged in age from 15 months to 14 years, with a mean age of 5.3 years. Two-thirds of the deaths occurred in children of kindergarten age or...
younger. Sixteen of the deaths (55.2%) involved girls; 12 (41.4%) involved boys; and the sex of 1 victim was unknown. Twenty-one of the deaths (72.4%) involved neck-level drawstrings; 8 (27.6%) involved waist-level drawstrings.

Of the 21 deaths involving neck-level drawstrings, all but 1 involved children younger than 8 years. Ten deaths resulted from entanglement strangulation when the child’s drawstring was entangled on a slide or sliding board; 2 involved strangulation on unspecified playground structures; and 3 involved strangulation on a crib. The remaining 6 deaths resulted from drawstring entanglement on a fence, a home stairway handrail, a lamp, an escalator, a hand grinder, and an automobile’s turn signal lever.

The 8 deaths resulting from entanglement of the waist-level drawstrings involved children aged 7 to 14 years; all but 1 were female. Seven occurred after drawstrings were entangled in school bus doors or handrails. All 7 children were dragged and, in most cases, crushed under the buses’ wheels. In the eighth case, an 8-year-old child was asphyxiated when her waist-level drawstring was caught on a backyard sliding board, pulling the coat up around her neck. All of the deaths involving the waist-level drawstrings occurred prior to the voluntary standard’s adoption in 1997.

REGRESSION RESULTS

The regression results (Table 2) quantify the effect of the drawstring requirements on the drawstring-related child deaths. The deviance and \( \chi^2 \) statistics for the models suggest that they fit the data reasonably well. The mean deviances (ie, deviance/df) ranged from 1.09 to 1.23, suggesting that overdispersion was not a problem. Additionally, based on an evaluation of the standardized Pearson residuals, there was no indication of serial correlation.19

Model 1 contains 2 predictor variables, standard and underreport, both of which were statistically significant. After adjusting for the possible underreporting of deaths from 1985 through 1993, the model 1 results suggest that the drawstring requirements may have reduced the drawstring-related child mortality rate by about 90.9% (95% CI, 70.9%-97.3%). If the results had not been adjusted for possible underreporting, as in model 2, the requirements of the voluntary standard still would have been estimated to reduce the mortality rate by about 77.7% (95% CI, 46.7%-91.9%).

The results from model 1 are illustrated in the Figure, which shows a substantial decline in the predicted (ie, fitted) number of drawstring-related deaths after the drawstring requirements went into effect, relative to predicted deaths in the absence of the drawstring requirements (ie, when the variable standard was set to 0). The gradual increase in predicted deaths that would have occurred in the absence of the drawstring requirements reflects the increase in the population of children at risk, which rose by about 20% from 1985 through 2009.15-17

SENSITIVITY ANALYSIS

Several analyses were conducted to evaluate the sensitivity of the statistical findings to variations in the specification of the regression model. Because all deaths involving school buses occurred prior to the adoption of the voluntary standard, we re-estimated model 1 (our primary model) after excluding the school bus–related deaths. Given this respecification, the drawstring requirements were estimated to reduce the mortality rate for the remaining deaths by 86.4% (95% CI, 46.4%-96.7%).

We excluded information on reported nonfatal injuries from the analysis because a comprehensive compilation of nonfatal injuries is more difficult than the collection of fatal injuries and hence subject to greater variability. For example, nonfatal injuries may be less likely to be reported in news accounts, and some children with minor injuries may not even receive emergency medical care. Nevertheless, when the 41 nonfatal injuries reported to the CPSC from 1985 through 2009 were included in the analysis,20 the drawstring requirements were estimated to reduce the expected rate of death or injury by 91.4% (95% CI, 69.4%-97.8%).

To account for possible long-term trends in the mortality data, we considered including a linear trend variable or, alternatively, a variable representing personal consumption expenditures in constant dollars.21 Including either of these variables marginally increased the estimated effectiveness of the voluntary standard. However, because these variables were not statistically significant and because their inclusion did not materially improve the models’ fit, they were excluded from analysis.

Finally, the statistical results were not sensitive to plausible variations in the specification of the variable standard. In addition, the results were not sensitive to variations in the specification of the underreport variable. Of course, the results in Table 2 show that the major find-
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string-related deaths involving drawstrings in children's upper outerwear garments. Additionally, because
have been no reported deaths involving drawstrings on school buses since the adoption of the voluntary standard, the requirements of the voluntary standard in combination with the remedial actions taken by the NHTSA appear to have been particularly effective in addressing the bus-related drawstring entanglements.

According to our primary model, the voluntary standard for drawstrings has reduced the drawstring-related child mortality rate by an estimated 90.9%. Such a reduction would have resulted in the prevention of an estimated 50 deaths from 1997—when the voluntary standard was adopted—through the end of our study period in 2009. Even if the school bus–related deaths had been excluded from the analysis, the drawstring requirements would still have been estimated to reduce the mortality rate associated with the remaining deaths by 86.4%.

Because our data suggest that drawstring-related deaths can be almost entirely eliminated if the requirements of the voluntary standard are followed, the effectiveness of the drawstring requirements is closely tied to industry compliance. A number of drawstring-related clothing recalls have been conducted in recent years, demonstrating less than full conformance with the voluntary standard. Nevertheless, available evidence suggests a high level of conformance with the voluntary standard. The CPSC staff estimates that 1% or fewer of children's upper outerwear garments have contained drawstrings in recent years. In contrast, prior to the adoption of the voluntary standard, a substantial proportion of children's upper outerwear garments contained drawstrings, possibly more than half. This high rate of conformance is related to several factors. Perhaps most importantly, drawstring hazards have become well known by the major suppliers of children's apparel and can be easily and inexpensively addressed by substituting alternative closures such as snaps, buttons, Velcro, or elastic. Additionally, suppliers of products not conforming to product safety standards are subject to increased product liability claims when injuries or deaths are caused by their products. Consequently, many major retailers require that their suppliers provide products conforming to existing safety standards.

Finally, CPSC enforcement policies have encouraged conformance. The CPSC's Office of Compliance has considered children's upper outerwear garments with drawstrings to be defective and to present a substantial risk of injury to children under section 15(c) of the Federal Hazardous Substances Act, 15 USC §1274(c). In recent years, the CPSC has aggressively initiated recalls of upper outerwear garments that do not comply with the drawstring requirements—recalls that are potentially costly to firms that do not comply. The CPSC also has the authority to seek civil penalties when sellers distribute into commerce noncomplying garments and fail to report this to the commission as required by section 15(b) of the Consumer Product Safety Act, 15 USC §2064(b).

Given the large number of producers and importers of children's apparel and the ease with which sellers can enter the market, CPSC's enforcement policies have probably played an important role in achieving the high level of conformance needed for an effective voluntary standard.

This analysis is subject to several limitations. Most cases were from the CPSC's Injury and Potential Injury Incidents database, a nonstatistical database that draws on reports from a number of different sources but does not necessarily provide a complete count. As described, an adjustment

### Table 2. Poisson Regression Results for Child Mortality Rate From Drawstring Entanglement From 1985 Through 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Predicted, without drawstring requirements</th>
<th>Predicted, with drawstring requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>1987</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>1988</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1989</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure.** Fitted model showing the effects of the drawstring requirements of the voluntary standard on child deaths from 1985 through 2009.

**COMMENT**

This analysis suggests that the drawstring requirements of the ASTM voluntary standard have been highly effective in reducing deaths involving drawstrings in children's upper outerwear garments. Additionally, because there have been no reported deaths involving drawstrings on school buses since the adoption of the voluntary standard, the requirements of the voluntary standard in combination with the remedial actions taken by the NHTSA appear to have been particularly effective in addressing the bus-related drawstring entanglements.

According to our primary model, the voluntary standard for drawstrings has reduced the drawstring-related child mortality rate by an estimated 90.9%. Such a reduction would have resulted in the prevention of an estimated 50 deaths from 1997—when the voluntary standard was adopted—through the end of our study period in 2009. Even if the school bus–related deaths had been excluded from the analysis, the drawstring requirements would still have been estimated to reduce the mortality rate associated with the remaining deaths by 86.4%.

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was made in the analysis to account for the possible underreporting of deaths in the early years of the study period. There is also a lag involving the collection of deaths reported through the CPSC’s death certificates database. Consequently, reported drawstring-related deaths, even in recent years, may not constitute a complete count. Since the mid 1990s, however, CPSC staff has attempted to collect information on all deaths resulting from this hazard pattern. Because there is no reason to believe that underreporting has increased in recent years, it is unlikely that underreporting would have materially altered our findings.

Additionally, the statistical analysis did not explicitly account for possible safety improvements in playground equipment that may have independently addressed the drawstring hazard. The CPSC publishes a playground safety handbook containing several recommendations for avoiding projections on playground equipment that may present a drawstring entanglement hazard. Some have been incorporated into voluntary standards for children’s playground equipment and may have contributed to the reduction in drawstring-related deaths. However, playground equipment improvements have occurred over time and are unlikely to explain the rapid reduction in drawstring-related deaths that occurred at or about the time the voluntary standard was developed.

Finally, the analysis did not account for the possible effect of changing designs in children’s outerwear garments during the study period. It is possible, for example, that the growing popularity of Velcro or other closures on children’s outerwear garments might have reduced the drawstring-related mortality rate over time, even in the absence of the drawstring requirements.

CONCLUSIONS

This analysis found that the drawstring requirements of the voluntary standard have been highly effective in reducing drawstring-related child deaths. Based on our analysis, the drawstring requirements may have reduced the drawstring-related mortality rate by 90.9% and may have prevented about 50 child deaths during the post-intervention period from 1997 through 2009.

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