



U.S. Consumer Product Safety Commission

VOLUNTARY STANDARDS PROPOSALS FOR CHILD RESTRAINT SYSTEMS ON HIGH CHAIRS AND STROLLERS

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BACKGROUND

Falls continue to be the leading cause of all juvenile product-related injuries reported through the National Electronic Injury Surveillance System (NEISS).¹ NEISS represents a statistical sampling of emergency room visits involving injuries incurred from consumer products. NEISS data provides minimal descriptions of injury incidents and cases may not indicate whether falls from juvenile products involved restraints.

The cases can provide indications of the injury potential from falls from juvenile products. A analysis of NEISS data involving falls from juvenile products found that in 1995 (the latest date for which information is available) there were an estimated 28,000 fall-related emergency room treated injuries for juvenile products such as strollers, high chairs, carriers, and swings. Of these, strollers and high chairs were the major contributors, accounting for about 17,000 falls per year.² Because restraints are intended to prevent falls, it is likely that a portion of these falls were caused by restraint failure.

The U.S. Consumer Product Safety Commission (CPSC) initiated the Child Restraint Project to address concerns about the effectiveness of restraints on juvenile products. One of the tasks of the project involved the gathering of more specific data on restraint-related incidents where the restraints were in use. Reported incidents indicated that children, while fastened in restraints, were able to defeat the restraints and put themselves at risk for injury.

The project focused on high chairs and strollers because the majority of reported restraint incidents involved these products. In-depth investigations of high chair and stroller incidents were conducted and the products involved in the incidents were collected for evaluation. The goal of the project was to determine why the restraints failed to securely hold children and then develop recommendations for voluntary standards that would address these failures.

The Division of Hazard Analysis provided analyses of restraint-related incidents for high chairs and strollers in April 2001 and July 2001, respectively.³ Although the data is anecdotal, it gives an indication of the types of restraint-related incidents that occur with these products.

¹ McDonald, J. (November 20, 2001). Nursery Product-Related Injuries and Deaths to Children under Age Five. Washington DC: U.S. Consumer Product Safety Commission

² Coonley, J. and Rutherford, G. (July 1996). Hazard Sketch: Restraints on Infant Products. Washington DC: U.S. Consumer Product Safety Commission

³ McDonald, J. (April 23, 2001). Preliminary Analysis of High Chair Restraint System Data. Washington DC: U.S. Consumer Product Safety Commission

McDonald, J. (July 26, 2001). Preliminary Analysis of Stroller Restraint System Data. Washington DC: U.S. Consumer Product Safety Commission

A contract was awarded to the Transportation and Safety Research Group at Westat in September 2000 to analyze high chair and stroller IDIs and the incident products to 1) determine the causes of high chair and stroller restraint failures and to 2) propose recommendations to correct these failures. Two reports were issued in July 2001 under that contract – a *Product Profile Report* on high chairs and strollers and *Causes of High Chair and Stroller Restraint System Failure*.

The *Product Profile Report* (Appendix A) constructs a composite view of high chairs and strollers from a wide range of information sources. High chair and stroller incidents are categorized into general scenarios, much like the hazard patterns identified in the CPSC staff's data analysis reports. A range of adult caregiver use factors that relate to the non-use or misadjustment of restraint features is also identified. This report provided a foundation for subsequent work that culminated in the second contractor report.

The *Causes of High Chair and Stroller Restraint System Failure* (Appendix B) report addresses the reasons restraints may fail to secure children. The report presents a framework for addressing improvement of restraints by providing general design considerations, design concepts and potential modifications to high chair and stroller voluntary standards.

The contractor found that the key to understanding restraint dynamics lies in the principle that critical movements must be executed to defeat the restraints and the degree to which product features afford this movement determines the likelihood of restraint failure. The contractor recommendations reflect this systems approach to restraint effectiveness; the entire product is viewed as a restraint system, not just the obvious configuration of waist, crotch and shoulder straps. Suggested recommendations account for product features not ordinarily linked to restraint components, such as seat compartment design.

The data analyses and contractor reports provide direction for the complex task of redefining restraints for juvenile products. While the data analyses identify and describe hazard patterns, the contractor reports offer conceptual and practical suggestions and recommendations to reduce or eliminate the hazards.

The suggested recommendations stated in the *Causes of High Chair and Stroller Restraint System Failure* report are not intended for immediate implementation or universal application. A more thorough development and evaluation of the potential individual countermeasures are required before they can be recommended for adoption. An evaluation of the countermeasures should include the issues of usability and consumer acceptance that are not addressed in the contractor reports.

VOLUNTARY STANDARDS PROPOSALS DERIVED FROM HAZARD PATTERNS

CPSC staff believes that the following hazard patterns need to be addressed by improvements to the voluntary standards for high chairs and strollers.⁴ These hazard patterns involve restraint failures that were identified from CPSC data.

The hazard patterns are:

1. High Chair Tray Disengagement
2. High Chair Restraint Failure
3. Stroller Restraint Failure
4. Stroller Leg-Hole Opening Hazard
5. Jogging Stroller Restraint Failure
6. Five-Point Harness Failures – High Chairs and Strollers
7. High Chair Passive Crotch Restraint Failure

Each hazard pattern is addressed in a separate section of this report. The hazard patterns are not presented in any particular order or ranking. Each section identifies the hazard pattern, provides supporting data from the Division of Hazard Analysis reports, cites relevant voluntary standards, discusses issues pertaining to the hazard pattern, and makes proposals and recommendations for voluntary standards revisions based on the contractor's findings and CPSC staff expertise and experience.

During the course of the Child Restraint Project, CPSC staff identified additional concerns with restraints not covered by the seven hazard patterns that have the potential to impact the effectiveness and safety of restraints. A listing of these concerns follows the discussion on hazard patterns.

CPSC staff believes that the issues addressed in this paper provide a strong foundation with which to begin the development of more effective requirements for child restraints. CPSC staff encourages the development of more effective standard requirements without advocating specific designs.

This report is not intended to be a summation or synthesis of the contractor reports. The findings from the contractor's reports are broadly discussed and not all concepts presented in the reports are included. The *Product Profile Report* and the *Causes of High Chair and Stroller Restraint System Failure* report need to be read in their entirety to gain a thorough understanding of the methodology, issues, and technical knowledge that contributed to the contractor's formulation of recommendations.

⁴ The current voluntary standard for high chairs is ASTM F 404-99a, Standard Consumer Safety Specification for High Chairs. The current voluntary standard for strollers is ASTM F 833-00, Standard Consumer Safety Performance Specification for Carriages and Strollers. The contractor used ASTM F833-99 because the 2000 edition was not available at the time the contract was awarded.

HAZARD PATTERN: HIGH CHAIR TRAY DISENGAGEMENT

Reports indicate that trays can be disengaged from high chairs when children push or lean on the trays or when they hit, kick or push the tray or locking mechanisms with their feet or knees.

DATA:

January 1, 1998 to February 7, 2001: 45 reports of high chair tray disengagement with 17 known injuries.

In 9 of these incidents, the tray and restraints failed simultaneously, accounting for 4 of the injuries. All these injuries involved the head and facial areas and were caused by a fall from the high chair. Injuries consisted of 2 bumps, 1 bruise, and 1 case of bleeding gums.

Fifteen of the remaining 36 incidents involved falls from high chairs and accounted for 12 of the injuries. Restraints were in use in 7 of these 15 fall incidents. Most of the injuries consisted of lacerations, contusions, or bruises.

Twenty of the 36 incidents involved near-misses when the tray became disengaged but no injuries occurred.

One incident involved breakage of a tray when a child disengaged it. The child received a bruise on the forehead.

PERFORMANCE REQUIREMENTS RELEVANT TO HAZARD PATTERN

ASTM F 404-99a, Standard Consumer Safety Specification for High Chairs

(Section 9.4 and 9.5) Current performance requirements specify horizontal and vertical pull tests to evaluate the capability of the high chair tray to remain engaged and in location.

DISCUSSION

There is a widespread perception that the tray is functionally part of the restraint system despite manufacturers' claims to the contrary.⁵ Consumers regard the tray as an additional restraint barrier that can prevent a child from climbing out of the chair. The current voluntary standard requires a passive crotch restraint that

⁵ Lerner, N.D., Huey, R.W., and Kotwal, B.M. (July 2001). Product Profile Report. Contract CPSC-S-00-5205.

prevents children from slipping down in the high chair and becoming entrapped by the restraint straps or the tray. The passive crotch restraint is required to be in place when the tray is attached to the chair. Some high chair designs that engineer the passive crotch restraint with the tray have made the tray part of the restraint system. When the tray disengages, the passive crotch barrier is removed and the potential exists for entrapment or strangulation by restraint straps if a child slips down in the seat. The potential also exists for falls and associated injuries.

Several incidents specifically mention that children could reach the tray release mechanism with feet, knees or legs to disengage the tray. Following are examples of such comments found in the incident reports.

- Child put her feet against the lip of the tray and pushed hard enough so the tray disengaged.
- Child stretched his legs and released the tray's locking mechanism with his feet.
- Child was fastened in high chair by waist strap and was able to push the tray away from him with his feet.
- On several occasions, child was able to push the high chair's tray with his feet.
- Child disengaged the press-release tray by kicking it and then leaned forward, falling out of the high chair.
- Child kicked against the tray from underneath and the tray detached.
- Child lodged his foot under the bar to release the tray of his high chair.
- On several occasions, child disengaged the tray lock mechanism on the underside of the tray with his foot.
- Child has easily hooked his feet on the tray release handle and sent the tray flying.

CPSC staff observed that the locking mechanisms on some brands of high chairs are difficult to engage and do not provide positive feedback to indicate that the tray is securely attached. Disengagement might occur if the trays are not firmly locked in to the high chair. Incorrect attachment may contribute to the disengagement of trays.

RECOMMENDATIONS

CPSC staff believes that tray disengagement leads to an increased potential for injury to children and that the current performance requirements do not adequately address the hazard. The performance tests do not take into consideration the forces exerted by children on the tray and the tray release mechanisms and the ready access to lock mechanisms.

CPSC staff agrees with the findings in the *Causes of High Chair and Stroller Restraint System Failure* report that the following options may reduce or eliminate the hazard of tray disengagement.

- Position the release mechanism so that it is inaccessible by children's hands and feet.
- Require the release mechanism to operate in a direction of motion counter to that which can be executed by a child.
- Require trays to have undersides without lips or protuberances against which children's feet can push.

Dual-action release mechanisms may present another alternative to front-release, single-action mechanisms. Dual-action mechanisms would have to prevent disengagement of the tray by a child without making tray removal difficult for caretakers.

HAZARD PATTERN: HIGH CHAIR RESTRAINT FAILURE

Reports indicate that children fastened in restraint straps can stand up in the high chair with the straps still on or can climb, wiggle, or slip out of the restraints.

DATA:

January 1, 1998 to February 7, 2001: 35 reported incidents in which restraints failed to secure child; 4 known injuries.

Three of the injuries involved the head (a mild concussion and bumps). One injury was a probable fractured elbow. All four injuries were caused by falls from the high chair.

In all incidents the children were reported as fastened in the restraint straps. None of the incidents involved the child defeating the latch or other latch disengagement. In some instances the tray was in place at the time of the incident.

Some incidents were not isolated occurrences. Children were able to defeat the restraints on more than one occasion. These multiple occurrences are not included in the total number of reported incidents given above.

**PERFORMANCE REQUIREMENTS
RELEVANT TO HAZARD PATTERN**

ASTM F 404-99a, Standard Consumer Safety Specification for High Chairs

This hazard pattern focuses primarily on the active restraints, straps that the caregiver must fasten, rather than the passive crotch restraint required by the standard. Therefore, only those provisions of the standard referring to active restraints are cited. The passive crotch restraint is addressed in a following section of this report.

(Section 6.8.1.1) Restraint systems for high chairs must have both crotch and waist restraints.

(Sections 6.8.2.1, 6.8.2.2, 9.8.4.1 and 9.8.4.3) Current high chair requirements specify an occupant retention test for active restraints (those that must be operated by caregivers) that entails horizontal and vertical pull tests on a restrained CAMI Infant Dummy. The criterion for the horizontal pull test does not allow the buttocks of the restrained dummy to slip "past the front edge of the

seat.” The criterion for the vertical pull test does not allow the bottom of the restrained dummy’s feet to touch or leave the seat.

DISCUSSION

Restraint systems are failing caregivers because they can be defeated by children. With little effort, children can place themselves at risk for head and other injuries due to falls. Caregivers are confident that children are securely restrained only to find them standing up in, or hanging from, a high chair. Some of these incidents occur in a matter of seconds with a caregiver in close proximity.

The *Causes of High Chair and Stroller Restraint System Failure* report presents general design considerations for restraint systems that aid in understanding the dynamics involved in these incidents. The design considerations were derived from an analysis of children’s movement behaviors and the space afforded by the product to perform these movements. These design considerations are described briefly below. Section six of the *Causes of High Chair and Stroller Restraint System Failure* report provides a more substantive and expanded discussion that explains how these issues relate to the incidents and restraint improvement.

The similarity in chest, waist, hip, and lower torso measurements for a young child gives the child’s body a cylindrical shape. Restraint straps designed to encircle a cylindrical body shape will easily slip up or down on the body when a child twists or pushes up. A number of incident reports stated that the caregiver discovered the child standing in the high chair with the restraints, still buckled, lying at the child’s feet.

The movement of the thighs is critical in escape maneuvers because thigh movement draws the knees and legs into the seating compartment. A design approach that limits thigh mobility may prevent a child from exiting a high chair. Design concepts and suggested modifications to the voluntary standard found in the report build on this concept.

Another general design consideration is to limit movement by reducing the amount of space that facilitates the drawing up of legs and knees into the seating compartment. The space in the seating compartment comprises a 3-dimensional area referred to as the “envelope of permitted movement of the knees and legs.” It takes into account the space in and around the seating compartment through which the legs pass as the child maneuvers them into the seat.

Movement of the hips can increase the envelope within which knees can move. Therefore, methods to keep the hips flat against the chair back and the buttocks at the juncture of the chair seat and back should be considered in the design of the product.

An important consideration particularly applicable to high chairs that feature reclining seat positions is the containment of the center of gravity. There is a

potential for tip-over should a child edge towards the head end of a reclined seat and shift the center of gravity so that stability is compromised.

One design consideration applies to footholds, such as footrests, that may provide a pushing surface for children to use to raise themselves up and out of restraints. Photographs of children seated in high chairs that are included with the IDIs show that some children have their feet resting flatly on the footrests. While none of the high chair reports specifically mention footholds as a contributory factor in the incidents, it does not necessarily exclude their involvement. Incident reports varied in the amount of detail provided and this particular aspect of the incident may not have been observed or recorded. Also, caregivers may not have noticed if footrests or other footholds aided a child in pushing free from a restraint.

CPSC staff agrees with the contractor finding that the criterion set in the standard for the degree of movement permitted during the occupant retention test is not adequate. Allowing a child to approach either of the positions described in the criterion is contrary to the task of restraint. The contractor advises that the CAMI dummy should be limited to less than 2 inches of movement during the occupant retention test.

RECOMMENDATIONS

The design of effective high chair restraints should take into consideration the cylindrical shape of a child's body, limitation of thigh movement, reduction in movement for knees and legs within the seating compartment, maintenance of hip and buttocks position within the chair seat, containment of the center of gravity, and the contributory role of footholds.

CPSC staff supports the contractor recommendation that the amount of permitted movement during the occupant retention test be limited to less than 2 inches.

HAZARD PATTERN: STROLLER RESTRAINT FAILURE

Reports indicate that children fall out of strollers because they are able to wiggle out of the restraints.

DATA:

January 1, 1998 to March 27, 2001: 56 reported incidents where restraints failed to adequately secure child; 13 known injuries.

Twelve injuries were the result of a fall from the stroller. One injury resulted when a child's hand and fingertips were caught in the wheel of a stroller when the waist straps loosened.

Eleven of the injuries were to the head and facial region. Most of the injuries were bruises, bumps, abrasions, or lacerations.

Five of the reports involved restraints on jogging strollers. These incidents are discussed in a subsequent section of the paper.

According to reports, a child's ability to get out of the restraints or the failure of restraints to hold the child in place were not isolated occurrences. One child was reported as being able to wiggle out of the restraint system of the stroller several times a day. These multiple occurrences are not reflected in the total number of incidents given above.

**PERFORMANCE REQUIREMENTS
RELEVANT TO HAZARD PATTERN**

ASTM F 833-99 Standard Consumer Safety Performance Specification for Carriages and Strollers

(Section 6.4) The stroller standard requires that both a waist and crotch strap be provided with the product.

(Section 7.5.2.2) The standard provides for an occupant retention test using a horizontal pull on the leg of a restrained CAMI Infant Dummy.

(Section 7.5.2.6 and 7.5.2.7) Occupant retention is tested by rotating a stroller, containing a restrained CAMI Infant Dummy, 360 degrees in two orientations – backwards and sideways.

DISCUSSION

Data indicate that ineffective stroller restraints present a fall potential that can result in head and facial injuries. This hazard pattern is similar to the one exhibited with high chair restraints where children defeated the fastened restraint system when performing common motor behaviors such as turning and twisting.

Incident reports referred to both single and multiple occupancy strollers. Back seat restraint systems on multiple occupancy strollers were specifically mentioned in some of the incidents. The stroller standard does not state if each restraint system on multiple occupancy strollers is required to be tested.

Restraint problems with jogging strollers are also represented in the data. Jogging strollers are discussed in a succeeding section of this report.

The discussion on general design considerations in the section on high chair restraint failures also applies to strollers. As with high chair restraints, the design of effective stroller restraints should take into consideration the factors of the cylindrical shape of a child's body, limitation of thigh movement, reduction in movement for knees and legs within the seating compartment, maintenance of hip and buttocks position within the chair seat, containment of the center of gravity, and the contributory role of footholds.

As with high chairs, a design consideration particularly applicable to strollers that recline is the containment of the center of gravity. There is a potential for tip-over should a child edge towards the head end of a reclined seat and shift the center of gravity so that stability is compromised. This is illustrated by one of the reported incidents in which a 23-month-old child was in a stroller in a reclined position. The child wiggled out of the restraints by sliding backward. The stroller tipped over and the child sustained a bump on the forehead when his head hit the floor.

CPSC staff observed that one of the problems with stroller restraints is the location of the crotch-strap-anchorage point. On the majority of strollers the crotch strap is attached near the front edge of the seat, allowing a substantial amount of "wobble room" in the seating compartment. One consumer complained, "The crotch strap for the back seat of the stroller is right at the edge of the seat. when (sic) the child is sitting upright, or semi reclined (sic), there is a very large space for his legs. He is big (19 pounds) baby (sic) and this may even be more of a hazard for a child with a smaller build."⁶

CPSC staff also observed that the majority of stroller crotch restraints cannot be adjusted. They cannot be fitted to accommodate the changing body shape of the wide age range of children for whom the product is intended. The standard states that strollers are intended both for infants and for older children up to 3 years of age.

⁶ Document Number I01C0017

RECOMMENDATIONS

CPSC staff recommends that the factors discussed above, be further explored as a basis for improving the effectiveness and safety of stroller restraints. These factors include the cylindrical shape of a child's body, limitation of thigh movement, reduction in movement for knees and legs within the seating compartment, maintenance of hip and buttocks position within the chair seat, containment of the center of gravity, and the contributory role of footholds.

CPSC also recommends that the stroller standard specifically address the testing of all restraint systems on multiple-occupancy strollers.

The high chair voluntary standard provides for a vertical occupant retention test. A pull force is exerted vertically on the dummy in line with the approximate centerline of the torso to determine how far the dummy releases from the seat. The stroller voluntary standard makes no such provision. The rotational test for occupant retention in the standard specifies some limited vertical pull on the CAMI dummy when the head of the dummy is toward the floor. However, CPSC staff believes that an independent vertical pull test, with the CAMI dummy seated in an upright position, is more indicative of real-use conditions and recommends that this performance test be implemented for strollers.

HAZARD PATTERN: STROLLER LEG-HOLE OPENING HAZARD

Reports indicate that restraints sometimes fail to prevent children from slipping down in the stroller. Children either put both legs through a leg opening and slip out of the stroller, slip through the space between the restraint bar and seat, or slip down in the stroller and get arms, faces, necks or shoulders caught in the restraints.

DATA:

January 1, 1998 to March 27, 2001: 13 incidents where a child slipped down in a stroller, resulting in 1 death and 2 injuries. The death was due to asphyxia. One injury involved entanglement in the waist strap that formed welts on the child's neck. The remaining injury was unspecified.

In 10 out of the 13 incidents, the child was restrained. Two injuries occurred in these incidents.

Eight incidents involved 2-point restraint systems (a waist belt). In 7 of these 8 incidents the children were caught in the restraint straps.

In at least 2 incidents, the child rolled over from the back to the stomach.

PERFORMANCE REQUIREMENTS and TERMINOLOGY RELEVANT TO HAZARD PATTERN

ASTM F 833-99 Standard Consumer Safety Performance Specification for Carriages and Strollers

(Section 3.1) The current voluntary standard makes a distinction among carriages, strollers, and convertible carriage-strollers.

(Section 6.4.1) Carriages intended for use only by an infant are not required to have a restraint system. Carriages with accessories that adapt its use to children beyond infancy must have a restraining system.

(Section 6.4.3) Convertible carriage-strollers must conform to requirements for both carriages and strollers.

(Sections 3.1.8 and 6.5.1) If a carriage or convertible carriage-stroller provides a reclining position greater than 150 degrees, it must provide a nondetachable feature that will prevent children from slipping through the foot portion of the stroller.

DISCUSSION

This is the only hazard category involving stroller-restraint incidents in which a death occurred. As described in the in-depth investigation, a 6-month-old male was lying unrestrained on his back in a stroller, drinking juice. His 14-year-old uncle was caring for him at the time of the incident. The uncle left and came back to find the child face down against the seat with both feet hanging out through one of the leg holes of the stroller. The child died of asphyxia. The in-depth investigation report does not specify whether the product is a stroller or a convertible carriage/stroller.

In another incident involving stroller leg holes, a 3-month-old baby slipped through the leg hole of a stroller that was in the maximum reclining position. The baby fell out of the stroller onto his stomach and sustained contusions on the mouth, upper lip and nose. He was treated and released from an emergency room. The mother stated that her child “was able to push himself up enough to move his right leg up and over the crotch strap...so both legs were through the seat restraint’s left leg opening.”⁷ Because the angle of recline formed at the junction of the seat and seat back is not greater than 150 degrees, the product, by standard definitions, is considered a stroller rather than a convertible carriage/stroller. Therefore, it is not required to provide a means to block slippage through the leg holes.

As mentioned in the previous section on stroller restraints, the crotch straps on the majority of strollers are located at the front edge of the seat and are not adjustable. Also, the location of the crotch strap anchorage point can influence the size of the leg hole. The lack of adjustment for the crotch strap means it cannot accommodate the wide range of body sizes of the age range of children who will use the product, which, according to the stroller standard, includes infants and older children up to 3 years of age. A narrow crotch restraint can also increase the size of a leg hole.

If waist strap adjustment is difficult, as it was in the incident involving the 3-month-old baby, caregivers are likely to keep the restraints set in one position. They are likely to choose an adjustment that will accommodate various layers of clothing and blankets, and growing room. Because some caregivers will likely compensate for the difficulty of strap adjustment by allowing flexibility in the fit of the restraint, some children will not be properly restrained.

An analysis of stroller-restraint incidents reveals that a number of issues must be considered and explored in the effort to improve the effectiveness and safety of stroller restraints. One issue is the reassessment of the defining features of the product, particularly the delineation of 150 degrees as the dividing line between strollers and convertible carriage/strollers. It may be that this demarcation angle needs to be set to a smaller angle.

⁷ IDI 010424HCC3279. This incident is not included in the Preliminary Analysis of Stroller Restraint System Data because it occurred after the report was completed.

RECOMMENDATION

At the October 2001 ASTM subcommittee meeting on strollers, plans were made to establish a task group to examine the hazard of children slipping through leg openings in strollers. The task group will explore options such as labeling and performance provisions. CPSC staff opposes the use of labeling as a primary means of reducing these types of incidents. Labeling is the least effective injury prevention means because it relies on active participation by consumers. Because a child is at risk for serious injury or death resulting from entrapment in leg holes, performance standards should be the primary target for consideration.

CPSC staff suggests that the voluntary standard require that the leg hole openings be automatically blocked when the seat is reclined.

In summary, CPSC staff recommends that the stroller standard be revised to address leg hole openings and the demarcation angle as it defines strollers and carriages.

HAZARD PATTERN: JOGGING STROLLER RESTRAINT FAILURE

Reports indicate that shoulder harnesses on jogging strollers may not adequately restrain children and, thereby, put children at risk of entrapment and fall hazards.

DATA: January 1, 1998 to February 7, 2001: 5 of the 56 incidents in which stroller restraints failed to securely hold children involved jogging strollers.

An additional incident involved an entrapment in the harness straps of a jogging stroller.

PERFORMANCE REQUIREMENTS RELEVANT TO HAZARD PATTERN

There is no voluntary standard that specifically addresses jogging strollers.

DISCUSSION:

Jogging strollers are treated as a separate, distinct product in this report because their intended use and design differ from that of traditional strollers. Jogging strollers are designed to be used on unpaved terrain and at higher speeds than traditional strollers. They are, generally, three-wheeled vehicles as opposed to four-wheeled traditional strollers. While traditional strollers can be used both indoors and outdoors, jogging strollers are generally too large and cumbersome for indoor use. *Jogging strollers generally are provided with a shoulder harness in addition to waist and crotch straps.* Staff could not find age recommendations for jogging strollers but they have observed jogging strollers that recline, which suggests that they are intended for use by infants.

Restraint incidents focus on the inability of shoulder harnesses to adequately secure children. Caregivers state that the shoulder straps are too long and too big and slip off children's shoulders. Some caregivers stated that they had continual problems with ill-fitting restraints throughout the age span of their children.

CPSC staff found that generally the shoulder straps are anchored too high above children's shoulders and can not be adjusted. Like traditional strollers, the crotch straps on jogging strollers are anchored far forward toward the edge of the seat and create "wobble room" for the children.

Following are descriptions of incidents that occurred with jogging stroller restraints. The first comment involves strap entanglement.

- While fastened in a jogging stroller, a 10 ½ -month-old male was able to stand up and turn around. When he did this, the shoulder straps became entangled around his arms and across his neck. He had to be cut out of the restraints. It took three people to free him. Two persons restrained him so he wouldn't strangle himself with the strap that was in front of his neck. He received red marks on his arms and chest. The consumer reported that the shoulder straps were too long even on the tightest setting.
- A 10-month-old female was fastened in a jogging stroller by waist and crotch straps. She leaned over to pick up a toy and nearly slipped out of the straps. Consumer was able to catch daughter before she completely slipped out.
- A 7 ½ -month-old male was fastened in a jogging stroller by waist and crotch straps. He leaned forward and slipped head first out of the stroller and landed on a concrete patio. He received a bump on the head.
- Child continually slipped out of shoulder straps from ages 6 to 19 months. The two shoulder harnesses were attached to a D-ring on the crotch strap.
- A 15-month-old female turned sideways in a jogging stroller and was able to free herself from the shoulder harness. She tumbled out the front of the stroller. No serious injury occurred.
- A 15-month-old female was able to free herself from a shoulder harness in a jogging stroller and was able to put her hand in the spokes of a wheel.
- Child continually slipped out of restraint system of jogging stroller from age 5 months through 19 months. The shoulder straps and waist strap were too big and did not adequately restrain the child.⁸

Ill-fitting shoulder harnesses on jogging strollers present potential entrapment and fall hazards. Jogging stroller restraints require specialized attention because the product is used at higher speeds than traditional strollers and over terrain that is potentially more jarring and jolting to children. Because some jogging strollers now offer a reclining feature, the necessity of a safe and effective restraint system becomes more compelling to avert entanglements and entrapments. Age appropriateness is an issue that should be examined to determine if infants are at risk from the jostling incurred by use on unpredictable terrain.

RECOMMENDATION

CPSC staff believes that jogging strollers are intended for purposes that are inherently different from those of traditional strollers and, therefore, recommends there be a separate standard for jogging strollers that includes performance

⁸ IDI 010104HAA3124. This IDI was not included in the September 2001 report, Preliminary Analysis of Stroller Restraint System Data, because it did not involve a fall or a near-miss.

testing of restraint retention. It is recommended that requirements in the standard take into consideration the recommendations provided in the contractor reports.

Shoulder harnesses may not be the most effective and safest means by which to restrain children. The *Cause of High Chair and Stroller Restraint System Failure* report recommends focusing on the limitation of thigh movements as a way of keeping children securely seated in high chairs and strollers. The report also includes a number of suggestions for design concepts that present innovative ways of restraining children. These design concepts would require research and exploration into their efficacy and safety before they could be implemented.

HAZARD PATTERN: FIVE-POINT HARNESS FAILURES - HIGH CHAIRS AND STROLLERS

Reports indicate that some children have been able to defeat 5-point restraint harnesses consisting of waist, crotch, and shoulder straps.

DATA:

The table below presents details of 4 in-depth investigations (IDIs) in which children were able to get out of 5-point shoulder harnesses. One involves a stroller and 3 involve high chairs. Two incidents occurred with the same brand of high chair. Two designs of shoulder harnesses are represented in the incidents.

Two of the 3 high chair incidents were not reported in the Preliminary Analysis of High Chair Restraint System Data because they were assigned after the report was completed.

PERFORMANCE REQUIREMENTS RELEVANT TO HAZARD PATTERN

The standards do not have specific provisions for the testing of 5-point-harnesses.

DISCUSSION

Many high chairs and strollers now come equipped with 5-point harnesses. Five-point harnesses are generally regarded as providing better retention than waist and crotch straps. However, there are reports that these harnesses also can fail to securely restrain children. Incidents cited below indicate that harness straps can slide off children's shoulders.

Date, IDI & Product	SYNOPSIS OF INCIDENT
January 2000 010101HAA0181 Stroller	An 8-month-old was able to disengage the shoulder straps in his stroller. His mother prevented him from falling out. The mother discovered that using a seat cushion insert would result in the restraining straps being able to hold the child.
November 2000 010515HCC3299 High Chair	A 15-month-old male was able to climb out of a high chair. He was fastened by a 3-point restraint system (crotch/waist straps). The mother caught the victim by his lower torso and broke his fall; however, he still struck his head on the kitchen floor. Mother contacted manufacturer who then sent out a 5-point restraint system (crotch/waist/shoulder straps) for the high chair. According to the mother, the victim was still able to get out of the 5-point restraint system. He is able to do so

	<p>at least once a day.</p> <p>The mother stated that the victim climbs out of the high chair when the shoulder straps slide down the victim's arms. He then turns around and places his hand on the top of the high chair backrest. He then twists and turns and pulls himself out of the waist and crotch straps.</p> <p>At the time of the incident, the victim was about 30" tall and weighed 20#.</p>
<p>November 2000 001130HAA2120</p> <p>High Chair</p>	<p>An 11-month-old female was fastened in a high chair with a 5-point restraint system. She was able to stand up in the chair and nearly fell over the front tray of the high chair. Her mother grabbed her before she fell and no injuries occurred. The complainant says the restraint system cannot be tightened enough to prevent the shoulder straps from falling off her daughter's shoulders.</p> <p>When the victim was seated in the high chair, the 5-point restraint system was adjusted as snug as possible and the tray was adjusted all the way in, but the shoulder straps had fallen off her shoulders and allowed the victim to stand up. The complainant thinks the shoulder harness adjustment bar (bar that has both shoulder straps running through it) should be in the front.</p>
<p>February 2001 010814HCC3401</p> <p>High Chair</p>	<p>Consumer reported that the shoulder straps on a 5-point harness cannot be adequately fastened to prevent them from falling off the child's shoulders. Complainant reported that while his daughter was sitting in the chair, the shoulder straps fell off her shoulders and this allowed her to move up. The complainant stated his daughter started to climb up, got one leg up and then the other, and then stood on the seat of the high chair. The complainant was approximately one foot away and watched as the child stood up. He has witnessed his daughter do this on several other occasions.</p> <p>At the time of the first incident, the child was about 3' tall and weighed about 28#. She was 17 months old at the time of the incident.</p>

In focus groups conducted by the contractor, respondents expressed mixed feelings about the desirability of 5-point restraint systems. Some respondents stated they did not use the harnesses that were provided because there were too many straps to contend with, the harness was too restrictive, or the child did not like the harness. Others were in favor of the harnesses.

According to the *Causes of High Chair and Stroller Restrain System Failure* report, "shoulder straps are unlikely to provide reliable deterrence to deliberate

escape from the restraint system because children can free their shoulders by wiggling or pushing them out of the way with their hands. When they are used in conjunction with other design aspects (e.g., inclined seat pan and/or seat back, seat back wings) they may be somewhat more effective, but are still of questionable utility. The inherent problem is in the mobile torso of children. Potentially more effective shoulder restraints that use lateral or diagonal straps prevent such movements, but such configuration may also present entrapment hazards. However, shoulder straps may serve an effective function in preventing forward pitch or excessive lean. Five-point restraint designs that anchor the rear of the shoulder straps to the waist belt or to a tether do not greatly restrict upper torso movement."

CPSC staff has reservations about certain designs of harness-type restraints because they may present a potential entrapment hazard. The Division of Health Sciences staff believes that shoulder harnesses have the potential to strangle if pressure is applied to the sides of the neck in amounts sufficient to occlude blood flow.

CPSC recalled an infant seat pad in July 2001 because its two shoulder straps created a v-shaped opening around the head and neck, presenting a strangulation hazard to young children. CPSC received two complaints of children getting their necks caught in the v-shaped opening when the restraint latch became undone.⁹ The type of restraint involved in the incidents was a 3-point harness that consisted of a crotch and shoulder strap. The restraint did not include a waist strap. Although a 5-point harness was not involved, the incidents are presented here to illustrate the potential problems inherent in certain designs of shoulder straps.

Such a potential problem is related in IDI 001130HAA2120 cited in the above table. The complainant thought that the shoulder harness "adjustment bar", through which the shoulder straps are threaded and adjusted, should be placed in front of the child, on the chest, rather than on the back of the child. Configuring the harness with the "bar" on the front forms a "v"- shape that presents a potential entrapment hazard. It is foreseeable that the complainant believed the "adjustment bar" should be placed in front because it resembles the front clip used on chest straps in some car seats.

RECOMMENDATIONS

While CPSC staff does not have specific recommendations for the voluntary standards at this time regarding 5-point-harnesses, the incident reports involving high chairs and strollers indicate that some 5-point harness designs may pose a strangulation hazard and may not necessarily provide improved occupant retention. A few of the issues that need to be taken into account in the design of 5-point-harnesses are location of anchorage points, types of fasteners, adjustability, overall fit, slippage of straps, and the configuration of straps.

⁹ IDI 010117CNN0252 and IDI 010918HCC3435

The CPSC encourages innovation in restraint technology. There may be alternatives to 5-point-restraints. For instance, The *Cause of High Chair and Stroller Restraint System Failure* report recommends focusing on the limitation of thigh movements as a way of keeping children securely seated in high chairs and strollers. The report also includes a number of suggestions for design concepts that present innovative ways of restraining children. These design concepts would require research and exploration into their efficacy and safety before they could be implemented.

HAZARD PATTERN: HIGH CHAIR PASSIVE CROTCH RESTRAINT FAILURE

The current voluntary standard may not adequately address the hazard of slipping through leg hole openings in high chairs.

DATA: 1 death in a conforming high chair since standard was revised in 1999

A 9-month-old female died due to traumatic asphyxia in a high chair after she was left unattended. The mother placed the victim in a high chair and did not use the restraint belt. The high chair was equipped with a passive crotch restraint. The child slid down in the high chair through one of the leg holes. Her chin caught on the tray and compressed her neck. She died of positional asphyxia.

PERFORMANCE REQUIREMENTS RELEVANT TO HAZARD PATTERN

ASTM F 404-99a, Standard Consumer Safety Specification for High Chairs

(Section 6.9.1.1) High chairs must be designed so that the tray cannot be attached without a passive crotch restraint in place.

(Section 6.9.1.1) Passive crotch restraints must comply with one of the two following sections, but does not have to comply with both.

(Section 6.9.1.1 (2)) The distance between the seat back and passive crotch restraint is to be less than 8.5 inches or else the leg openings must not permit the passage of a test probe.

(Section 6.9.1.1(3)) Occupant retention test for passive restraint does not allow passage of a probe through the leg openings on either side of passive crotch restraint.

DISCUSSION

While CPSC staff recognizes that the active restraint was not used in the incident that resulted in the death of the 9-month-old child that is cited above, the passive crotch restraint was implemented to safeguard against instances in which the active restraint failed or was not used.

The intent of Section 6.9 of the standard is to provide a means to prevent children from slipping down (submarining) in a high chair and becoming entrapped by the tray or restraint straps. The standard requires that this be done

in one of two ways. Either a passive crotch restraint can be used as a barrier to keep children from placing both legs through a leg hole (and to keep them from sliding down in the seat) or leg holes can be sized to prevent passage of a child's body. If a passive crotch restraint is used, the standard states that the distance between it and the seat back must be less than 8.5 inches when the tray is positioned as close to the seat back as adjustments permit. The high chair involved in the submarining death of the 9-month-old child met the 8.5-inch criterion.

The *High Chair and Stroller Restraint System Failure* report states that the 8.5-inch dimension makes it easy "for children at the lower end of the at-risk age range to pull legs and feet into the seat area." The report recommends that the dimension should be modified to 5 inches to decrease the amount of maneuvering room in the seating compartment. Adjustability features may have to be provided to accommodate larger users.

The report also states that the standard should not offer optional means for retention but should require that both the provision for passive crotch restraints and the provision on size limitation for leg holes be met.

The report recommends an additional requirement to limit seat dimensions. "Such a section should not only deal with the basic width and depth of the seat, but the effective size as a function of the passive restraint position."

RECOMMENDATIONS

The death of a child in a high chair that conforms to the passive crotch restraint requirement intended to prevent such incidents is cause for concern. CPSC staff believes that the passive restraint requirement does not adequately address the submarining and entrapment hazards. The 8.5-inch dimension affords some children enough room to draw the knees and legs into the seating compartment. Children can then move their legs up and over the crotch restraint and either stand up or, in some cases put both legs through one leg hole.

CPSC staff agrees with the contractor recommendations to decrease the 8.5-inch dimension to 5 inches and to require that high chairs meet both this distance and the leg hole-opening requirement.

The ASTM subcommittee on high chairs, F15.16, has been notified of this incident.¹⁰ CPSC staff recommended that the subcommittee consider revisions to the standard to address this incident.

¹⁰ February 15, 2001 Letter from Mark Kumagai, P.E., Division of Mechanical Engineering, U.S. Consumer Product Safety Commission, to Mr. Arthur Kazianis, Chairman, ASTM Subcommittee on High Chairs, F15.16

ADDITIONAL ISSUES FOR CONSIDERATION

- Standards should require that restraint straps anchor onto a rigid surface. Some restraint straps tie into non-rigid surfaces, such as seat cushions, that can allow the child, restraint system, and anchoring surface to move forward because there is too much give in the seat backs.
- The products should allow detachment of restraint straps for cleaning. Otherwise, inability to clean the straps may lead to permanent removal because of sanitary or aesthetic reasons. There should be only one way to attach straps to avoid error when reattaching.
- The effects of speed and terrain should be addressed in restraints designed for strollers, both traditional and jogging. Children may be pitched forward during unexpected stops.
- Restraint systems should account for a tipping potential when strollers are navigated over curbs and changes in terrain.
- Restraint devices should not pinch the skin or compromise the blood supply. Straps should not be constructed or adjusted to fit in such a manner as to compress the skin.
- Straps should be wide and comfortable. In the event of an incident, a narrow strap has the potential to do more damage than a wider strap, which can distribute the force over a wider area.
- So as not to injure the child, restraint systems should not require the adult to have to press against the child's body to secure the child in the restraint.
- One alternative for adapting the size of the seating compartment for a wide range of users is to use inflatable devices to customize seats. If these type of devices are used they must not present a suffocation hazard.
- Metal parts that could interface with a child's bare skin should be avoided. Metal parts that are exposed to the sun can become very hot and burn underlying skin.

SUMMARY and CONCLUSIONS

Restraint systems must be thought of in a wider context than waist, crotch, and shoulder straps. They encompass all features of juvenile products that directly or indirectly contribute to the capability of effectively securing children within the product. Any aspect of the restraint system may affect, either positively or negatively, the way other parts of the system function. It is this vision of a system that makes designing efficient and safe restraints a challenging task.

Many of the recommendations in this report are not intended for immediate implementation or universal application. A more thorough development and evaluation of the potential countermeasures are required before they can be recommended for adoption. An evaluation of countermeasures should include the issues of usability and consumer acceptance that are not addressed in the contractor reports.

The CPSC staff's data analyses, the contractor's reports, and this report provide the basis for a dialog on restraint requirements and set a direction for the development of more effective voluntary standard requirements for restraints on juvenile products.