

# Survey Analysis to Assess the Effectiveness of the Bull Tough Helmet in Preventing Head Injuries in Bull Riders: A Pilot Study

\*Mark A. Brandenburg, MD, FAAEM, and †Pam Archer, MPH

\*Trauma Emergency Center, St. Francis Hospital, Tulsa, Oklahoma, USA; and †Assistant Director, Injury Prevention Service, Oklahoma State Department of Health, Oklahoma City, Oklahoma, USA.

**Objective:** The purpose of this pilot study was to assess the effectiveness of the Bull Tough helmet (Bull Tough, Seguin, TX) in preventing head injuries to bull riders. The hypothesis was that this helmet is effective in diminishing the incidence of head injuries in bull riders.

**Design:** This study was a retrospective study.

**Methods:** Surveys were mailed to 320 purchasers of the Bull Tough helmet. Participants were asked to recall the numbers of rides performed in 1999 while wearing the helmet and the number of rides performed in 1999 while not wearing the helmet. In addition, they were asked to provide the number and severity of head injuries suffered in 1999 both while wearing the helmet and while not wearing the helmet.

**Setting:** Participants responding to the survey were bull riders from the United States and Canada.

**Participants:** Eighty-one riders responded to the survey.

**Main Outcome Measurements:** The primary outcome measurements were planned before data collection began and included the incidence of head injuries to bull riders both while wearing the helmet and while not wearing the helmet.

**Results:** While not wearing a helmet, the incidence of head injury was 1.54% per ride (11 head injuries/713 rides). While wearing the helmet, the incidence of head injury was 0.80% per ride (28 head injuries/3,518 rides). Using the  $X^2$  test, the *p* value was 0.0570.

**Conclusions:** This study supports the hypothesis that the Bull Tough helmet diminishes the incidence of head injury in bull riders.

*Clin J Sport Med* 2002;12:360-366.

## INTRODUCTION

Bull riding is a mainstay event in American competition rodeo. This sport has been implicated in up to 37% of rodeo injuries and is one of the most dangerous sporting activities of the modern era.<sup>1</sup> The incidence of injury associated with bull riding has been shown to be two times higher than with other major rodeo events (3.6 versus 1.8 per 100 competitor exposures).<sup>2</sup> In one small, amateur bull riding series, the incidence of head injuries in participants was 5.1% per ride (Brandenburg MA, Unpublished data, 1998). Bull riding participants frequently suffer head and neck injuries, which sometimes result in permanent neurologic sequelae or death.<sup>3,4</sup>

Despite these known risks of head injury while bull riding, no prior research into the efficacy of wearing protective headgear has been conducted. Consequently, rodeo organizations do not have an evidence-based impetus to require that bull riders wear protective headgear.<sup>5,6</sup> In one rule book, a mouthpiece and sternal vest is mandated for each bull riding participant. It is men-

tioned that "helmets may be worn in lieu of western hats," but no requirements have been established.<sup>5</sup>

During recent years, some bull riders have been using the Bull Tough helmet. This piece of equipment is a modified hockey helmet with a steel or titanium face guard manufactured by Bauer and distributed by Bull Tough (Seguin, TX). One accessory, a clear polycarbonate shield that can be placed on the outside of the face guard, is also available. The effectiveness of this helmet in preventing head injuries while bull riding has not previously been studied. It was hypothesized that this helmet is effective at diminishing the incidence of head injuries in bull riders who wear it. The purpose of this pilot study was to gather preliminary data in an effort to test this hypothesis.

## METHODS

### Survey Technique

This study was performed by survey mailings. The names and last known addresses of the bull riders who purchased Bull Tough helmets from June 5, 1995, to July 19, 1999, were obtained from the customer database of Bull Tough. A total of 320 surveys were sent out to bull riders, professional and amateur. Riders were asked to approximate the number of rides taken in 1999. Details

Received November 2001; accepted August 2002.

Address correspondence and reprint requests to Mark A. Brandenburg, MD, FAAEM, Trauma Emergency Center, St. Francis Hospital, 6161 S. Yale, Tulsa, OK 74136, USA. E-mail: MBrand2435@aol.com

were sought on the head and neck injuries sustained and use of the Bull Tough helmet, and how use of this helmet related to sustained injuries. Data on the age, weight, and height of each rider was also obtained.

- 1) The incidence of head injuries with the Bull Tough helmet is described as a percentage and was determined by taking the number of head injuries that occurred while the Bull Tough helmet was being worn, dividing it by the total number of rides with the Bull Tough helmet, and multiplying by 100. The definition of a head injury was given as "any event that results in you being dazed, confused, having brief visual changes, cuts or bruises anywhere above the neck, tooth or mouth injuries, headaches, loss of consciousness or facial injuries as a result of a head or face impact."
- 2) The incidence of head injuries without the Bull Tough helmet is described as a percentage and was determined by taking the number of head injuries that occurred while the Bull Tough helmet was not being worn, dividing it by the total number of rides that took place while not wearing the Bull Tough helmet, and multiplying by 100.
- 3) The incidence of neck injuries with the Bull Tough helmet is described as a percentage and was determined by taking the number of neck injuries that occurred while the Bull Tough helmet was being worn, dividing it by the total number of rides with the Bull Tough helmet, and multiplying this figure by 100. The definition of a neck injury was given as "any impact against the neck or sudden jerking of the neck that results in unusual soreness, pain, swelling or stiffness in the neck or a broken neck."
- 4) The incidence of neck injuries without the Bull Tough helmet is described as a percentage and was determined by taking the number of neck injuries that occurred while the Bull Tough helmet was not being worn, dividing it by the total number of rides without the Bull Tough helmet, and multiplying this figure by 100.

## RESULTS

### Age, Weight, and Height of Respondents

Of the 320 surveys sent to purchasers of the Bull Tough helmet, 81 completed surveys, or 25.3%, were returned. However, 55 surveys were undeliverable by the

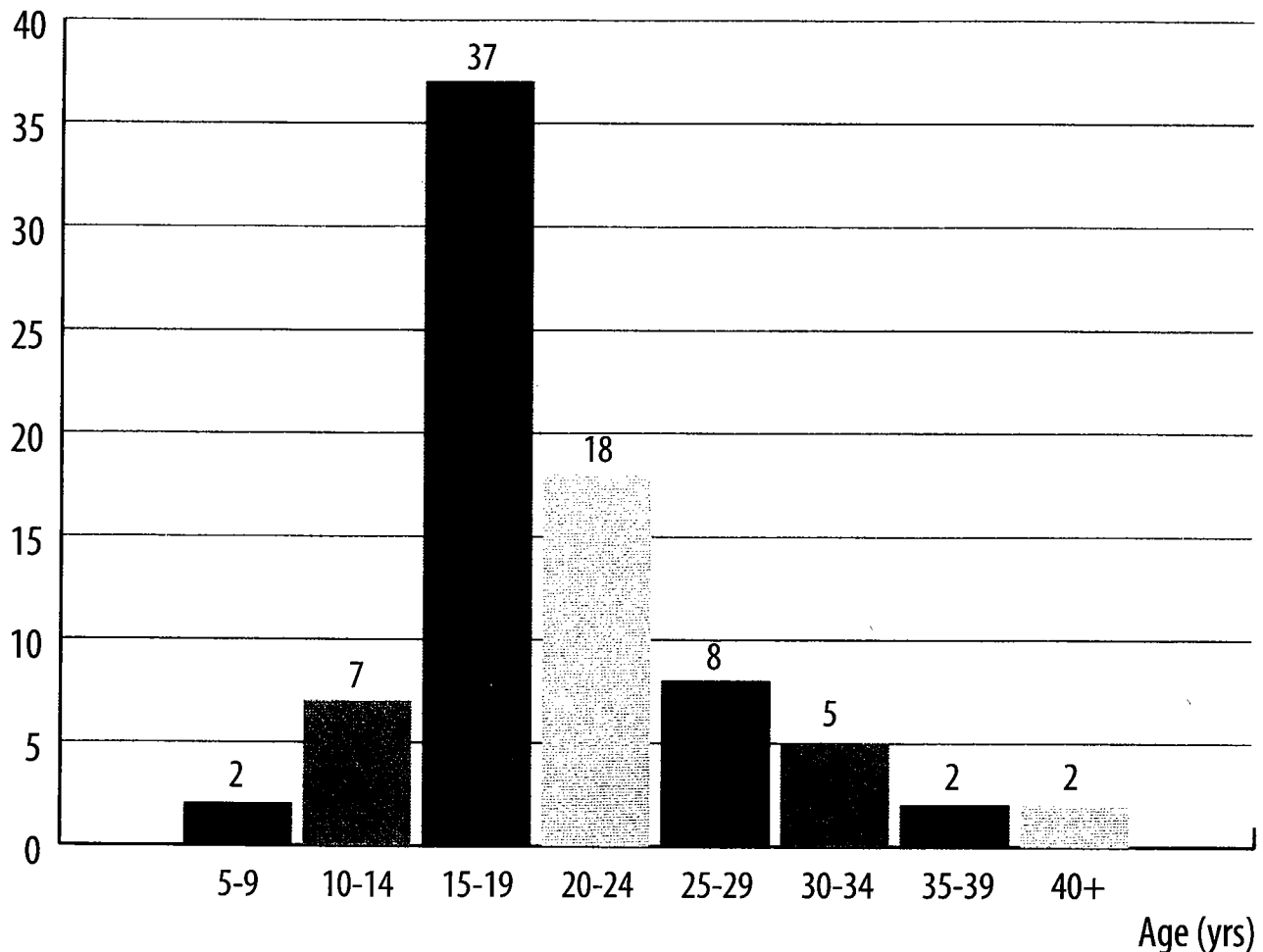


FIG. 1. Age distribution of bull riders who responded to the survey.

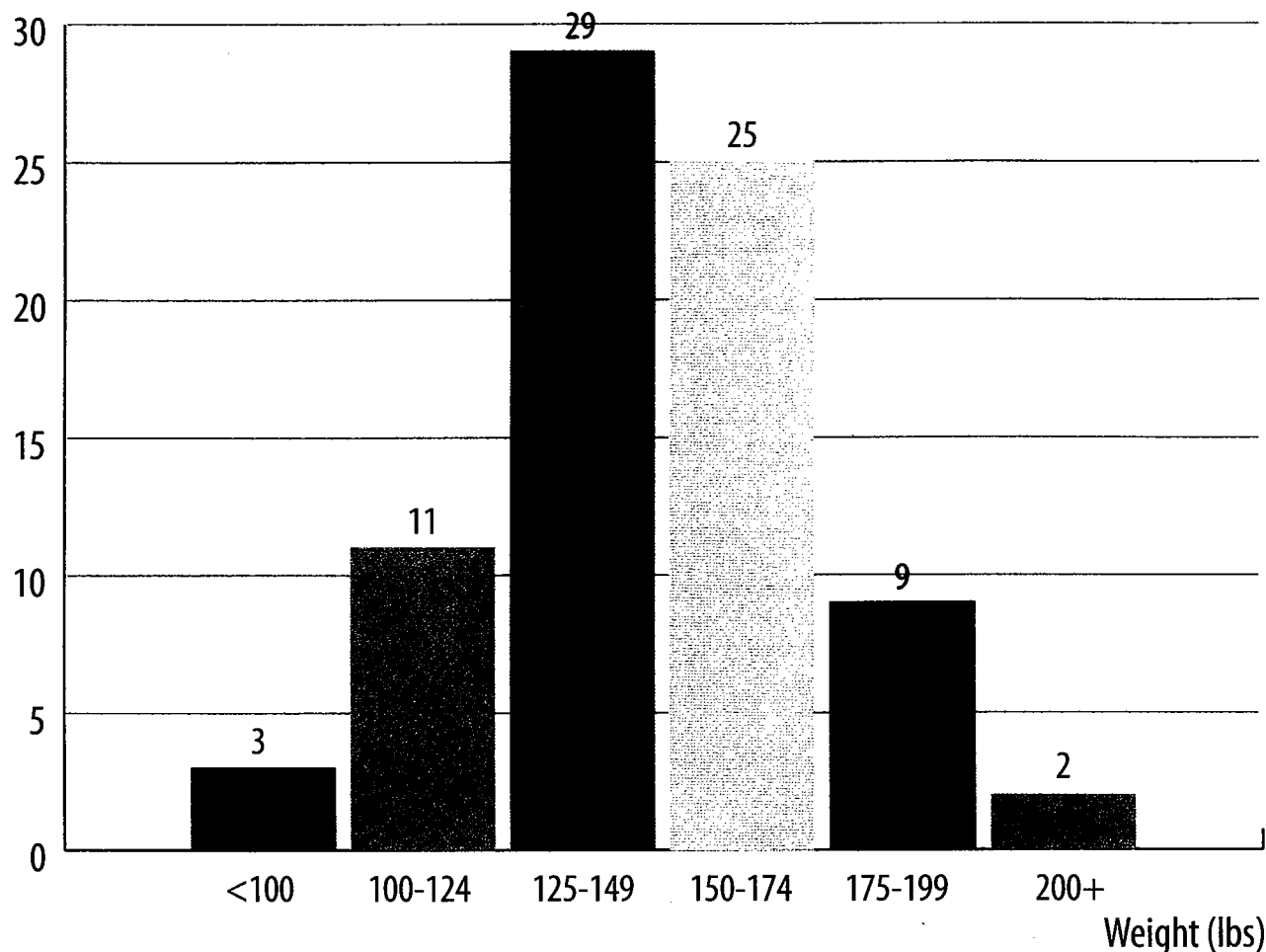


FIG. 2. Weight distribution of bull riders who responded to the survey.

US Postal Service. Of those reaching the intended address, 30.6% (81/265) of the surveys were completed and returned.

The mean age of the respondents was 20 years, while the median was 20.5 years. The youngest riders were 7 and 8 years old. There were six riders less than 13 years of age. The oldest riders were 51 and 52 years old. Seven riders were older than 30 years (Fig. 1).

The mean weight of the bull riders was 139 pounds, while the median was 144 pounds. The range was 42 to 220 pounds (Fig. 2).

The mean height of the bull riders was 67 inches (5 feet and 7 inches), while the median was 68 inches. The range in height was 47 inches (3 feet and 11 inches) to 76 inches (6 feet and 4 inches) (Fig. 3).

#### Percentage of Professional Riders versus Amateur Riders

Seven of the respondents (8.6%) were full-time, professional bull riders, while the rest (91.4%) were part-time competitors.

#### Incidence of Head Injury

There were 713 rides without the helmet, with 11 injuries occurring to those riders. While not wearing a

helmet, the incidence of head injury was 1.54% per ride. There were 3,518 rides with the helmet and 28 head injuries occurring to those riders. While wearing the Bull Tough helmet, the incidence of head injury was 0.80% per ride (Fig. 4). This rate represents a 1.9 times greater likelihood of head injury occurring to the riders while not wearing the helmet. In other words, wearing the Bull Tough helmet decreased the incidence of head injury by 48%. Using the  $X^2$  test, the  $p$  value is 0.0570.

#### Perception of Head Injury Protection

The question, "Has your Bull Tough helmet saved you from head injury?" examined the rider's perception of whether the Bull Tough helmet was protective. Seventy-nine (97.5%) of the respondents answered the question with a "yes" or "no." Of these, 74 (93.7%) respondents answered "yes," and five (6.3%) answered "no."

By asking, "If so, how many times?" we attempted to determine the number of prevented head injuries each rider perceived as a result of wearing the Bull Tough helmet. Of the 74 respondents who answered "yes" to the question, 23 failed to put a figure in the blank space provided. However, eight of these respondents who

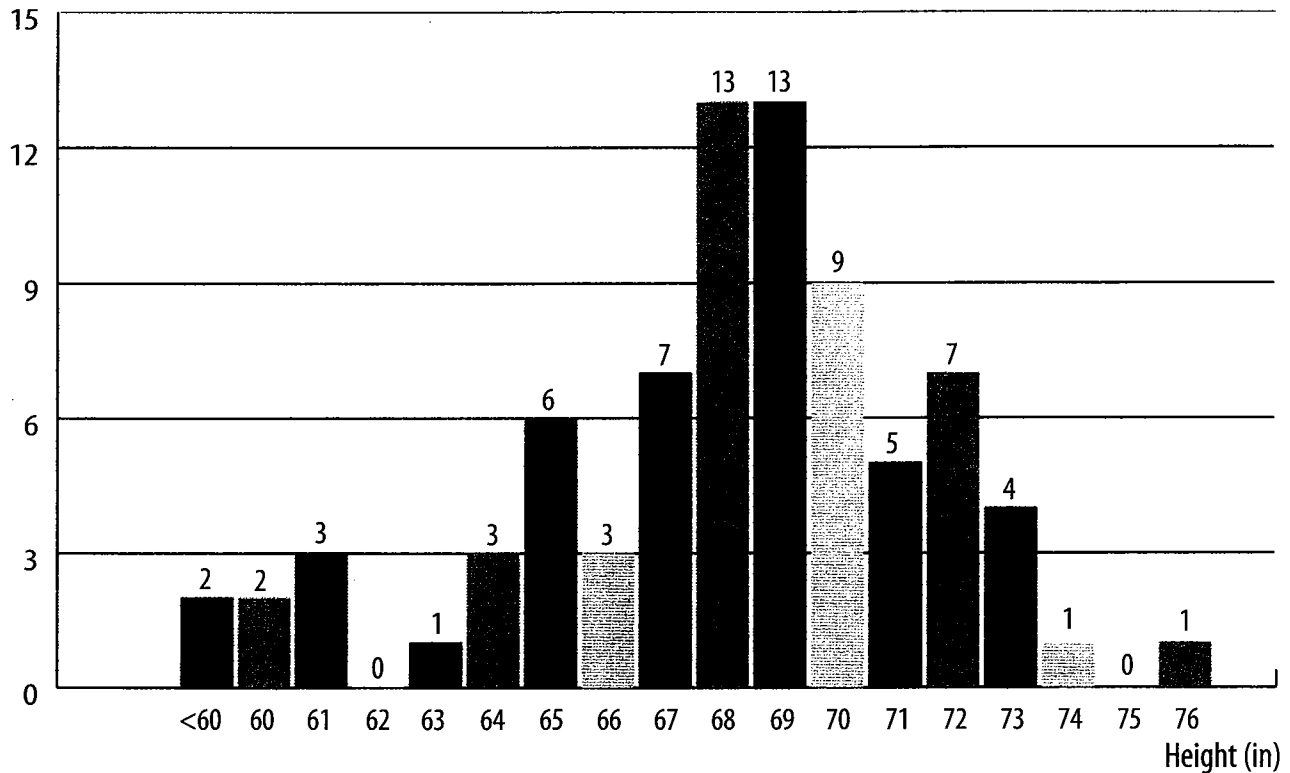


FIG. 3. Height distribution of bull riders who responded to the survey.

failed to put a figure did put "many," and another 10 wrote "several" in answer to this question.

#### Incidence of Neck Injury

There were 713 rides without the helmet and three neck injuries to the riders while not wearing the device. The incidence of neck injury while riding without a helmet was 0.42% per ride. There were 3,518 rides with the helmet and 11 neck injuries while wearing the device. The incidence of neck injury with the helmet was 0.31% per ride (Fig. 5). Using the  $X^2$  test, the  $p$  value was 0.648.

#### Problems With the Bull Tough Helmet

In response to the question, "Have you had any problems with the Bull Tough helmet?" 29 (35.8%) of the riders said "yes." However, these problems were all limited to minor issues of helmet wear and tear after much use, with the three exceptions described in the following paragraph. Ten riders commented that the foam padding inside the helmet wore off and needed replacing at some time. Seventeen riders had complaints about the chin strap or the snaps on the strap, saying either that the snaps came loose during impact or that they were too difficult to fasten before the ride. Twelve riders commented that the clear polycarbonate face shield on the helmet would obstruct vision, because it was prone to being scratched in falls or fogging up during use. Most riders stated that they did not use this shield. Five riders commented that the Bull Tough helmet was heavy or cumbersome while riding.

Three riders each attributed one injury to the Bull

Tough helmet. The first injury was a minor cut to the chin that occurred during a ride when the chin strap broke. The second injury was described as follows: "I was bucked off between the bull and the out gate and the bull kicked my face guard off from the underside and the chinstrap on my helmet cut my neck open and cut the artery to my tongue. It knocked me out." The third such injury attributed to the Bull Tough helmet was described as follows: "I got jerked down—horn came through face piece—horn went into head between eye and temple—shattered face, jaw broken—tore out sinus cavity—3-4 surgeries on eye—think it was because of helmet—horn got caught on helmet—think it would have glanced off otherwise."

The incidence of injury attributed to the helmet by the riders was no more than 0.085% per ride (3/3,518 rides). The precise likelihood could not be determined, as these injuries perceived to be due to the helmet occurred over the span of the rider's career, while we obtained an estimate of the number of rides specifically for the year 1999. Clearly, this incidence would be much lower if the career total number of rides with the helmet could be substituted into the equation.

#### DISCUSSION

The results of this retrospective analysis provide evidence to support our hypothesis that the Bull Tough helmet decreases the incidence of a head injury in the sport of bull riding. A large majority of the respondents,

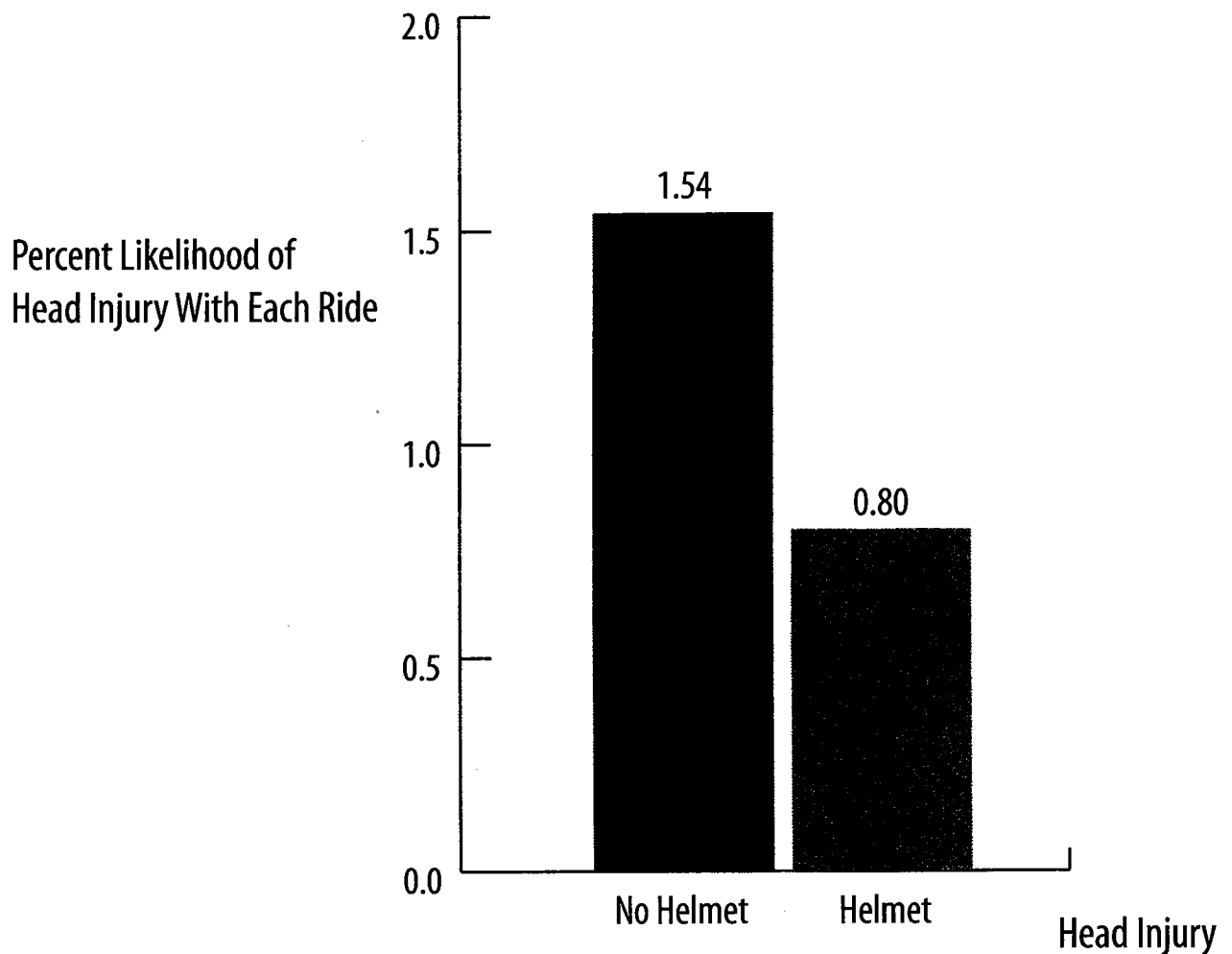


FIG. 4. Likelihood of head injury while not wearing the BTH versus while wearing it.

93.7%, also believe that the Bull Tough helmet saved them from at least one head injury. Except for the removable polycarbonate shield, there is no evidence to suggest that this particular helmet impairs vision and thus the ability to engage in this sport.

A total of three different bull riders described injuries they believe were caused by the Bull Tough helmet. It is important to note that two of these injuries occurred during a serious bull riding incident and might have simply been injuries resulting primarily from the incidents rather than the helmet. The injuries sustained might have been more severe were it not for the helmet. The results of this study do not support the contention that this particular helmet puts the bull rider in greater danger.

Regarding the clear polycarbonate face shield, there does seem to be concern by the riders that the bull rider's visual field can be compromised by the shield, which has a tendency to become scratched and fogged up during use.

#### Weaknesses of the Study

The surveys were sent to the last known addresses of bull riders who purchased the Bull Tough helmet. Eighty

one (25.3%) of the surveys were filled out and returned. Many of the surveys were returned because the purchaser of the helmet had moved to an unknown address. One reason for the low survey return rate could be that bull riders tend to be young and therefore more likely to be on the move from one residence to another. Future studies may be more successful if telephone follow-up calls are made in an effort to increase the survey response rate.

The data obtained from this survey are vulnerable to bias by the individual respondents. The riders who responded to this survey may have a different perspective on safety or the Bull Tough helmet than those who, for various reasons, could not or would not return the survey.

Also, this is a retrospective study, the results of which could be more accurate if performed in prospective fashion, with each participant taking a precise number of rides with and without the helmet. A study of this type would require two large cohorts of bull riders, one in which the riders all rode with a helmet, and the other in which all riders rode without a helmet. At present, the authors are not aware of any group, organization, or cir-

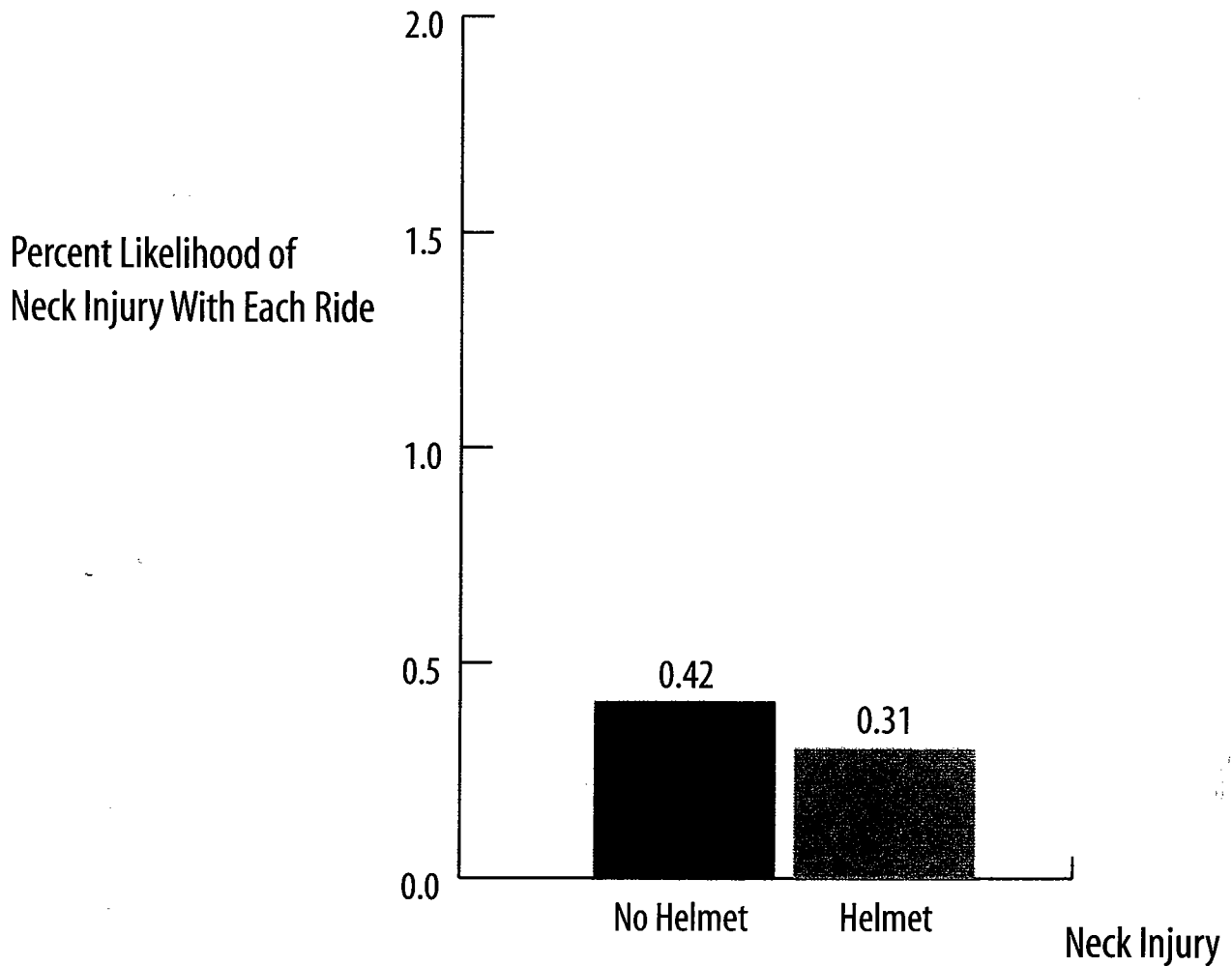


FIG. 5. Likelihood of neck injury while not wearing the BTH versus while wearing it.

TABLE 1. Specific incidents of protection from head injury while wearing protective headgear

1. "I got thrown into the shoot and the first thing that hit was my head on the crossbar. I walked away from it."
2. "I was riding toward a fence when the bull ran into the fence and I fell forward hitting the facemask against the fence very hard. I did not get hurt at all".
3. "I got hung up on the bull and he smacked me in the face with his head".
4. "The bull turned back and kicked me in the back of my head".
5. "I got bucked off and over the head of a steer. He stuck his horn into the facemask and it protected my face".
6. "This guy who used it fell underneath the bull and the bull stepped right on his face. The helmet flew about 20 feet across the arena. All that happened to him was a scratch under his eye. The helmet's titanium bars, where it was stepped on, were severely bent down".
7. "Thrown face first into the ground hard. Dirt was in my face. Helmet facemask took all the impact. No injury".
8. "I don't remember all of them, but I've been whipped down before and hit the back of the bull's head two or three times. I've had the back of my head stepped on and kicked. With the helmet it just gives me a really bad headache".
9. "The first time I ever used the Bull Tough helmet, I was slapped down into the horns of a head-slinging bull. My head hit hard and the horn hit me square in the face. The mask separated from the helmet. The helmet came off. My left collarbone was broken from the horn, but my face and neck never got a scratch. This would have been a severe injury if I didn't have the titanium facemask".
10. "I was kicked in the facemask while on the ground. The facemask was dented".
11. "I was thrown into the fence hitting the facemask on the fence rail. People said they heard the impact from the other side of the arena".
12. "I was jerked down and butted heads with a bull. The facemask was bent but if I was not wearing the helmet I probably wouldn't be here."

**TABLE 2.** *Specific incidents of head injury while not wearing protective headgear*

1. "The bull turned back and hit me in the face with his horn. It broke my cheek bone and knocked my lower jaw out of socket".
2. "Bull slammed his head back while turning. Stuck his horn up under my chin into my mouth, knocking me out. I received 14 stitches in my chin, broke both of my jaw bones, broke both cheekbones, broke nose, crushed sinus cavity. The hit me two more times while I was knocked out and hung up".
3. "Collided heads with the bull. Comatose for 14 hours. Really shook up my mind. Took me at least a month and a half to regain a lot of my memories".
4. "I had the bull jerk me down and hit me in the side of the head. I was knocked out for quite a while and had severe seizures. I was hospitalized overnight and released the next day".
5. "Kicked in the side of my head and fractured my skull. This required an extended period of hospital time. This is the reason I purchased the helmet".
6. "Broke my jaw and four teeth by connecting with a horn".
7. "Bull stepped on my head, pulling my lower lip away from my jaw. It took 36 stitches to repair".
8. "Dragged along the fence. The result was 8 stitches in the back of my head and a concussion".
9. "Severed left ear when a bull stepped on my head. Re-injured left ear on pipe fence while getting off after a ride. Pulled ear loose and had to have it reattached".
10. "Face first against back of bull's head. Broke both cheekbones, nose, right eye socket and upper right jaw".
11. "Jerked down. Broke nose, cheek and eye socket. Had surgery on nose and eye." "Brain stem damage. Double vision. Now has intention tremor disorder". (Filled out by a parent.)

cuit that mandates the use of protective headgear during bull riding.

Finally, this study sample was a heterogeneous group of bull riders, ranging in age from 7 to 52 years. Other variables include the size, strength, and ferocity of the bucking stock, as well as the skill levels of riders. There exists a potential for varied results depending upon these factors. Therefore, it is difficult to apply or compare these results to a specific group of bull riders, as there might be significant differences in injury rates between various groups. In the future, it may be necessary to define the subject sample better so that interpretations between study groups can be accurately made.

#### Further Research

In the United States, attempts are being made at the prevention of physical injuries, especially to children. Organized sports such as bicycling, skate boarding, rock climbing, motocross, horseback riding, and football now have requirements for the use of protective headgear. In football, helmets are an integral part of the game and are considered standard safety equipment.<sup>7</sup> More recently, it has been shown that the use of helmets by horseback riders can decrease the frequency and severity of head injuries.<sup>8</sup>

With the extremely high incidence of head injuries in bull riding, it is clear that more research is needed to assess and evaluate the effectiveness of protective headgear in this sport. The results of this study suggest that bull riders can safely use the Bull Tough helmet to decrease the incidence of head injury. However, each helmet design is different and may produce results different from those in this study. Until further studies are performed, caution must be used in attempting to extrapolate these conclusions to other helmet designs.

#### Children's Issues

Finally, mention should be made of the fact that a large number of respondents in this study were children;

16% were less than 16 years of age, and 40% were less than 18. This finding points to the fact that bull riding is as much a sport for children as it is for adults. More emphasis must be placed on the safety of minors who engage in the sport of bull riding. High schools and other organizations sponsoring bull riding events should require children to wear helmets in addition to other accepted safety equipment, such as protective vests and mouthpieces.

**Acknowledgments:** Thanks to the following people for their invaluable assistance: Sue Mallonee, Injury Prevention Service, Oklahoma State Department of Health; Sheryll Brown, MPH, Tori Johnson, and Diana Lambert, Chief, Injury Prevention Service, Oklahoma State Department of Health; and P. L. Claypool, PHD, Professor of Statistics, Oklahoma State University, Stillwater, OK.

#### REFERENCES

1. Gibbs LI, Lawrence DW, Reilley BA. Bull riding-related brain and spinal cord injuries: Louisiana, 1994-1995. *MMWR* 1996;45:96-98.
2. Butterwick DJ, Nelson DS, La Fave, et al. Epidemiological analysis of injury in one year of Canadian professional rodeo. *Clin J Sports Med* 1996;6:171-177.
3. Brandenburg MA, Schmidt A, Mallonee S. Bull riding injuries. *Ann Emerg Med* 1998;32:118.
4. Schmidt A, Brandenburg MA. Central nervous system injuries associated with bull riding, Oklahoma, 1992-1995. In: *Injury update, Oklahoma State Department of Health*. 1997:1-5.
5. National High School Rodeo Association. *1996-1997 Rules, constitution and by-laws, National High School Rodeo Association*. 1996:73-74.
6. International Professional Rodeo Association. *1996 Bylaws and rules, International Professional Rodeo Association*. 1996:89-90.
7. McLatchie G, Jennett B: Head injury in sport. *BMJ* 1980;281:789-791.
8. Bond GR, Christoph RA, Rodgers BM. Pediatric equestrian injuries: assessing the impact of helmet use. *Pediatrics* 1995;95:487-489.