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

660.L 1/19/01

MEMORANDUM

DATE: 8/15/00

TO : ES

Through: Sadye E. Dunn, Secretary, OS

FROM : Martha A. Kosh, OS

SUBJECT: Petition CP00-1, Petition Requesting Performance Requirements for Non-Wood Baseball Bats

ATTACHED ARE COMMENTS ON THE CC 00-1

COMMENT	DATE	SIGNED BY	AFFILIATION
CC00-1-1	6/06/00	Janiece Landry	3424 Vine Chickasha, OH 73018
CC00-1-2	8/02/00	Jess Heald Chairman of the Board	Worth, Inc. P.O. Box 88104 Tullahoma, TN 37388
CC00-1-3	8/03/00	Stephen Keener President & CEO	Little League Baseball Incorporated P.O. Box 3485 Williamsport, PA 17701
CC00-1-4	8/07/00	Cedric Dempsey President	The National Collegiate Athletic Association P.O. Box 6222 Indianapolis, IN 46206
CC00-1-5	8/10/00	M.W. Archer,Jr President Louisville Slugger Division	Hillerich & Bradsby Co., Incorporated 800 West Main St. P.O. Box 35700 Louisville, KY 40232
CC00-1-6	8/13/00	Sophie Llorens	sophie123@yahoo.com

Petition CP00-1, Petition Requesting Performance Requirements for Non-Wood Baseball Bats

CC00-1-7	8/14/00	Howard Iwrey Atty for Easton Sports, Inc.	Honigman Miller Schwartz And Cohn 2290 First National Bldg Detroit,MI 48226
CC00-1-8	8/15/00	Rafael Cortada Alejandra Escalona Jeanette Piotrowski Janet Pujol Vanessa Ruiz	
CC00-1-9	5/11/00	Bill Thurston NCA Baseball Rules Editor	Amherst College Dept. of Physical Education and Athletics Campus Box 2230 P.O. Box 5000 Amherst, MA 01002

LATE COMMENTS

CC00-1-10	10/03/00	Peter Visclosky Member of Congress	House of Representatives Washington, DC 20515
CC00-1-11	10/23/00	Bill Thurston Former NCAA Baseball Rules Editor	Amherst College Dept. of Physical Education & Athletics Campus Box 2230 P.O. Box 5000 Amherst, MA 01002
CC00-1-12	11/28/00	Bill Thurston Former NCAA Baseball Rules Editor	Address same as above

non wood Baseball bats

EHD C006001
6/6/00

1

Dear Mrs Brown,

I understand that Jack MacKay has a petition before you concerning the dangers and misinformation regarding the use of non-wood bats. I became aware of this after a serious baseball accident involving my 14 year old son, Josh. Many times I have sat down to put my feelings on paper simply trying to express the events of that horrible day and the days to follow. I'm not sure words can convey to you what I felt then and what I am feeling now so I have enclosed some pictures so that you could at least get a picture of the degree of pain and suffering I am trying to describe. I too would like to petition you and ask that you hear my story with the ears and heart of a mother.

On April 12 of this year Josh was hit in the head with a baseball while at a school organized practice. He wasn't ~~just~~ hit, but was hit in the head with such force that the impact of the ball caused a near fatal blow. During batting practice Josh pitched the ball and before he realized what had happened he was on the ground surrounded by people asking him who he was and where he was. As I entered the complex where practice was being held I saw a sight I wouldn't wish on my worst enemy. He was so helpless. The ball had hit him in his temple breaking his temporal artery, fracturing his skull which resulted in an epidural hematoma. He was rushed by ambulance to the emergency room of our local hospital only to find he would have to be transferred to another hospital 45 minutes away; to one that was capable of handling such an injury. That was the longest 45 minutes of my life. He was examined immediately by neurosurgeons and rushed into surgery where by the absolute grace of God his life was spared. Even though that day has passed, the memories of that day will never pass. Josh tells me so frequently that he will never look at life the same again. nor will I. As I sit and think about the events of that day I am horrified at what I saw, but even more about what I now know.

Just 3 weeks before this accident another identical situation took place, only the boy was not hospitalized but was knocked unconscious and still continues to seek medical attention. On each occasion both boys had pitched the ball, said it came off the bat so fast they never saw it coming at them. It was described by both boys as a "rocket". As I sit here tonight telling my own story a phone call informing me of yet another incident - only this time "death". I am sickened and in shock as to "what is going on"? I feel helpless that I cannot get my plea to you fast enough. I have played sports all my life and have never been around injuries of this magnitude and severity. I am reminded of an article published on the exact day of my sons accident involving a pitcher being struck by a ball being projected off an aluminum bat. Oh the heartache when I think about the seriousness of his injury and the familiarity of his story. Enclosed you will find a copy of this article along with any others I have obtained. Again I repeat "WHAT IS GOING ON"? These accidents that have been labeled as "Freak accidents" have become far too numerous to now be labeled "Freak".

After just a small amount of research and a few phone calls I am absolutely compelled to plead that you please give immediate attention to this petition explaining the hidden and deceitful dangers of these bats. I am truly disturbed that as a mother I took my children to purchase these lethal weapons without knowing or being informed of the danger I was placing my child in as well as those around him. A great concern of mine is the way these manufacturers lure consumers to buy these bats without any regard for injury or loss of life. The manufacturers know and have known for many years that these bats were capable of such injury yet they are willing to risk the lives and futures of our children all for their own gain and greed.

How tragic that the only way to become informed of these dangers is to be a victim of their "performance." I mean aren't they only doing what they were designed to do? I understand that with any sport there is a reasonable amount of danger to be assumed, but there is nothing reasonable about any of this.

I am not bitter at what has happened to my son only brokenhearted that I was so ignorant of such a danger. Had I known then what I know now he would not be near one of these bats without a helmet. There is a chance that Josh won't get to continue in some contact sports he loves so much. In turn, we as a family may have been robbed of the joy of watching our son play. Please do not misunderstand... We are truly grateful beyond measure that Josh is alive and overcoming his circumstances, but at the same time I am horrified at the thought his life could have been taken all in the name of "Super Performance." I can tell you that not only has Josh had to adjust, but seeing the guilt on the faces of the ones that hit the ball has been just as hard for me to bear. I have not only had to comfort my own son but anothers son and anothers mother. The mental anguish these poor children have had to face, feeling responsible for the injury "they" thought "they" inflicted is beyond heartbreaking. The industry knew all along that these injuries could happen and would happen if the bat performed as it had been designed to do, yet did not and will not do anything to prevent it. I address my greatest concern to you in the form of a question. What is the number of bats that must be sold to replace the life of one child, or to ease the heartache of one life destroyed or comfort the pain of one parents' loss? Can we really put a price tag on dreams fulfilled or life itself?

Again, I say that I am not bitter but only heartbroken and ripped in two at what has been taken from Josh and what he has had to deal with at such an early age. I will not allow myself to use all my energy on revenge but on a plea for your help in the matter of considering this petition. I ask you from my heart that we remove or reduce the risk of injury that these high performance bats are inflicting. I know that the primary concerns of the US CPSC are to protect the public against unreasonable risk of injury associated with consumer products, and to develop safety standards for these products. I trust that is your primary concern as well. I plead for your consideration to recall those bats and make the game of baseball, just that, once again an enjoyable and safe game.

Thank you so much for allowing me to share my heart with you concerning a matter that has now become so important to me. I thank you for your patience and for taking time out of your Schedule to hear my plea.

Sincerely,
Janice K. Landry

U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Todd A. Stevenson
Deputy Secretary and
Freedom of Information Officer
Office of the Secretary

Tel 301-504-0785X1239
Fax 301-504-0127
Email· tstevenson@cpsc.gov

June 22, 2000

Mrs. Janiece Landry
3424 Vine
Chickasha, OH 73018

Consumer Product Incident Report Number : C0060018 (Baseball Bats)

Dear Mrs. Landry:

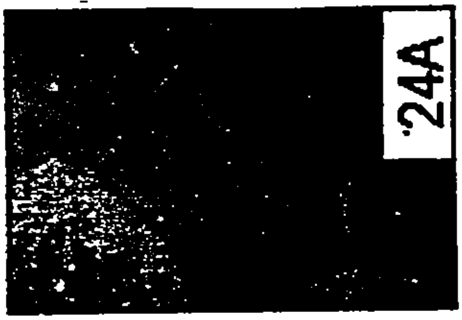
Thank you for your recent letter to the U.S. Consumer Product Safety Commission (CPSC). Our staff will review the information you provided and add it to the CPSC databases or the appropriate agency project file. This type of information allows us to focus on cases which pose the greatest degree of risk to consumers In determining whether to take action, the Commission considers a number of factors including the likelihood of injury, the nature and degree of injury, and whether action by the Commission can correct the problem.

Our staff will contact you if we need additional information.
The Commission appreciates the interest you have shown in helping us to reduce the unreasonable risk of injury from consumer products.

Sincerely,

Todd A Stevenson

Todd A. Stevenson



Josh Landry

Baseball player recovering after being struck by ball

A Chickasha eighth grader was listed in stable condition in the Children's Hospital Pediatric Intensive Care Unit Thursday morning after being struck by a ball during baseball practice Wednesday afternoon.

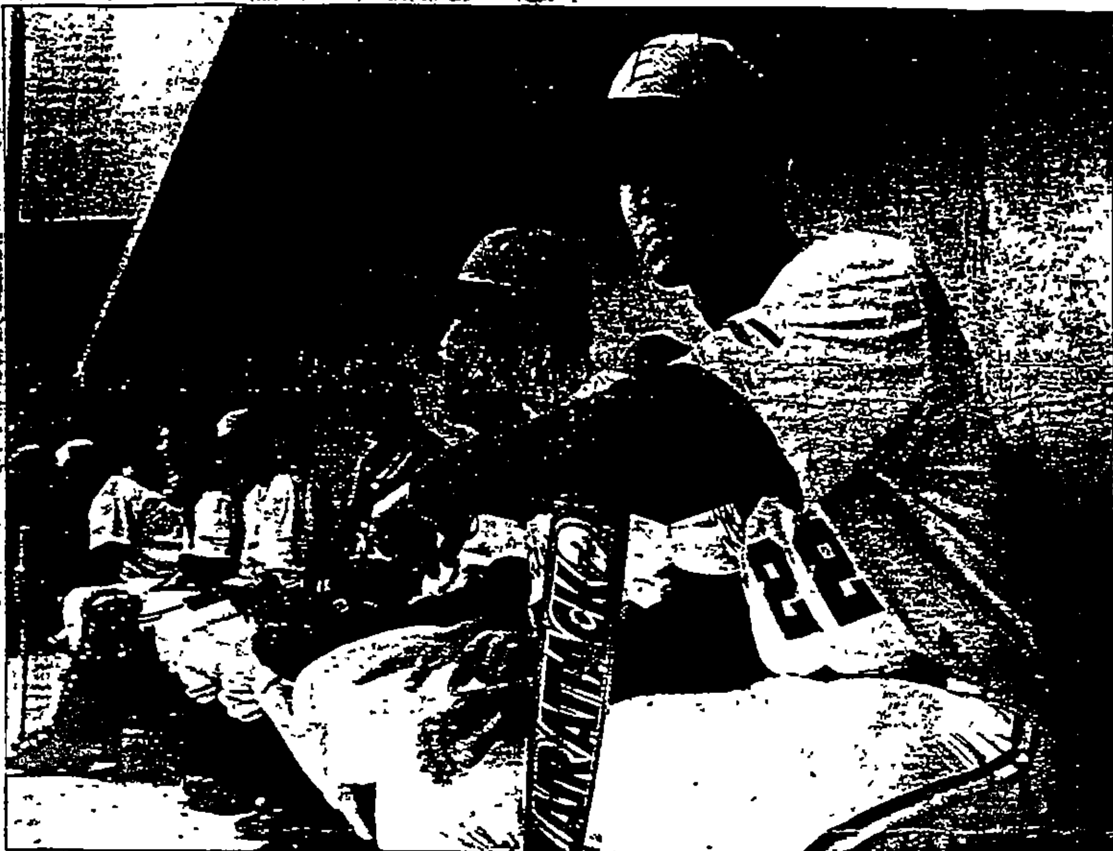
Josh Landry was taking part in batting practice with the rest of the Chickasha Junior High baseball team when a ball hit by another player struck him in the head. Landry was reportedly knocked unconscious for a time and had several other symptoms of a concussion.

Chickasha EMS was called to the E.J. Powell indoor practice facility on the grounds of Elliott Field where they attended to the injured player.

Landry was taken from Chickasha to Children's Hospital in Oklahoma City for surgery which reportedly went well.

A staff member in the PICU unit said Landry was expected to be moved out of the department into a regular room later Thursday.

THE METAL AGES



Enid pitcher Jeremy Brett hold the type of bat used when he was hit in the head with a baseball.

STAFF PHOTO BY PAUL HELLSTERN

The aluminum bat debate

- The Air Attack 2 (Model BB,12 (-5)) bat, made by Louisville Slugger is legal in high school baseball, but not in college. The NCAA has set -3 as the limit. The -5 bat becomes illegal in high school beginning in 2001.
- Jack MacKay, inventor of the Air Attack 2 and former employee of Louisville Slugger, said bat speed is the important factor.

"When you hit with an aluminum bat, the ball doesn't deform. The ball's caught, like in a tennis racket, and propelled off."

- The average player swings 5 mph faster with an aluminum bat than a wood bat, according to a Cape Cod League Study. The exit speed of the ball off the bat is 10 mph faster.
- The same study found that college players using aluminum hit 107 points higher than with wood. Home runs were up 67 percent. Runs were up 300 percent.

Aluminum bats are unsafe, says a family that learned the hard way

By Andrew Gilman
Staff Writer

ENID — The ball came off the bat hot.

That's how baseball players say it. Hot like, fast. Fast like, oh my gosh.

A line drive up the middle hit Enid High School pitcher Jeremy Brett so hard his coachthought Jeremy was dead.

Jeremy said he remembers his body vibrating. That's it.

"I only know what they told me," he said.

There was nothing Jeremy could do.

A cell phone was in Terry Brett's hand as the car sped into the April night a year ago

She needed the phone to call for directions to Midwest City, where her son had been playing against Carl Albert. Her checkbook was in the other hand, ready to pay any ticket she might get from any cop who dared to stop her.

Jeremy was taken to the hospital. She was told he had been hit in the head with a baseball. Hit hard.

There was nothing she could do.

David Brett's phone rang that night.

On business in Mexico, what seemed like a million miles away, David heard everything: Your son has been hit in the head during a baseball game; he's in the hospital, he's gone through surgery; we don t know what's going to happen.

"That was the hardest thing," David said. "I couldn't be there. I never got to see him."

There was nothing David Brett could do.

A year and nine days later, back in

See BAT, Page 7-D

Bat: Aluminum fuels controversy

From Page 1-D

id, the ball came off the bat hot; just ssing the pitcher's head.

That's how baseball players say it. Hot, e fast. Fast, like, oh, no, not again.

David Brett shakes his head from his it at David Allen Memorial Park.

"You see that? Every time I hear that, I ok and see if someone got hit."

No one did. Not this time, anyway, but ll Terry Brett wants to scream.

"I hate that sound," she said.

Jeremy Brett is still scared.

"When the ball hits the bat like that, I ll flinch," he said.

A high-performance aluminum bat arly took Jeremy Brett's life. His teamates saw it happen.

Five metal plates, 75 staples and 12 rews in the head later, Jeremy's injury me home to Enid.

Little has changed.

And there's nothing the Bretts can do out it.

trike 1

The Bretts are stuck in another battle. A battle in some ways more difficult and ustrating than seeing their own son hurt.

High-performance bats, like the Air Atck 2 that hit the ball that nearly killed remy, are still being used by Enid and her teams across the state. Aside from remy, few pitchers wear a protective helet.

That's partly the reason the Bretts have led suit in federal court against Louisille Slugger. They are trying to force ange because nothing else seems to be tting through.

Jeremy has lost some vision. He is back ith the team but plays sparingly. His life as been shaken, and Louisville Slugger, ccording to the Bretts and their lawsuit, new it could happen.

"It wasn't a freak accident," David Brett id. "As a parent, if I had known then hat I know now and did nothing about it, en it would be my fault as a parent. The formation is there.

"Yeah, it bothers me nothing has hapened. If any of these kids get hurt, it will estroy me. I have tried and tried to let eople know what happened."

The thing is, these Enid teammates do now. So do their parents. This injury idn't happen in New York or Florida or California. It happened to one of their own, ust like Jack MacKay said it would.

MacKay invented the technology for the Air Attack 2. He knew what it could do.

"I invented the Atom bomb and didn't realize it until we got out there and shot it," aid MacKay, who worked for Louisville Slugger. "Lots of kids are being hurt, and ots of it is being hidden, too. I turned the echnology loose."

MacKay, the father of former Oklahoma State baseball player Tripp MacKay, said e warned the company what was going on. He said he warned them for five years. Still nothing.

STAFF PHOTO BY PAUL HELLSTERN

David Brett, father of Jeremy Brett, watches an Enid game.

Metal bats mean performance. Performance means sales, and until someone decides there is a danger to lining up against what MacKay calls "the monster," bat companies will continue to manufacture them.

"No one will do anything until you start talking money," David Brett said. "I'm sorry. It shouldn't be that way."

MacKay agrees. He called the Bretts after he heard of the injury. He said it was his fault.

"The technology that I opened up just allowed further and further increases in performance," MacKay said. "That's what sells bats."

Strike 2

David Brett is exhausted. Tired of fighting but never tired of talking.

He talks to anyone who will listen. He's talked to Fox Sports. He's been interviewed by countless newspapers. He's not out of breath.

He went to the Enid High athletic director and offered to supply the team with wooden bats.

He offered to get the pitchers special helmets like the one Jeremy wears.

He was denied. And that's no surprise.

Sure, the Enid team would be protecting opposing pitchers, but opponents wouldn't be doing the same thing. You can't blame Enid for not switching to something safer, right?

"Our kids are entitled to use the same bats as Westmoore, Midwest City, Jenks and everyone else," Enid coach Mickey Geurkink said. "How can you make a kid use a wood bat? You could be taking away a scholarship or a chance for a kid to get drafted. I wouldn't force a kid (pitcher) to wear a helmet. If they want to, fine. That's something that's up to them."

There's no way players will stop using metal bats and start wearing protective helmets until the issue is forced on them.

Not Jeremy's injury, not a special on FOX Sports, nothing will change the minds of teen-agers. Certainly the facts don't mean much.

"The ball is harder more frequently," said Amherst College coach Bill Thurston, a member on the NCAA rules committee. "It's like a shooting gallery out there. There's still a major difference between the performance of aluminum and wood. There's going to have to be an across-the-board ruling, and we're a long way from that now."

That means more injuries, said Thurston, who has conducted and been involved in several studies of the dangers of metal bats, including a 1998 study that projected more than 375 pitchers would get hurt from batted balls.

MacKay said the NCAA had an agreement with metal-bat makers that they would not manufacture bats to exceed the performance of a 1988 Easton B9 Black Magic. But he claims the industry didn't adhere to the agreement. MacKay's opinion, which he stated in an affidavit for the Bretts' lawsuit, is that the Air Attack 2 performed at a dangerous level. Dangerous to such an extent that the "ball jumps off the surface on impact with the bat analogous to a tennis ball off a tennis racket."

MacKay said Louisville Slugger knows that and does nothing about it.

Louisville Slugger failed to return calls to *The Oklahoman.*

Strike 3

This is how Jeremy Brett would write this story.

"It's got be a happy ending," he said. "I can still play baseball, and this injury didn't stop me. It would have me playing baseball and doing something that I love to do."

But that's just a fantasy for now. The reality of it goes like this:

"I want to go to court and kick their (Louisville Slugger) [redacted]," Jeremy said. "They know these bats are dangerous, and they keep selling it. That's what makes me mad."

And it makes Jeremy's parents mad, too. Maybe a settlement in their favor, a big settlement, big enough to take away the money in a garbage bag, would make them happier.

But maybe not.

Likely, until high school federations intervene, players will continue to swing with heavy metal and the Bretts will keep flinching and trying to get others to understand the severity of staring down a silver bullet launched from 60 feet, 6 inches away.

Beginning next season, the particular Air Attack brand that struck the ball that hit Brett will be illegal under national high school federation rules. But MacKay and the Bretts say that's little consolation, that most metal bats remain dangerous and legal.

"I'm frustrated," Terry said. "There's a few parents that I want to shake and say, 'Don't you know what these bats can do?' But I can't make them do anything."

Jeremy has thrown less than 15 innings this season. He warmed up Monday but didn't play. His coach said others have moved ahead of him in the rotation.

Geurkink said he's not scared to put Jeremy into games. He also said Jeremy isn't the same pitcher he was a season ago.

"When I see him at home and how sad he is that he didn't get to play, that hurts me more," Terry said.

What hurts even more is that the Bretts are helpless. Jeremy can wear his special helmet and use a less dangerous bat. That means he'll be safer. But what about everyone else?

"It kind of feels like that night when Terry called me from the hospital," David Brett said. "There's not a lot I can do.

"But I'm not going to stop trying."

STAFF WRITER RANDY ELLIS CONTRIBUTED TO THIS REPORT

Teen softball star struck by ball dies

By Natalie Pompilio
Staff writer

Daina Nicole Pierce
She was hit during practice with a friend

A 14-year-old New Orleans native who started swinging a baseball bat at age 6 and was recently voted her high school softball team's Most Valuable Player died Monday after being struck in the head with a softball while practicing with a friend last week in Mississippi.

Daina Nicole Pierce never regained consciousness after being hit by a line drive May 8, family

See SOFTBALL, A-7

dedicated.

Miss. honors student, 14, was pitching to friend

SOFTBALL, *from A-1*

members said. She died at Wesley Medical Center in Hattiesburg, Miss.

Daina was born in New Orleans but moved to Poplarville, Miss., with her mother and two brothers about 10 years ago. Her father, Derrel Pierce Jr., and most of her extended family still live in New Orleans.

"It's not something we expected and not something that's going to be easy to get over," said Sherri Pierce, Daina's aunt and godmother, who lives in Gretna.

Serious injuries on the baseball field are rare, experts say. Deaths are even more unusual. But between 1989 and 1996, 16 players on organized baseball and softball teams were killed in accidents during games or practice, according to U.S.A. Baseball, a Trenton, N.J., group that oversees amateur leagues nationwide.

About half of such deaths occur when a player is struck in the chest with a ball. That was the case in Jefferson Parish in 1997 when an 8-year-old Metairie boy died of cardiac arrhythmia, an electrical short circuit in the heart, when he was hit with a tossed ball during practice.

Daina was hit with a softball she had pitched to her friend during one-on-one practice. She died from brain injuries.

Daina was a ninth-grader at Poplarville High School. She was an honors student who served as secretary of the school's Student Council and was a member of the Beta Club.

But softball was her passion. Daina was a catcher and outfielder for the school's Lady Hornets. A week before her death, she had been voted the team's Most Valuable Player.

Services for Daina will be held Friday at 2 p.m. at West Lawn Cemetery in Gretna.

Line drives break two pitchers' jaws

By Arnie Stapleton
AP Sports Writer

MINNEAPOLIS — Two line drives off high-performance metal bats in the NCAA tournament break two pitchers' jaws on the same field 48 hours apart. Coincidence?

Wichita State coach Gene Stephenson thinks so. He said it's strictly a "freak of nature" and not a red flag for the NCAA to investigate the metal bats once again.

"I don't think it has anything to do with the bats," Stephenson said after the Shockers eliminated Butler from the NCAA tournament 15-5 on Sunday. "Major League Baseball has more pitchers hit like that than you'll ever see in college, and those are wood bats."

Stephenson said he hadn't seen a pitcher struck in the face in 20 years "and now we get two in the same tournament. It's a freak of nature, obviously."

Butler freshman Pat Neshek's jaw was broken by Dustin Hawkins' line drive in the sixth inning of the NCAA regional game at Siebert Field on Sunday.

On Friday, Butler's Eddie Olszta lined a pitch off Nebraska ace Shane Komine's jaw, breaking it in three places. Komine, the Big 12 Player of the Year, underwent surgery Saturday at University Hospital in Minneapolis.

Neshek won't need surgery, the school said. His jaw swelled immediately when he was hit and he stumbled to the grass.

Butler coach Steve Farley disagreed with Stephenson's contention that this was all coincidental: "Pat is one of the best athletes on our team and I know Shane Komine is a great athlete for Nebraska. If those two guys can't get their gloves up in time, it makes me wonder about the bats issue."

U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Todd A. Stevenson
Deputy Secretary and
Freedom of Information Officer
Office of the Secretary

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Fax: 301-504-0127
Email: tstevenson@cpsc.gov

June 22, 2000

Mrs. Janiece Landry
3424 Vine
Chickasha, OH 73018

Consumer Product Incident Report Number : C0060018 (Baseball Bats)

Dear Mrs. Landry:

Thank you for your recent letter to the U.S. Consumer Product Safety Commission (CPSC). Our staff will review the information you provided and add it to the CPSC databases or the appropriate agency project file. This type of information allows us to focus on cases which pose the greatest degree of risk to consumers. In determining whether to take action, the Commission considers a number of factors including the likelihood of injury, the nature and degree of injury, and whether action by the Commission can correct the problem.

Our staff will contact you if we need additional information. The Commission appreciates the interest you have shown in helping us to reduce the unreasonable risk of injury from consumer products.

Sincerely,

Todd A Stevenson

Todd A. Stevenson

2

WORTH®

Worth, Inc. • P.O. Box 88104 Tullahoma, TN 37388-8104 • Tel 931-455-0691 • EDI Ext.227 • FAX 931-454-9164 • http://www worthsports com • Email - worthinc@edge net

CPSC/OFC OF THE SECRETARY
2000 AUG -4 P 2:13

August 2, 2000

Office of the Secretary
Consumer Product Safety Commission
Room 501
4330 East-West Highway
Bethesda, MD 20814

Subject: *Petition CP00-1, Petition on Baseball Bats*

On behalf of Worth Inc , a baseball and softball equipment manufacturer, I would like to submit the following information and comments relative to the above-cited petition:

1. A performance standard for non-wood bats has been developed and implemented by NCAA beginning with year 2000. The same standard has been adopted by the National High School Federation The performance limit for non-wood bats has been set to not exceed the batted ball speed of wood bats based on a laboratory test. The max batted ball speed is 97 mph. Therefore, there already exists a standard to limit batted ball speeds in high school and college play to the level of wood bat performance.

2. Information available to us indicates there is no unreasonable risk of injury posed by non-wood bats and no increase in injuries in collegiate, high school, or youth baseball. Attachments 1 and 2 are taken from NCAA injury statistics showing very low injury rates for baseball and extremely low rates for batted ball impact injuries. Attachment 3 compares the NCAA injury rate for pitchers hit by batted balls to Major League baseball rates where wood bats are used. Note that the collegiate rate with aluminum bats is lower than the Major League rate with wood. Attachment 4 shows the injury rate for pitchers hit by batted balls as reported by Little League, Inc. (ages 6-18) where aluminum bats are used almost exclusively. Note that the rate is not only low but has decreased over the last several years. Attachment 5 is a report from Dr. Fred Mueller, Director of the "National Center for Catastrophic Sport Injury Research covering collegiate and high school sports injuries from 1982 to 1988. This report shows that serious baseball injuries are low in incidence and not increasing.

3. The NCAA bat performance standard was implemented primarily to maintain the balance of the game between offense and defense, not to lower the incidence of ball impact injuries. I am aware of no correlation between bat performance and the risk of ball impact injury; however, a recent reaction time study by Dr. Richard Brandt does give some relevant information (attachment 6). Based on Dr. Brandt's measurements, it appears that the collegiate pitcher has sufficient time to respond to batted balls at speeds up to at least 105 mph., which is well above the NCAA limit of 97 mph. Dr. Brandt's correlation of reaction time to probability of impact also gives some insight into what may be an acceptable level of risk. Here again the results indicate that the pitcher is generally in an environment with reasonable time to respond.

4. In summary, there is no evidence of increased batted ball impact injuries, no correlation of risk of this type injury to bat performance, and evidence that the pitcher has sufficient response time. Additionally, there is evidence that such injuries are just as likely to happen when wood bats are used, and a bat performance standard is in use correlating bat performance to that of wood bats Finally, if it is desired to lower the risk of batted ball impact to the pitcher there are other practical options such as the use of head/facial protective equipment and lower risk of injury baseballs, both of which are readily available but not mandated.

I appreciate your consideration for this information, and if you have any questions, I will gladly respond.

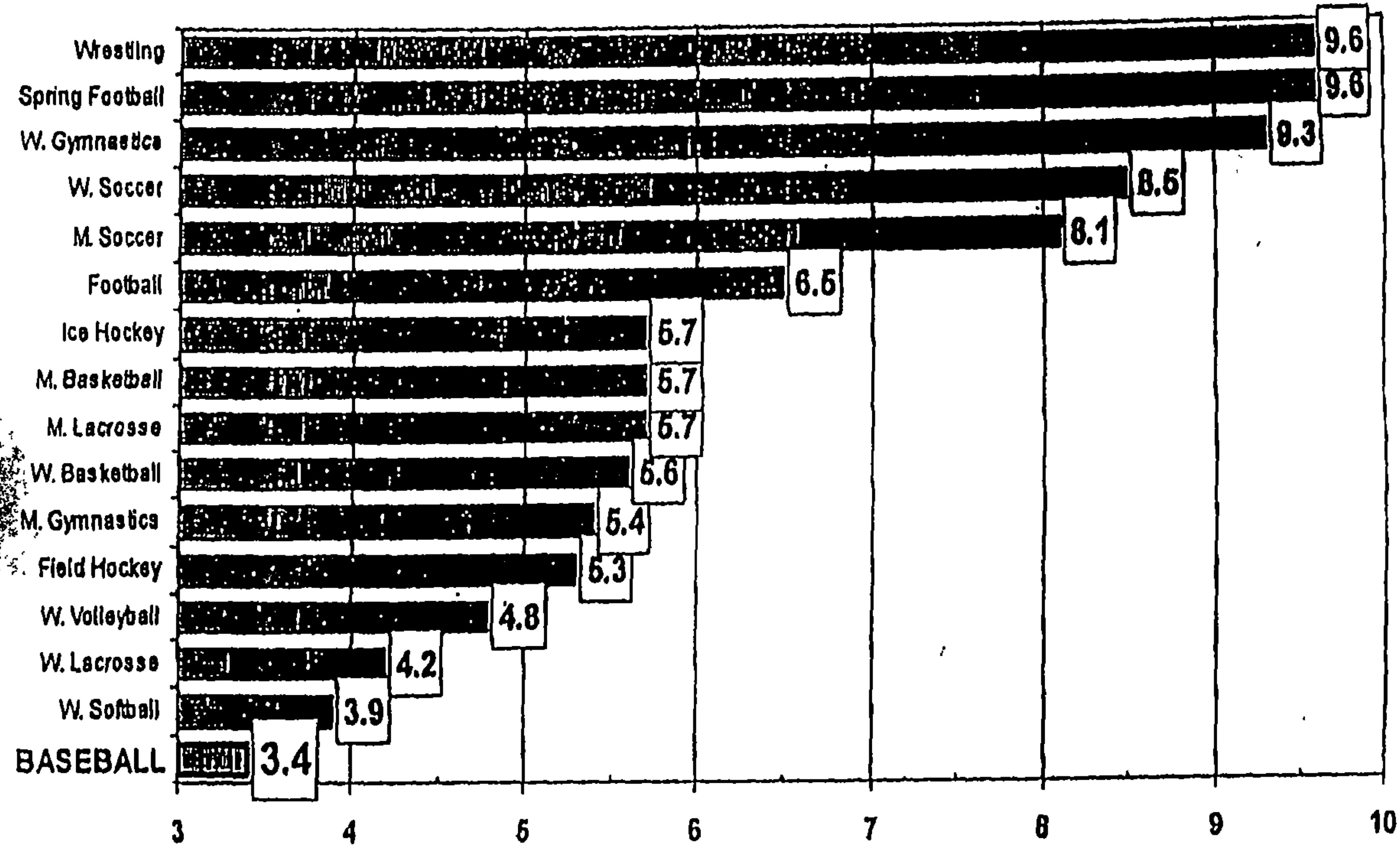
Sincerely yours,

Jess Heald

Jess Heald
Chairman of the Board

Attachment 1

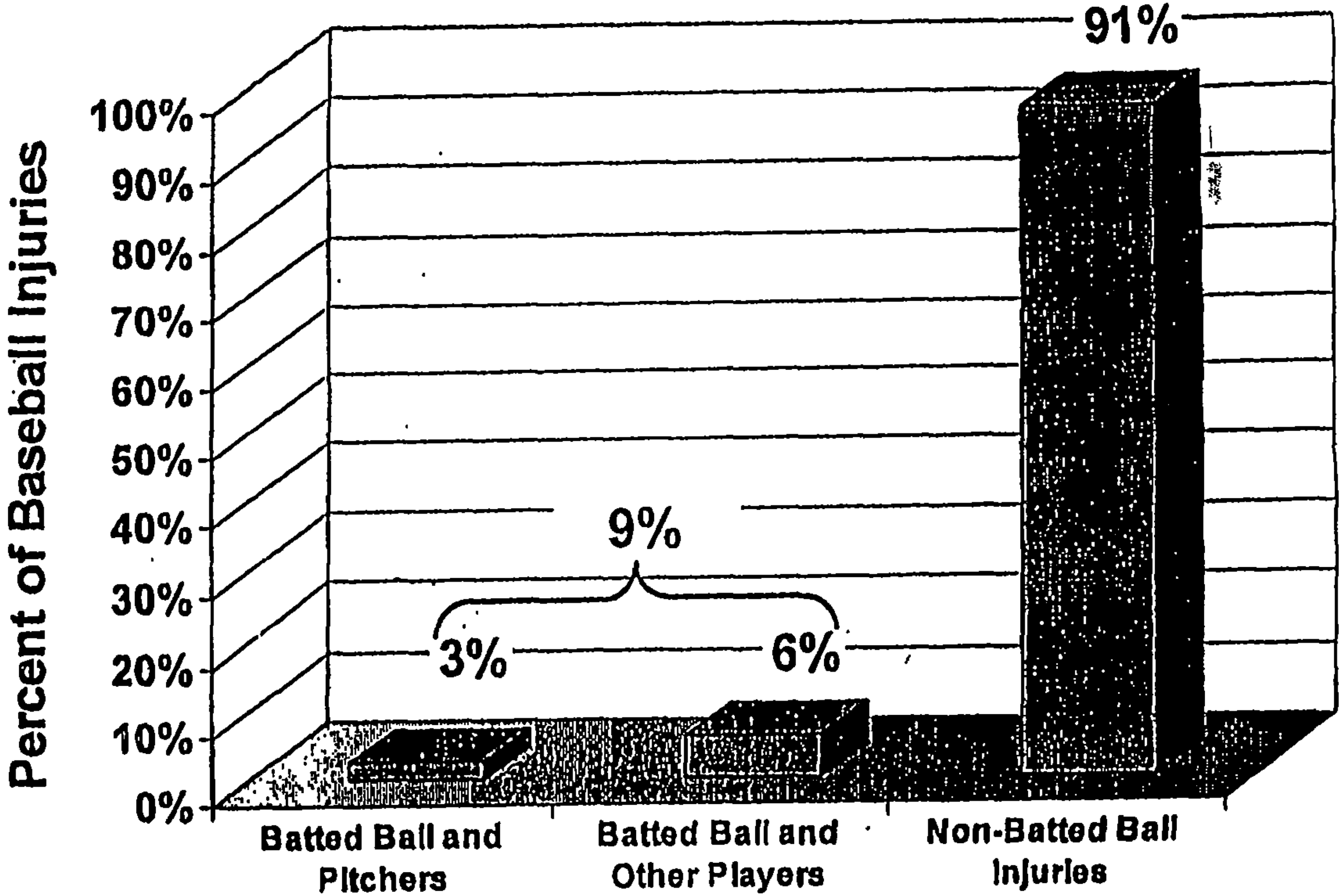
NCAA Division 1 Total Combined Practice and Game Injury Rate



Source: NCAA Injury Surveillance System (NCAA ISS)

Attachment 2

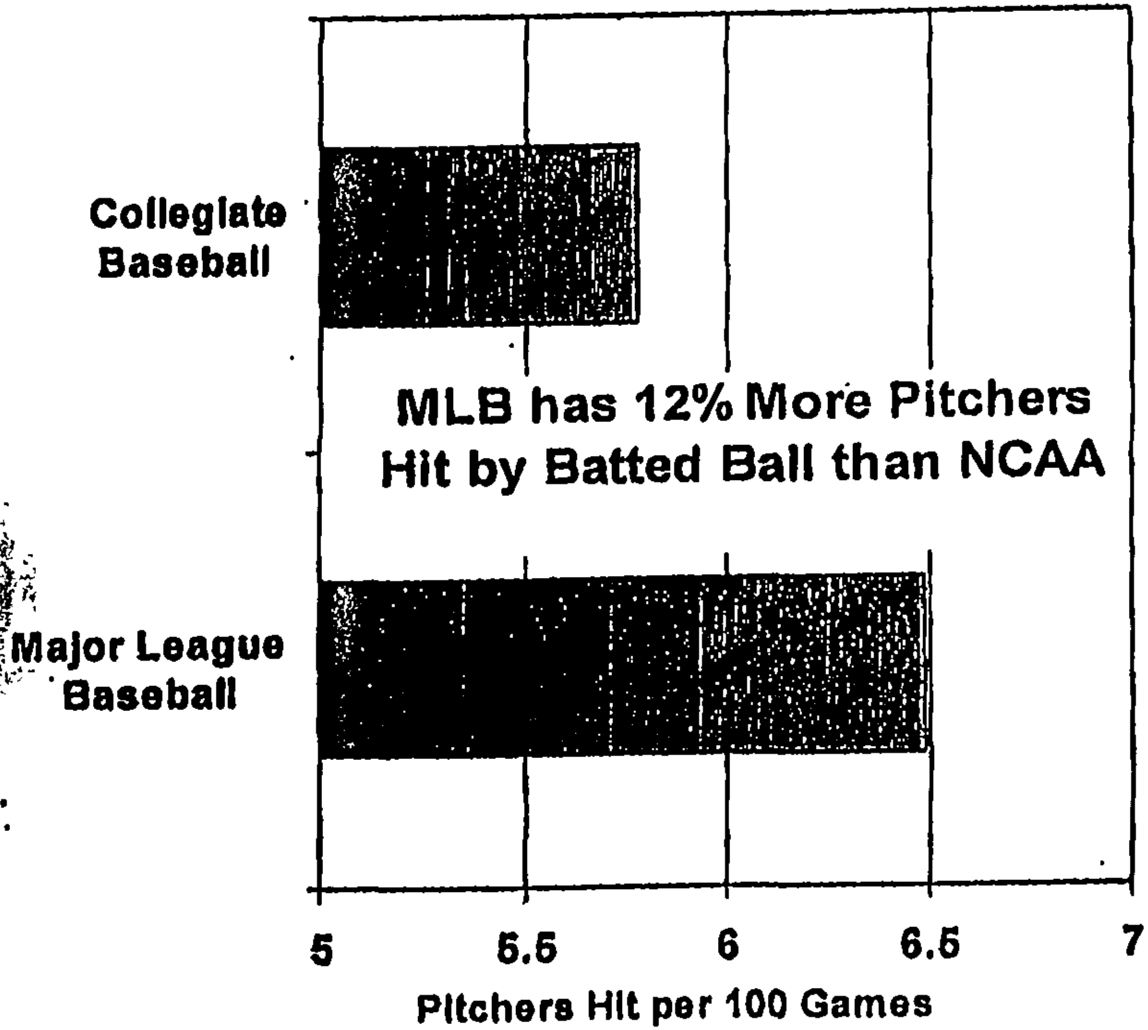
Break Down of All NCAA Baseball Injuries

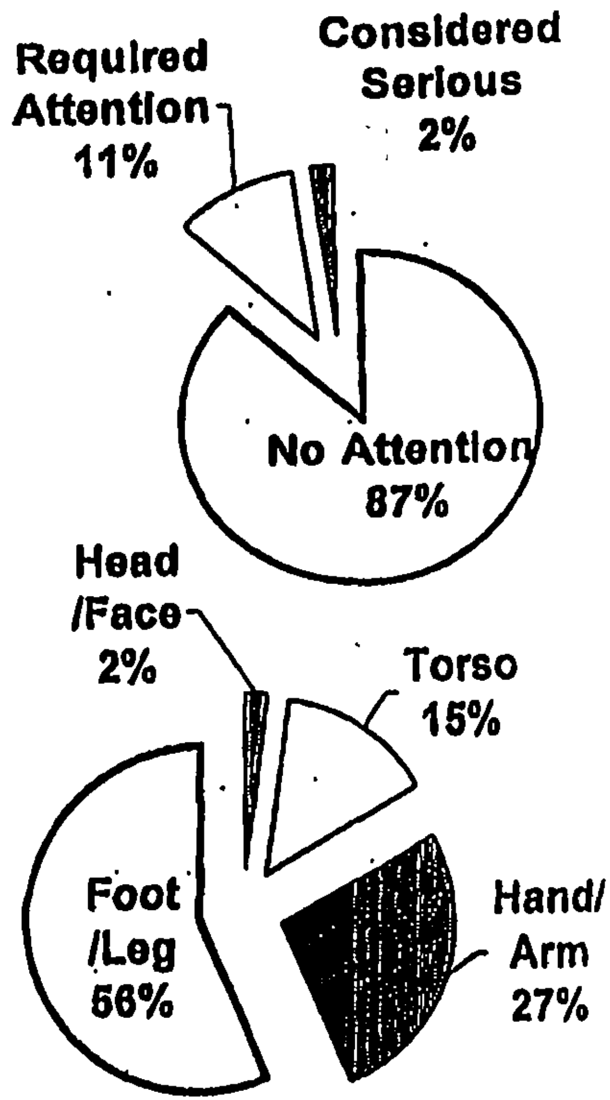


Source: 1997 NCAA Injury Surveillance System (NCAA ISS)

Attachment 3

Review of NCAA/MLB Pitchers Hit by Ball

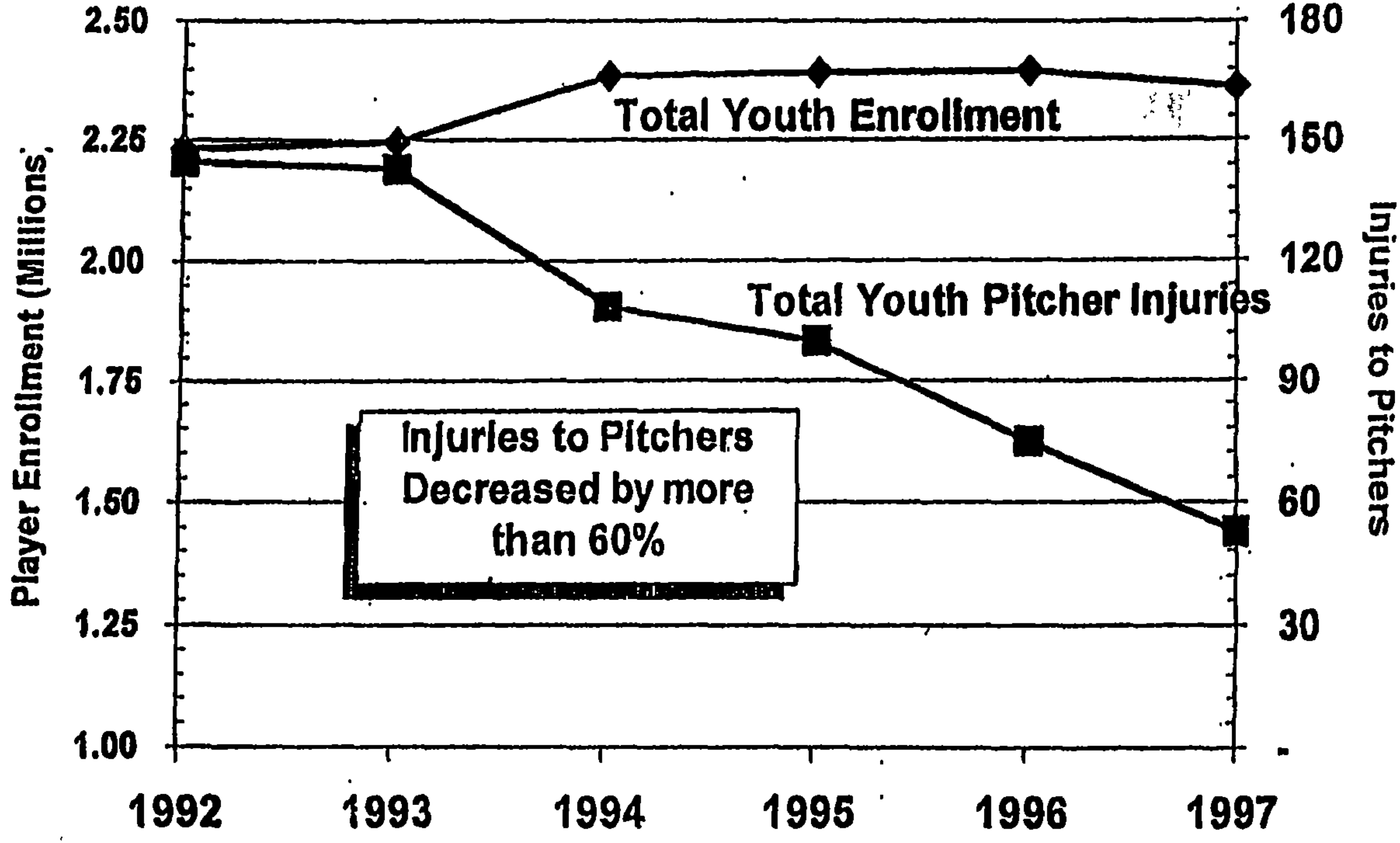




Source: 1997 NCAA Injury Surveillance System (NCAA ISS) and MLB Trainer's Study 1998

Attachment 4

Little League - Injury Rates



Source: Little League Statistics

RESPONSE TIMES FOR HIGH-SPEED BALL DEFLECTIONS IN BASEBALL AND SOFTBALL

Richard A. Brandt

Department of Physics

New York University

October 19, 1998

THIRD DRAFT

1. INTRODUCTION

This paper reports the results of a preliminary determination of safe response times and hit ball speeds for a number of baseball and softball venues. This determination was based on tests in which balls were randomly shot with measured speeds towards subjects standing a measured distance away behind a protective net. The subjects were instructed to attempt to deflect the incident ball with a glove before being hit. The result of each attempted deflection (success or failure) was recorded for each shot. (Attempted deflections from pitching positions or by dodging motions were also recorded.) A total of 31 male and female subjects from various categories (college, high school, recreational, senior, and youth baseball and softball) were tested, and the results of over 2000 shots were recorded.

The tests were run during the course of a four days at the H&B indoor testing facility in Texas in August 1995, but, because the necessary funding was unavailable, the data were not tabulated or analyzed until August 1998. During the three years between the tests and the analysis reported here, player safety has become of increasing concern because of the use of high-performance balls and bats, in spite of the fact that baseball and softball remain among the safest of sports and there has been no increase in injuries from hit balls during the past five years.

The results reported here are preliminary. They suggest reliable first estimates of safe response times and hit ball speeds in the college baseball, senior softball, and women's high school softball venues, for which there were sufficient data to insure reasonable statistical significance, but more data is needed in the youth, high-school, and recreational baseball venues, as well as in the men's B-level and senior softball and women's college venues.

For a given measured projected ball speed v and subject distance d, the time of flight between the cannon and the subject is not simply the ratio d/v because of the presence of air resistance. It is crucial to incorporate the effects of this air resistance because these effects are of the same order of magnitude as the difference in flight times arising from hits off of high-performance and low-performance bats. For example, for a baseball hit at v=100 mph = 147 fps, the actual time taken to travel a distance d=55 ft is 0.396 sec, whereas the naïve time d/v is only 0.374 sec, which is 6% less. The is the same percentage difference in the hit speeds off of a high-performance (BPF=1.15) and a low-performance (BPF=1.05) bat. (For 70-mph pitch and bat speeds and a ball COR of 0.54, the high-performance hit speed is 104.6 mph and the low-performance hit speed is 98.8 mph. See Reference 1 for definitions of BPF and COR.) Air resistance has an even greater effect in softball. It takes 0.404 sec for a typical softball hit at 100 mph to travel 55 ft.

The flight time for each shot was therefore evaluated from the measured ball speed and flight distance using the well-known effect of air-drag. These evaluations are based on the trajectory equations given in Appendix 1. As many shots as time and fatigue-avoidance permitted were made for various distances and speeds, and the result (hit or miss) was recorded. These data were then used to determine which flight times are safe and which are unsafe for each category.

The goal is to determine from these results reliable estimates of the maximum safe flight time in each category. The maximum safe hit-ball speed can then be calculated, again taking air resistance into account. To proceed, it must be decided what is an acceptable level of injuries arising from hit balls. For example, virtually no injuries will result from a flight time of 0.50 sec, but a game with such a large travel time between a hitter and a pitcher would require such dead bats that far too few hits would occur. On the other hand, a flight time of 0.23 sec would result in far too many injuries. (Elite college baseball pitchers would be hit 50% of the times a ball was directed at them in this case.) It is not the purpose of this report to recommend an acceptable injury level and so the question of what is a safe maximum flight time will not be fully answered here. More data in the neighborhood of 0.4-sec flight times is necessary, as well as information on how often a hit ball is actually directed towards a pitcher.

It is, however, possible to make reliable first estimates of safe maximum times and speeds based on the present data and reasonable extrapolations thereof. This will be done in Sec. 5. For college baseball players, the maximum flight time for which a subject was hit was 0.368 sec, the proposed maximum safe flight time is 0 38 sec, and the maximum safe hit–ball speed is 104 mph.

One interesting and unanticipated result of these tests should be mentioned here. For the game venues for which sufficient data exists, the graphs of deflection failure percentage verses flight time have been plotted and found to be very well fit by straight lines. This observed regularity is useful for extrapolating the existing data, and its significance should be explored in the future.

In extrapolating the test results reported here to real game situations, important differences should be kept in mind. The test subjects were always concentrating on the task, always alert, and were required to perform a single anticipated response. These facts tend to lower response times since ballgame players can loose concentration, become distracted, and have to worry about various responses such as fielding. On the other hand, the test subjects did not have the opportunity to observe a hitter swing a bat before a ball was projected towards them, and this obviously tends to increase the response times observed in the tests. To the extent that these and other differences cancel out or are unimportant, the test and game situations can be directly compared.

If, for a given shot, the subject's response time is less than the ball's flight time, the ball is deflected and the response is a success, whereas if the response time is more than the flight time, the subject is hit and the response is a failure. The response time here is actually the sum of three separate times: viewing time, reaction time, and movement time. The viewing time is the time during which the subject observes the approaching ball before he decides what to do. The reaction time is the time between the subject's decision to respond and the initiation of his responding motion. The movement time is the time taken for the subject to move his glove to the position where it can deflect the ball. As mentioned above, there is present in an actual game a fourth time (anticipation time), during which the pitcher observes the motion of the hitter before the ball is hit. The existence of this anticipation time reduces the necessary viewing time. There is also evidence that the reaction time tends to shorten as the hit-ball speed increases, but the movement time tends to remain constant. See, for example, Reference 2.

Although the determination of safe response times is of paramount importance in addressing baseball and softball safety concerns, I am unaware of previous realistic attempts to accurately measure this quantity.

The following sections execute the program outlined above. The test protocol and subject demographics are given in Section 2 The test results are summarized in Section 3, analyzed in Section 4, and expressed in terms of hit ball speeds in Section 5. The conclusions are discussed and suggestions for further research are given in Section 6 The air drag equations are given in Appendix 1, the bat performance equations are given in Appendix 2, and the complete test data are given in Appendix 3.

2. PROCEEDURES

The tests were carried out at the H&B indoor test facility in Mt. Pleasant, Texas. A Jugs pitching machine (cannon) was used to propel baseballs or softballs towards the subject. The cannon was randomly re-aimed for each shot. The exit ball speed was set on the cannon for each data set, mainly between 90 and 100 mph, but the cannon itself provided random variations in this speed of about $\pm$ 5 mph. The precise value of the exit speed for each shot was measured and recorded using an Euler projectile speedometer The cannon was shielded from the subjects so that the precise aim or time of firing could not be observed. The subjects were placed behind a protective net, which allowed them to freely attempt to deflect the incident balls, but which prevented these balls from hitting them. The subjects were given between five and ten practice shots before data were taken. The distances between the cannon and the subject were fixed at 15, 20, 30, 40,or 50 ft. I, at least one college baseball player, and usually other personnel observed each shot. If these observers agreed on whether or not the subject was successful in deflecting the ball, the result (hit or miss) was recorded, but if there was disagreement, the shot was repeated. In addition, each shot was taped by a video camera situated behind the cannon and aimed directly towards the subject. These tapes were all reviewed in slow motion to confirm the result of each shot.

For each shot, the following information was thus recorded: subject name and venue, distance from cannon, exit ball speed, and deflection success or failure. Over 2000 shots were recorded on 31 different subjects. The complete list of subjects and demographics (game category, sex, age, height, weight, and years of experience) is given in Table 1.

TABLE 1: LIST OF SUBJECTS						
CATEGORY	SEX	SUBJECT	AGE	HEIGHT	WEIGHT	EXPERIENCE
College Baseball	M	tm	22	5'10"	160	15
		tc	18	6'1'	180	10
		js	20	6'0"	230	14
		jc	18	6'1"	195	11
		da	18	5'10"	168	11
		cz	22	6'0"	185	15
		bt	20	6'3"	190	13
		tb	19	5'10"	145	11
High School Baseball	M	ws	17	6'4"	180	10
		bm	17	5'8"	150	10
Recreational Baseball	M	mr	20	5'5"	128	6
		tc	30	6'6"	225	20
		rn	33	6'2"	235	10
		jm	54	5'8"	158	30
Dixie Youth Baseball	M	cm	11	4'9"	80	6
B-Level Softball	M	cd	24	6'4"	230	19
		ln	19	6'1"	196	15
Senior Softball	M	rh	39	6'5"	275	8
		da	42	6'3"	200	
		mc	44	5'5"	175	16
		jm	54			
		rn	33	6'2"	235	10
		mr	40			6
Girls (Dixie WS) SB	F	mp	14	5'6"	125	9
		mh	13	5'5"	120	8
High School Softball	F	jg	16	5'2"	130	10
		nz	16			11
		as	16			11
		lc	16			11
		tr	15			10
College (NTCC) SB	F	lm	18	5'7"	155	10

In addition to the above deflection tests from a standing position, a number of tests were run in which the subject executed a pitching motion before the ball was shot. The subjects were instructed to pitch an imaginary ball towards the cannon, and about 0.4 sec later (a typical fastball flight time from pitcher to hitter) a ball was shot back at the subject. These tests were performed in order to confirm that such pitching motions did not increase the response time necessary to avoid being hit by the return ball. Tests were also run in which the subjects were instructed to avoid being hit by attempting to dodge out of the ball's way. Such motions were seen to require larger response times.

From the exit ball speed and flight distance recorded for each shot, the ball's time of flight was evaluated taking into account the effect of air resistance. The deflection success rate was thus determined for a range of flight times from 0.10 sec to 0.45 sec. These data were then used to estimate the response times and hit-ball speeds necessary for safe play in each of the game categories.

3. RESULTS

After the ball exit speeds and flight distances were converted to flight times, a table of times and outcomes (success or failure) was obtained for each subject in each category. The data for all the subjects in each category were then combined and sorted according to increasing times. The results are given in Appendix 3, where all the calculated times are listed in columns and the corresponding outcomes (1 for failure or 0 for success) are given in the same row in the next column to the right. In order to interpret this data, the outcomes must be combined for specified, relatively small, time ranges. The data, in fact, fall naturally into four separate time ranges corresponding to the four main chosen distances of 20, 30, 40, and 50 ft. For those categories in which sufficient data existed, each of these time ranges was further divided into two separate ranges, giving a total of eight ranges.

Consider first the data for men's college baseball. The subjects were eight excellent players from various colleges. Their demographics are given in Table 1. The initial round of tests consisted of ten shots at each of the four distances for each subject, for a total of 320 shots. The combined data were divided into eight time ranges, two for each distance, and the results are given in Table 2. Each row in the table corresponds to a time range which starts at the time given (in ms) in the first column and ends at the time given in the second column. The averages of these two times are given in the third column. The fourth column gives the number of hits (failures), and the fifth column gives the total number of shots in each time range. The final column gives the percentage of shots that resulted in hits.

The increase in hit percent with decreasing flight time is clearly seen. There were no hits in the first range with the average time of 0.39 sec, whereas the subjects were hit nearly 50% of the time when the average time was 0.23 sec, and nearly 77% of the time when the average time was 0.14 sec. These results will be exhibited more clearly in a graph given in Section 4.

The data for women's high-school softball are also given in Table 2. The subjects were five excellent players who played on the 1995 NET Sluggers team. Their demographics are also given in Table 1. There were 440 recorded shots in the initial round of tests. The results are similar to those for college baseball, but the hit percentage is significantly higher in each time range. There was about a 10% failure rate for a flight time 0.41 sec, 51% for 0.21 sec, and 90% for 0.14 sec. The time range for which no hits occurred was from 0.405 to 0.433 sec.

TABLE 2: COLLEGE BASEBALL SUMMARY					
min time	max. time	ave. time	hits	shots	hit percent
376	398	387	0	36	0.0
363	373	368	4	44	9.1
297	318	307.5	8	35	22.9
279	295	287	13	45	28 9
221	236	228.5	17	35	48.6
209	219	214	27	45	60.0
145	153	149	27	37	73.0
135	144	139.5	33	43	76 7
HIGH SCHOOL WOMEN SOFTBALL SUMMARY					
389	433	411	6	58	10.3
360	386	373	13	62	21.0
307	336	321.5	13	48	27.1
290	305	297.5	18	52	34.6
224	245	234.5	28	61	45.9
190	222	206	30	59	50.8
149	167	158	37	53	69.8
141	148	144 5	42	47	89.4

The data from the other subject categories are given in Table 3. The results for the two high school and four recreational baseball players are grouped into four time ranges, and the same trends as noted above are observed Only one (11-year-old) Dixie Youth player participated in the tests, and, for safety concerns, data was only taken for him at 40 and 50 ft His response times are clearly much greater than those above, but the statistics here are unfortunately limited

TABLE 3: OTHER MENS BASEBALL DATA SUMMARY

CATEGORY	min time	max time	ave time	hits	shots	hit percent
High School	373	390	381 5	9	30	30 0
	293	325	309	8	20	40 0
	215	227	221	15	20	75 0
	140	148	144	18	20	90.0
Recreational	358	405	381 5	14	40	35.0
	281	315	298	21	40	52 5
	206	232	219	41	54	75.9
	140	156	148	15	20	75 0
Dixie Youth	401	424	412 5	12	20	60 0
	313	336	324 5	13	20	65 0

OTHER SOFTBALL DATA SUMMARY

CATEGORY	min time	max time	ave time	hits	shots	hit percent
Coll. BB play	392	455	423.5	0	40	0 0
	305	344	324 5	1	40	2 5
	228	250	239	10	40	25.0
	149	165	157	15	40	37 5
	109	125	117	21	40	52.5
Coll Women	368	407	387.5	4	10	40 0
	288	318	303	4	10	40 0
	216	241	228.5	7	10	70.0
	139	156	147.5	10	10	100.0
B-level Men	353	429	391	2	20	10 0
	288	333	310.5	2	20	10 0
	213	250	231.5	14	20	70 0
	135	162	148.5	14	20	70 0
	103	120	111.5	14	20	70.0
Girls (DWS)	404	440	422	2	20	10.0
	423	341	382	4	20	20.0
	235	254	244 5	7	20	35.0
	151	163	157	8	20	40.0
Senior Men	373	440	406.5	19	60	31.7
	294	341	317.5	25	60	41.7
	219	254	236 5	28	60	46.7
	143	169	156	29	50	58.0

The remaining categories in Table 3 refer to shots with softballs. The results are grouped into four or five time ranges, depending on whether on not data were also taken at 15 ft. The subjects consisted of four of the college baseball players, two B-level men, one college woman, two girls, and six senior men. The trends are as before, but, because there is much less data, the results are, of course, not as statistically significant Some noteworthy features of these results are the better performance of the college baseball players at deflecting softballs instead of baseballs, and the good performance of the two (13 and 14 year old) girls.

From the point of view of player safety, a most important number obtained in these tests is the maximum time for which a failure occurred (MAX HIT TIME). These times are given in Table 4 in increasing order. The number of subjects tested (SAMPLE), age range, and number of shots recorded is also given for each category of baseball and softball. All of these results will be analyzed in the following section, but it is immediately clear form these trends that response times vary considerably from category to category, and so the high-performance bats and balls that may be safe for college players may not be safe for younger or older players.

TABLE 4: CATCH TEST SUMMARY				sec
CATEGORY	SAMPLE	AGES	SHOTS	MAX HIT TIME
College BB	8	18-22	320	0 368
High School BB	2	17	94	0.381
Recr. BB	4	20-54	154	0.387
Youth BB	1	11	40	0.417
Coll. men SB	4	18-22	200	0 331
Coll. women SB	1	18	40	0 373
B-level men SB	2	19,24	100	0.395
H S women SB	5	15-16	440	0 404
Girls (DWS) SB	2	13,14	80	0 413
Senior men SB	6	39-54	230	0 413

Additional tests, as described above, were performed on some of the college baseball players. The first issue addressed was whether or not a pitcher is in more danger of being hit by a batted ball than a player who is standing still before the ball is hit. Tests were performed at 40 and 50 ft on the three college players who had pitching experience. Ten shots at each distance and at each pitcher were recorded, and the result is that there was no observed increase in the response time needed to deflect the incident balls. Specifically, in both the 0.283-0.315 sec and 0.365-0.405 sec flight time ranges, there were 2 failures out of 30 shots; a 7% failure rate. There were no failures in the 0.370-0.405 sec time range, and the maximum time for which a failure occurred was 0.368 sec, exactly as in the standing tests. It seems safe to conclude, even with these limited statistics, that the pitchers do not require longer response times. The time taken for the ball to travel to the hitter is apparently sufficient for them to recover from their more-vulnerable post-pitch position.

Three of the college players were also subjected to tests in which they were instructed to avoid being hit by dodging out of the incident ball's path. 30 shots were recorded in the flight time range of 0.287-0.378 sec, and there were 18 observed failures out of 30 shots, for a failure rate of 60%. This is much worse than the 15% failure rate for the standing players (12 hits out of 79 shots) in this time range. Such dodging tests (100 shots) were also performed on four of the high school women softball players, and again the failure rate was found to be very high (75% in the 0.35-0.40 sec range, 65% in the 0.43-0.47 sec range, and 14% in the 0.50-0.54 sec range). It is therefore not recommended that players use such dodging motions to avoid being hit, but players never seem to attempt this anyway.

Additional standing tests at 20 ft were made on two of the college baseball players on another day, and the result was a slightly improved success rate. Since only 60 shots were recorded, however, this was not statistically significant. Tests on five of these players were also made at a 15-ft distance, and there were 51 failures out of 77 shots. This failure rate of 66% is less than anticipated from the trend observed in Table 2, but again this is not statistically significant.

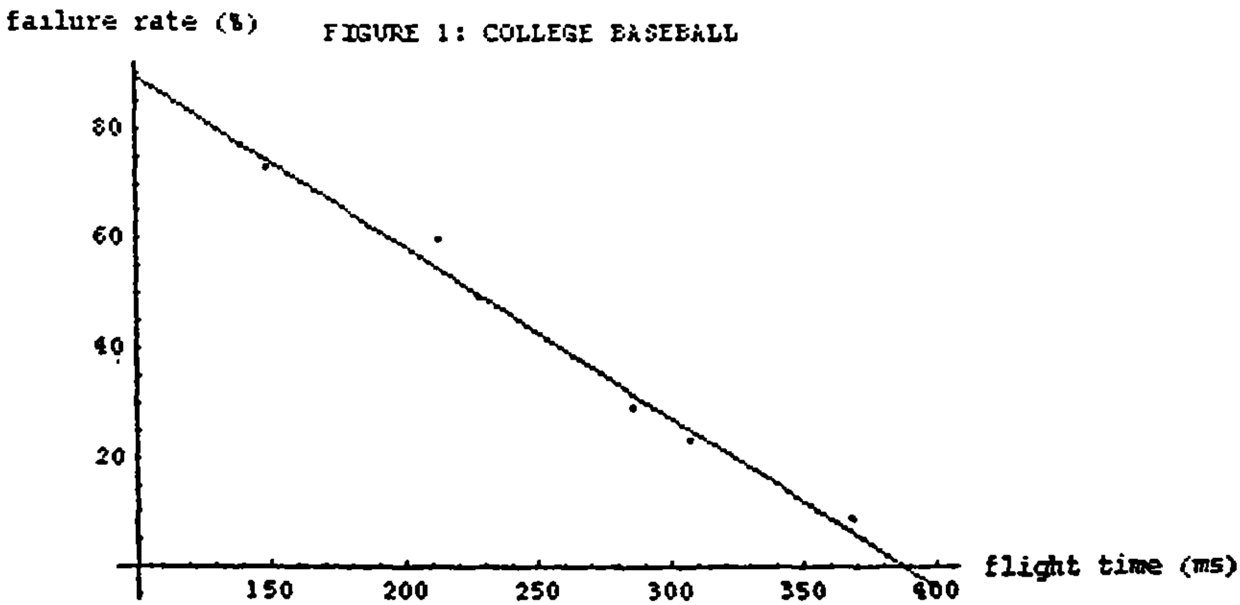
4. ANALYSIS

Consider again the college baseball data in Table 2. The plot of the hit percent (sixth column) verses average flight time (third column) is given by the points in the graph shown in Figure 1. These points are seen to lie close to a straight line, and this is confirmed by the solid line shown in the graph, which is a least-squares quadratic fit to the data. This fit is indistinguishable from the straight line given by the equation

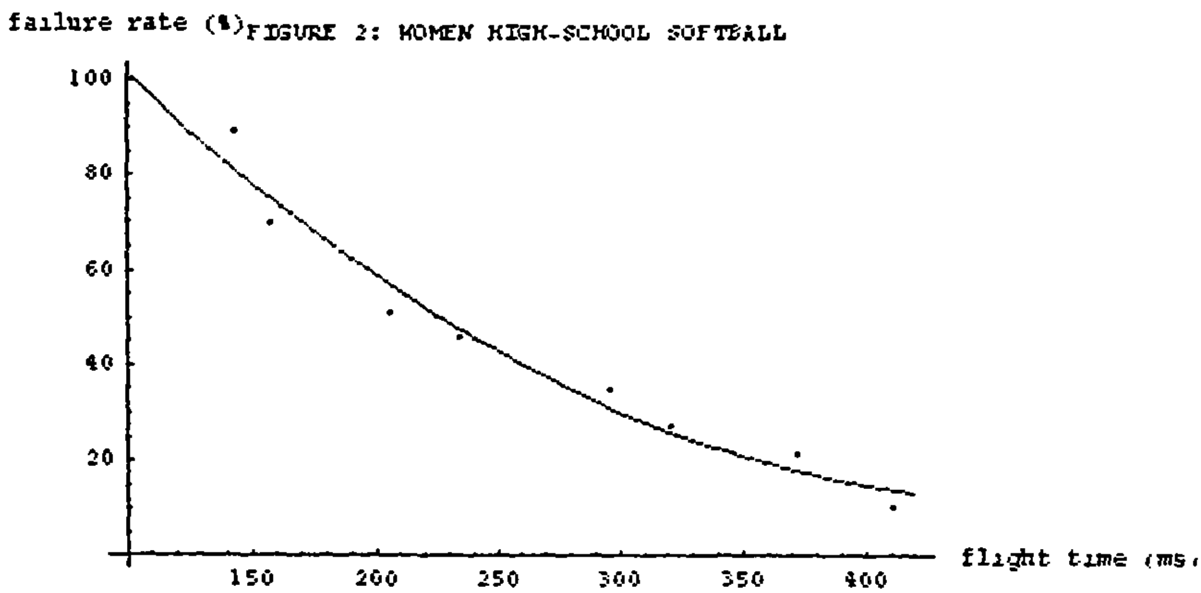
$$P = 120.6 - 312\,T,$$

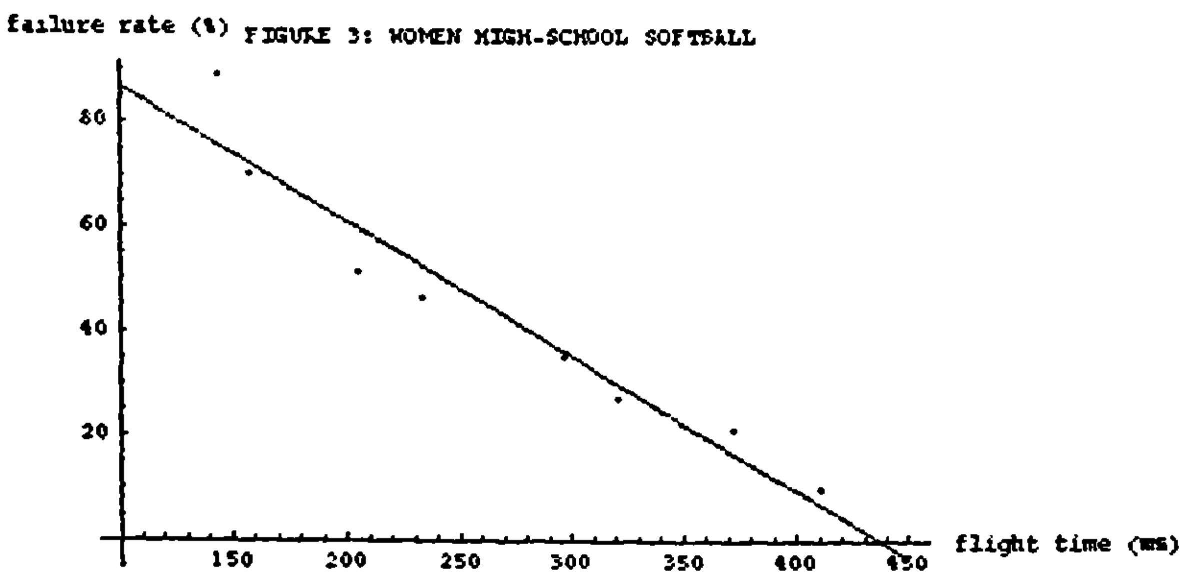
where P is the hit percentage and T is the flight time in seconds. This linear expression provides an excellent fit to the data (χ^2 =2.56 for 6 degrees of freedom). This reveals a remarkable and unexpected regularity of the data, which does not seem to have been previously noted. It may have significant implications, which should be investigated in the future.

FIGURE 1: COLLEGE BASEBALL

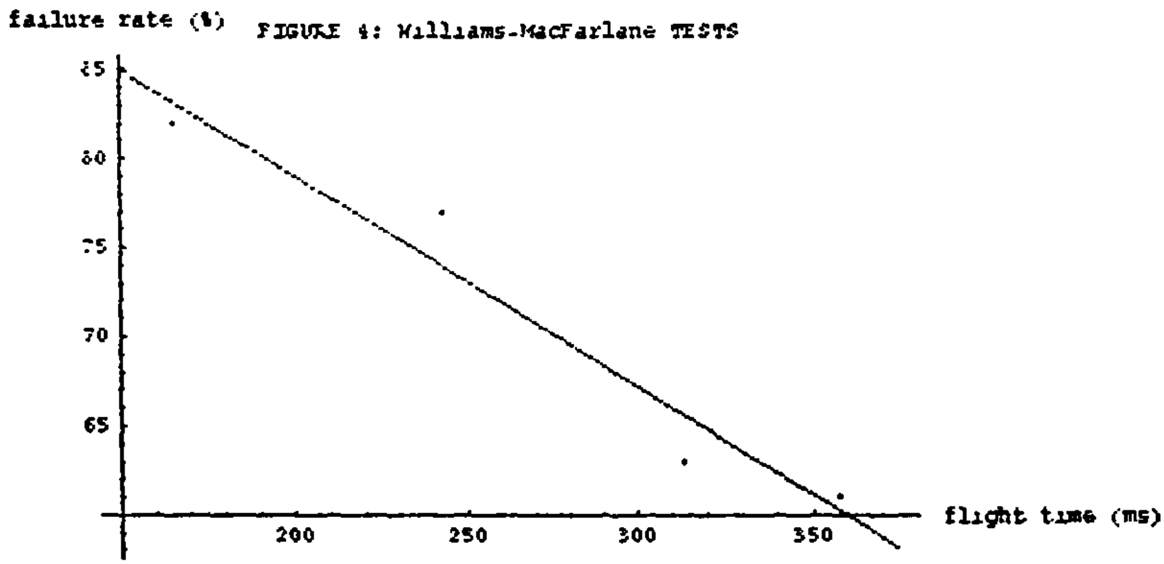


The women's high school softball results in Table 2 can be analyzed in exactly the same way. The hit-percent verses average-time data points are plotted in Figure 2. The best quadratic fit, shown in the Figure, is no longer a straight line, but the linear fit, shown in Figure 3, is as good. (χ^2 =4.21 with 5 degrees of freedom for the quadratic fit and χ^2 =7.32 with 6 degrees of freedom for the linear fit.)





Given the above interesting straight-line fits to the failure-rate verses flight-time data, it is relevant to ask if there is independent evidence for this. It is, in fact, possible to extract supporting information from Reference 2 (Williams and MacFarlane). The reported tests had male college students attempt to catch tennis balls shot at speeds of 57 to 123 mph from 20 or 30 ft. (The stated flight times are from 0.111 to 0.353 sec, but these figures fail to take air-resistance into account, and this effect is even more important for tennis balls than for baseballs.) Reaction times are reported to increase from 0.16 to 0.18 sec as the ball speed increased, whereas the movement time remained approximately constant at about 0.10 sec. In Table III of this reference, the error percentages are given for each of the (not very accurately measured) four ball speeds. These results, converted to failure-rates verses flight-times, are plotted in Figure 4. The results are consistent with the measurements reported in this paper, and the indicated linear fit is seen to be good.



For the remaining categories given in Table 3, the quantity of data is insufficient to warrant a display of graphs and χ^2 evaluations, but all of the results are seen to be consistent with linear fits as above. It will be interesting to see if more extensive future data confirms the accuracy of these fits.

5. HIT BALL SPEEDS

In the previous sections, the deflection success and failure rates were given as functions of the flight times of the incident ball. In order to convert these rates into functions of hit ball speeds, the distances between the hitters and the pitchers must be estimated. The distances between the home plate and the pitching mound are specified for each venue, but the actual flight distance is less than this for baseball, because of the forward motion of the pitcher during the pitch, and more than this for slow-pitch softball, because of the backward motion of the pitcher after the pitch. Typical values for these flight distances are 54 ft for conventional baseball, 42 ft for youth baseball, and 50 ft for slow pitch softball. Given such a distance and a flight time, the corresponding initial speed of the ball can be evaluated, again taking into account the important effects of air resistance. The results are given in Table 5.

TABLE 5: CATCH TEST SUMMARY				sec	feet	fps	mph
CATEGORY	SAMPLE	AGES	SHOTS	MAX HIT TIME	DISTANCE	MIN HIT SPEED	MIN HIT SPEED
College BB	8	18-22	320	0.368	54	155	105
High School BB	2	17	94	0 381	54	150	102
Recr. BB	4	20-54	154	0.387	54	147	100
Youth BB	1	11	40	0 417	42	107	73
Coll. men SB	4	18-22	200	0.331	50	159	108
Coll. women SB	1	18	40	0.373	50	144	98
B-level men SB	2	19.24	100	0.395	50	133	91
H.S. women SB	5	15-16	440	0.404	50	133	90
Girls (DWS) SB	2	13,14	80	0.413	50	127	87
Senior men SB	6	39-54	230	0.413	50	130	88

Table 4 is incorporated here as the first five columns. The sixth column gives the flight distance (in feet) between hitter and pitcher, as discussed above. The seventh column gives the initial hit ball speed (in feet per second) that results in the flight distance (column 6) being covered in the maximum hit time (column 5), and the final column gives this same speed in mph. The significance of these speeds is that there were no deflection failures for initial speeds greater than the given minimum hit speed.

What can we conclude from these results about the safe response times and hit ball speeds in baseball and softball? To completely answer this question, more data is needed, especially in the neighborhoods of the maximum failure times observed in these tests. It is also necessary to address the differences between these test conditions and game conditions in a quantitative way. It is finally necessary to decide on what is an acceptable level of injury for each category of play.

To illustrate how to proceed form the maximum failure times observed in these tests to recommendations for the values of safe response times and corresponding hit ball speeds for the various game categories, I consider first the college baseball data. Given that there were no failures out of 36 shots in the 0.376-0.398 sec time range (Table 2), that the maximum failure time was 0.368 sec (Table 4), and the regularity of the data as indicated in Figure 1, I conclude that a very conservative safe response time for college baseball players is 0.38 sec. To confirm this, it is necessary to obtain more data in the vicinity of 0.38 sec, so that the tail of the failure rate distribution can be fully explored It can, however, be concluded now that the failure rate is less than 1 in 36 for flight times greater than 0.368 sec, with an 83% confidence level. It is very likely that the failure rate will be rather less than 1 in 36, but even this upper limit could be acceptable. If it is assumed that 1 in 100 hits are directed towards the pitcher and are such that an impact with the pitcher would result in a serious injury, and that 1 in 10 of these hits have flight times to the pitcher of less than 0.368 sec (hit speeds greater than 105 mph), then at most 1 in 36,000 hits would lead to a serious injury. If it is further assumed that there are 20 hits per game, than a pitcher would be possibly injured at most once in 1800 games.

Given that the safe response time is 0.38 sec, the safe maximum hit ball speed can be evaluated, again taking into account the important effect of air resistance. Assuming that the pitcher is 54 ft from the hitter at the time of the hit, it would require a hit speed greater than 104 mph for the ball to reach the pitcher in less than 0.38 sec. It is therefore concluded that, if the baseballs and bats are restricted to give rise to hit ball speeds of 104 mph or less, than the college baseball players will not be subjected to an inappropriate level of risk.

To determine the corresponding restriction on baseball bats, a pitch speed (at the bat) of 70 mph and a bat speed (at the point of impact) of 70 mph will be assumed. For a bat of typical weight and moment of inertia, this restricts the bat-ball COR to be 0.616 or less. If the ball COR is 0.54, this restricts the BPF to be at most 1.14. This was the maximum BPF of the bats used in the 1994 college baseball season. For this restriction to be meaningful, the ball properties (COR and compression) must also be restricted. See Appendix 2 for more details.

As a second example, I consider next the women's high school softball data in Tables 2 and 4. Given that the maximum failure time was 0.404 sec (Table 4) and that there were 0 hits out of 32 shots in the 0.405-0.433 sec time range, a very conservative safe response time for this category is 0.43 sec. A greater safety margin his been given here than for the men's college category because of the smaller slope of the linear fit of Figure 3 compared to Figure 1, because of the generally better response time of the male players, and because of the obvious desire to provide more leeway for these younger female players. Although the precise conclusion from the test results is that the probability of failure for response times of 0.405 sec or greater is less than 1 in 32 (82% confidence level), the above graph strongly suggests that the failure rate is considerably less than that. The 0.43-sec safe response time therefore is very reasonable. More data in the neighborhood of this time is, of course, needed to finalize this conclusion.

6. DISCUSSION

The results of the tests reported in this paper are summarized in Tables 2 – 5 and figures 1 – 3. I have stressed that more tests are necessary to confirm these results, especially in the game categories in which less than 200 shots were recorded or less than 5 subjects were involved. What is needed in particular is additional measurements in the neighborhoods of the maximum failure times. When such additional information is incorporated into the determination of safe times and speeds, the recommended values may increase or decrease, but, given the conservative choices made here for these times and speeds, I expect that future contributions will decrease, rather than increase these estimates.

To illustrate this in detail, I consider again the measurements taken with the college baseball players. Since no deflection failures were observed for flight-times greater than 0.368 sec, I concluded that the failure rate is less than 1 out of 36 for times greater than 0.368 sec. When additional tests are made with flight-times greater than 0.368 sec, failures will inevitably occur. Let us say that when this new information is incorporated into the analysis, the resultant failure rate becomes 1 out of N, where N is an integer, presumably greater than 36. Let us also say that detailed observations reveal that 1 out of M game line-drives by batters result in a shot that would seriously injure the pitcher if it were not deflected. It would follow that 1 out of MN hits would actually seriously injure a pitcher. If this is the injury rate chosen to be acceptable, then the choice of 0.368 sec as the minimum safe response time will be confirmed. If this rate is greater then the chosen one, then the safe time must be increased, and if it is less than the chosen one, then this time must be decreased. The final choice for the safe time can thus be precisely determined.

The minimum safe flight time of 0.38 sec for college baseball corresponds to a maximum safe hit-ball speed of 104 mph. For typical college pitch and swing speeds (about 70 mph) and a typical bat weight and moment of inertia, this corresponds to a BPF of about 1.14. (See Appendix 2 for details.) Coincidentally, or perhaps not, this is the maximum measured BPF of the 1994 college bats (tested at 60 mph). In fact, in the 1995 SGMA-NCAA field test, where the pitch speeds were only 60 mph, the two bats with BPF's of 1.15 produced maximum observed hit speeds of 103 and 104 mph. The details of this test are given in Reference 3.

For the other categories given in Table 5, the maximum hit times are greater and the speeds are less. In using these results to estimate safe response times and hit ball speeds, due allowance must be made for the limited sample size or the perceived vulnerability of some categories. Thus, for male student baseball players, the times increase progressively as we proceed from college to high-school to youth venues, and the same is true for the female student softball venues. It is also interesting to note which categories have similar response times. The college (male) baseball players and (female) softball players are in the first class, with times of 0.37-0.38 sec. The high-school and recreational baseball players, B-level softball players, and high-school female softball players fall in the next class with times of 0.38-0.40 sec, and the final class consists of the youth baseball and softball players and the senior softball players with times of 0.41-0.42 sec.

It is also interesting to compare two individual subjects, the youngest, 11-year-old Dixie Youth pitcher Chance Murray, and the oldest, 54-year old retired player Jack MacKay. In the baseball tests, the young player had a maximum failure time of 0.417 sec and a no-failure range of 0.421-0.424 sec, whereas the old player had a maximum failure time of 0.363 sec and a no-failure range of 0.368-0.387 sec. Keep in mind that individual comparisons such as this are based on limited data and are therefore not necessarily statistically significant.

All of the data obtained in the tests have been seen to satisfy the linear relationships given by the straight-line fits shown in Figures 1 and 3. It was also shown that the data from Reference 2 could be similarly described. It will be interesting to see if future measurements confirm these remarkable regularities. If player response times were normally distributed, a faster than linear rise in failure percentage would be expected for decreasing times. It is possible that it is the decrease in reaction time with increasing ball speed that maintains the slower linear rise. These issues constitute an area for future research. It should be noted, in connection with data plots such as those in Figures 1 – 4, that error bars should be associated with the data points. Horizontal error bars, corresponding to the time ranges in Table 2, and vertical error bars, corresponding to the finite sample sizes, should be incorporated into the figures.

The importance of air resistance in the determination of flight times has been emphasized in this paper. To illustrate this, I note that the college baseball no-failure time range of 0.368-0.398 sec would have decreased to 0.355-0.379 sec if air resistance had been neglected. Although neglecting air drag decreases the calculated values of flight-times, it also decreases the calculated values of hit speeds corresponding to given flight time values, and these affects tend to cancel one another.

The differences between tests such as those reported in this paper and real game situations should be kept in mind. I have given some contributions to these differences is Section 1. Laboratory measurements are obviously useful, but they must supplemented by detailed information about actual injuries sustained in games. Such game injuries should be carefully monitored and recorded. It is in everyone's interest to keep baseball and softball among the safest sports.

ACKNOWLEDGEMENTS

I would like to thank the following people for their help with this research: Marty Archer and George Manning of H&B, for permission to use their facility in Texas; Jack, Kay, and Tripp MacKay for their hospitality in Texas, for supplying the subjects, and for help in running the tests; Jess Heald and Dan Pitsenberger of Worth, for funding the project; Andy Rodriguez of AMMCO, for introducing me to the bat performance issue; Dewey Chauvin of Easton, for sending me Reference 1; and Professor Allen Mincer of the NYU Physics Department, for useful conversations about statistics.

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APPENDIX 1: Air Drag Effects on Ball Trajectories

Consider a ball of mass m moving though the atmosphere with velocity $\vec{v}$ (speed $v=|\vec{v}|$) and with zero spin. In addition to the downward force mg of gravity, the ball experiences a resistive drag force

$$\vec{F}_D = -\tfrac{1}{2}C_D \rho A v^2 \hat{v},$$

where $\hat{v}$ is the unit vector in the direction of the velocity, A is the cross-sectional area of the ball, ρ is the density of air, and C_D is the drag coefficient. For smooth spheres and typical ball speeds, C_D is approximately equal to 0.5, but for baseballs and softballs, it is speed-dependent and its values are in the 0.3 to 0.4 range for speeds in the neighborhood of 90 mph.

If the ball has non-zero spin, then it experiences an additional force, which is perpendicular to the direction of the velocity. This force is directed upwards if the ball has bottom-spin, and downwards if it has topspin. The presence of bottom spin is useful for hits to the outfield because the upward (lift) force gives rise to longer hit distances. For line drives to the pitcher, however, this effect is negligible, and any spin imparted to the hit ball will be at the expense of hit ball speed. For a given pitch and swing speed, the fastest hit ball speed arises when no significant spin is imparted to the ball. In the determination of maximum hit speeds and minimum flight times to the pitcher, it will therefore be assumed that the hit ball has negligible spin.

The flight of the ball after it leaves the bat is determined by the differential equation

$$m\frac{d\vec{v}}{dt} = -mg\hat{y} - \tfrac{1}{2}C_D\rho A v^2\hat{v},$$

where m is the mass of the ball (the ball weights are about mg=6.5 oz for softballs and mg=5.2 oz for baseballs). Given the drag coefficient as a function of speed, and the initial velocity, this equation can be solved numerically to obtain the trajectory $\vec{r}(t)$. The ball's position $\vec{r}(t)$ and velocity $\vec{v}(t) = \frac{d\vec{r}(t)}{dt}$, at any time t after the hit, is thus obtained. The time of flight to any specified distance can then be evaluated.

In the evaluation of the flight times between the cannon and the subjects used in this paper, it was assumed that the hit balls were directed, at the measured initial speed, towards the face of the subject standing at the measured distance from the cannon. In the evaluation of the flight times between a hitter and a pitcher, it was assumed that the hit balls were directed, at the specified initial speed, at the face of the pitcher standing 54 feet from the hitter.

APPENDEX 2: Bat Performance

In the text of this paper, data on response times and corresponding hit ball speeds were presented and analyzed. To relate this data to bat performance, I will use the following equation for hit ball speed v':

$$v' = \frac{V(1+e) + v(e-k)}{1+k},$$

where V is the bat swing speed at the impact point, v is the pitch speed, e is the COR between the bat and ball, and k is the combination

$$k = \frac{w}{W} + \frac{w(R-a)^2}{I - Wa^2},$$

in terms of the ball weight w, bat weight W, bat center of mass a, bat moment of inertia I, and impact distance R. (a, I, and R are relative to a fixed point six inches from the bat knob.) The hit speed is seen to depend and many factors: bat properties (W, a, I), ball properties (w), ball-bat properties (e), pitcher properties (v), and hitter properties (V, R).

To simplify these expressions, I use the factorization $e=Be_0$, where e_0 is the ball COR and B is the bat performance factor (BPF). B, defined as the COR between the bat and a test ball divided by the COR of the test ball, is approximately a property of the bat alone. I also will assume that the impact point R is the center of percussion of the bat. This point is approximately the point of maximum hit speed. Then the hit speed depends separately on the bat properties (B, W, I), ball properties (e_0, w), and player speeds (v, V).

For further simplification, I will use the fact that v' depends only weakly on the bat weight W and MOI I. This fact is a consequence of the decrease in bat speed V with increasing W or I. This leads to optimal values of these bat properties, which are about W = 30 oz and I = 9675 oz-in^2 for a typical adult male hitter. I will also use 70 mph as the typical bat swing speed V at the COP for such a hitter, and assume that the pitch speed v (at the bat) is 70 mph for college baseball and 30 mph for slow-pitch softball. Finally, the ball parameters will be those specified by most ballgame associations: w = 5.25 oz and $e_0 = 0.54$ for baseball and w = 6.5 and $e_0 = 0.47$ for softball. With these assumptions, k = 0.25 for baseball and k = 0.30 for softball.

The above equation for hit speed v' can now be used to translate the maximum safe values of v' into maximum safe values of BPF B. For college baseball, v' = 104 mph was the maximum safe hit ball speed, and this gives e = 0.554 as the maximum safe bat-ball COR at the ball-bat relative speed V + v = 140 mph. The BPF tests and ball COR measurements are currently performed at the relative speed of 60 mph, and so to compare this result to the existing bat BPF measurements, the value of the baseball COR $e_0 = 0.54$ at 60 mph must be extrapolated from 60 to 140 mph. Using the existing information on how baseball CORs decrease with increasing speed, the result is that $e_0 = 0.485$ at 140 mph. Therefore, the maximum hit speed of 104 mph corresponds to a maximum BPF of 0.554/0.485 = 1.14. This is the maximum BPF of the bats used in the 1994 college baseball season. For men's B-level softball, the maximum safe hit speed of 94 mph corresponds to a maximum ball-bat COR of 0.612 at 100 mph, and a maximum BPF of 1.38. Since this is much greater than the BPF of 1.20 allowed by the USSSA, player safety does not appear to be a factor in the determination of bat performance limits in softball.

National Center for Catastrophic Sport Injury Research

Director: Frederick O. Mueller, Ph.D.
Medical Director: Robert C. Cantu, M. D.

SIXTEENTH ANNUAL REPORT
FALL 1982 - SPRING 1998

Research Funded by a Grant from the
National Collegiate Athletic Association
American Football Coaches Association
National Federation of State High School Associations

Introduction

In 1931 the American Football Coaches Association initiated the First Annual Survey of Football Fatalities and this research has been conducted at the University of North Carolina at Chapel Hill since 1965. In 1977 the National Collegiate Athletic Association initiated a National Survey of Catastrophic Football Injuries which is also conducted at the University of North Carolina. As a result of these research projects important contributions to the sport of football have been made. Most notable have been the 1976 rule changes, the football helmet standard, improved medical care for the participants and better coaching techniques.

Due to the success of these two football projects the research was expanded to all sports for both men and women, and a National Center for Catastrophic Sports Injury Research was established. The decision to expand the research was based on the following factors:

1. Research based on reliable data is essential if progress is to be made in sports safety.
2. The paucity of information on injuries in all sports
3. The rapid expansion and lack of injury information in women's sports

For the purpose of this research the term catastrophic is defined as any severe injury incurred during participation in a school/college sponsored sport Catastrophic will be divided into the following three definitions:

1. Fatality
2. Non-Fatal - permanent severe functional disability.
3. Serious - no permanent functional disability but severe injury. An example would be a fractured cervical vertebra with no paralysis.

Sports injuries are also considered direct or indirect. The definition for direct and indirect is as follows:

<u>Direct</u> - Those injuries which resulted directly from participation in the skills of the sport.

<u>Indirect</u> - Those injuries which were caused by systemic failure as a result of exertion while participating in a sport activity or by a complication which was secondary to a non-fatal injury.

Data Collection

Data were compiled with the assistance of coaches, athletic directors, executive officers of state and national athletic organizations, a national newspaper clipping service and professional associates of the researchers Data collection would not have been possible without the support of the National Collegiate Athletic Association, the National Federation of State High School Associations and the American Football Coaches Association. Upon receiving information concerning a possible catastrophic sports injury, contact by telephone, personal letter and questionnaire was made with the injured player's coach or athletic director. Data collected included background information on the athlete (age, height, weight, experience, previous injury, etc.), accident information, immediate and post-accident medical care, type injury and equipment involved. Autopsy reports are used when available.

In 1987, a joint endeavor was initiated with the Section on Sports Medicine of the American Association of Neurological Surgeons. The purpose of this collaboration was to enhance the collection of medical data. Dr. Robert C. Cantu, Chairman, Department of Surgery and Chief, Neurosurgery Service, Emerson Hospital, in Concord, MA, has been responsible for contacting the physician involved in each case and for collecting the medical data. Dr Cantu is also the Past-President of the American College of Sports Medicine.

Summary

Fall Sports(Tables I - VIII)

As indicated in Tables I through VIII, football is associated with the greatest number of catastrophic injuries. For the 1997 football season there was a total of 29 high school direct catastrophic injuries, which is an increase of six from 1996, but a dramatic decrease when compared to the 1993 season. This is the fourth highest number since 1982, and future reports should be monitored closely. College football was associated with six direct catastrophic injuries in 1997, which is an increase of two when compared to 1995 and 1996.

In 1990 there were no fatalities directly related to football. The 1990 football report is historic in that it is the first year since the beginning of the research, 1931, that there has not been a direct fatality in football at any level of play. This clearly illustrates that this type of data collection and constant analysis of the data is important and plays a major role in injury prevention. The 1994 data shows zero fatalities at the high school level and one at the college level, with a slight rise in 1995 to four and zero. These numbers are very low when one considers that there were 36 football direct fatalities in 1968.

In addition to the direct fatalities in 1997 there were also eight indirect fatalities. Seven of the indirect fatalities were at the high school level and none at the college level. Six of the high school indirect fatalities were heart related and one was heat related One indirect death was associated with sandlot football and was heart related.

In addition to the fatalities there were nine permanent paralysis cervical spine injuries in 1997. This number is low when compared to the 25 to 30 cases every year in the early 1970's. Seven injuries were at the high school level, one at the college level, and one in sandlot football. Football in 1997 was also associated with cerebral injuries that resulted in permanent disability. Seven injuries were at the high school level and one at the college level.

Serious football injuries with no permanent disability accounted for 12 injuries in 1997 - nine in high school and three in college. High school athletes were associated with five cervical spine fractures and four subdural hematoma injuries with full recovery. College athletes were associated with one cervical spine contusion, one herniated cervical disc, and one with transient cord symptoms.

This decrease in catastrophic football injuries illustrates the importance of data collection and being sure that the information is passed on to those responsible for conducting football programs. A return to the injury levels of the 1960's and 1970's would be detrimental to the game and it's participants.

Cross country was associated with one indirect injury in 1997. For the sixteen years indicated in Tables I through VIII, cross country was associated with one direct non-fatal injury and 11 indirect fatalities at the high school level and one indirect fatality at the college level. All eleven of the indirect injuries were heart related fatalities. Autopsy reports revealed congenital heart disease in three of these cases.

Table I shows that high school soccer had no direct serious injury in 1997 and a total of 12 catastrophic injuries for the past sixteen seasons. The three direct catastrophic injuries in 1992 was the highest number in the past sixteen years. There were no high school soccer indirect fatalities in 1997. In 1997 college soccer was not associated with any direct catastrophic injuries, but was associated with two indirect injuries. One of the indirect injuries was a heart death, and the other involved a player being struck by lightning with permanent disability.

In 1988 field hockey was associated with its first catastrophic injury since the study began in 1982. It was listed as a serious injury at the college level. The athlete was struck by the ball after a free hit. She received a fractured skull, had surgery and has recovered from the injury. The 1996 data shows two field hockey direct injuries at the high school level. Both injuries involved being hit by the ball and resulted in a head and an eye injury. There were no field hockey injuries in 1997.

In 1992-93 high school water polo was associated with its first indirect fatality and in 1988-89 college water polo had its first indirect fatality. There were no water polo injuries in 1997.

In summary, high school fall sports in 1997 were associated with 29 direct catastrophic injuries. All 29 were associated with football. There were six fatalities, 14 involved permanent disability, and nine were considered serious. For the sixteen year period 1982-1997, high school fall sports had 418 direct catastrophic injuries and 374 or 96.4% were related to football participants. In 1997 high school fall sports were also associated with seven football indirect fatalities, and one in cross country for a total of eight indirect fatalities. For the period from 1982-1997 there was a total of 126 indirect fall high school catastrophic injuries. One hundred and twenty-five of the indirect injuries were fatalities and 95 were related to football. Two of the indirect fatalities involved females - a soccer player in 1986 and a cross country runner in 1992.

During the 1997 college fall sports season there was a total of six direct catastrophic injuries and all six were in football. For the sixteen years, 1982-1997, there was a total of 96 college direct fall sport catastrophic injuries and 94 were associated with football. There were two indirect college fatality during the fall of 1997. Both, one fatality and one disability, were associated with soccer. From 1982 through the 1997 season there was a total of 30 college fall sport indirect catastrophic fatalities. Twenty-four were associated with football.

High school football accounted for the greatest number of direct catastrophic injuries for the fall sports, but high school football was also associated with the greatest number of participants. There are approximately 1,500,000 high school and junior high school football players participating each year. As illustrated in Table II, the sixteen year rate of direct injuries per 100,000 high school and junior high school football participants was 0.29 fatalities, 0.71 non-fatal injuries and 0.77 serious injuries. These catastrophic injury rates for football are higher than those for both cross country and soccer, but all three classifications of catastrophic football injuries have an injury rate of less than one per 100,000 participants. Table IV shows that the indirect fatality rates for high school football, soccer and cross country are similar and are also less than one per 100,000 participants. Water polo rates are high, but are based on only six years of data, and water polo has approximately 10,000 participants each year.

College football has approximately 75,000 participants each year and the direct injury rate per 100,000 participants is higher than college soccer and field hockey. The rate, for the sixteen year period indicated in Table VI, for college football fatalities is less than one per 100,000 participants, but the rate increases to 1 92 per 100,000 for non-fatal injuries and 5 42 per 100.000 participants for serious injuries

Indirect fatality rates are similar in college cross country and soccer, increase in football, with water polo being associated with the highest indirect fatality rate. Water polo has approximately 1000 participants each year (Table VIII). There were two college female athletes receiving a direct or indirect catastrophic injury in a fall sport for this sixteen year period of time. One was a serious injury in field hockey, and the other was an indirect death in soccer.

Incidence rates are based on sixteen year participation figures received from the National Federation of State High School Associations and the National Collegiate Athletic Association. (Figure I)

Winter Sports (Tables IX - XVI)

As shown in Table IX, high school winter sports were associated with nine direct catastrophic injuries in 1997-1998. Three injuries were related to basketball, one to ice hockey, one to swimming, and four to wrestling.

High school winter sports were also associated with eight indirect injuries during the 1997-1998 school year (Table XI). All of the injuries were fatalities, and all were associated with basketball. Five of the fatalities were heart related, one was listed as natural causes, one was related to asthma, one was listed as unknown. One of the eight was a female, and her death was heart related.

College winter sports, Tables XIII - XVI, did not have any direct catastrophic injury during the 1997-1998 season. College sports were also associated with six indirect fatalities during the 1997-1998 school year. Two were in basketball, three in wrestling, and one in volleyball. The two basketball deathes were heart related, all three wrestling deaths were heat related and associated with weight reduction, and the volleyball death was a female and heart related.

A summary of high school winter sports, 1982-1998, show a total of 80 direct catastrophic injuries (6 fatalities, 43 non-fatal, and 31 serious) and 84 indirect. Wrestling was associated with 37 or 45.7 percent of the direct injuries. Gymnastics was associated with 12 or 14 8 percent of the direct injuries. Ice hockey was associated with 12, swimming was associated with eight direct injuries, volleyball one, and basketball ten. Basketball accounted for the greatest number of indirect fatalities with 62 or 73.8 percent of the winter total.

College winter sports from 1982-1998 were associated with a total of 19 direct catastrophic injuries. Gymnastics was associated with six, ice hockey seven, basketball three, swimming one, skiing one and wrestling one. There were also 25 indirect injuries during this time period. Fourteen or 56% were associated with basketball, three in wrestling, two in ice hockey, four in swimming, one in skiing, and one in volleyball.

High school wrestling accounted for the greatest number of winter sport direct injuries, but the injury rate per 100,000 participants was less than one for all three injury categories. High school wrestling has approximately 237,000 participants each year. High school basketball and swimming were also associated with low direct injury rates. As shown in Table X, ice hockey and gymnastics were associated with the highest injury rates for the winter sports. Gymnastics has averaged approximately 4,600 male and 27,300 female participants during the past sixteen years. Ice hockey averages 23,000 participants each year. A high percentage of the ice hockey injuries involve a player being hit by an opposing player, usually from behind, and striking the skate rink boards with the top of his/her head.

Indirect high school catastrophic injury rates, as indicated in Table XII, are all below one per

100,000 participants.

Catastrophic direct injury rates for college winter sports are higher when compared to high school figures. Gymnastics had five non-fatal and one serious injury for the past sixteen years, but the injury rate is 25 51 per 100,000 participants for non-fatal male injuries and 8 16 per 100,000 for female non-fatal injuries. Participation figures show approximately 735 male and 1530 female gymnastic participants each year.

College ice hockey was associated with three serious and four non-fatal injuries in sixteen years, but the injury rate is 6.50 per 100,000 participants for non-fatal and 4.97 for serious injuries. There are approximately 4000 ice hockey participants each year. Swimming non-fatal incidence rates were not as high as gymnastics or ice hockey, but could be totally eliminated if swimmers would not use the racing dive into the shallow end of pools during practice or meets. In fact there has not been a direct injury in college swimming since the one non-fatal injury in 1982-1983

College wrestling had only one catastrophic injury from the fall of 1982 to the spring of 1998. For this period of time there were 115,172 participants in college wrestling for an average of approximately 7,198 per year. The injury rate for this sixteen year period of time was 0.87 per 100,000 participants. College skiing has approximately 505 female participants each year and the one fatality in 1989-1990 produced a sixteen year injury rate of 12.50 per 100,000 participants. This was the only skiing direct fatality since the study was initiated.

Injury rates for college indirect fatalities were high when compared to the high school rates. Basketball had an injury rate of 6.08 fatalities per 100,000 male participants, skiing 8.61, ice hockey 1.62 and swimming 3.14. The female indirect injury rate for basketball was 0.55 per 100,000 participants, and 2.10 per 100,000 for volleyball. This is the first year where there were any indirect fatalities in wrestling. the wre three deaths due to heat strke associated with te wrestlers trying to make weight for a match. the indirect injury rate for wrestling was 2.60 per 100,000 participants.

Spring Sports (Tables XVII - XXIV)

High school spring sports were associated with seven direct catastrophic injuries in 1998. Baseball was associated with four and track three. One of the track injuries were associated with the pole vault and resulted in death. The two other track injuries involved participants being struck by a discuss and a shot put. These track injuries do not include the death of a coach who was demonstrating the pole vault, bounced off the end of hte mat, and struck his head on concrete. There were no indirect fatalities in high school spring sports during the 1997-1998 school year.

College spring sports were only associated with one direct injury in 1998 and it was in baseball. There were no college indirect injuries in the spring of 1997.

From 1983 through 1997, high school spring sports were associated with 70 direct catastrophic injuries (Table XVII). Twenty-three were listed as fatalities, 23 as catastrophic non-fatal and 24 as serious. Baseball accounted for 28, track 39, lacrosse one, and softball two. Injury rates were less than one per 100,000 participants for each sport. There were three direct injuries to females in track and two in softball. There were also 29 indirect fatalities in high school spring sports during this time span (Table XIX). Nineteen were related to track, seven in baseball, two in lacrosse and one in tennis. Four of the indirect fatalities involved female track athletes.

As illustrated in Table XXI, college spring sports were associated with 16 direct catastrophic injuries from 1983 to 1998. Four of these injuries resulted in fatalities, six were listed as non-fatal and six were listed as serious. Baseball accounted for four injuries, lacrosse four and track eight. Table XXIII shows that there were also six indirect fatalities in college spring sports during this time. Two indirect fatalities were associated with tennis, one was associated with track, two in baseball and one in lacrosse.

Injury rates for high school spring sports direct injuries were low as illustrated in Table XVIII Baseball participation reveals approximately 420,000 players each year, track 850,000, and tennis 265,000. The baseball figures do not include the 274,000 softball participants each year. Lacrosse has approximately 30,000 participants each year Injury rates, as shown in Table XX, for high school indirect injuries are also low.

College spring sports, Table XXII, are related to low injury rates for direct injuries Men's lacrosse had two non-fatal and two serious injuries and the injury rates were slightly higher than the other sports. Participation figures reveal approximately 5,000 men and 3.000 women lacrosse players each year. The 1991 injury was to a female lacrosse player.

Rates for indirect college fatalities in baseball, tennis, and track are low with lacrosse being slightly higher. There were two indirect tennis fatalities, one male and one female, but participation figures are low. Men average approximately 7,700 and women 7,450 participants each year. (Table XXIV)

Discussion

Football is associated with the greatest number of catastrophic injuries for all sports, but the incidence of injury per 100,000 participants is higher in both gymnastics and ice hockey. There have been dramatic reductions in the number of football fatalities and non-fatal catastrophic injuries since 1976 and the 1990 data illustrated an historic decrease in football fatalities to zero. This is a great accomplishment when compared to the 36 fatalities in 1968. This dramatic reduction can be directly related to data collected by the American Football Coaches Association Committee on Football Injuries (1931-1998) and the recommendations that were based on that data Non-fatal football injuries, permanent disability, decreased to one for college football in 1995. There was a dramatic reduction in high school football from 15 in 1990 to four in 1991. There was an increase to ten in 1992 and 13 in 1993, but a reduction to five in 1994. The 1997 data show an increase to fourteen. Permanent disability injuries in football have seen dramatic reductions when compared to the data from the late 1960's and early 1970's, but a continued effort must be made to eliminate these injuries In addition, there were 12 serious injuries in football in 1997 - nine in high school and three in college. All of the serious cases involved head or neck injuries and in a number of these cases excellent medical care saved the athlete from permanent disability or death

Football catastrophic injuries may never be totally eliminated, but progress has been made. Emphasis should again be focused on the preventive measures that received credit for the initial reduction of injuries.

1. The 1976 rule change which prohibited initial contact with the head in blocking and tackling. There must be continued emphasis in this area by coaches and officials.
2. The NOCSAE football helmet standard that went into effect at the college level in 1978 and at the high school level in 1980. There should be continued research in helmet safety.
3. Improved medical care of the injured athlete. An emphasis on placing athletic trainers in all high schools and colleges. There should be a written emergency plan for catastrophic injuries both at the high school and college levels.
4. Improved coaching technique when teaching the fundamental skills of blocking and tackling. **Keeping the head out of football!**

It should be noted that since 1979, according to the Consumer Product Safety Commission, there have been at least 18 deaths and 14 serious injuries to children when movable soccer goals have fallen on them. The most recent case involved a 10 year old male in May 1998. A soccer goal frame fell on his head while he was helping move it. The injury left him paralyzed. According to the Consumer Product Safety Commission, climbing and hanging on the goals, as well as high winds, can cause the goals to tip The Commission suggests that goals be anchored and that participants be warned not to climb on the goals. There has been one fatality in this study which involved a college athlete hanging on a soccer goal and the goal falling and striking the victim's head A Loss Control Bulletin from K & K Insurance Group, Inc., Fort Wayne, IN, suggests the following safeguards·

1. Keep soccer goals supervised and anchored.
2. Never permit hanging or climbing on a soccer goal.
3. Always stand to the rear or side of the goal when moving it - NEVER to the front.
4. Stabilize the goal as best suits the playing surface, but in a manner that does not create other hazards to players.
5. Develop and follow a plan for periodic inspection and maintenance (e.g., dry rot, joints, hooks).
6. Advise all field maintenance persons to re-anchor the goal if moved for mowing the grass or other purposes.
7. Remove goals from fields no longer in use for the soccer program as the season progresses.
8. Secure goals well from unauthorized access when stored.
9. Educate and remind all players and adult supervisors about the past tragedies of soccer goal fatalities.

There is also a list of guidelines available for movable soccer goal safety and warning labels. To obtain a copy contact the following:

The Coalition to Promote Soccer Goal Safety
C/O Soccer Industry Council of America
200 Castlewood Drive
North Palm Beach, FL 33408

High school wrestling, gymnastics, ice hockey, baseball and track should receive close attention. Wrestling has been associated with 37 direct catastrophic injuries during the past sixteen years, but the injury rate per 100,000 participants is lower than both gymnastics and ice hockey. Due to the fact that college wrestling was only associated with one catastrophic injury during this same time period, continued research should be focused on the high school level. High school wrestling coaches should be experienced in the teaching of the proper skills of wrestling and should attend coaching clinics to keep up-dated on new teaching techniques and safety measures. They should also have experience and training in the proper conditioning of their athletes. These measures are important in all sports, but there are a number of contact sports, like wrestling, where the experience and training of the coach is of the utmost importance. Full speed wrestling in physical education classes is a questionable practice unless there is proper time for conditioning and the teaching of skills. The physical education teacher should also have expertise in the teaching of wrestling skills. It should also be emphasized that wrestling coaches need to be aware of the dangers associated with athletes making weight. Improper weight reduction can lead to serious injuries and death. During the 1997-1998 academic year there were three college that died while trying to make weight for a match. all three died of heat stroke complications. These were the first wrestling deaths associated with weight reduction, but there is no information on the number of wrestlers who had medical problems associated with weight loss, but recovered. all three of these wrestlers were trying to lose large amounts of weight in a short period of time. all three were also working out in areas of high heat, and were all wearing sweat clothes or rubber suits. Making weight has always been a part of the wrestling culture, but it is dangerous and life threatening. New rule changes went into effect for the 1998-99 high school and college seasons, and hopefully, making weight will be a thing of the past and will never result in the deaths of young high school and college athletes.

Men and women gymnastics were associated with high injury rates at both the high school and college levels. Gymnastics needs additional study at both levels of competition. Both levels have seen a dramatic participation reduction and this trend may continue with the major emphasis being in private clubs.

Ice hockey injuries are low in numbers but the injury rate per 100,000 participants is high when compared to other sports. Ice hockey catastrophic injuries usually occur when an athlete is struck from behind by an opponent and makes contact with the crown of his/her head and the boards surrounding the rink. The results are usually fractured cervical vertebrae with paralysis. Research in Canada has revealed high catastrophic injury rates with similar results. After an in-depth study of ice hockey catastrophic injuries in Canada, Dr. Charles Tator has made the following recommendations concerning prevention:

1. Enforce current rules and consider new rules against pushing or checking from behind.
2. Improve strength of neck muscles.
3. Educate players concerning risk of neck injuries.
4. Continued epidemiological research.

Catastrophic injuries in swimming were all directly related to the racing dive in the shallow ends of pools. There has been a major effort by both schools and colleges to make the racing dive safer and the catastrophic injury data support that effort. There has not been a a college injury for the past 15 years, but in 1997-98 a high school swimmer was paralyzed after diving into the shallow end of a pool while practicing a racing dive. It is a fact that since the swimming community was made aware of this fact, and along with rule changes and coaches awareness, the number of direct catastrophic injuries in swimming has been reduced. The competitive racing start has changed and now involves the swimmer getting more depth when entering the water Practicing or starting competition in the deep end of the pool or being extremely cautious could eliminate catastrophic injuries caused by the swimmer striking his/her head on the bottom of the pool. The National Federation of State High School Associations Swimming and Diving Rules Committee voted that in pools with water depth less than three and one-half feet at the starting end, swimmers will have to start the race in the water. This rule change is a refinement of a 1991-1992 rule change and took effect in the 1992-1993 season. The new rules read that in four feet or more of water, swimmers may use a starting platform up to a maximum of 30 inches above the water. Between three and one-half and four feet, swimmers may start no higher than 18 inches above the water. Less than that, it's in the pool In April 1995 the National Federation revised rule 2-7-2, which now states that starting platforms shall be securely attached to the deck/wall. If they are not, they shall not be used and deck or in-water starts will be required. These new rules point out the importance of constant data collection and analysis Rules and equipment changes for safety reasons must be based on reliable injury data

High school spring sports have been associated with low incidence rates during the past sixteen years, but baseball was associated with 32 direct catastrophic injuries and track 42. A majority of the baseball injuries have been caused by the head first slide or by being struck with a thrown or batted ball. The 1998 data show one player paralyzed after sliding head first into home plate. If the head first slide is going to be used, proper instruction should be involved. Proper protection for batting practice should be provided for the batting practice pitcher and he/she should always wear a helmet. This should also be true for the batting practice coach. During the 1998 baseball season a high school coach as struck in the head by a batted ball and died. There are always a number of non-school baseball injuries and the cause of injury is usually the same.

The pole vault was associated with a majority of the fatal track injuries. There have been fourteen high school fatal pole vaulting injuries from 1983 to 1998. This does not include the coach who was demonstrating in 1998, bounced out of the pit, struck his head on concrete, and died. In addition to the fatalities there were also seven permanent disability and six serious injuries. All 27 of these accidents involved the vaulter bouncing out of or landing out of the pit area The three pole vaulting deaths in 1983 were a major concern and immediate measures were taken by the National Federation of State High School Associations. Beginning with the 1987 season all individual units in the pole vault landing area had to include a common cover or pad extending over all sections of the pit.

BASEBALL

HIGH SCHOOL

A 16 year old high school baseball player was injured on February 26, 1998. He was hit in the chest with a pitched ball after turning toward the pitcher to bunt. He died of cardiac arrest.

A high school baseball player was struck in the head with a batted ball while pitching during an intersquad game on June 9, 1998. He was in a coma for 1 1/2 days. He had a fractured skull and surgery. He had a full recovery.

A high school baseball player was injured in a game on April 3, 1998, while sliding head first into home plate and striking his head against the catchers chest. He had a fractured cervical vertebra and surgery. Recovery is incomplete.

A 17 year old high school baseball player was injured on March 31, 1998, during pick-off practice. He was struck in the neck by the ball and had to have three surgeries for aneurysms and bleeding in the skull cavity. He did have a full recovery.

An high school coach was hit in the head by a line drive during batting practice. He died two days later.

TRACK

HIGH SCHOOL

A volunteer high school track coach died in a pole vaulting accident on March 2, 1998. He was demonstrating the pole vault when he bounced out of the landing mat and struck his head on concrete. He was taken to the hospital but never regained consciousness.

A 14 year old middle school track athlete walked into the danger zone to pick up a discus, and was struck in the back of the head by a thrown discus. She had a fractured skull, but recovered.

A 16 year old high school track athlete died on May 4, 1998, after bouncing out of the pole vault pit to a hard surface. He struck his head on the hard surface.

A 16 year old track athlete was struck in the head during practice by a shot put He was bent over picking up his shot when he was struck by another throwers shot. He was in critical care at the hospital, but has had a full recovery.

COLLEGE

A college freshman pole vaulter died from injuries suffered after doing a handstand on an 11 foot observation tower. He planned to drop to the mats below, but his back hit the platform and he fell forward into metal supporting pipes. He severed an artery near his heart and had liver damage.

Special Section on Cheerleading

The Consumer Product Safety Commission reported an estimated 4,954 hospital emergency room visits in 1980 caused by cheerleading injuries. By 1986 the number had increased to 6,911 and in 1994 the number increased to approximately 16,000. Granted, the number of cheerleaders has also increased dramatically during this time frame. It is important to stress that catastrophic injuries have been a part of cheerleading during the last 16 years, and coaches and administrators should be aware of the situation.

The National Center for Catastrophic Sports Injury Research has been collecting cheerleading catastrophic injury data during the past fifteen years, 1982-83 - 1997-98. There were no injuries during the 1997-1998 school year. Following is a sample review of the data:

1. In the early 1980's a female college cheerleader fractured her skull after falling from a human pyramid. She recovered and returned to cheerleading after several weeks in the hospital.

FEMALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASKETBALL	0.55	0.00	0 00
GYMNASTICS	0 00	0 00	0 00
ICE HOCKEY	0.00	0.00	0.00
SWIMMING	0.00	0.00	0.00
WRESTLING	0.00	0.00	0.00
SKIING	2.10	0.00	0 00

HIGH SCHOOL SPRING SPORTS
DIRECT CATASTROPHIC INJURIES
1982-83 - 1997-98

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
BASEBALL	1982-83	0	1	2	3
	1983-84	2	0	0	2
	1984-85	0	0	0	0
	1985-86	0	1	3	4
	1986-87	0	0	0	0
	1987-88	0	1	0	1
	1988-89	0	2	1	3
	1989-90	0	2	0	2
	1990-91	1	0	0	1
	1991-92	0	0	0	0
	1992-93	0	0	3	3
	1993-94	0	0	1	1
	1994-95	1	3	0	4
	1995-96	0	0	0	0
	1996-97	2	1	1	4
	1997-98	1	1	2	4
	TOTAL	7	12	13	32
LACROSSE	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	1	0	0	1
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	0	0	0

	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	1	0	0	1
TRACK	1982-83	3	0	0	3
	1983-84	0	1	0	1
	1984-85	1	0	0	1
	1985-86	0	1	0	1
	1986-87	1	0	1	2
	1987-88	0	0	2	2
	1988-89	0	0	1	1
	1989-90	1	0	2	3
	1990-91	2	2	0	4
	1991-92	1	2	0	3
	1992-93	0	2	2	4
	1993-94	2	1	2	5
	1994-95	1	0	1	2
	1995-96	0	0	0	0
	1996-97	4	1	2	7
	1997-98	1	0	2	3
	TOTAL	17	10	15	42
TENNIS	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	0	0	0
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0

	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	0	0	0
SOFTBALL	1993-94	0	1	0	1
	1994-95	0	1	0	1
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	2	0	2
TOTAL		25	25	28	78

HIGH SCHOOL SPRING SPORTS
DIRECT INJURIES PER 100,000 PARTICIPANTS
1982-83 - 1997-98

MALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.10	0.18	0.19
LACROSSE	0.31	0.31	0.00
TRACK	0.21	0.13	0.16
TENNIS	0.00	0.00	0.00

FEMALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.00	0.00	0.00
SOFTBALL	0.00	0.05	0.00
LACROSSE	0.00	0.00	0.00
TRACK	0.02	0.00	0.05
TENNIS	0.00	0.00	0.00

HIGH SCHOOL SPRING SPORTS
INDIRECT CATASTROPHIC INJURIES
1982-83 - 1997-98

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
BASEBALL	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	2	0	0	2
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	0	0	0	0
	1988-89	1	0	0	1

	1989-90	1	0	0	1
	1990-91	1	0	0	1
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	1	0	0	1
	1995-96	0	0	0	0
	1996-97	1	0	0	1
	1997-98	0	0	0	0
	TOTAL	7	0	0	7
LACROSSE	1982-83	1	0	0	1
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	0	0	0
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	1	0	0	1
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	2	0	0	2
TRACK	1982-83	3	0	0	3
	1983-84	0	0	0	0
	1984-85	2	0	0	2
	1985-86	1	0	0	1
	1986-87	0	0	0	0
	1987-88	1	0	0	1
	1988-89	1	0	0	1
	1989-90	3	0	0	3
	1990-91	2	0	0	2
	1991-92	0	0	0	0
	1992-93	3	0	0	3
	1993-94	1	0	0	1
	1994-95	0	0	0	0

	1995-96	0	0	0	0
	1996-97	2	0	0	2
	1997-98	0	0	0	0
	TOTAL	19	0	0	19
TENNIS	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	1	0	0	1
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	0	0	0
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	1	0	0	1
SOFTBALL	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	0	0	0
TOTAL		29	0	0	29

HIGH SCHOOL SPRING SPORTS
INDIRECT INJURIES PER 100,000 PARTICIPANTS
1982-83 - 1997-98
MALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.11	0.00	0.00
LACROSSE	0.63	0.00	0.00
TRACK	0.20	0.00	0.00
TENNIS	0.05	0.00	0.00

FEMALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.00	0.00	0.00
SOFTBALL	0.00	0.00	0.00
LACROSSE	0.00	0.00	0.00
TRACK	0.07	0.00	0.00
TENNIS	0.00	0.00	0.00

COLLEGE SPRING SPORTS
DIRECT CATASTROPHIC INJURIES
1982-83 - 1997-98

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
BASEBALL	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	1	0	0	1
	1986-87	0	0	0	0
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	1	1
	1990-91	0	0	0	0
	1991-92	1	0	0	1
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	1	0	1
	1997-98	0	0	0	0
	TOTAL	2	1	1	4
LACROSSE	1982-83	0	1	1	2
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	1	0	1
	1991-92	0	0	0	0

	1992-93	0	0	1	1
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	2	2	4
TRACK	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	1	1
	1985-86	0	0	0	0
	1986-87	0	1	0	1
	1987-88	0	0	0	0
	1988-89	0	0	1	1
	1989-90	1	0	0	1
	1990-91	0	1	0	1
	1991-92	0	0	0	0
	1992-93	1	0	0	1
	1993-94	0	0	0	0
	1994-95	0	0	1	1
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	1	0	1
	TOTAL	2	3	3	8
SOFTBALL	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	0	0	0
TOTAL		4	6	6	16

COLLEGE SPRING SPORTS
DIRECT INJURIES PER 100,000 PARTICIPANTS
1982-83 - 1997-98
MALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.58	0.29	0.29
LACROSSE	0.00	1.25	2.50
TRACK	0.37	0.55	0.55
TENNIS	0.00	0.00	0.00

FEMALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
SOFTBALL	0.00	0.00	0.00
LACROSSE	0.00	1.97	0.00
TRACK	0.00	0.00	0.00
TENNIS	0.00	0.00	0.00

COLLEGE SPRING SPORTS
INDIRECT CATASTROPHIC INJURIES
1982-83 - 1997-98

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
BASEBALL	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	1	0	0	1
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	1	0	0	1
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	2	0	0	2
LACROSSE	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	0	0	0	0
	1987-88	0	0	0	0

	1988-89	1	0	0	1
	1989-90	0	0	0	0
	1990-91	0	0	0	0
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	1	0	0	0
TRACK	1982-83	0	0	0	0
	1983-84	0	0	0	0
	1984-85	0	0	0	0
	1985-86	0	0	0	0
	1986-87	1	0	0	1
	1987-88	0	0	0	0
	1988-89	0	0	0	0
	1989-90	0	0	0	0
	1990-91	0	0	0	0
	1991-92	0	0	0	0
	1992-93	0	0	0	0
	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	1	0	0	1
SOFTBALL	1993-94	0	0	0	0
	1994-95	0	0	0	0
	1995-96	0	0	0	0
	1996-97	0	0	0	0
	1997-98	0	0	0	0
	TOTAL	0	0	0	0
TOTAL		6	0	0	6

COLLEGE SPRING SPORTS
INDIRECT INJURIES PER 100,000 PARTICIPANTS
1982-83 - 1997-98

MALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
BASEBALL	0.58	0.00	0.00
LACROSSE	1.25	0.00	0.00
TRACK	0.18	0.00	0.00
TENNIS	0.81	0.00	0.00

FEMALE

SPORT	FATALITIES	NON-FATAL	SERIOUS
SOFTBALL	0.00	0.00	0.00
LACROSSE	0.00	0.00	0.00
TRACK	0.00	0.00	0.00
TENNIS	0.84	0.00	0.00

PARTICIPATION FIGURES
1982-83 - 1997-98

	HIGH SCHOOL		COLLEGE	
	MEN	WOMEN	MEN	WOMEN
FOOTBALL	22,800,000	3,238	1,200,000	0
CROSS COUNTRY	2,566,274	1,808,447	156,910	125,384
SOCCER	3,681,907	2,137,347	239,842	122,962
BASKETBALL	8,339,177	6,492,629	213,748	181,798
GYMNASTICS	73,635	437,536	11,758	24,496
ICE HOCKEY	375,783	8,613	61,576	2,878
SWIMMING	1,272,224	1,493,800	127,317	126,542
WRESTLING	3,780,295	7,428	115,172	0
BASEBALL	6,720,776	9,716	344,334	0
SOFTBALL	13,856	4,380,769	0	164,852
LACROSSE	320,184	171,282	80,028	50,768
TRACK	7,625,824	6,013,045	540,604	360,361
TENNIS	2,138,347	2,102,524	123,966	119,201
FIELD HOCKEY	200	818,913	0	81,691
SKIING	42,142 (94-98)	34,984 (94-98)	11,608	8,001
WATER POLO	65,159	25,729	16,448	0
VOLLEYBALL	127,929 (94-98)	1,441,928 (94-98)	3,921 (94-98)	47,642 (94-98)
TOTAL	**59,943,712**	**27,387,928**	**3,247,232**	**1,416,576**

Last updated: August 10, 1999

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LITTLE LEAGUE BASEBALL® INCORPORATED
INTERNATIONAL HEADQUARTERS

Stephen D. Keener
PRESIDENT AND CEO

August 3, 2000

Office of the Secretary
Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814

RE: *Petition CP00-1 on Baseball Bats*

On behalf of Little League Baseball, Incorporated, I am responding to the U.S. Consumer Product Safety Commission's call for comments in reference to Docket #CP00-1.

While no sport or athletic activity is played without some risk of injury, baseball, and specifically Little League Baseball, is among the safest of all youth sports activities. Ten years of injury data compiled from 1987-1996 in the enclosed report will support the conclusion that youth baseball is essentially a very safe activity.

Although an analysis of injury data for 1997-1999, comparable to the ten year study enclosed, does not exist, it is clear from various records of injury data maintained by Little League Baseball, Incorporated that the number of injuries in Little League Baseball have declined since 1996. I am therefor confident that since the overall injuries in Little League Baseball have declined from 1996 through 1999, any detailed injury analysis would validate the past reports and further underscore the relative safety of Little League Baseball. We believe this trend to be largely due to our affiliated local program' efforts and initiatives in ASAP, A Safety Awareness Program.

Little League Baseball, Incorporated will work cooperatively with all parties regarding the subject matter of Docket #CP00-1, and will disseminate appropriate information to the CPSC upon request.

Sincerely,

Stephen D. Keener

STEPHEN D. KEENER
President and
Chief Executive Officer

cc: Daniel Kirby

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INJURIES IN LITTLE LEAGUE BASEBALL – 1987-1996

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INJURIES IN LITTLE LEAGUE BASEBALL

1987 - 1996

Baseball is the second most commonly played team sport in the country (after basketball) with approximately 8.6 million participants aged six to 17 participating each year.[1] In 1995 there were over four million boys and girls in organized amateur youth baseball leagues, with Little League Baseball, Inc. (LLB) comprising over 50% of these.

Baseball has been cited as a sport with a high number of injuries. The Consumer Product Safety Commission (CPSC) stated that there were 88 deaths in baseball from 1973 to 1995, more than any other sport.[2] Sixty-eight of the deaths were caused by ball impact and thirteen were caused by bat impact.

The purpose of this paper is to describe the incidence of injuries to Little League Baseball players aged five to 12 years for a ten year period of time - 1987 through 1996. There are some controversial areas associated with youth baseball and equipment. These areas include the impact-reduced ball, batter chest protectors, facemasks, and safety bases. This paper places the injuries that this equipment is supposed to help prevent in the context of all injuries in LLB.

METHODS

Little League Baseball, Inc. is located in Williamsport, Pennsylvania and represents players in that specific organization. There are many other youth baseball organizations, but there is only one Little League Baseball, Inc. This organization has been collecting insurance data for many years from all of their leagues across the United States

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(approximately 6200 leagues), and that database was used for the current analysis. Little League Baseball programs are required by Little League regulation to obtain accident insurance coverage for all players, managers, coaches, and umpires. The accident insurance plan is made available to all Little League programs and is administered by Little League Baseball Incorporated at its international headquarters in Williamsport, Pennsylvania. The policy provides insurance benefits up to $100,000 for treatment rendered within 52 weeks from the date of the accident on an excess basis. The excess provision means that the plan only provides benefits for treatment that is not covered in full by the parents' or claimants' personal or group insurance plan. The vast majority of affiliate leagues (97%) participate in the insurance option. Approximately one-third of all the claims are made on a primary basis, meaning that there is no other insurance in effect to pay the bills.

All injuries not directly related to baseball were deleted from the insurance database. Analysis was also restricted to players' aged 5 – 12 since this is the age group predominantly involved in Little League Baseball. Denominator data on the participants is also collected by LLB on an annual basis.

RESULTS

Little League baseball, Inc. had an average of 1,722,121 male and female participants age 5 - 12 for the ten-year period from 1987 through 1996 for a total of 17,221,210 athlete years of follow-up. There were 29,038 injuries (including warm-up and batting circle injuries) and an injury rate of 1.69 injuries per 1,000 participants per season in the age group 5 – 12 years. The greatest number of injuries was associated with the runner. Runners accounted for 6,137 injuries or 21.1 percent of all injuries. Infielders

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had the greatest number of injuries for defensive positions accounting for 6,012 injuries or 20.7 percent of all injuries. Infielders were followed by the batter with 5,567 injuries. It was interesting to note that the runner and batter were associated with 40.3 percent of all injuries. The outfielders accounted for 14.2 percent of the total injuries and were second to infielders when looking at defensive positions. Catchers were associated with 3649 or 12.6 percent of the total injuries, and they were followed by the pitcher with 2080 injuries or 7.2 percent of the total injuries. It was also interesting to note that warm-up activities and being in the on deck circle accounted for 5.1 percent of the total injuries. Little League Baseball eliminated the on deck circle for the Little League Baseball Division in 1996. Senior and Big League Divisions continue to use an on-deck circle.

POSITION AT TIME OF INJURY

Three quarters of the injuries to runners (73.7%) took place in games. The body part most injured by the runner was the ankle, followed by the arm-wrist-elbow and the knee. If the ankle and knee injuries were combined they would have accounted for approximately 40% of the injuries. Sliding is associated with a high percentage of lower leg injuries and nearly two-thirds of injuries to the base runner resulted from sliding. (Table 1) There were also 559 facial injuries and 180 head and neck injuries to the runner. Fracture, sprains, and contusions accounted for 85% of the injuries to runners. Forty percent of the injuries were fractures, 30% sprains, and 14% contusions.

Infielders received a majority (56%) of their injuries in games. The face was the most injured body part and accounted for 2253 or 37% of the injuries to infielders. Teeth were the second most injured body part followed by the hand-fingers, arm-wrist-elbow, knee-

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ankle, and head-neck. Fractures accounted for one-third of the injuries to infielders, closely followed by contusions. Dental injuries were third on the list followed by lacerations and sprains. Concussions were associated with 1.2% of the injuries to infielders. The batted ball accounted for over one-third of the total injuries, being struck by a thrown ball was second, and colliding was third. (Table 1)

Batters received a majority of their injuries (72%) in games from pitched balls. (Table 1) The body part most injured was the hand-finger, followed by the face, arm-wrist-elbow, knee-ankle, head-neck, chest, and leg. The three leading injury types for batters were contusions (46.0%), fractures (29.7%), and sprains (6.4%).

In contrast to the other positions, outfielders received more injuries during practice than in games. Facial injuries (eye, face, mouth, nose, and lips) accounted for 40.7% of the injuries. Teeth injuries were the next most injured body part accounting for 18.4% of the total injuries. Facial injuries combined with teeth injuries accounted for 59.1 % of injuries to outfielders. Fractures are the most prevalent injury to outfielders accounting for 30.3%. Fractures were followed by contusions (25.6), dental injuries (18.5), lacerations (11.3), sprains (6.9), and concussions (1.5%). There was also one fatal injury among the outfield group. The baseball was in some way associated with two-thirds of the injuries to outfielders. (Table 1)

Catchers were fifth on the most injured position list with 3,649 injuries. Two-thirds of the injuries to catchers took place in games. The body part most injured for catchers was the hand-fingers with 36.0% of the total injuries. The second most injured body part was the arm-wrist-elbow (16.1) followed by the face (14.7%), knee-ankle (9.5%), teeth (6.7%), and head-neck (5.6%). As was true for outfielders, infielders, and runners, fractures were the type injury most associated with the catcher (35.4%), followed by contusions (32.0%), sprains (13.8%), dental (6.8%), lacerations (5.0%), and concussions (1.0). There was also one fatal injury to catchers. Catchers were most frequently injured by the pitched ball as opposed to the batted ball.(Table 1) This would seem logical since the catcher is involved with every ball that the pitcher throws.

The body part most injured for pitchers was the face with 32.3% percent of the injuries, followed by the arm-wrist-elbow (13.4%), knee-ankle (10.1%), teeth (10.1), hand-fingers (9.7%), and head-neck (7.8%). Type injuries most associated with pitchers were contusions (36.5%), fractures (25.4%), sprains (11.2%), dental (10.1%), lacerations (6.9%), and concussions (2.0%). Pitchers were injured approximately one-half of the time by the batted ball, with the thrown ball being the second leading cause of injuries. (Table 1)

TYPE OF INJURY

A majority of the knee and ankle injuries were sprains (44.8%). If contusions were combined with sprains, they would account for 65.7% of the total knee and ankle injuries. Fractures accounted for 20.2% of the injuries. The single greatest cause of knee and ankle injuries is sliding. (Table 2)

The two major types of facial injuries to Little League Baseball players were dental injuries and fractures. These two injury types accounted for 63.8% of the facial injuries to the 5-12 age group. Contusions and lacerations ranked third and fourth. The two leading types of facial injuries, dental and fractures, are serious injuries and the facemask has been recommended as a preventive measure. It is a popular belief that a majority of the facial injuries in youth baseball are caused by the pitched ball, but in fact the thrown ball accounts for one-third of the facial injuries and the batted ball accounts for another one-third. The pitched ball was associated with only 11% of the facial injuries. (Table2)

Contusions, lacerations, and hemorrhages accounted for a majority of the injuries to the eye (83.5%). As was true for facial injuries the leading causes of eye injuries were the batted and thrown ball.

The four major injuries to the head were contusions, concussions, lacerations, and fractures. Contusions accounted for 43.6%, concussions 21.5%, lacerations 19.8%, and fractures 2.8%. Concussions and fractures are serious injuries and the helmet should play a major role in preventing these injuries. The leading causes of head injuries were the batted ball, the thrown ball, being hit by a bat, and the pitched ball. (Table 2)

Chest injuries to youth baseball players receive a lot of attention as a cause of death. There were only 343 chest injuries out of a total 29,038 injuries. Approximately 75% of the chest injuries occurred in games and contusions accounted for a majority of the injuries (85.7%). There were no fatalities. One-third of the chest injuries are caused by the pitched ball, followed by the batted ball, colliding, the thrown ball, and being hit by a bat. Table 2)

COMMENT

The data in this paper presents a descriptive analysis of the injuries in the nation's largest organized youth baseball league. The ten years of injury data from Little League Baseball, Inc. is the only national injury information available, and epidemiological analysis of this data is critical to future research in youth baseball safety.

The Consumer Product Safety Commission stated in 1996 that the National Electronic Injury Surveillance System estimated 168,000 emergency room visits annually due to baseball/softball/t-ball injuries among 5 to 14 year olds. The Commission concluded that about one third of these injuries could be prevented or reduced in severity if reduced impact balls, safety bases, and face guards were universally worn.[2] The CPSC data made headlines in many national newspapers and caused concern among baseball parents and administrators.

We agree that prevention efforts are important to the sport, and support any intervention that has proven its effectiveness. It is also important to frame each intervention within the overall spectrum of injury in this sport. Looking at the context of the data presented in this paper, the potential benefits of safety bases and reduced impact balls are large. However, two other controversial areas, chest protectors and face protectors, appear to be of lesser importance.

Sliding was associated with almost two-thirds of the injuries to runners, and if collisions were included the percentage would increase to 71%. Sliding has always been associated with a large percentage of youth baseball injuries and will remain at the top of the list until proper sliding techniques are taught by coaches and until the debate over the use of safety bases is settled.[3]

Modified balls, designed to generate lower impact forces, also hold considerable promise in this game where over one-half of all injuries relate to contact with the ball. Although the impact dynamics of modified balls clearly differs from the traditional hard ball, there is still a need for a large scale epidemiologic study examining their effectiveness in the field.

There are a number of people who feel that all batters should be made to wear a protective vest.[4,5] A major problem is the lack of evidence that a vest will protect the batter and, as shown in this research, the very small number of chest injuries. In view of this, it is currently difficult to argue for use of protective vests.

It has been suggested that the facemask be required for all helmets in order to prevent facial injuries to the batter, and very good shatterproof eye protection is now available.[6,7] Our data, however, show that a majority of the facial injuries are received while playing defense. Data that is needed is whether facial injuries to the batter being hit by a pitched ball have a higher percentage of serious injuries, and if the facemask is in fact preventing facial injuries. Additional data is needed concerning the use of the facemask while running the bases.

The injury rate observed in this study is consistent with that found by Pasternak, et.al. in a survey of Little League affiliates in Rochester, NY.[8] The risk of injury – 1 in 500 players per season – is low, considering the risks associated with full body contact sports such as football.

Based on these data it appears that youth baseball is essentially a very safe activity. In addition, team sports can be used to promote physical activity, leadership, and teamwork. Given the declining levels of physical activity in the general population, and the ever increasing proportion of sedentary adolescents, we would do well to continue to promote baseball as America's national pastime.