BICYCLING SAFETY: HOW CAN INJURIES BE REDUCED?

By

GLENN WARREN BLACKWELDER

Bachelor of Science

Texas A&M University

College Station, Texas

1976

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1988

BICYCLING SAFETY: HOW CAN

INJURIES BE REDUCED?

Report Approved:

Claudia Peck

Report Adviser

Gwendolyn J. Brewer

Margaret J. Weber

Norman N. Durham

Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to the individuals who helped me with this report. Many thanks go to Dr. Claudia Peck, my major adviser, for all of the support and guidance that enabled me to complete this project. Her suggestions and leadership were very helpful throughout the study.

Special thanks to my committee members, Dr. Margaret Weber and Dr. Gwendolyn Brewer, for their involvement with this report and other coursework. I extend a sincere thank you to them and any others who have inspired me to complete this study.

TABLE OF CONTENTS

Introduction

Each year more than 1300 bicyclists die and over 30,000 children are non-fatally injured in the United States as a result of bicycling accidents (Weiss & Duncan, 1986). These figures are likely to increase each year as bicycling becomes more popular. At the present time, bicycles are owned by about 30% of the United States population and 45% ride at least occasionally (Kraus, Fife, & Conroy, 1987). Even though some people do not own or operate a bicycle on a regular basis, most have friends or family members that do.

Child cyclists are frequently involved in accidents and regularly require hospital admission for head injuries (Clark & Sibert, 1986). Some researchers believe these injuries could be prevented with the proper use of an approved bicycle helmet. Protective helmets have reduced the incidence of serious head injuries in other sports such as hockey and football and bicycle helmets have the potential to protect riders from head injury (Weiss & Duncan, 1986). At the present time, however, few adults or children are wearing bicycle helmets. Weiss (1986) conducted a survey and found that only 2% of young children and 10% of college students actually wear helmets. It is apparent that helmet effectiveness is not getting the publicity it should. In addition, many bicycle owners' manuals never specify the use of a helmet when riding.

This report focuses on whether bicycle helmet use should become mandatory, or can alternative measures reduce injuries and deaths of bicyclists? These and other ideas will be studied in this report.

The purpose of this report is to examine the number and kinds of injuries to cyclists to investigate who is being injured and how severe the injuries are. Next, bicycle helmets will be studied with emphasis on testing, quality, and likely benefits in bicycling accidents. Finally, alternative solutions to reduce the

injuries to bicyclists will be considered. These include mass education, bicycling paths, and requirements for safe riding.

The information contained in this report comes from studies conducted in the United States, Canada, Great Britain, and Australia by researchers studying bicycling injuries and helmet effectiveness. One must remember that when using injury data, only the serious cases that were reported in hospitals, emergency rooms, and police departments are included. The actual number of unreported minor injuries is unknown, but the incidence is suspected to be significant. Kruse and McBeath (1980) found in a study conducted on a college campus, only 8% of bicycle accidents were reported to the police. This was found by interviewing college students who had bicycles at the campus. If this trend holds true for other populations, the actual number of bicycling injuries could be quite large.

Bicycle Injuries

Several studies have been conducted to determine the number and kinds of injuries sustained by bicyclists. Studies were conducted from New Zealand to Canada, and date from 1958 to 1986.

As was stated earlier, many people, and especially children, are injured each year from bicycling accidents. In fact, the number of bicycle-related childhood deaths in the United States exceed that from accidental poisonings, falls, firearm injuries and many serious medical illnesses (Weiss & Duncan, 1986).

Study in Dade County, Florida

In one of the most notable studies, conducted in Dade County, Florida, from March 1958 through December 1979, cases consisted of all fatally injured bicyclists autopsied by the Medical Examiner's Office in the County (Fife, Davis, Tate, Wells, Mohan, & Williams, 1983). Fife et al. found that of the 173

individuals who died, 139 were male, 34 were female, and the median age was 14 years. It was also discovered that 159 of those who died had serious head injuries and 101 had skull fractures of some kind. The Medical Examiner's Office identified fractures by a thorough physical examination confirmed by dissection. Fife et al. reported that none of the fatalities was wearing a helmet. Another fact that came out of the study was that children under 12 were more likely to be hit on the left side of their body because they often ride out of their driveways and were hit by oncoming cars. Since most of the deaths were caused by striking blunt objects, the author concluded that bicycle helmets should be designed to withstand primarily blunt impacts.

Calgary, Alberta Study

Guichon and Myles discuss a similar study conducted in Calgary, Alberta, Canada, a city of 450,000 people. Police records were examined along with admissions to hospitals to determine the number and severity of injuries to bicyclists. In this study, head injuries were again the leading cause of death to the individual. Of the 107 people who died, 67% (73) received trauma to the head, and 4 of these died from subsequent hematomas. Again, none of the individuals was wearing safety helmets. Guichon and Myles found that upper arm injuries comprised the second largest group of injuries, with 18% having problems of this type. Twenty percent of the injuries occurred from collisions with motor vehicles, and it was discovered that all of the deaths occurred from mishaps involving motor vehicles. This study concluded that there are many severe injuries associated with bicycle use, and head injury is the most common.

The majority of persons involved were between 10 and 16 years of age and 60% were male. Guichon and Myles noted it was ironic that the law of the province requires motorcyclists to wear helmets, but bicyclists who can attain a

speed of 30 miles an hour on a ten speed bicycle are not required to wear helmets.

Study of Brain Injury

A survey of brain injury to bicycle riders was conducted in San Diego County, California. This study compares the incidence of bicycling-related brain injuries to brain injuries of the general population. Kraus et al. (1987) defined brain injury as physical damage to or functional impairment of the cranial contents from acute mechanical energy exchange. Put more simply, it means damage to the brain from a sharp blow to the head. Of the 3,358 brain injuries in San Diego County during the study, 7% were bicycle-related with an annual incidence of 13.5 injuries per 100,000 people. Kraus et al. reported that bicycle-related brain injuries were more severe when the mishap involved collision with a motor vehicle. Even though bicycle-related injuries not involving motor vehicles generally have a good prognosis, some mild injuries were not always trivial and could lead to medical complications. Kraus also found that for individuals 14 years of age or younger, 22% of all the brain injuries were bicycle related. It is not known if the higher percentage is due to children riding bicycles more than adults, or if children are more careless and get involved in more mishaps.

Other Studies

In a one-year study conducted in Minneapolis, similar results can be found with respect to the age and sex of injured bicyclists as well as the most common types of serious injuries. Of the 192 injuries studied, 60% of the victims were male, 40% were female; the average age of the cyclist was 15 years (Davis, Litman, Crenshaw, & Mueller, 1980). Davis et al. reported that motor vehicles

were involved in only 13% of the accidents, and bicyclists were at fault 42% of the time.

There were many associated factors that contributed to bicycling injuries. Some of these were mechanical defects of the bicycle, loose sand covering the road, and excessive speed while coasting downhill. When bicyclists encounter these situations, mishaps with some injury can result. Davis et al. (1980) concluded that face and head injuries were the most common type of injury with hands and wrists comprising the second largest number of injuries.

A study of 174 cycling accidents was conducted in 1977 in Tucson, Arizona. This study placed more emphasis on young adult injuries, due largely to the University population there. Halek, Webster and Hughes (1980) indicated that the most frequent accidents occurred at intersections and the greatest number of people involved in the accidents were 16 to 25 years old. The age of the individuals involved reflects the University community where the study was conducted.

Out of the 174 bicycle accidents reported, 169 involved mishaps with motor vehicles. This percentage is considerably higher than in other studies. Most of the accidents occurred during rush hour traffic, indicating that most of the bicyclists commute to work or school. Halek et al. (1980) concluded that measures should be taken to reduce the number of accidents and the injury level. Halek reported that public education and the increased use of protection devices such as helmets should be emphasized.

Finally, a look at studies conducted in New Zealand and Great Britain should give international input into the problem of bicycling head injuries and related information on who is being injured. In Auckland, New Zealand, 20 bike riders were killed between 1974 and 1984; most of these were young males (Sage, Cairns, Koelmeyer, & Smeeton, 1985). Sage et al. (1985) found that 14 cyclists

had fatal injuries to the brain. Of the 20 who were killed, 19 were involved in collisions with autos. Ballham, Absoud, Kotecha, and Bodiwala (1985), in a study of bicycling in Great Britain during 1983, discovered that of the 382 cases studied, head and face injuries constituted 48% of all injuries. Sixty-six percent of the victims were children between 6 and 15 years of age. It seems that regardless of where one looks at the problem, young people are being involved in serious bicycling accidents with injuries to the head being of most concern.

In summary, one can note some general conclusions about bicycling injuries and victims. Head injuries are the most common type of injury and young males between the ages of 12 and 16 are more frequently involved in mishaps. While bicyclists seldom come into contact with motor vehicles, most deaths are the result of collisions with motor vehicles. In some instances, the bicyclist was at fault in the accidents studied. It is evident that a problem exists and solutions should be found to reduce both the number of bicycle accidents as well as the severity of injuries sustained by bicyclists.

Help From Helmets

There are many kinds of injuries involved with bicycling accidents, but one type is most common. Head trauma is involved in the largest percentage of serious bicycling mishaps and is the cause of death in the majority of fatal bicycling accidents (Weiss & Duncan, 1980). Larson and Schwab (1985) found that 75% of deaths from cycling accidents are the result of head injuries, and this suggests the proper use of helmets could reduce deaths and injuries. Information related to these concerns is being published more widely with articles in the popular press becoming more common. In the Washington Post, Colburn and Berg (1986) state that only 2% of elementary, junior, and senior highschool students currently wear helmets while riding bicycles. This is an

alarming statistic considering how many head injuries occur. Still, more publicity should be given to not only the number of bicycling injuries that occur but also protective measures that could prevent injury.

Bicycle Helmet Advocates

What have these researchers who conduct studies of injuries of bicyclists said about the bicycle helmet and its effect on injury? Most seem to agree that the regular use of an approved helmet would reduce the majority of injuries and possibly prevent some of the deaths. This is based on the supposition that bicycle helmets do prevent injuries in a manner similar to other sports helmets. Weiss and Duncan (1986) suggest that the frequency of bicycle-related injuries could be reduced markedly if cyclists wore protective helmets. Clark and Sibert (1986) concluded that head protection, if used widely, would considerably reduce the severity of bicycling accident head injuries.

The list of advocates for the use of bicycle helmets goes on. Although not effective in all mishaps, bicycle helmets do have the potential to help. The use of helmets for all forms of bicycling is a necessary and logical means to prevent and reduce brain injury from mishaps involving motor vehicles (Kraus et al., 1987). McDermott (1984) indicated that head injuries in Australia are the cause of most deaths in bicycle accidents, while cuts and abrasions to knees and elbows are the injuries requiring the most first aid. McDermott also found that only 1% of children injured in BMX races suffer head injuries because helmets are compulsory for competition. Data on head injuries suggest that if head injuries were prevented, many of the dead would be alive (Fife et al., 1983). They concluded that a helmet would be the obvious countermeasure against head injury. Their statements on the use of the helmet are strong and to the point.

In contrast, the New Zealand study of 20 deaths indicated that compulsory wearing of helmets by cyclists is unlikely to lead to a great reduction in fatal injuries (Sage et al., 1985). This is because injuries of fatal severity to multiple organ systems were seen in 16 of 20 deaths and 6 cases had no significant head injury. They et al. (1985) concluded that this does not exclude the possibility that a significant reduction in severity of nonfatal injuries to head might result if helmets are worn.

Helmet Testing

Taken as a whole, the experts seem to agree that helmet use by bicycle riders could reduce injury and death. However, there are many different kinds of helmets in the market and some are significantly better than others. While it is true that some type of protection is better than none at all, consumers have a right to know which ones are better than others so they can make intelligent buying decisions.

Testing of bicycle helmets began over 10 years ago, but quality helmets were not available and few passed the examinations. One of the earliest comprehensive studies was conducted in 1983. The study was made to evaluate selected bicycle helmets in order to assess their impact capabilities (Bishop & Baird, 1984). The test consisted of dropping an instrumental headform from a height of 1.0, 1.54, and 1.82 m with an acceleration criterion of 300 g. Simply stated, they dropped a helmet with an imitation head inside and electronically measured the G force on impact. Of the 21 bicycle helmets that were tested, the 9 that passed had solid polystyrene liners and hard shells. None of the helmets with resilient foam liners passed the testing. Helmets were also tested in a second crash to see how well the helmets stood up to multiple impacts. Bishop and Baird found that on the second impact, even the solid polystyrene

helmets did not provide very much protection because the polystyrene liner was crushed in the first impact.

The helmets that utilized expanded polystyrene liners were capable of absorbing a great deal of energy and did not approach their limits when tested at 1.0 m. When tested at 1.75 m, the poor quality helmets registered acceleration readings well into the fatal range. The outcome of the tests was that helmets with expanded polystyrene liners provided the most protection to cyclists, but that the helmet should be replaced after becoming involved in an impact of any significance.

Helmet Standards

Until recently, no standard had been recommended for bicycle helmets and the consumer could not be certain about the quality of a particular helmet. In 1984, the American National Standards Institute (ANSI) and the Snell Memorial Foundation adopted similar advisory performance standards for bicycle helmets (Larson & Schwab, 1985). Both standards specify test methods for impact attenuation which is tested by placing the helmet on a head form and then letting it fall onto flat and hemispheric anvils. The subsequent impact should not exceed 300 g's force to the head; an impact over 400 g's may cause permanent brain damage.

Both standards do test the retention system, but the Snell and ANSI standards differ in the required drop height. The ANSI standard sets minimum performance criteria, and the Snell standard is intended to reflect state-of-the-art technology. For this reason, the ANSI standard is easier to pass.

Many tests were conducted and replicated to insure accurate results. Larson and Schwab (1985) found that the helmets passing the tests all had hard, full covershells made of either fiberglass, ABS plastic, or Lexan plastic to spread

the impact over a wide area. The helmets that passed or exceeded the standards also had liners of expanded polystyrene (EPS) which is a high grade of styrofoam designed to crush upon impact.

According to Larson and Schwab (1985), some helmets are widely distributed but are not safe. One that is particularly ineffective is the "hairnet" helmet often worn by racers. The most effective practice is to buy a quality helmet with a hard shell on the outside and expanded polystyrene material for a liner.

Safety Alternatives

Researchers seem to agree that the diligent use of approved bicycle helmets would reduce the injury level to bicyclists and in some cases save lives. Using a helmet helps, but there are other ways to improve bicycle safety which would in turn reduce the number of serious injuries.

In this section, the education of bicyclists and parents will be examined as one way of improving the safety record. In addition, bicycle paths will be discussed briefly as well as some rules to be followed to help ensure the safety of the bicyclist.

Fort Meyers Safety Program

One bicycle safety program that has been successful in educating children and parents is the Fort Meyers Florida Police Department Bicycle Safety Program. House and Schwein (1984) report that each year during the month of May, the Fort Meyers Police Department conducts a bicycle safety rodeo for third and fourth grade children throughout the public schools in the Fort Meyers area. This program gets a good deal of community support in the form of generous donations of bicycles to the winners of the competition.

The rodeos are conducted in the school gymnasium and start with a clown act that discourages clowning around on bicycles. According to House and Schwein (1984), the children are then tested on the safety rules, their bikes are given safety inspections, and then they are asked to drive through an obstacle course with emphasis on following traffic safety rules. The event is participatory in nature and everyone who participates gets some kind of reward. Overall winners are awarded bicycles which are presented one week later at a dinner at police headquarters.

How effective is this program? House and Schwein (1984) found that this police department is recognized by the National Child Safety Council for dedication to the safety of children. Additional benefits include better community and police relations and the education it provides is not only to the participants but to the parents as well. Parents get involved with sponsoring parts of the program and helping the children with the rules.

Assistance From Doctors

Another useful way to inform children and adults about the hazards of riding bicycles would be more preventative information given by doctors who routinely see bicyclist's injuries. Weiss and Duncan (1986) report that in a study of 161 pediatricians in Tucson, Arizona, very few doctors bring up the subject of bicycle safety to their patients, even though the doctors are quite knowledgeable of bicycle accident and helmet usage statistics. Ninety-two percent of the doctors studied knew that children rarely use bicycle helmets and most believed this was due to inadequate parental awareness of the importance and effectiveness of helmets.

Weiss and Duncan (1986) reported that 29% of the doctors never discuss bicycle safety during child well care. Bicycle safety, with particular emphasis

on helmet use, might be appropriate for discussions with the parents of young grade school children. Discussions with the children are also important, especially junior highschool students, since bicycle-related deaths are highest in this group. Doctors are urged to play a role in the education of parents and children on bicycling risks. It is important for physicians to become involved in this effort and inform the public of bicycling risks.

Education

Education of the public on bicycling injuries is getting more support elsewhere. A 1983 study of bicycle accidents in Australia led those researchers to a definite opinion. Armson and Pollard (1986) reported that more education on the rules of the road and the proper use of safety helmets would cut injuries drastically. In the Victorian schools in Australia, the Education Department has a "Bike-Ed" program. This type of mandatory education has led to rules including the use of helmets when riding to and from school (McDermott, 1984). In addition, McDermott pointed out that the mass media there features tragedies of school children dying of head injuries and this has helped with public awareness of the problem. This kind of graphic display of injury may not be easy to see, but it is suspected to be an effective means of bringing the point across.

Other people are coming up with similar findings regarding a positive education program. Clark and Sibert (1986) found that the answer to bicycling injuries is the education of its people, especially the children. Children are very receptive to external stimuli and should be taught at an early age about bicycle safety. Educating the public raises the awareness level of everyone, even if they never ride bicycles.

Bicycle Pathways

Bicycle pathways were introduced some years ago and have encountered problems and complications. Kroll and Sommer (1976) reported that bikeway proposals and construction in the last decade have seen little funding or interest. There are several reasons for this, and one is the lack of rider interest. They surveyed 190 cyclists on urban streets and found that most were not using bikeways because of their inconvenience and some were totally unaware of their existence. The interviewed cyclists did say that safety and comfort would be better if bikeways were added to existing streets (Kroll and Sommer, 1976). Bike paths would clearly be safer to travel on, but the logistics of building them convenient to bicycle traffic is very difficult.

Even though bikeways have their problems, some have found them to be practical and useful. Gouichon and Myles (1975) reported that bikeways in Canada have been advocated for years in order to reduce the number of bicycle-related injuries. Although they too are in need of financial support for more and better bikeways, the Canadians seem to be using this type of system to enhance the overall safety of their cyclists.

Obeying the Rules

It is believed by some that bicycle injuries could be best reduced if bicyclists obeyed traffic rules more often. Davis et al. (1980) reported that cyclists' disregard for basic traffic laws was a major factor in 70% of bicycle and motor vehicle accidents. This is not too hard to believe as one can often observe cyclists who slow down but do not stop for stop signs.

Trinkaus (1985) reported on a study conducted in New York at a busy intersection where 137 bikes passed per hour; 61 of these encountered a red light. He

found that 19 went through, and 41 seemingly stopped because cross traffic did not permit. Only one stopped simply because the light was red! At a nearby stop sign, 140 cyclists were observed and only 3 stopped correctly (Trinkaus, 1985).

Other Measures

Bicyclists' disregard for vehicular rules and traffic signals is a problem of great proportion and cannot be ignored as a means to reduce injury among cyclists. Rules to help ensure the safety of bicyclists have been proposed by several authors. McDermott (1984) suggested that bicyclists under the age of seven should be forbidden on the street. At seven years of age, the proper use of the safety helmet should be explained as well as the meaning of road signs. The safe use of a bicycle should be demonstrated to the children, after which they can be allowed to practice under supervision, and finally issued a license when proficient (McDermott, 1984).

That proposal is good for educating the young and getting them off to a safe start in cycling. The following suggestions would be of value to the adult cyclist as well. Davis et al. (1980) suggest that accidents can be reduced by properly maintained bicycles, using helmets and protective clothing, and avoiding loose sand or gravel. In addition, the use of lights and reflectors would help as well as obeying basic traffic laws. These items all seem to be commonsense and would not be unrealistic for the cyclist.

Conclusion

It has been shown that many cyclists are injured and killed each year in cycling accidents. A large proportion of these are young males with serious head injuries. In fact, 75% of all bicycling-related deaths involve serious head trauma, suggesting that safety helmets would be an excellent countermeasure.

While only a small percentage of bicycling accidents involve motor vehicles, most of the bicycling deaths involve mishaps with motor vehicles.

Researchers involved with bicycling injuries all seem to agree that the proper use of an approved helmet would reduce the number of serious head injuries. It has been found that good quality, lightweight helmets were not widely available until recently. Helmets are now tested and the ANSI or Snell seal ensures that these helmets meet or exceed the prescribed safety standards. The test results indicate that the best helmet has a hard shell cover with an expanded polystyrene liner.

Safety alternatives include safety education programs such as the Fort Meyers Police Department bike rodeo held in Florida and the "Bike-Ed" program in Australia. These programs introduce safe cycling to children and also educate the adults on safety measures to help prevent injury. Bicyclists often disregard traffic rules and this cannot be ignored as it is a serious problem. Bicyclists need to obey the laws like any motor vehicle operator. It was found that bike pathways are difficult to implement and are not used regularly once in place. Although bike pathways increase bicycle safety, their impact in overall injury reduction are not significant at this time.

Recommendations

The evidence presented suggests that the mandatory use of bicycle helmets would help reduce the number of bicycle injuries and prevent some fatalities. Future research could determine the feasibility of implementing a law requiring the use of bicycle helmets on public streets. This research could determine if the law should be enacted on a state or federal basis. A mandatory helmet law could have problems passing state or local governments and could be difficult to enforce. Active consumer involvement could help initially bring about an aware-

enforce. Active consumer involvement could help initially bring about an awareness and then could focus on legislation to make helmets mandatory.

More emphasis could be placed on certifying young children on the rules of the road and the importance of obeying all the road signs. Education could take place in the public schools and emphasize the use of bicycle helmets and their effect on reducing injury. Children could learn in school that wearing a helmet is the right thing to do.

Cyclists who ignore the traffic rules need to be dealt with. Education and strict traffic rule enforcement could be one solution to the problem. Adults tend to disregard the rules and need to be educated on the consequences of disobeying the rules. In addition, local law enforcement personnel need to enforce the law and stop anyone who is in violation. An awareness program of this type could be set up on a local basis with cities or universities publishing the rules and penalties of disregarding the law.

Bicycle owners' manuals could also help the problem. Bicycle manufacturers have a responsibility to the public to provide information that could reduce injuries. The manual could have a safety section that discusses the use of a bicycle helmet and obeying traffic rules.

It has been shown that bicycle helmets could reduce injury in bicycling accidents. Educational programs on the risks involved with riding bicycles with emphasis on rules to be followed could also help. These two measures taken together would be the most effective way to make bicycling a safer means of transportation.

References

Armson, C. J., Pollard, C. W. (1986). Child cyclist injuries: A prospective study. The Medical Journal of Australia, 144, 144-146.

Ballham, A., Absoud, E. M., Kotecha, M. B., & Bodiwala, G. G. (1985). A study of bicycle accidents. Injury, 16, 405-408.

Bishop, P. J., & Baird, B. D. (1984). Impact performance of bicycle helmets. Canadian Journal of Applied Sport Sciences, 9, 94-101.

Clark, A. J., & Sibert, J. R. (1986). Why child cyclists should wear helmets. The Practitioner, 230, 513-514.

Colburn, D., & Berg, P. (1986, July 30). Doctors urged to promote helmets for cyclists. Washington Post, p. 5.

Davis, M. W., Litman, T., Crenshaw, R. W., & Mueller, J. K. (1980). Bicycling injuries. The Physician and Sports Medicine, 8, 88-93.

Fife, D., Davis, J., Tate, L., Wells, J. K., Mohan, D., & Williams, A. (1983). Fatal injuries to bicyclists: the experience of Dade County, Florida. Journal of Trauma, 23, 745-755.

Guichon, D. M., & Myles, S. T. (1975). Bicycling injuries: One-year sample in Calgary. Journal of Trauma, 15, 504-506.

Halek, M. J., Webster, L., & Hughes, J. H. (1980). Pedalcycle traffic accidents in Tucson, Arizona. Arizona Medicine, 37, 425-427.

House, M. L., & Schwein, S. (1984, June). Fort Meyers bicycle safety program. The Police Chief, pp. 50-51.

Kraus, J. F., Fife, D., & Conroy, C. (1987). Incidence, severity, and outcomes of brain injuries involving bicycles. American Journal of Public Health, 77, 76-78.

Kroll, B., & Sommer, R. (1976). Bicyclists' response to urban bikeways. American Institute of Planners Journal, 42, 42-51.

Kruse, D. L., & McBeath, A. A. (1980). Bicycle accidents and injuries. The American Journal of Sports Medicine, 8, 342-344.

Larson, L. A., & Schwab, M. (1985, September). Bicycle helmets: The hard facts. Trial, pp. 72-73.

McDermott, F. T. (1984). Why pedal cyclists should wear safety helmets. Australian Family Physician, 13, 284-289.

Sage, M. D., Cairns, F. J., Koelmeyer, T. D., & Smeeton, W. M. (1985). Fatal injuries to bicycle riders in Auckland. The New Zealand Medical Journal, 98, 1073-1074.

Trinkaus, J. (1985). Stop-light compliance by cyclists: An informal look. Perceptual and Motor Skills, 61, 814.

Weiss, B. D. (1986). Bicycle helmet use by children. Pediatrics, 77, 677-679.

Weiss, B. D., & Duncan, B. (1986). Bicycle helmet use by children: Knowledge and behavior of physicians. American Journal of Public Health, 76, 1022-1023.

VITA

Glenn Warren Blackwelder

Candidate for the Degree of

Master of Science

Report: BICYCLING SAFETY: HOW CAN INJURIES BE REDUCED?

Major Field: Housing, Interior Design and Consumer Studies

Biographical:

Personal Data: Born in Pilot Point, Texas, March 8, 1954, the son of Leonard L. and Dorothy Blackwelder.

Education: Graduated from Pilot Point High School, Pilot Point, Texas, in May, 1972; received the Bachelor of Science degree in Agronomy from Texas A&M University in May, 1976; completed requirements for the Master of Science degree at Oklahoma State University in May, 1988.

Professional Experience: District Manager for DeKalb Ag Research, May, 1976, to September, 1978. United States Air Force pilot, Reese Air Force Base, February, 1979, to October, 1983. Aircraft commander and instructor pilot, Tinker Air Force Base, October, 1983, to present.