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Bicycle Riding and Accidents Among Youths

A SUMMARY REPORT

By

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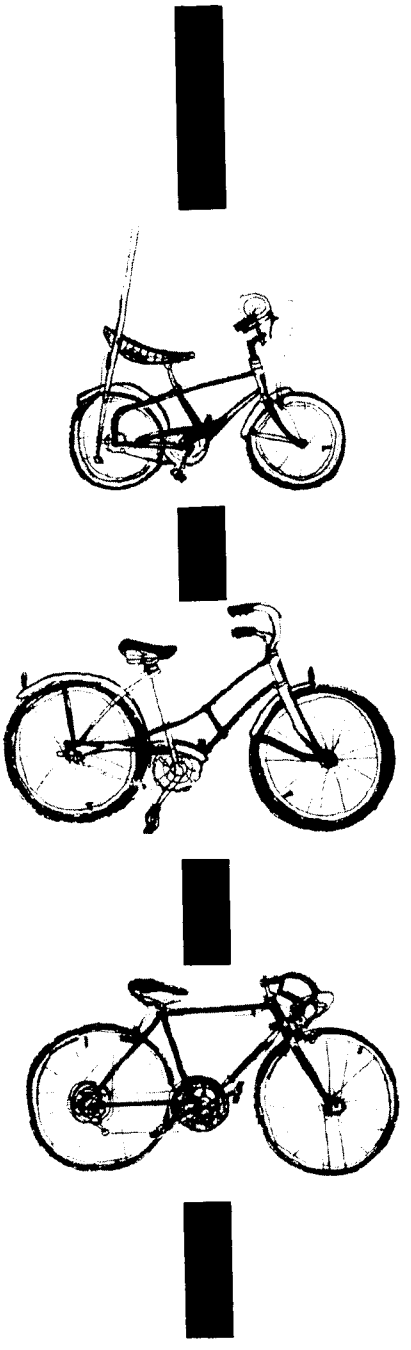


This is a condensed, nontechnical version of

"CHARACTERISTICS OF YOUTHFUL BICYCLE RIDERS IN AN URBAN COMMUNITY AND EVENTS ACCRUING TO OPERATION OF THEIR VEHICLES"

Copies of the full technical report can be
ordered from
The University of North Carolina
Highway Safety Research Center
Craige Trailer Park
Chapel Hill, N. C. 27514

July, 1971

acknowledgements

This study of bicycle accidents was possible only by virtue of faithful cooperation by Raleigh elementary and junior high school students, their teachers, and supervisory officials of the Raleigh Public Schools.

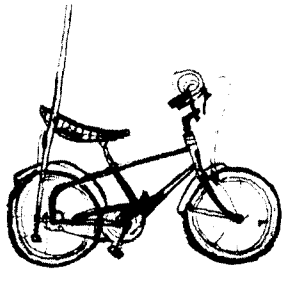
Similarly, only the cooperation of Raleigh police officers, physicians, and hospital administrators made it possible for UNC to obtain injury data.

The Raleigh Optimists Clubs gave valuable assistance in the planning phases of the study and in mounting mileage meters on hundreds of bikes.

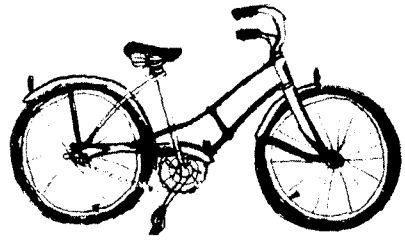
Finally, a generous, unrestricted financial gift from the Bicycle Institute of America made the whole effort possible.

Grateful thanks are tendered to all of these.

B. J. Campbell, Director
Highway Safety Research Center
University of North Carolina



Highrise



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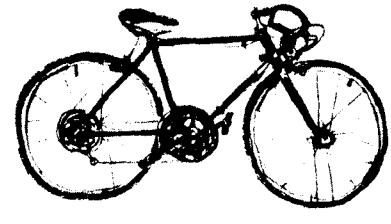
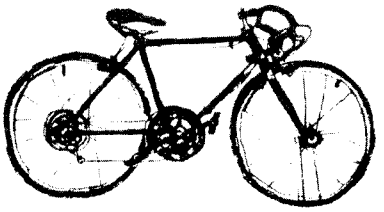


Lightweight



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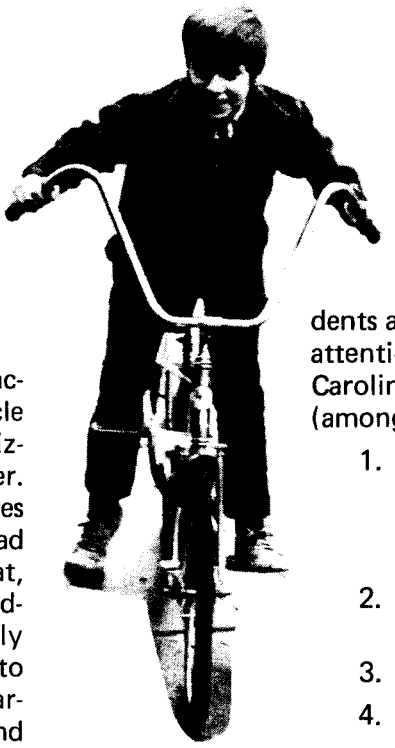
the introduction

The last decade of the 19th Century may be thought of as "The Golden Age of Cycling" in America, but the last 20 years has seen a renaissance of cycling interest far beyond that of the "Gay Nineties."

By 1960, bicycle sales had risen to an annual figure of over three and a half million, and that figure doubled again by 1970. An estimated 70 million Americans ride bicycles every year. A recent survey by the U.S. Department of the Interior called cycling "America's fastest growing outdoor recreation activity."

During the decade of the 60's, the bike changed remarkably in configuration. Manufacturers began developing and marketing models reflecting the popular influence of individually customized bikes which were found in increasing numbers in southern California. These new styles, eventually called highrise models, increased in consumer popularity until, by 1969, they dominated bicycle sales in the United States.



"I like a bicycle because it gives a boy a chance to have a big responsibility." Michael Farnum, Raleigh, N.C., a participant in the bicycle study.

The distinctive style characteristics of the highrise bicycle make it immediately recognizable, even to the casual observer. Among its prominent features are: exceptional loft and spread of handlebars, an elongated seat, small wheels usually not exceeding 24" in diameter and generally 20", a standard frame of 16" to 24" size, and an overall appearance suggesting massiveness and strength. It lends itself to any number of accessories and gearing combinations, limited only by the imagination and resources of the owner.

The resulting high visibility of the bicycle in the mid 60's, led several observers to theorize as to the inherent riding safety of the bicycle relative to its various configurations. From there it was but a short step to expansion of the question to include riding experience for all bicycle types.

During 1970, the Highway Safety Research Center of the University of North Carolina undertook a study of bicycle accidents among youthful riders, concentrating its attention on 500 youngsters in Raleigh, North Carolina. Central points of interest included (among others):

1. Accidents related to bicycle type
   - Highrise
   - Standard
   - Lightweight
2. Frequency, type, and severity of resulting injury
3. Associated mechanical problems
4. Accidents related to rider factors
   - Type of riding activity and use
   - Mileage and hourly exposure
   - Road, weather and traffic conditions, time of day
   - Sex, age, and riding experience

The overriding objective of the study was to deal with these factors in terms of exposure estimated from mileage, a factor not measured in previous studies.

This report, being a summary, necessarily omits most of the text on methodology, and also omits some of the secondary findings. Readers interested in the details of sampling, study methodology, and analytical procedures may wish to order the full technical report from UNC-HSRC.

the method

A survey of bicycle riding and accidents in Raleigh, N.C., was conducted in 1970. Close monthly surveillance was maintained on a sample of about 500 youths regarding riding practices, mileage exposure, and accidents, including even minor mishaps requiring only first aid from a parent.

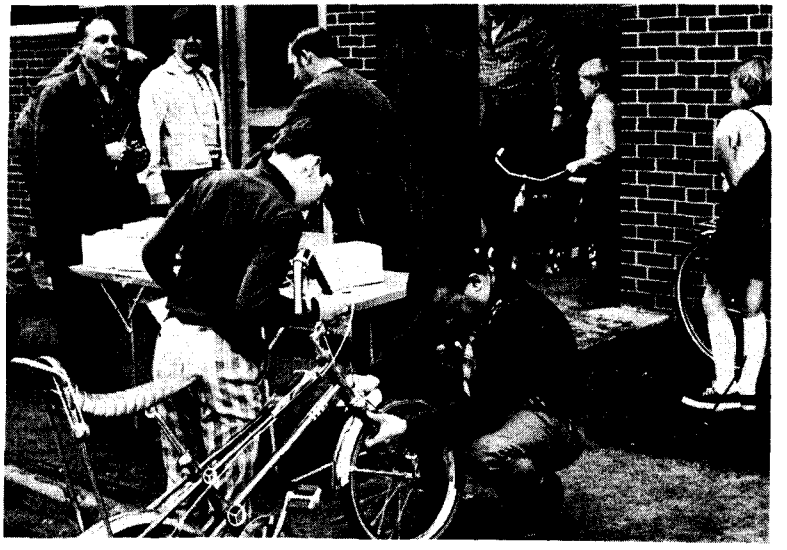
This was supplemented through more conventional sources such as city-wide hospital and police reports of the more severe bicycle accidents that had come to the attention of these sources.

Unique features of this study are:

1. Actual mileage exposure was measured with cyclometers for several hundred bikes and their riders. All told, more than 60,000 miles of bike riding (more than twice around the earth) were reported and studied.
2. Several levels of accidents were reported and studies from the severe—but thankfully rare—crash, to the much more common and usually unreported minor mishap.

Thus, this study includes "the top of the iceberg" accidents reported through hospital and police sources, as well as the normally hidden greater bulk of minor accidents. No fatal bicycle accidents occurred in Raleigh during the study period.

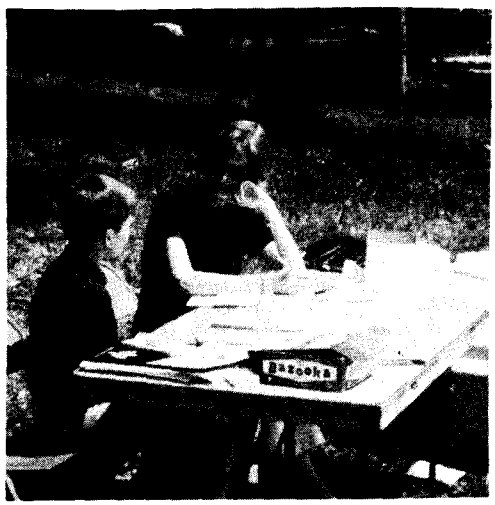
Information about Raleigh's bicycle riding population was collected here. Each child's height was measured, then a picture of the child and his bicycle was taken. The youngster was given a similar polaroid picture to keep. A bicycle safety inspection followed.



Next, each child received his cyclometer. More than 500 cylometers were mounted on the bicycles of the Raleigh school children so that cumulative mileages could be compiled. For the first time, researchers were able to estimate how much boys and girls ride their bikes in a year.

cyclometer installation

the sample



Finally, each youngster was asked several questions about his bicycle description and other owner information. To top off a busy and exciting day there was a piece of Bazooka Bubble Gum for the school children.

Through a random sampling process, 2369 Raleigh school children were asked to participate in the study. These children were students in grades 2 through 9. They were asked to supply:

1. Initial data on bike use in the household.
2. Continuing mileage data for 6 months.
3. Continuing accident data for 6 months.

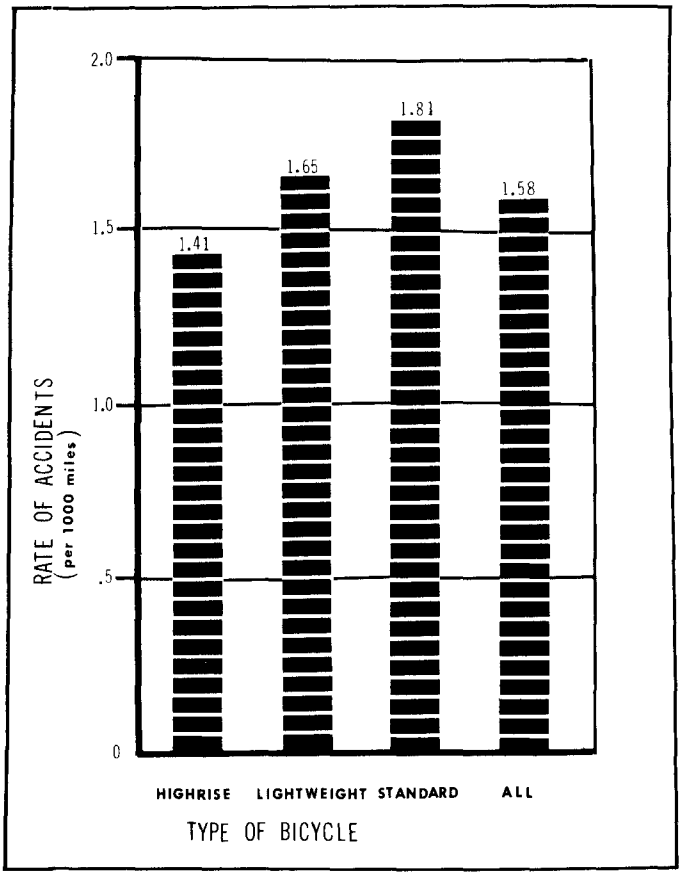
Naturally, many did not elect to participate. While the original 2369 were a random sample, it is obvious that self-selection factors also entered in. We cannot say that the cyclometer sample is a random cross section of Raleigh school youth, but it is an acceptable base on which to study accident factors related to bicycle type. Among the youths who *did* have a cyclometer mounted, there was very good cooperation, and the great majority stayed with the project to the end.

the data elements

Police Reports: Police report forms from bicycle accidents in Raleigh were assembled. These accidents occurred at a rate of about one a month. Most are bicycle-car crashes.

Hospital Reports: Arrangements were made with emergency room personnel at three hospitals so that information was obtained on more than 100 youths injured in bicycle accidents.
Injury data were obtained from the hospitals. Through telephone or personal interviews, additional information about the accident was obtained. This included the bike type, circumstances of the accident,and related factors.

Rider Reports: Detailed, continuing data on accidents and mileage exposure were obtained throughout the entire half-year period. At an initial interview, bike data, personal data, and a photograph were obtained, and a cyclometer was attached to each bike. During the 6-month period there were losses from families moving, non-reporting, etc., but almost four hundred subjects gave detailed data on mileage and accidents sufficient to constitute the reporting base for the study.



summary of principal findings

1. Based on exposure—the actual number of miles ridden—accident rates do not differ significantly among highrise, standard, and lightweight bikes for all youths in the study.

Figure 1: *Accident Rate by Bicycle Type.* Injury rates do not vary significantly with bicycle types. The overall rate is 1.58 accidents per 1000 miles of riding.

		HIGHRISE	LIGHTWEIGHT	STANDARD	ALL
MALE 5-9	RATE/1000 MILES	1.60	0.00	2.44	1.81
	MILES	10,627	780	5,132	16,538
	ACCIDENTS	17	0	13	30
	SUBJECTS	56	3	29	88
MALE 10-14	RATE/1000 MILES	.94	1.83	9	1.33
	MILES	11,757	6,557	5,757	24,071
	ACCIDENTS	11	12	1.56	32
	SUBJECTS	71	34	28	133
MALE 15-19	RATE/1000 MILES	0.00	1.00	0.00	.607
	MILES	154	998	495	1,647
	ACCIDENTS	0	1	0	1
	SUBJECTS	2	4	3	9
FEMALE 5-9	RATE/1000 MILES	1.90		2.25	2.02
	MILES	5,402		4,007	9,409
	ACCIDENTS	10		9	19
	SUBJECTS	39	0	45	84
FEMALE 10-14	RATE/1000 MILES	1.98	2.20	.90	1.44
	MILES	2,521	1,369	4,435	8,325
	ACCIDENTS	5	3	4	12
	SUBJECTS	23	15	43	81
FEMALE 15-19	RATE/1000 MILES		0.00	8.53	8.50
	MILES		.6	117	117.6
	ACCIDENTS		0	1	1
	SUBJECTS	0	1	1	2
TOTAL		1.41	1.65	1.81	1.58
		30,462	9,704	19,944	60,109
		43	16	36	95
		191	57	149	397

Table 1: *Accident Rate and Accumulated Mileage by Bicycle Type, Age, and Sex of Rider.*

2. No significant difference was observed in injury severity, or bodily location from accidents involving highrise, lightweight, or standard bicycles. (Figure 2 and Figure 3)

3. Falls from the bike, where no other vehicle is involved, are the most frequent accident type. No significant difference was observed according to bicycle type. In this study falls are more frequent and bike vs car accidents relatively less frequent because of the very sensitive reporting criteria. Minor falls which would often go unreported are included in this study, and these events occur much more frequently than the more severe car vs bike accidents. (Figure 4)

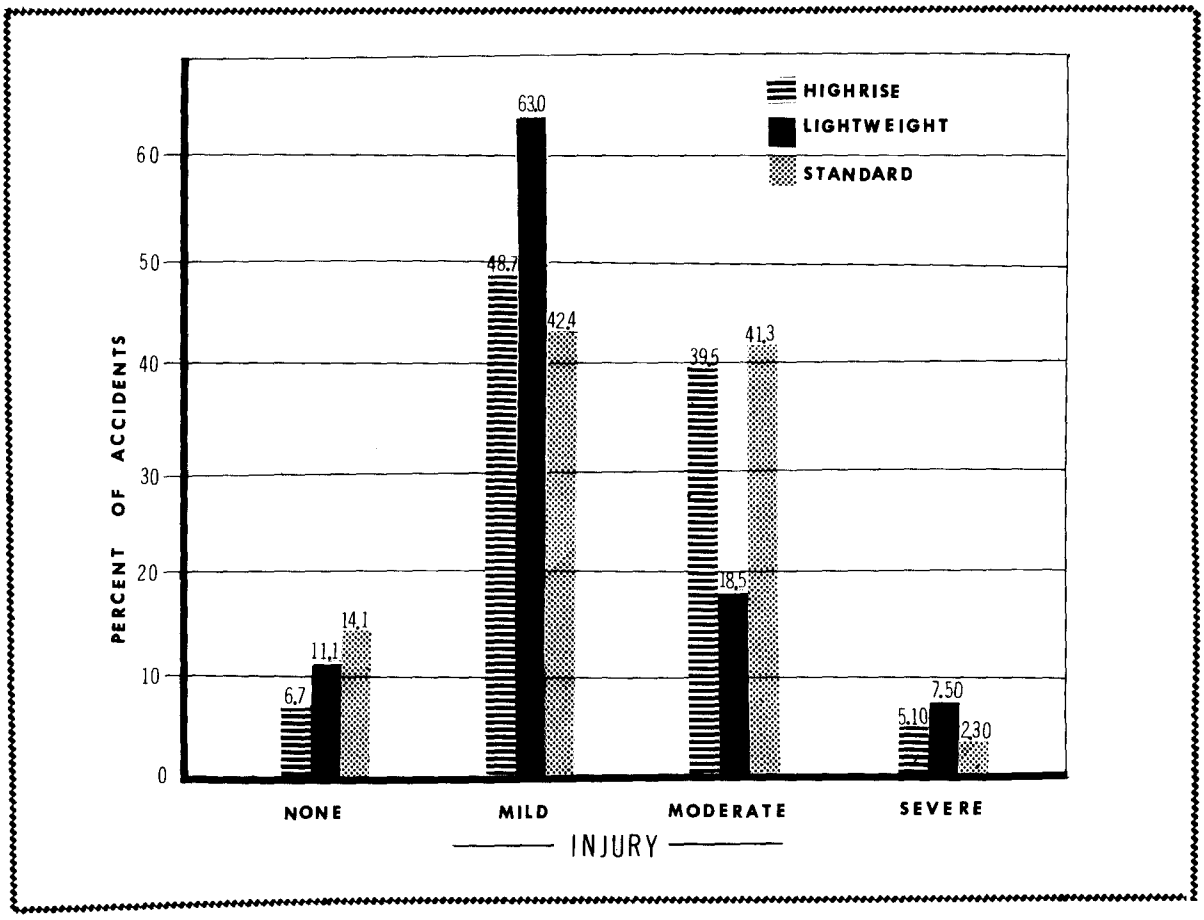


Figure 2: *Severity of Accidents by Type of Bicycle.* For main study accident cases. Most accidents observed in this study were of a mild nature with highrise and standard bicycle types demonstrating similar values.

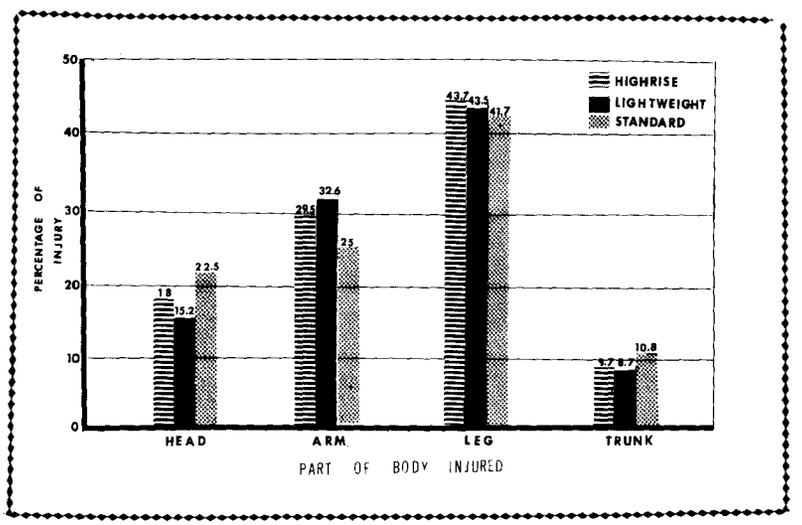


Figure 3: *Part of Body Injured by Type of Bicycle.* Differences are not statistically significant between bicycle types. Legs and arms are most often injured.

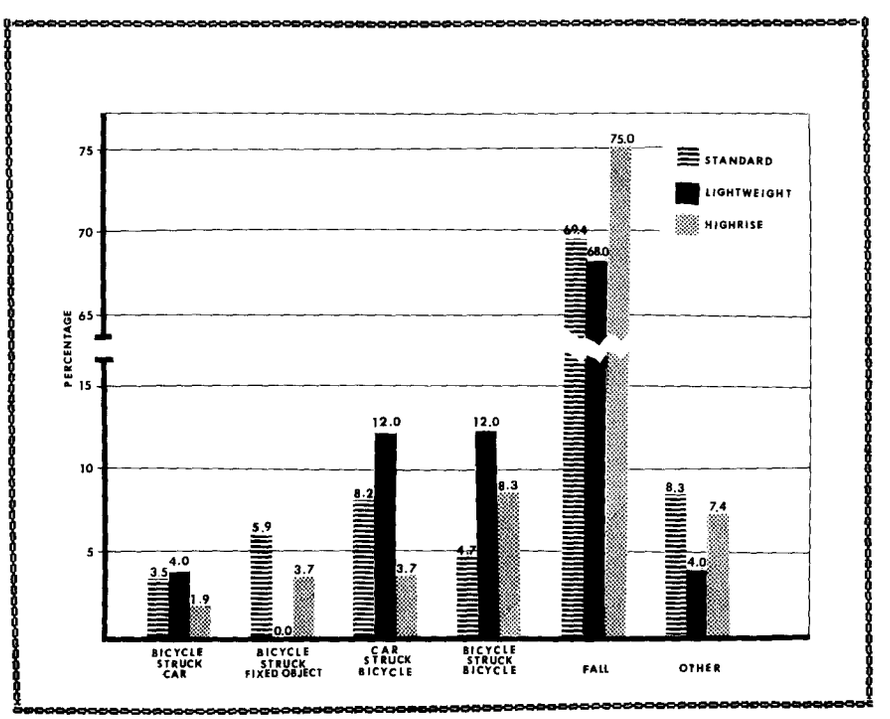


Figure 4: *Category of Accident by Type of Bicycle.* Differences between bicycle types are not statistically significant. The majority of accidents are classified as falls involving nothing more than first-aid at home.

FAILURE CATEGORY	HIGH-RISE	LIGHT-WEIGHT	STAN-DARD	TOTAL
BRAKE FAILURE				6
BRAKES	1_g 1_h 1_i	1_f		
BRAKE CABLE		1	1	
WHEEL				12
CAME OFF	1_j		1 1_e 1	
LOCKED	1_j			
LOOSE	1_j		1 1 1	
WOBBLED	1_j	1_k 1_k		
CHAIN CAME OFF	1 1_j		1 1_d	4
HANDLEBARS				3
LOOSE		1_c		
FELL OFF			1	
MISALIGNED			1_k	
PEDAL BROKE			1	1
SEAT FELL OFF	1_b 1_a			2
GEARSHIFT FAILURES		1_a		1
TIRE BLOWOUT			1	1

a. Owner had just adjusted bicycle
b. New bicycle
c. Passenger on handlebars
d. Chain failure
e. Bicycle had been tampered with
f. On fast downhill curve
g. Rear axle also "gave way"
h. Rear brake failed, front worked
j. Passenger carried
k. Loss of Stability

4. In 13% of the 224 accidents the rider cited a mechanical factor as being associated. In nearly all of the cases the resulting event was a fall. Six were reported as "brake failure", 12 as "wheel trouble", with other classes of mechanical factors appearing once each. In several cases passengers were being carried. From the nature of the reporting it was not possible to say with certainty how many of these associated mechanical problems were truly causal in nature. Nor can we know with certainty the condition of the component immediately prior to the accident. (Table 2)

Table 2: *Mechanical Failure Category by Type of Bicycle.* In 13% of the accidents the rider cited a mechanical failure as being associated.

	HIGHRISE			LIGHTWEIGHT			STANDARD			TOTAL		
	SAMPLE SIZE	ESTIMATED MILES		SAMPLE SIZE	ESTIMATED MILES		SAMPLE SIZE	ESTIMATED MILES		SAMPLE SIZE	ESTIMATED MILES	
		STUDY PERIOD MILES	ANNUAL MILES		STUDY PERIOD MILES	ANNUAL MILES		STUDY PERIOD MILES	ANNUAL MILES		STUDY PERIOD MILES	ANNUAL MILES
MALE	129	251.2	314.0	41	272.8	341.0	60	235.0	293.8	230	250.8	313.5
FEMALE	62	150.9	188.6	16	104.9	131.1	89	115.4	144.3	167	127.6	159.5
5–9	95	227.2	284.0	3	335.3	419.1	74	154.7	193.4	172	197.9	247.4
10–14	94	212.6	265.6	49	206.4	258.0	71	171.0	213.8	214	197.4	246.7
15–19	2	93.5	116.9	5	349.0	436.3	4	193.4	241.8	11	246.0	307.5
TOTAL	191	220.6	275.8	57	225.7	282.1	149	163.6	204.5	397	199.9	307.9

Table 3: *Estimated Miles Traveled by Bicycle Type for Study Period and Year for age and sex of rider.*

5. Conspicuous by their absence are noted failures of frame, crank, hanger, and sprockets.

6. The overall accident rate for all bicycle types is 1.58 accidents per 1000 miles ridden (for accidents resulting in moderate and severe injuries the rate is .133 per 1000 miles or 1.33 per 10,000 miles).

7. The average boy in the study rode his bike about 250 miles in the 6-month summer study period (and an estimated 313 miles for the year). At this mileage accumulation, an average of 25 years would elapse between accidents severe enough to require medical treatment. (Table 3).

8. Since highrise bikes are ridden more miles, and since there are more of them, their accident *frequency* (actual count) is higher even though their *rate* (per 1000 miles) is not.

9. No significant sex difference was observed in terms of accidents per 1000 miles ridden.

10. Accidents are relatively more frequent among the younger, more inexperienced riders.

"the average boy in the study rode his bike about 250 miles in the 6-month summer study period."

additional findings

1. Bicycle mishaps are mostly of a mild nature. The more severe the accident, the more rarely it occurs. This is consistent with most classes of accidents. (Figure 5).

2. Extrapolating from the sample, it is estimated that 8% of bicycle accidents in Raleigh are severe enough to require some kind of medical attention.

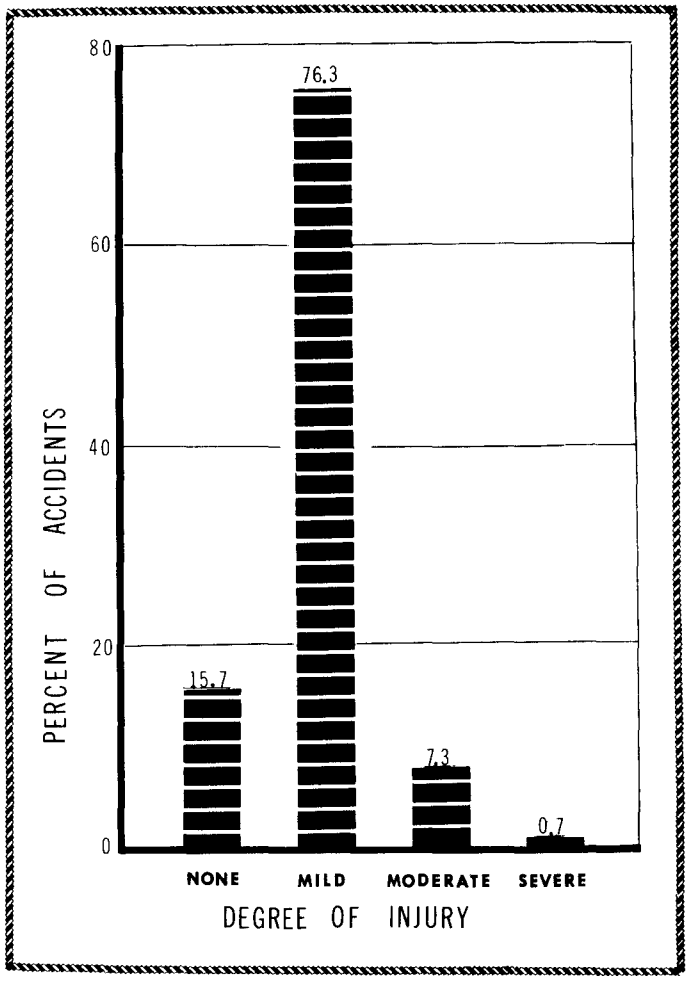


Figure 5: *Estimated Degree of Injury for Accidents Occurring in the Total Raleigh Bicycling Population.* Most accidents are of a mild nature only requiring minor first-aid and can be treated at home. The typical bike rider—an active 10 year old boy—would experience an injury-producing accident approximately once for every two years of regular bicycle operation.

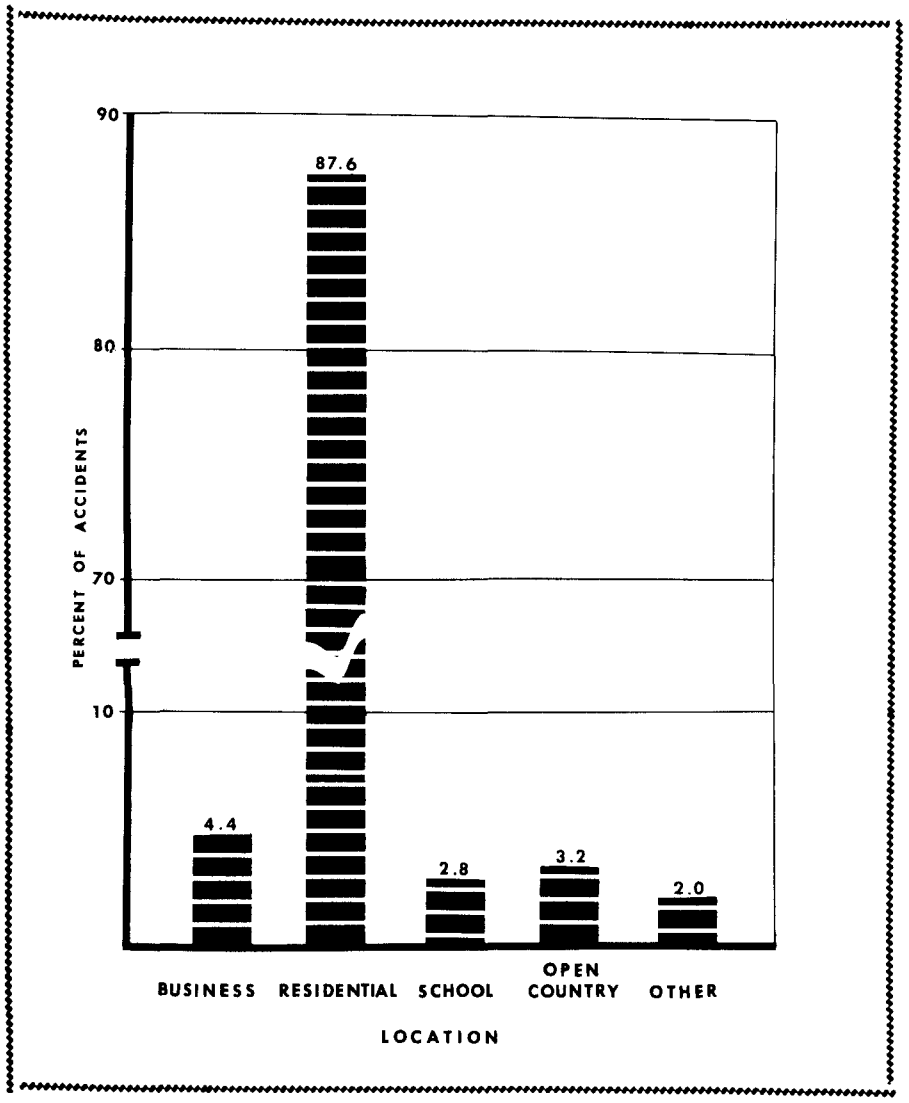


Figure 6: *Percentage of Accidents Occuring by Character of Location.* A majority of accidents occur in residential areas during the daylight hours.

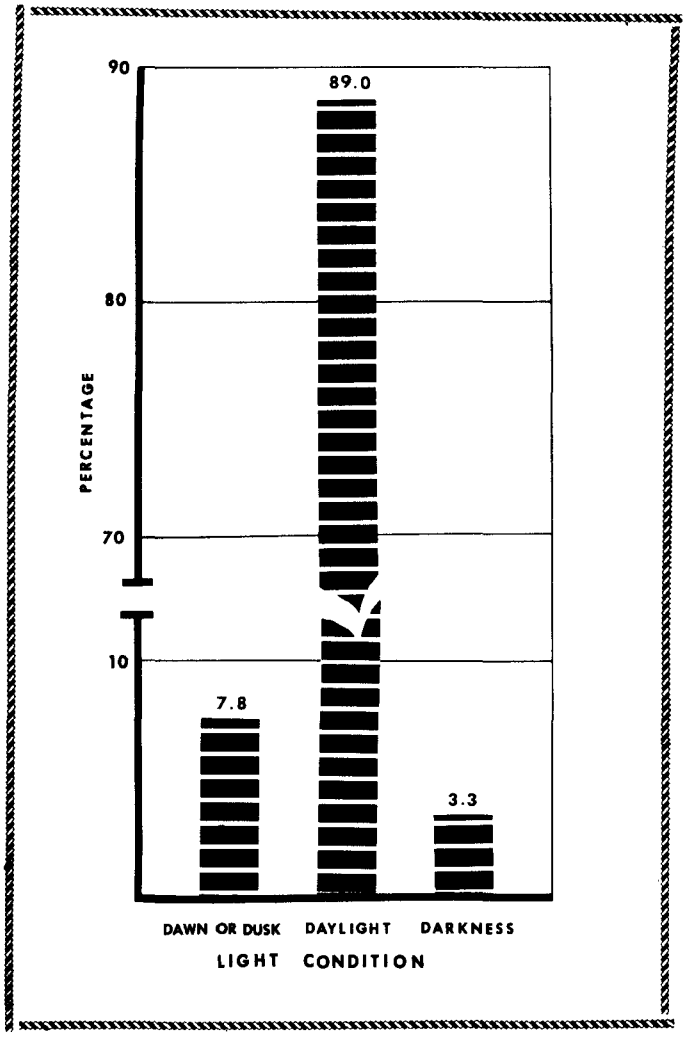


Figure 7: *Light Condition at Time of Accident.* Most accidents occurred during the daylight hours.

3. Most injuries are lacerations and abrasions—cuts and scrapes—with some skeletal injuries. It was impossible to tell the difference between injury from contact with the ground and injury from contact with the bike.

4. Based on this study it is estimated that the average boy rides his bike 313 miles a year; a girl, 159 miles a year.

5. Based on this study it is estimated that the average male cyclist has a minor accident once in every two years of riding.

6. Almost 88% of all accidents occurred in residential areas, during daylight hours in clear weather. (Figures 6, 7, and 8)

7. Of accidents which took place in the street, 33% of the time the cyclist was traveling other than with the flow of traffic. That is, he was riding against traffic or was in the middle of the road. (Figure 9).

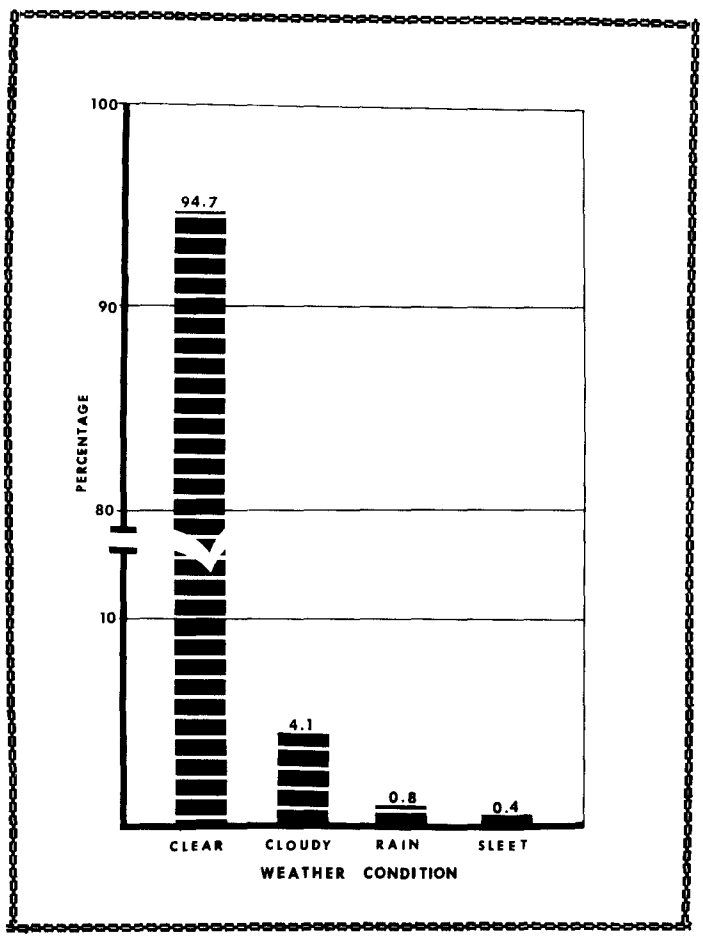


Figure 8: *Weather Condition at Time of Accident.* Almost 95% of the accidents were reported to have occurred during clear weather.

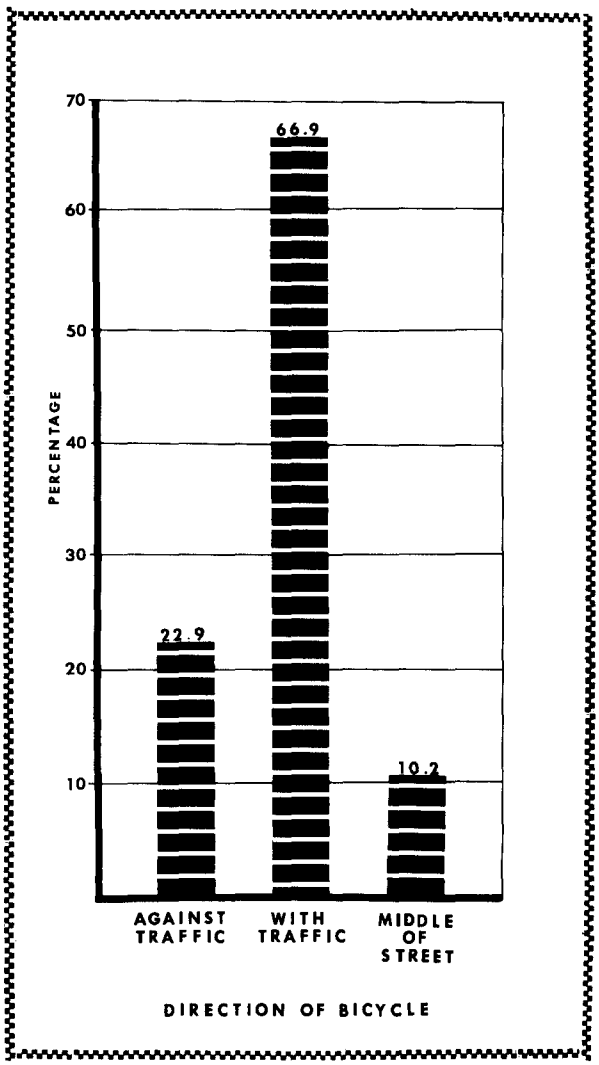


Figure 9: *Direction of Travel at Time of Accident.* When an accident occurred the rider was traveling with the traffic a majority of the time.

the conclusions

1. The data do *not* support the contention that any particular bicycle type, including the highrise, is associated with a higher accident rate. Nor was type of bike significantly associated with injury severity or body area.

2. Bike accidents occur at a high mileage rate relative to other transportation forms, partly because of the very sensitive reporting threshold in this study. However, this is hardly an appropriate yardstick considering that the majority of "drivers" in this study were 6-14 years old.

More to the point, rider involvement in a minor accident would occur on an average of once in two years, and a serious accident requiring medical attention once in 25 years.

3. The youngest of the riders more often show up in accidents than older riders. This is a familiar finding in accident research, but takes on added significance when one considers the sharp bicycle marketing changes that have been seen in recent years.

Today, children commonly begin riding even before going to school—at age 5 or even 4. This is, of course, even before they have been exposed to school safety programs.

It is clear that they need even more intensive indoctrination, and efforts need to be re-doubled to reach these youngest and highest risk children. Since the very young riders are a relatively new part of the bicycling scene, perhaps programs of education and control have not yet been sufficiently geared for this new segment of the market.

This also suggests the possibility of special equipment requirements and manufacturing standards. It may be, for example, that a 5-6 year old will pay even less attention to bike maintenance than will an 8-10 year old. Both manufacturers and parents may need to exercise even higher standards of care for this part of the market.

4. Mechanical problems play a role in bicycle accidents. The size of the *causal* role is difficult to ascertain because of reporting ambiguities. Also it was impossible to distinguish mechanical problems stemming from maintenance as opposed to original design.

Even though the *probability* of a mechanical failure may be low, there will still be very many such events because of the huge size of the bicycle population. In view of this, even greater attention is warranted in two rather obvious areas. First, riders need to inspect their bikes regularly and to maintain them within proper limits. Second, manufacturers should keep mechanical designs under continuous review, and in view of the riders age and the nature of bike use, should expand the concept of designing the bikes for minimum maintenance and maximum abuse.

"a serious accident requiring medical attention would occur once in 25 years."

5. When a child falls or is knocked from a bicycle he will hit the ground, and may contact the bike in the process. The bike may contribute to the injury, but even if the bike does not, the rider will still hit the ground. It was not possible to distinguish injuries from striking the ground and injuries from striking the bike. However, manufacturers could make further contributions to safety through a continuing program to review bike components most likely to strike the rider during an accident, and to design and test injury reducing countermeasures.

Such concepts as energy absorbing structures, placement of controls, etc., clearly do *not* have the same potential for protection of bicycle riders as they do for car occupants because the bicycle rider is going to hit the ground regardless. (The same reasoning regarding motorcycles has led to programs of padding the *rider* rather than the vehicle—i.e., helmets). Nevertheless, there may be some applicability, and continuing exploration of the potential and limits of these concepts is in order.