United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: January 7, 1997

TO : The Commission
Sadye E. Dunn, Secretary

Through: Eric A. Rubel, General Counsel
Pamela Gilbert, Executive Director

FROM : Ronald L. Medford, Assistant Executive Director
Office of Hazard Identification and Reduction
Elizabeth W. Leland, Economist
Directorate for Economic Analysis

SUBJECT: Economic Analysis Estimates Related to Petition HP 95-1

This memorandum provides information about the estimates developed by the Directorate for Economic Analysis (EC) for use in consideration of Consumer Product Safety Commission (CPSC) Petition HP95-1; these estimates were provided in the staff briefing package to the Commission dated December 18, 1996. The estimates were the subject of a December 29, 1996, letter from Drs. Pasternack and Veenema of the University of Rochester, who wrote in response to the briefing package (Attachment A).

1. Cost Estimates

In their letter, Drs. Pasternack and Veenema noted that "The assumption ... that 40% of medically treated children go to an emergency room may be reasonable, but certainly most or nearly all of the seriously injured do go to an ER (emergency room). In other words, 60% of the 9,670 injuries in Ms. Leland's analysis are minor and cost no where near the $3700 that is assumed." Their letter suggests that "it would be more reasonable to estimate the cost of treatment at $15 million rather than $35.8 million."

The CPSC Directorate for Epidemiology and Health Sciences (EH) estimates that about 1.6 percent of the facial injuries to batters are severe enough to require hospitalization. With respect to severity of non-hospitalized injuries, CPSC staff believes that the injuries treated in emergency rooms are similar in severity to those treated in doctor's offices, walk-in clinics, and other medical settings. The medical cost estimates used by CPSC staff represent an average of treatment costs by emergency rooms and other treatment centers. Therefore, the average cost used by the staff in its analysis may be lower than emergency room costs and higher than costs of treatment in other

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Products identified

settings, but represents a reasonable mix of a variety of treatment settings.

Medical costs, however, are only a fraction of the $35.8 million societal cost estimate cited in the EC analysis. In developing its cost estimates for the various projects under its consideration, the EC uses a model, known as the CPSC Injury Cost Model, to estimate the total or societal cost of an injury. The model is structured to measure eleven different types of costs separately, one component at a time, and then to add them together to establish the total cost of an injury. The eleven components include medical costs as well as other costs, such as pain and suffering caused by the injury. The injury costs are calculated in the model by integrating injury frequency statistics from the CPSC National Electronic Injury Surveillance System (NEISS) with the estimates of the average costs for each type of injury and body part injured, given the age and sex of the victim.

Thus, in the analysis of injuries to batters under the age of 14 years, EC staff used the Injury Cost Model along with information about diagnosis of body part injured and age and sex of the victim. The average injury cost of $3,700 includes all costs related to the injury, not only medical costs of treatment.

Thus, CPSC staff believes that the average injury cost of $3,700 is reasonable.

2. Estimates of Number of Injuries

Drs. Pasternack and Veenema noted that CPSC EC staff estimated that 9,670 medically-attended injuries resulted from ball impact to the face of batters during organized play on youth baseball teams. Their letter described a survey which they conducted in the Rochester, New York area and from which they were able to calculate rates of injury. They noted: "If we extrapolate our injury rates to 5.8 million children playing for one year, we get an estimate of 4,055 injuries to batter/baserunners. This is much less that the estimated 9,670 and in fact approximates 40% of that number."

One reason for the different estimates may be the specific samples used for developing the estimates. From the September 1996 article in *Pediatrics* which described the Pasternack, Veenema, and Callahan survey (Attachment B), CPSC staff understands that their sample consisted of two local Little League Baseball organizations in suburban Rochester, New York. When combined, over 2,800 participants, ages 7 to 18, were included. There is no indication from the article that the sample used for their study was a probability sample.

The estimates made by CPSC staff were based on the probability sample of the NEISS system. As noted in the May 31, 1996, CPSC "Youth Baseball Protective Equipment Final Report", hospitals in the United States and its territories having emergency departments (about 6000) provide the sampling frame for NEISS. These hospitals are stratified by hospital size into four strata. From these strata, 91 sample hospitals, including two children's hospitals, participated in the NEISS system in 1995. Thus, CPSC staff believe that its estimate is representative of the numbers of facial injuries occurring to batters.

3. Product Life of Helmets

Drs. Pasternack and Veenema stated in their letter that "A minor point is that we seriously doubt that the helmets last 10 years, probably 5 years is closer to reality." CPSC staff relied on discussions with helmet manufacturers and baseball league representatives, which we believe is the only information available, for its 10-year estimate. CPSC staff agrees that estimated product life is a minor point for this particular analysis and, unless "hard" data become available, believes that a 10-year estimate is not inappropriate.

ATTACHMENT A

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December 29, 1996

Susan B. Kyle, Ph.D.
Directorate for Epidemiology and Health Sciences
Consumer Product Safety Commission
Washington, D.C. 20207

Re: Petition HP 95-1 on face guards for children's batting helmets

Dear Dr. Kyle:

Thank you very much for sending us the copy of the briefing package on the youth batting helmet petition. It is very helpful for us to see some of the information that is available to you.

Although cost is not really the paramount issue here, we need to point out what appears to be a serious overestimate of the value of the face guards in the economic estimate by the economist Elizabeth Leland. The assumption in foot note 1 on page 93, that 40% of medically treated children go to an emergency room may be reasonable, but certainly most or nearly all of the seriously injured do go to an ER. In other words, 60% of the 9,670 injuries in Ms. Leland's analysis are minor and cost no where near the $3700 that is assumed. Referring to paragraph 1 on page 94, it would be more reasonable to estimate the cost of treatment at $15 million rather than $35.8 million.

Coincidentally, in our survey 15.3 % of the player hours involved players wearing a face guard which corresponds to the estimate of 16 % nationally in Ms. Leland's analysis. If we extrapolate our injury rates to 5.8 million children playing for one year, we get an estimate of 4,055 injuries to batter/baserunners. This is much less than the estimated 9,670 and in fact approximates 40 % of that number.

A minor point is that we seriously doubt that the helmets last 10 years, probably 5 years is closer to reality.

The core issue here is whether or not it is true that a high percentage of the rare severe facial injuries occur to batter/basrunners. Clearly, the statement from the American Academy of Pediatric Dentistry and from Dr. Castaldi and Dr. Cipes that most facial injuries occur to batters is inconsistent with the data from our study and from the CPSC study.

Very truly yours,

Joel Pasternack

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Baseball Injuries: A Little League Survey

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ABSTRACT. *Objectives.* To determine the patterns of injury in youth baseball and apply the data to estimate the value of proposed safety equipment.

Design. Prospective population-based injury survey.

Participants. 2861 Little League baseball players (ages 7 to 18) for 140 932 player-hours.

Measurements. An injury was included in the data only if it was serious enough to require medical/dental care, caused missing a game, or disallowed playing a certain position. The injuries were subdivided into acute or overuse. The acute injuries were classified as either catastrophic, severe, or minor. Injuries were categorized according to mechanism, area injured, and whether the player was on offense or defense.

Results. There were 81 total injuries, of which 66 (81%) were acute and 15 (19%) were overuse. Of the acute injuries, 11 were severe and 55 were minor. The overall injury rate was .057 injuries per 100 player-hours. The severe injury rate was .008 injuries per 100 player-hours, of which 46% were ball-related injuries and 27% were collisions. The most frequent mechanism of injury was being hit by the ball, which represented 62% of the acute injuries. Of the 41 ball-related injuries, 28 (68%) occurred to players on defense. Of the 18 ball-related facial injuries, 16 occurred to players on defense.

Conclusions. 1) Little League baseball is a safe activity with a low injury rate and a particularly low rate of severe injury;

2) impact by the ball causes more than half the acute injuries, thus safety interventions should be directed towards decreasing these injuries, especially on defense; and

3) facemasks on batters can safely eliminate facial injuries to offensive players, but would only moderately reduce the incidence of ball-related facial injuries as most of these injuries are sustained by defensive players. *Pediatrics* 1996;98:445–448; *baseball (in injuries), child, adolescence.*

ABBREVIATIONS. CPSC, Consumer Product Safety Commission; AAP, American Academy of Pediatrics; RIF, reduced injury factor.

Baseball continues to be one of the most popular sports in the United States. Injuries in organized youth baseball occur at a small, but not insignificant rate, and have been the subject of inquiry by several groups including the Consumer Product Safety Commission (CPSC),[1–3] the American Academy of Pediatrics (AAP),[4] and Little League Baseball, Inc.[5] Previous studies generally indicate that 2% to 8% of players are injured per season in organized youth baseball,[4] with most of the injuries being minor. The CPSC reported 164 800 baseball-related injuries during 1993 to children ages 5 to 14. Of these injuries 76 000 (46%) were head or facial injuries.[3]

National organizations, including the AAP, the American Dental Association, and the Society to Prevent Blindness, have made safety equipment recommendations designed to reduce injuries. Some of these recommendations are not generally accepted by organized youth baseball, in particular, the use of face protection for batters and the use of a reduced impact baseball (*Wall Street Journal*, May 24, 1994:B2).

We present data from an injury survey of two Little League baseball organizations involving over 2800 players for the 1994 season with the goal of identifying interventions likely to be effective in reducing injuries. Special focus was placed on injuries of the head and face in an effort to identify injury patterns and the potential value of proposed safety equipment. Unlike previous studies that obtained injury data from medical insurance reports or hospital emergency department visits, we obtained data by direct interview of the managers of virtually all teams in the organizations studied for an entire season.

MATERIALS AND METHODS

The setting for our study was two local Little League Baseball organizations in suburban Rochester, New York. The leagues were of comparable size and, combined, included over 2800 participants, ages 7 to 18. Both leagues had a softball program that was for girls only. Although the hardball programs were co-ed, there were no girls over age 12 participating.

In one league, the hardball players ages 9 to 12 were required, while at bat or running bases, to wear a batting helmet equipped with a wire mesh face guard (see Fig 1). All other players in both leagues, when at bat or on base, wore a standard batting helmet with double earflaps without a face guard (see Fig. 2.) Further, in one league, the 8-year-old group played with a reduced impact baseball manufactured by Worth, Inc called RIF #5.

At the beginning of the 1994 baseball season, an injury reporting survey form was given to the manager of each team. The survey form requested demographic and injury information. The demographic information included: type of ball (hardball, softball, or RIF), number of players on team, age range, number of games in season, number of hours of practices per week, and whether or not there were face masks on the batter's helmet. The managers were asked to report all injuries that satisfied any of the following criteria:

1) required missing a game;
2) required evaluation by a physician or dentist; or
3) caused an inability to play a certain position (ie, throwing injury: no pitching)

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TABLE 2. Injury Counts by Body Area Injured

Body Area Injured	Severe	Minor	Total
Hip/pelvis	0	1	1
Knee	2	7	9
Ankle/foot	1	5	6
Leg, not near joint	1	2	3
Shoulder	1	1	2
Elbow	0	3	3
Wrist/forearm	0	5	5
Hand/finger	3	11	14
Back	0	1	1
Head	0	3	3
Neck	0	0	0
Facial (dental)	2	2	4
Facial (not dental)	1	13	14
Chest	0	1	1

(68%) occurred to players on defense, 11 (27%) to players on offense, and 2 (5%) to players sitting on the bench.

Focusing on head and facial injuries, we found that 18 of 21 (86%) were caused by the impact of the ball. Of the 18 head and facial injuries caused by the ball, 2 were severe injuries (1 offense/1 defense), and 16 were minor injuries (1 offense/15 defense). A significantly greater number of ball-related facial injuries occurred on defense than on offense (16 versus 2; $P = .0013$). Defensive injuries occurred most frequently in the infield: 9 infield, 2 outfield, and 5 warm-ups ($P = .0654$).

There were 21 486 player-hours in the 9- to 12-year-old hardball group where the batting helmet with face mask was required. There were 4 ball-related facial injuries in this group, all of which occurred on defense. There were no reported problems with compliance in using face masks, and there were no injuries attributable to face masks. There were 39 522 player-hours in the 9- to 12-year-old hardball where the helmet did not have a face mask. This group had 3 ball-related facial injuries (2 on defense and 1 on offense).

With regard to the reduced impact ball, there were 6855 player-hours by 8-year-olds playing with the reduced impact ball. There was only 1 ball-related-injury in this group, a minor thumb contusion. In the remaining group of 7- and 8-year-olds playing with a regular baseball, there were 15 779 player-hours and 2 ball-related injuries including a subluxed tooth and a fractured thumb.

DISCUSSION

Injuries in organized baseball are classified as catastrophic, severe, and minor. By all accounts the minor injuries predominate, with rare severe injuries and very rare catastrophic injury.[1-4]

In our survey we identified no catastrophic injuries. From 1983 to 1993, the CPSC reported 35 deaths from playing baseball for children ages 5 to 14.[3] The deaths were mostly from the impact of the ball either to the head or the chest. During 1983 there were an estimated 11 500 000 to 13 600 000 children playing organized baseball.[1] Thus, the occurrence of a fatality is very rare, on average, less than 1 per year for every 3 000 000 participants. This study is unlikely to shed any light on the incidence of fatalities.

TABLE 3. Summary for Mechanism of Injury

Mechanism	Injury Count	Percent
Running	13	19.7
Collision	8	12.1
Ball	41	62.1
Bat	3	4.5
Other	1	1.5

In our survey we identified a predominance of minor injuries and infrequent severe injuries. Our occurrence rate of 2.3 injuries per 100 players per season is on the low end of previously reported series.[2] Similar to our study, the CPSC found that impact of the ball was the most frequent mechanism of injury. They estimated that 45% of injuries resulted from being hit by the ball. This compares with 62% of the acute injuries in our series. Focusing our attention on head and facial injuries we noted that 86% were ball-related. Therefore, it seems logical that interventions and protective equipment should be directed towards reducing the incidence of ball-related trauma especially to the head and face.

With this theme in mind, the AAP has recently reviewed the risk of injury to children 5 to 14 years of age in organized baseball and has made injury prevention recommendations.[4] Furthermore, the American Dental Association supports mandatory use of oral/facial protection in youth sports,[6] and, the National Society to Prevent Blindness specifically recommends the use of face masks on batting helmets.[8,10]

There is a mixed reaction from coaches and parents to the mandatory use of the face mask or eye protection for batters. In the leagues we surveyed, some adults voiced the concern that the face mask might restrict vision, making it more likely that a batter would be hit by a pitch or otherwise be hurt while running. Also, as pointed out by the CPSC[13] there is a theoretical risk that head and face protection can place more stress on the neck.

Our data is helpful in understanding the overall patterns of injury and the effect of possible rule and equipment changes that have been suggested. We noted the following:

1) The majority of head and facial injuries caused by the ball occurred on defense, and thus would not be prevented by the face mask on the batting helmet.
2) No injury was identified as being caused by the face mask on the helmet. If injury attributable to the face mask occurred more frequently than .013 per 100 player-hours we had greater than 95% probability of observing an injury.
3) All facial injuries that occurred on offense would have been prevented by the batting helmet with face mask, but not by a helmet with only eye guards.

To estimate the reduction in facial injuries that could be expected if face masks were mandated on the batting helmets, we note that in the pool of participants playing without face masks 2 of 14 facial injuries were on offense. Thus, 14% of the injuries

Fig 1. Batting helmet with earflaps and wire facemask.

Fig 2. Batting helmet with earflaps but no facemask.

For each injury, the managers reported the player's name, age, how long the player was out of action, a description of how the injury occurred, what was injured, and the treatment.

At the end of the season, each manager was called by one of the authors and a report of the injury survey data was taken on the telephone. If additional injury information was needed, one of the authors directly contacted the parent or the physician of the injured child.

Injuries were categorized as acute injuries or overuse syndromes. The acute injuries were classified as either:

a. catastrophic—death, permanent central nervous system dysfunction, loss of vision, loss of limb;
b. severe—more than 1 month lost time or permanent disability; or
c. minor—less than 1 month lost time and no permanent disability.

Further, the acute injuries were categorized by mechanism of injury, and by body area injured. The following mechanisms were considered: sliding, running not sliding, collisions, ball injuries, and bat injuries. The ball injuries were further subdivided into injuries on offense (occurred to a batter or a base runner) and injuries on defense (occurred to infielders, outfielders, or players warming up). Injury rates were calculated[9] as injuries per 100 player-hours as follows:

1 player-hour = 1 hour of practice or game by 1 participant
injury rate per 100 player-hours = (number of injuries/total player-hours)* 100

We assumed that a game took 2.5 hours and that 90% of players were in attendance at games and 75% were in attendance at practices. This assumption was based on information derived by the manager interviews and by direct author observation.

The data was analyzed for statistical significance using a multinominal model for injury counts. The *P* values for statistical significance were calculated by summing all the one-sided exact binomial *P* values, and multiplying by the number of multinominal categories to correct for selection of the hypothesis posthoc, based on the data.

RESULTS

We received injury information from 226 of 230 managers (98%) representing 2861 players, participating for 140 932 player-hours. There were 105 286 player-hours of hardball, and 35 646 player-hours of softball.

There were no catastrophic injuries. There were 66 acute injuries (50 hardball, 16 softball) and 15 overuse injuries (11 hardball, 4 softball). Of the 66 acute injuries, 11 (8 hardball, 3 softball) were classified as severe. These severe injuries included a tear of the medial meniscus of a knee, two injuries to permanent teeth, and eight fractures. The fractures classified as severe were of the femur, tibia, ankle, clavicle, thumb metacarpal, thumb proximal phalanx, index finger, and nose. The minor injuries included 27 contusions, 12 sprains, 4 fractures, 4 lacerations, 3 dental injuries, 2 closed head injuries, 2 abrasions, and 1 muscle strain.

Over the course of one season, 2.3% of the players sustained an acute injury. The acute injury rate was .057 injuries per 100 player-hours, and the severe injury rate was .008 injuries per 100 player-hours.

The acute injuries were categorized by mechanism of injury (Table 1) and by body area injured (Table 2). The data in Table 3 illustrates that ball-related injuries occurred more frequently than any other mechanism ($P = .0004$). Of the 41 ball-related injuries, 28

TABLE 1. Injury Counts by Mechanism of Injury

Mechanism of Injury	Severe	Minor	Total
Running-sliding	1	5	6
Running nonsliding	1	6	7
Collision-player	3	3	6
Collision-object	1	1	2
Ball-offense	1	10	11
Ball-defense	4	24	28
Ball-other	0	2	2
Bat-thrown	0	0	0
Bat-not thrown	0	3	3
Other	0	1	1

could have been prevented. It follows that the mandatory use of face masks on batting helmets would not have prevented 86% of the facial injuries caused by the ball. Nelson et al[7] reported on 26 eye injuries from baseball seen at an urban eye emergency department in 1 year. The player population base was not reported, so we cannot infer any incidence. However, they do report that 37% of these eye injuries occurred while at bat. Thus, perhaps as many as 63% of eye injuries would not be prevented by face masks on the batting helmet. On the other hand, in a prior study at the same hospital, Grin[8] reported on eye injuries serious enough to require admission to the hospital. In a 3-year period, there were 10 baseball injuries requiring hospital admission, 7 of which occurred to children who were at bat. Thus, it is possible that the facial injuries occurring on offense may represent a disproportionate number of the severe, and even catastrophic, injuries.

Regarding the reduced impact baseball, we look forward to gathering more data so that we can estimate what effect these balls will have on injury rates. However, our data shows that 62% of all injuries and 85% of facial injuries are caused by the ball. Therefore, if an acceptable reduced impact ball were developed, it could potentially significantly reduce the rates of injury in youth baseball. At this point, however, these reduced impact balls have not been shown to reduce catastrophic or serious injuries.

Finally, this study is a more accurate representation of injury incidence and severity in Little League baseball because of the way the data were obtained. We collected our injury data in a manner different from the CPSC[1-3] and from the method used by Hale.[5] Hale used physician reports to the accident insurance company. The CPSC uses surveillance of emergency department visits to identify injuries and uses national data such as from the Sporting Goods Manufacturers Association to estimate players at risk. We obtained injury information on every child playing in the local leagues. We reported our data as injuries per 100 player-hours, and thus our data can be compared with other leagues with different numbers of players and lengths of season. Further, we identified more injuries, as some injuries were treated by pediatricians in their offices rather than in emergency departments. It is reasonable to assume that many of the additional injuries we identified were minor.

In summary, we conclude that:

1. Little League baseball is a generally safe activity with a low injury rate;
2. The most common mechanism of injury is impact by the ball, accounting for over 60% of the injuries in this series. The majority of these injuries occur on defense (68%);
3. Face masks on batters can reduce or eliminate facial injuries to offensive players, but would only moderately reduce the incidence of ball-related facial injuries as most of these injuries are sustained by defensive players; and
4. Further surveillance is indicated as the severe injury rate is quite low and thus a larger number of player-hours is required to produce a large sample of severe injuries. For example, it is possible that a disproportionate number of severe facial injuries occur to offensive players even though most facial injuries occur to defensive players.

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