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GRADUATE COLLEGE

THE ROLE OF CHRONIC MEDICAL CONDITIONS IN HIGHWAY SAFETY

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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degree of

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BY

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Oklahoma City, Oklahoma

1972

THE ROLE OF CHRONIC MEDICAL CONDITIONS IN HIGHWAY SAFETY

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THE ROLE OF CHRONIC MEDICAL CONDITIONS IN HIGHWAY SAFETY

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

During the decade of the sixties accidental deaths took a toll of about 1,050,000 lives, an increase from 934,000 in the decade of the fifties. Disabling accidental injuries totalled about 100,000,000 in the sixties, compared to about 93,000,000 in the fifties (1). Interestingly, almost all of the increase was due to motor vehicle accidents. The public non-motor vehicle totals also increased, while the home totals were almost unchanged and work totals decreased slightly (1). Even when the increase in total population is taken into account, the number of injuries and deaths due to motor vehicle accidents has not improved to any great degree. That no noticeable improvement has been effected is a sad indictment of today's modern technology. It would seem that any country that has put a man on the moon as a result of one short decade of concentrated effort could effectively reduce death and injuries due to motor vehicle accidents.

The magnitude of accidents as a major public health problem is apparent when it is considered that as a leading cause of death among all age groups, accidents rank third behind heart disease and cancer (1). Until an individual reaches age 44, the leading cause of death is

accidents. When accidental injuries are considered, the magnitude of the problem is greatly increased.

It has been noted, and long accepted as fact, that the task of driving a motor vehicle involves the integration of considerable perceptual information, rapid and frequent decision-making, and the exercise of considerable motor skills (2). Interference with any of these steps could be expected as a result of stress, fatigue, drug or alcohol ingestion, disease or other physiologic determinants (2). Such interference could cause the driver of a motor vehicle to be involved in a traffic violation or accident; consequently, various highway safety programs focus their attention and resources on eliminating one or more of these causative factors. With one notable exception, disease, the major causative factors are basically transient, in effect self-induced and; therefore, more readily controllable by individual drivers. It is the exception, disease, specifically chronic disease, that in the opinion of some safety experts, is the most often overlooked and hardest factor to evaluate and control. It is imperative that if highway safety is to assume its proper place in a highly mobile, technologically advanced society, this factor, too, must be clearly understood.

In all states, motor vehicle administrators and departments of public safety are required by law to prohibit drivers who are mentally or physically unfit from driving motor vehicles (3). It is interesting to note that these officials have been seeking aid from the medical profession and health departments for the purpose of helping to establish realistic standards for the regulation of medically restricted drivers. The first public health agency to become involved in this subject was

the Oklahoma State Board of Health in the year 1907 (4).

To date, medical advisory or review boards have been established in most of the states, but they lack uniformity in organization, policies, and procedural practices (5). Their recommendations are based on a review of medical conditions which may constitute driver limitation and cause an individual driver to be a hazard on the highway. Driver licensing administrators then render decisions on whether to grant drivers licenses based on the medical advice in combination with other facts pertinent to each case (5). In most states, the final decision whether a person should be permitted to drive or not is the responsibility of the licensing agency no matter what the recommendation of the medical advisory board (6). An equally important function of medical advisory boards has been to act as "watchdogs" to prevent unnecessary denial or restriction of driving privileges to handicapped persons, who despite their handicaps, are safe and qualified, and who deserve to be allowed to drive (7).

California was one of the first states to regulate the driving privileges of drivers with specific chronic medical conditions. The basis of their regulation was the assumption that the existence of certain conditions represented a handicap to driving and therefore a danger to the driving public (8).

Many physicians with strong feelings about medically restricted drivers have felt that the goal of licensing should be to license all applicants who can operate a motor vehicle with safety to themselves and others and to restrict, withdraw, or deny the license to those who present an unwarranted risk (9, 10). However, some physicians have

expressed the sentiment that it is unfair to expect them to furnish a written endorsement as to the ability of an individual to drive a motor vehicle (11). These physicians have stated that there are too many variants that may lead to a motor vehicle accident including the traffic flow, the behavior of other drivers, and innumerable factors having nothing to do with the health or physical status of the individual (11). Most physicians probably would not be reluctant to advise those patients suffering from one of the chronic medical conditions as to the hazards that may be involved in their driving. Karns (7) has suggested that physicians must use their influence to urge patients who have chronic medical conditions which may cause them to be unsafe drivers to refrain voluntarily from driving.

Dunlop (12), one of the first to be concerned about the role of medical disabilities as a cause of motor vehicle accidents, reported in 1945 that there were many disabilities which prevented safe driving and others which were of a borderline type. No statistics were given to support his contention.

According to some estimates, as much as 20 per cent of the population has some defect which makes them somewhat more likely to be involved in a motor vehicle accident (13). Waller (14) felt that, based on his experience, impairment to drivers or pedestrians from chronic medical problems, frequently acting at a subclinical level could be a contributing factor in 15 to 25 per cent of motor vehicle accidents. In actual numbers, it has been estimated that there are some 40 million people with hidden medical defects, such as 2 million diabetics and 2 million epileptics (15). While these estimates appear to be reliable,

there is very little basic information on the role that chronic medical problems actually play in causing accidents (16).

West (17) has suggested that a substantial barrier to adequate basic research in the area of chronic medical conditions and motor vehicle accidents has been the assumption that more has been known about the underlying causes of accidents than actually was known. West continued by stating that within the medical profession, there has been a tendency to assume that physical impairments of drivers are important in the causation of accidents, although little evidence has been collected to confirm or deny this assumption. There is, in fact, some evidence which suggests that certain impaired drivers have no more accidents than unimpaired drivers (18).

In 1964, The American Medical Association (10) stated that no scientific data were available to indicate that drivers with any particular disease, including diabetes, epilepsy, color blindness, cardiovascular disease, or deafness had higher motor vehicle accident rates than comparable groups not having the condition. Grattan and Jeffcoate (19) acknowledged that the literature on the relation between chronic medical conditions and accidents was extensive, but that most of the papers had not made use of control groups. McFarland (20) also recognized the weakness of much of the literature because of a lack of studies utilizing control groups. The current situation was viewed by Waller and Goo (21) when they stated, "The effects of chronic medical conditions on the ability to drive have been - and remain - the subject of considerable controversy but relatively little study using scientifically acceptable methodology."

Several studies have been conducted which have attempted to statistically determine the effect of various chronic medical conditions on the accident and violation rates of affected drivers. The most widely quoted has been Waller's (8) 1965 California study. The records of 2,672 people with chronic medical conditions who were known to the California Department of Motor Vehicles were compared with those of 922 California drivers renewing their licenses who were not known to have chronic medical conditions. The medical groups differed from the comparison sample in distribution according to age, sex, marital status, and socioeconomic status. Results of the study showed that drivers with diabetes, epilepsy, cardiovascular disease, alcoholism and mental illness averaged twice as many accidents per 1,000,000 miles of driving and 1.3 to 1.8 times as many violations per 100,000 miles as drivers in the comparison group. In a similar study, Waller and Goo (21) compared types of accidents and violations for 1,701 drivers with chronic medical conditions known to the California Department of Motor Vehicles with 921 drivers not known to have medical conditions. Drivers without medical conditions committed no errors in about half of their accidents, whereas those with alcoholism committed no errors in only 13 per cent, and drivers with other medical conditions committed no errors in a third of their accidents. More recently, Waller (22) has emphasized that persons who have such substantial medical impairment that they are likely to represent an undue hazard on the highways comprise only a minority of those with chronic medical conditions. This hopefully was not intended as a proclamation that additional information is unnecessary.

Crancer and McMurray (23) compared the traffic accident and

violation rates of Washington's 39,242 medically restricted drivers with the accident and violation rates of all 1.6 million licensed Washington drivers. Statistically higher accident rates were reported for persons whose licenses were restricted as a result of diabetes, epilepsy, and fainting. Persons with a license restriction for heart disease had slightly, though not statistically, higher accident rates, and persons with vision deterioration had slightly, though not statistically, lower accident rates. Statistically higher violation rates were recorded for persons with diabetes and epilepsy. The violation rate for the group with heart disease was statistically lower.

Driving records of 266 diabetics under treatment and 100 persons who had been hospitalized with cardiovascular illness were compared with 687,228 driving records of persons living in the same general driving environment in Washington (24). The diabetics had a statistically higher accident rate than the comparable population, while the cardiovascular group had a similar accident rate. Both groups had statistically higher violation rates than the population. Compared to the population, the cardiovascular group had more violations for drunken driving, reckless driving, negligent driving, failure to stop, failure to yield, disobeying road signs, and improper turn. The diabetics had fewer violations that result in license suspension such as drunken and reckless driving; however, they had more violations for failure to stop, failure to yield, improper turn, and speeding.

Ysander (25) discovered in his study of 612 drivers in Sweden that the percentage of drivers in a chronic disease group experiencing accidents was about half that of drivers in a control group. The

drivers in the chronic disease group had been diagnosed as suffering from either diabetes, cardiovascular disease, renal disorders, or diseases of the sensory organs. Frequency of road accidents and serious driving offenses during a 10-year period were recorded and compared with a control group matched with regard to number, sex, age, and duration of license-holding. The conclusion was drawn that any increased risk to road safety constituted by drivers with specified chronic diseases may be satisfactorily offset by the restrictions applied in Sweden in the granting of licenses to those drivers. However, it may not be possible to compare the results obtained by Ysander directly to those obtained by Waller in California and Crancer in Washington since the proportions of diseases covered in the investigations were not the same (19). For example, epilepsy was the most common disease in Waller's 1965 study, while there were only six cases of epilepsy out of the 612 cases studied by Ysander.

Rees (26) in an attempt to determine the extent of medical disabilities among drivers, conducted a survey to assess the known mental and physical disabilities of ordinary drivers in a rural area of England. With the help of the local police, Rees was able to identify all of the drivers that lived in one area. It was found that 1,552 persons in the area drove motor vehicles and that 1,190 were patients of one clinic. From a review of the records, it was found that 9.2 per cent or 109 of the drivers had at least one significant mental or physical illness which would render the driver unsuitable to drive a public service vehicle. This study points out the fact that it is almost impossible for motor vehicle authorities to know the full extent of the involvement of

persons affected with chronic medical conditions in motor vehicle accidents and violations.

Even more disturbing were the results released by researchers who worked with a psychiatric clinic associated with a Detroit traffic court (27). Of 812 traffic offenders seen in the clinic in 1953, 90 were feeble-minded or borderline feeble-minded; 154 were of inferior intelligence; 16 were overtly psychotic; 23 had organic brain diseases; 18 were convulsive states with psychosis; 19 were chronic alcoholics; 103 exhibited inadequate personality; personality trait disturbances numbered 262; and sociopathic personality numbered 13. This sample population was certainly not representative of the average driving population, but had these individuals been identified earlier, their involvement in traffic violations and accidents might have been reduced. There appears to be a real problem in the satisfactory identification of medically impaired drivers.

A study by Eelkema et al. (28) indicated that persons who have suffered from some types of mental illness might, in fact, be better drivers than a control group. It was discovered that psychotics and psychoneurotics, after discharge from a state mental hospital, tended to have better driving records than their matched comparison groups.

Physical Disabilities

There is general agreement among most authorities that the actual role of physical disabilities, or mechanical disabilities, in motor vehicle accidents is relatively minor as compared to chronic medical or psychiatric conditions. It is also quite well accepted and documented that orthopedically handicapped persons do not, as a rule, meet

with accidents more often than those not so affected (29).

Four hundred and ninety-four disabled drivers, the majority with loss of function in the legs as the result of poliomyelitis or amputations, were studied with respect to the frequency of traffic accidents and serious traffic offenses during a 10-year period (30). Traffic accidents which might have been caused by their disability occurred in only three of the total number of drivers investigated. It was concluded that disabled drivers were not an increased hazard in traffic.

Crancer and McMurray (23) discovered that Washington drivers in the group with physical handicaps such as paralysis or loss of limb had a statistically significant higher accident rate and a slightly, though not statistically significant higher violation rate than a control group.

Sudden Illness

Sudden illness, usually leading to complete or partial loss of consciousness, is a well-recognized cause of accidents, though not a common cause (19). Herner et al. (31) indicated that 41 of the 44,255 road accidents reported to the police in one region of Sweden during 1959 to 1963 were, or probably were, caused by sudden illness in the driver of a motor vehicle. All 41 were male, and the illness was most often due to epilepsy or myocardial infarction. Eight drivers died at the wheel from their disease. Only in 19 out of the 41 cases was there any reasonable possibility of a previous medical examination having indicated that the man was unfit to drive.

Baker and Spitz (32) concluded that the hazard associated with sudden natural death of drivers suggests that the magnitude of the problem does not warrant costly and restrictive control efforts. Their

investigation of 591 accidents that caused fatal injuries to drivers or pedestrians revealed that none of them resulted from natural death at the wheel.

West et al. (33) discovered that 155 drivers or 15 per cent of 1,026 drivers dying within 15 minutes of their single-vehicle accidents in California, 1963 to 1965, died of natural causes. Ninety-six per cent were men with a mean age of 60 years. Ninety-four per cent died of heart disease, primarily coronary artery disease. Of those dying of heart disease for whom past medical history was available, 40 per cent were unaware of their heart condition.

Sudden illness or sudden natural death is usually ill-defined in the literature. Since most studies indicated that the primary cause was heart disease, the condition is usually reported as a chronic medical condition.

Epilepsy

No chronic medical condition that could affect driving has received as much attention from authorities as epilepsy. Even today, regulations vary from state to state. In Wisconsin, where since 1949 patients who have been free of attacks for 2 years are allowed to drive, it seems that the accident rate for licensed epileptic drivers has been much lower than the general average (34).

A great deal of the controversy over the licensing of epileptics has had to do with the stigma that has historically been associated with such individuals. Until recently, it was the opinion of most people, including many physicians, that all or at least the majority of epileptics were or eventually would become mentally retarded (35). This

impression has been expressed in many state laws. Prior to 1962, a Michigan law classified epileptics as mentally diseased, one act stated, "In this act, the term 'mentally diseased' shall be considered as referring to any person who is either mentally ill, mentally handicapped, or epileptic" (36). Under such circumstances, it has been no great surprise that many epileptics would not admit to being epileptic when making application for drivers license (37).

Glaser and Irons (38) emphatically concluded in 1946 that epilepsy was a definite motor vehicle danger and patients so afflicted should not be permitted to drive, unless seizure-free for 3 years. This conclusion was reached without the benefit of any concrete statistical data.

Hierons (39) disagreed with those who held the view that epilepsy was the cause of motor vehicle accidents only on incredibly rare occasions. He felt that only in selected cases should epileptics be granted a license, then only after 5 years of being seizure-free.

Elliott (40) felt so strongly about epileptic drivers that he recommended that physicians had a responsibility to the community to inform the licensing authorities of patients who held licenses.

In a study by Schwade reported by Keys et al. (41), the accident rate of epileptics in Ohio during the 10-year period 1949 to 1959 was only one-sixth that of the driver population as a whole. This study would tend to take away some of the argument against licensing epileptic drivers. Unfortunately, the results of recent studies have not been consistent with the above cited study (21, 23).

The exact number of epileptics in the United States is difficult

to determine. One estimate given is that among persons of driving age the prevalence, or number of cases existing at any one time, is about four per 1,000 population (6). In addition, it has been estimated that there are 0.6 new cases of epilepsy per 1,000 population each year, of which 40 per cent are in people of driving age (8).

Until about 1948 it was generally held that a person who had at any time suffered from epileptic seizures should be refused a driving license (42). Today, the American Medical Association (43) feels that epileptic patients who have been seizure-free for at least a year, and who are reliable in taking their medication, should be considered good risks for the operation of private vehicles but should be advised not to drive commercial or passenger transport vehicles. Other authorities and some state licensing authorities agree generally with the American Medical Association's recommendations, but feel that an epileptic applicant should be seizure-free for at least 3 years before being considered (44, 45).

Diabetes

Diabetes as a chronic medical condition allegedly having some effect on accident and violation rates of drivers has been the subject of many studies. Studies previously quoted by Waller (8) and Crancer and McMurray (23) tended to show that diabetic drivers had a higher accident and violation rate than drivers not known to be diabetics.

Three hundred and forty-six licensed, known diabetic drivers in Prince Edward Island, Canada were compared to age-matched, non-diabetic licensed drivers in respect to accident and minor convictions for moving traffic offenses during the period of January 1, 1963 to June 30,

1968 (46). Diabetic drivers appeared to be involved in 1.72 times as many accidents, 2.5 times as many major convictions, 1.2 times as many minor convictions or 1.7 as many combined convictions as were age-matched non-diabetic controls. The comparisons were based simply on incidence over the 5.5-year period. It was also noted that the type of diabetic therapy did not seem to bear significant relationship to involvement of diabetics in any particular type of incident.

Baldwin et al. (47) reported that as a result of their experience in Maryland, diabetes was an important cause of motor vehicle accidents not only because of the vascular pathology of the retina, heart, and extremities but also because of the more common and dangerous hypoglycemia as a side effect of drug treatment. Incidences have been reported in the literature of diabetic patients being accused of driving a motor vehicle while under the influence of a drug (48).

Fowler (49) felt that the diabetic was a stable type of law abiding citizen and felt that they should not be singled out as a group considered to be unstable drivers. He further stated, "It is my impression that diabetics are one of the safest groups of drivers on the highway regardless of whether they do or do not take insulin." No statistics were given to support Fowler's contention that diabetic drivers have accident and violation rates similar to the rates of non-diabetics.

Cardiac and Circulatory

As is true with most chronic medical conditions, it is extremely difficult to obtain accurate data to prove the relationship between diseases of the circulatory system and the actual etiology of an accident (50). There are many instances reported in the literature of individuals

being involved in motor vehicle accidents as a result of cerebrovascular insufficiency (51, 52). While these incidences may have had tragic results, they are considered rare by many authorities (19, 32).

Odens (53) observed 10 cases of coronary thrombosis during a 14-month period in London, eight of which had been driving their motor vehicle prior to the attack. None of the drivers were involved in an accident, but Odens felt that as the traffic in London became more and more congested, there would be a proportionate increase in coronary thromboses.

There has been a great deal of concern about the effect of heart disease on the driving records of drivers of public motor vehicles. Levy et al. (54) reported a case in which a bus driver with a known heart condition was subsequently involved in an accident that fatally injured himself and six passengers. Among the conclusions, it was noted that an individual who has had a coronary attack is more susceptible to further trouble than if he has never had a previous cardiac illness.

Norman (42) considered that people who had made a good recovery from myocardial infarction, or whose attacks of angina pectoris were mild and infrequent, should be advised that they may continue to drive private motor vehicles. He felt that in such cases there was an increased risk of an accident, but that the increase was probably small and acceptable.

Trapnell and Groff (55) recommended prohibiting the operation of commercial or passenger transport vehicles by any driver who has had a myocardial infarction. This recommendation has been taken into account by most driver licensing authorities. The importance of such a policy

was made evident by a study carried out in 1959 by Norman (56) which showed that 73 out of 2,130 drivers of London Transport buses were unfit to drive, 51 because of a cardiovascular condition. Of additional interest was the fact that 22 out of the 73 drivers who were found unfit were over 65 years of age.

Crancer and O'Neall (57) attempted to determine if there were drivers with specific heart diseases, masked by the over-all heart disease group, that have significantly higher accident, violation, or accident and violation rates than those of a comparable non-restricted population. A random sample of drivers restricted for specific heart diseases was selected for the study. These included arteriosclerotic, hypertensive, rheumatic, and other heart disease. A sample of non-restricted drivers was matched to each member of the disease group samples in terms of age, sex, and city of residence. It was found that the arteriosclerotic and hypertensive disease groups had a significantly higher accident rate than that of their matched groups. The rheumatic and other heart disease groups were not significantly different from their matched groups in terms of accident rates. None of the violation rates for any of the four disease groups were significantly different from those of their matched groups.

There seems to be no general agreement as to the magnitude of the effect of cardiac and circulatory conditions upon the accident and violation rates of those so affected.

Aging

It is felt by some authorities that the involvement of older persons in increased numbers of motor vehicle violations and accidents

is more a function of age itself than any specific chronic medical condition.

There is no doubt that a special problem may be presented by the aged with regard to the operation of motor vehicles. Poor night vision, poor tolerance of glare, a diminished field of vision, and lessened visual acuity coupled with slower reflexes make the aged driver both a more accident prone driver and pedestrian (58). Also, quick problem solving, fine perception of light and estimation of the speed of moving objects may be impaired in the aging driver (58). All of these abilities are necessary for safe driving. Therefore; it apparently is generally agreed that organic disease, impaired functions, and aging processes increase the accident potential of persons (59).

The concern with the aging driver has been increasing in recent years. One factor causing an increased concern has been the increasing number of persons in this country over the age of 65, many who continue to drive for pleasure or necessity. Foley et al. (51) estimated that there were 20 million people in the United States over the age of 65.

A California report concluded that older drivers were involved in an average number of accidents (60), but cautioned that their exposure or the number of miles they drove was well below average. The report also stated that age brings about a distinct change in the accident involvement, only 55 per cent of all California drivers involved in accidents are cited for traffic rule violations at the time of the accident. In drivers aged 61 through 70 who are involved in accidents, the rate of citations rose to 69 per cent. Further, drivers over 70 were cited in 70 per cent of all accidents in which they were involved.

Berkey (61) concluded that drivers over 65 have twice the accident rate of average drivers. Fishbein (62) noted that accidents per 100,000 miles driven increased sharply for both men and women after age 60, but that the older driver never reached the rate of accidents as that for drivers less than 21 years of age.

Waller (63) showed that the accident experience of drivers age 60 or older differed both quantitatively and qualitatively from that of drivers age 30 to 59. Mean individual traffic accident and violation rates were compared for 267 healthy drivers age 30 to 59, 83 persons age 60 or older, 82 senile persons age 60 or older, 80 oldsters with cardiovascular abnormalities, and 199 oldsters with cardiovascular and senile changes. Accident rates significantly higher than that of the middle-aged drivers were found only for the senile oldsters and the oldsters with cardiovascular and senile changes. The latter group also had significantly higher violation rates. Drivers with cardiovascular disease only also had an apparent increase in accident and violation rates, but the differences were not statistically significant.

A study by Finesilver quoted in a California journal indicated that the aging driver may not be as hazardous as was previously suspected (64). The study was based on an examination of the records of the total driver population of each of 30 states and the District of Columbia. In the 31 jurisdictions for which data were available, persons of age 65 and over averaged 37 per cent fewer accidents than would exist if their proportion of accidents had been in exact ratio to their proportion of the driving population. Although aging drivers represented 7.4 per cent of all drivers in the states surveyed, they were involved

in only 4.8 per cent of all accidents in those states. Also, aging drivers averaged lowest of all age groups in frequency of injury - producing accidents. The portion of the study dealing with Washington, D.C. showed that there was a direct correlation between an increase in age and a decrease of responsibility for accidents. Planek and Fowler (65) felt that the study was not completely valid because Finesilver did not take mileage driven or exposure into account.

The type of accident involvement of older drivers has been shown to be different from other age groups (66). Older drivers are more likely to be involved in accidents resulting from improper starting and turning and failure to give right of way. Younger drivers tend to be involved in accidents resulting from speeding and the use of faulty equipment. This difference in type of accident involvement has been reported by other researchers (32, 65).

Planek and Fowler (67) attempted to picture the typical aging driver when they described him as a male who had been driving for many years and who faced the complexities of the driving task with lessened sensory capacity and a less efficient information coding system, both of which contributed to a slower response to complex stimuli situations. His physical performance had become lessened. He became selective in his perception due to inhibited sensory processes and such attitudinal factors as withdrawal. When he became involved in an accident, it was likely to be of the multiple vehicle type, and he was likely to be more seriously injured, even though the accident itself was less severe and occurred at slower speeds. His limitations and deficits were somewhat counter-balanced by his increased experience. As a result, Planek and

Fowler felt that the aging driver should be educated to his circumstances rather than being denied his driving license.

There appears to be no age at which all drivers become a hazard to themselves and others. This presents a dilemma to licensing authorities who often have to make decisions based on the type of conflicting evidence discussed.

An equally strong argument has been raised that age itself is not an important factor in the occurrence of traffic accidents, but that the increase in accident risk is the result of the more frequent occurrence among older persons of various medical conditions (63).

Neurological Problems

In most states, drivers suffering from certain neurological conditions are permitted to drive if their condition is such that the Medical Advisory Committee feels the individual will not be a hazard to himself or other drivers.

Baldwin et al. (47) feel that the most important consideration in evaluating a neurological driver is not the specific disability but how the individual handles it. Their experience in Maryland probably has been typical of the situation in many other states. Between July 1, 1962, through June 30, 1965, 578 people were seen with atrophic or degenerative neurological conditions, including multiple sclerosis, myasthenia gravis, Parkinson's disease, and Huntington's chorea. Of these, 256 were recommended for driving and 222 were rejected.

It is virtually impossible to evaluate the involvement of this disease group in motor vehicle accidents and violations, because most states simply categorize this group under the heading, other conditions.

In summary, the literature appears to be replete with studies dealing directly or indirectly with the subject of chronic medical conditions and their role in motor vehicle accidents and violations. Unfortunately, most of the studies are inconclusive and the data cannot be readily utilized by driver licensing authorities in the various states to aid in assessing the extent of their problem. Many of the studies were contradictory, in part due to the lack of a standard procedure among states in categorizing chronic medical conditions. In some instances the conclusions reached by investigators were diametrically opposed to those reached by other investigators. For these reasons, there appears to be a need for considerable additional study.

CHAPTER II

PURPOSE AND SCOPE

Evidence does indicate that any of the recognized chronic medical conditions such as diabetes, alcoholism, drug addiction, epilepsy, neurological disorders, psychiatric conditions, and heart disorders could have an effect on driving behavior. It was the purpose of this study to determine whether licensed Oklahoma drivers suffering from diabetes, epilepsy, cardiac or circulatory conditions, or neurological disorders such as stroke or chronic brain syndrome, have a higher accident and violation rate than licensed Oklahoma drivers not known to be affected.

The driving records of all individuals in the above specified disease categories who were granted Oklahoma drivers licenses after being reviewed by the Oklahoma Medical Advisory Committee (OMAC) in 1969 were studied. Specifically, the accidents and violations recorded for the disease categories during 1970 were tabulated according to age and sex. The accident and violation rates obtained were compared to the accident and violation rates of all licensed Oklahoma drivers according to age, sex and year of driving exposure.

It was felt that the investigative technique as well as the information obtained from this study could be used by the OMAC and similar agencies in other states to evaluate their programs.

CHAPTER III

METHODS AND PROCEDURES

The OMAC was established in 1967 for the purpose of evaluating the driving ability of medically restricted drivers. It is composed of four members appointed by the Commissioner of Public Health and three members appointed by the Commissioner of Public Safety. By state law, the personnel of the OMAC shall include, but not be limited to, an internist, a vision specialist, a neurologist, a psychiatrist, and an orthopedic surgeon. Each member serves in the interest of public health and safety and serves without compensation. The meetings of the OMAC are closed to the press and the public.

There are several routes by which an Oklahoma driver affected with a chronic medical condition may be brought to the attention of the OMAC. The usual routes are as follows:

a) Referral from driver license examiners who detect such individuals when applicants acknowledge on their driver license application that they presently are, or have suffered from a condition that might effect driving ability.

b) Referral from physicians.

c) Referral from enforcement officers.

d) Referral from family or friends.

e) Referral from courts.

f) Referral from hospitals.

g) Referral from other states.

h) Referral from Department of Public Safety record files.

The individuals thusly referred are then sent a letter instructing them to take an enclosed medical examination form to their family physician. The physician is instructed to examine the individual and to mail the form to the Executive Secretary of the OMAC. The information provided on the examination form is used for the purpose of determining the individual's fitness to operate a motor vehicle.

The policies of the OMAC are generally consistent with those outlined in Driver Licensing Guidelines for Medical Advisory Boards (5) and Physician's Guide for Determining Driver Limitation (43). The important exceptions are as follows:

a) Epileptics who have been seizure free for a period of 6 months may be permitted to drive. The usual recommendation is that persons with epilepsy should be seizure free for at least 2 years before being permitted to drive (6).

b) The medical category, Other Neurological Disorder, includes conditions such as stroke or chronic cerebral arteriosclerosis, chronic brain syndrome and chronic senility. Licensees suffering from either of these conditions are required to successfully complete a review examination prior to each driver license renewal.

The name and Oklahoma driver license number of all medically restricted drivers whose medical condition was reviewed by the OMAC during 1969 were obtained from the Oklahoma Department of Public Safety

through the Driver Improvement Division. It was necessary to identify the medically restricted drivers in order to obtain their files from the central files of the Oklahoma Department of Public Safety. As part of the agreement with the Department of Public Safety and the OMAC, all means of identification of individual drivers were omitted from the study. Also, in accordance with the agreement, no attempt was made to contact any individual whose record was a part of the study.

The data utilized in the study were extracted from the individual file jackets after the individual files had been removed from the central files by the second-shift file clerks. The records were reviewed between 5:00 P.M. and 11:00 P.M. on week days and in the presence of the second-shift file clerks. The data were collected during the period from June 21 to October 3, 1971.

From the record file of each of the individuals in the study, the number of moving violations and accidents accumulated during 1970 were recorded on individual cards. Also, recorded was the sex, birthdate, medical condition, and referral source. Accidents were considered to be single or multiple motor vehicle accidents in which the subject was the driver of a motor vehicle (68). Speeding, exceeding legal or safe speed limits, and moving violations were recorded under the heading of moving violations. Moving violations also included violations of established legal traffic regulations such as:

a) Reckless driving.

b) Disregarding stop sign.

c) Driving without lights.

d) Improper passing or turn.

e) Careless driving.

f) Driving while intoxicated.

g) Following improperly.

h) Hit and run.

i) Starting improperly from a parked position.

j) Improper backing.

k) Failure to yield right of way.

All accidents in which the medically restricted person was a driver were included in the study. Only moving violations for which the medically restricted driver entered a plea of guilty, was convicted by a court, paid a fine or offered bond forfeiture were included in the study.

All medically restricted drivers in the four specific categories who were licensed to drive in Oklahoma during the entire year of 1970 were included in the study. Medically restricted drivers whose license was revoked or suspended for all or part of 1970 were not included. This information was available from the individual file.

The accident rates of 77 epileptics, 108 diabetics, 78 individuals in the other neurological disorder category, and 55 persons in the cardiac or circulatory category were compared with matched age and sex accident rates of all of Oklahoma's 1,651,245 licensed drivers for the year 1970.

The violation rates by age and sex of the four disease categories were compared with the total violation rate of all 1,651,245 licensed Oklahoma drivers. Statistics were not available from the Department of Public Safety to allow for the calculation of violation rates by age and sex for all licensed Oklahoma drivers.

CHAPTER IV

OBSERVATIONS AND DISCUSSION

The proportion of males in the chronic disease groups was 69.8 per cent, while the proportion of males in the total licensed driving population was 54.2 per cent. This probably is a reflection of the fact that some medical conditions affect males more often than females, or that males suffering from a chronic medical condition are more insistent in their efforts to obtain a driving license in spite of their medical condition. These proportions were similar to those reported by Waller (8) in 1965. The distribution by age and sex of the selected study categories is shown in Table 1.

During 1970, the greatest percentage of persons in the selected chronic disease groups were not involved in an accident or guilty of a moving violation. Of those involved in accidents or violations, few were involved in more than one violation or accident. In terms of violations, the cardiac and circulatory group had the highest percentage of persons not guilty of a violation. For accidents, the diabetics had the highest percentage of persons not involved in an accident. The actual percentages are shown in Tables 2 and 3.

The OMAC recommended that drivers licenses be granted to 20 persons who were suffering from more than one recognized medical condition. For those persons whose primary condition was diagnosed as other

TABLE 1

AGE AND SEX DISTRIBUTION OF OKLAHOMA DRIVERS WITH SELECTED CHRONIC MEDICAL CONDITIONS, 1969

Medical Diagnosis	Age Group														Totals
	14-15		16		17-21		22-24		25-44		45-64		65+		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Cardiac and Circulatory	0	0	1	0	1	1	0	0	2	1	13	5	24	7	55
Epilepsy	0	0	0	0	23	15	5	5	18	5	4	1	1	0	77
Other Neurological	0	0	0	0	14	5	7	1	16	4	13	2	15	1	78
Diabetes	1	0	2	2	26	19	7	2	8	9	11	5	10	6	108
Totals	1	0	3	2	64	40	19	8	44	19	41	13	50	14	318

TABLE 2

DISTRIBUTION OF VIOLATIONS FOR SELECTED CHRONIC DISEASES

Number of Violations	Diabetes		Other Neurological		Cardiac and Circulatory		Epilepsy	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent
0	79	73.15	60	76.92	47	85.45	57	74.03
1	24	22.22	9	11.54	5	9.09	13	16.88
2	0	0.00	6	7.69	2	3.64	5	6.49
3	4	3.70	0	0.00	1	1.82	1	1.30
4+	1	0.93	3	3.85	0	0.00	1	1.30
Totals	108		78		55		77	

TABLE 3

DISTRIBUTION OF ACCIDENTS FOR SELECTED CHRONIC DISEASES

Number of Accidents	Diabetes		Other Neurological		Cardiac and Circulatory		Epilepsy	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent
0	101	93.52	68	87.18	50	90.91	65	84.41
1	6	5.56	8	10.25	5	9.09	10	12.98
2	1	0.92	2	2.57	0	0.00	2	2.61
3+	0	0.00	0	0.00	0	0.00	0	0.00
Totals	108		78		55		77	

neurological, four were also suffering from diabetes, one was diagnosed as being psychiatric, two had restrictions for vision, and one was suffering from a cardiac or circulatory condition. For those in the cardiac and circulatory category, five were also diabetic, one was diagnosed as other neurological, three had restrictions for vision, and one was also an alcoholic. One epileptic and one diabetic were each diagnosed as suffering from a cardiac or circulatory condition. In no case did the OMAC recommend that any person suffering from more than two recognized chronic medical conditions be granted a drivers license.

The crude or over-all violation rate for all licensed Oklahoma drivers was determined to be 26.41 per 100 drivers. The total number of moving violations reported by the Department of Public Safety was 436,129. This crude violation rate was considerably less than the violation rate of 81.01 for all licensed Washington drivers reported by Crancer and McMurray (23). dowever, it may not be possible to directly compare these rates as Crancer did not elaborate on his method of categorizing violation types.

For epileptic drivers, it was determined that males as a group had an accident rate approximately 3 times greater than that of all licensed males. The accident rate of each age group for which a rate could be calculated was also higher than the matched age groups of the population. As might be expected, the 17-21 and 22-24 age groups were responsible for the highest rates. The violation rate was considerably higher than the overall population violation rate. Again, the 17-21 and 22-24 age groups were responsible for the highest violation rates.

Epileptic females as a group had a higher accident rate than

that of all licensed females and had a lower violation rate than the overall population. The 17-21 age group accounted for all the violations attributed to female epileptics. It is interesting to note that the accident and violation rates for Oklahoma epileptics was lower than that for Washington epileptics (23).

Males in the cardiac and circulatory category had an accident rate slightly higher than the rate for all licensed males. The accident rate of each age group, for which a rate could be calculated, was also slightly higher than that of the matched age groups. The violation rate was slightly lower than that for the overall population. The 65+ age group accounted for the majority of the accidents and violations. It appears that these rates were lower than those reported by Waller (8).

Females in the cardiac and circulatory category as a group had a violation rate considerably lower than the overall rate. No accidents were recorded for females in this disease category.

The accident rate for male diabetics was slightly higher than the overall rate for all male drivers. The accident rate of male diabetics age 17-21 was noticeably lower than that of all male drivers age 17-21. The violation rate for male diabetics was 1.8 times greater than the overall violation rate for all licensed drivers.

The accident rate for all female diabetics was lower than that for all female drivers, and the violation rate was much lower than the overall population rate.

With respect to persons diagnosed as other neurological conditions, males in the 22-24, 25-44, and 45-64 age groups had a higher accident rate than the comparison groups, while the 17-21 age group had

a rate one-half that of the comparison group. This is interesting in that the 17-21 age group has one of the highest accident rates of all licensed drivers. The violation rates of the age groups, for which a rate could be calculated, were all higher than the overall population rate.

As a group, females with other neurological conditions had an accident rate 7 times greater than the overall accident rate for females. The 17-21 age group accounted for the high rate in this case. The violation rate was almost one-half the overall violation rate. The 17-21 age group was responsible for all the violations credited to this chronic medical condition.

The age-sex specific accident and violation rates by chronic disease, and the age-sex specific accident rates for all licensed Oklahoma drivers are shown in Tables 6, 7, 8, 9, 10, 11, 12, 13, and 14 in the Appendix.

It was felt that an attempt to determine whether the age-sex specific rates of the chronic disease groups were statistically different from the matched age-sex specific rates of the licensed driving population, by using the Student's t-test or a similar technique, would be misleading in light of the small number of persons in many of the age-sex disease groups. For example, the addition of a single accident to the 22-24 age group of male epileptics would change the rate from 40.00 to 60.00. The age-sex specific comparisons are not to be discounted because these comparisons minimize the effect of the over-representation of males and older persons in the chronic disease groups. For these reasons, the rates were reported as being higher or lower than those of the matched groups.

Table 4 shows the types of moving violations according to medical condition. Speeding was the most common violation attributed to diabetics, epileptics and persons in the other neurological category. The distribution of other violations is fairly random, except that persons in the other neurological category were credited with more violations for reckless, careless, or negligent driving than any of the other disease groups. Surprisingly, driving while intoxicated accounted for few of the recorded violations. It has been reported that the violation experience of drivers with recognized chronic diseases is different than that of drivers not known to be affected (21).

As indicated in Table 5, most of the chronic medical conditions were brought to the attention of the OMAC by driver licensing examiners. These individuals had indicated on their driver license applications that they had a medical condition that could affect driving. The fact that this referral source only screens those who are applying for their first drivers license, or drivers moving from other states, could help explain the age distribution of the medical groups. Enforcement officers were responsible for the referral of an additional 10 per cent. The majority of these persons had been involved in an accident or violation, and the enforcement officer had reason to suspect that they were suffering from some medical condition. Physicians were responsible for referring very few persons, which adds some support to the contention that physicians are very reluctant to refer patients to medical advisory committees (11). In fact, the families of persons suffering from a medical condition were responsible for the referral of more persons than physicians. A significant percentage of persons directly informed the OMAC that they were suffering from a medical condition.

TABLE 4

DISTRIBUTION OF VIOLATIONS BY TYPE
FOR SELECTED CHRONIC DISEASES

Category of Violation	Diabetes	Cardiac and Circulatory	Other Neurological	Epilepsy
Speeding	21	3	10	13
Reckless, careless, or negligent driving	2	1	6	4
Driving while intoxicated	1	2	2	
Failure to obey traffic sign	4	1	2	1
Failure to yield	2		4	
Improper turn	2	1	2	4
Defective equipment	2		2	1
Improper passing	3		1	2
Driving on wrong side	1	3		3
Failure to observe traffic signal	1	1	5	1
Following to closely	1		1	1
Improper parking	1			
Totals	41	12	35	30
Number of Drivers	108	55	78	77

TABLE 5

DISTRIBUTION OF REFERRAL SOURCES BY MEDICAL CONDITION

Medical Category	Referral Sources								
	Driver Licensing Examiner	Self	Other States	Hearing Officer	Enforcement Officer	Physician	Courts	Family	Total
Epilepsy	56	5			6	1	3	6	77
Cardiac and Circulatory	30	5		4	7	1	1	7	55
Diabetes	97	2		4	3	1		1	108
Other Neurological	37	8	1	6	19	1	5	1	78
Totals	220	20	1	14	35	4	9	15	318

CHAPTER V

SUMMARY AND CONCLUSIONS

This research was designed to determine whether persons suffering from selected chronic medical conditions have higher accident and violation rates than drivers not known to be affected. The driving records of 108 diabetics, 77 epileptics, 78 persons diagnosed as other neurological, and 55 persons diagnosed as cardiac or circulatory who were granted Oklahoma drivers licenses after being evaluated by the OMAC in 1969 were studied. The accident rates were compared to the accident rates of licensed Oklahoma drivers according to age, sex and year of driving exposure. The violation rates were compared to the overall violation rate of all licensed Oklahoma drivers. In addition, the referral sources to the OMAC were tabulated and studied.

Based on the results and observations of this study, the following were concluded:

1. Oklahoma drivers diagnosed as being epileptic, diabetic or having other neurological conditions have higher accident and violation rates than licensed Oklahoma drivers not known to be affected.
2. Oklahoma drivers diagnosed as suffering from cardiac or circulatory conditions, as a group, have lower violation rates, and slightly higher accident rates than drivers not known to be

affected.

3. The driving exposure of medically restricted drivers may, or may not, be similar to that of Oklahoma drivers not known to be affected.

It is recommended that the OMAC obtain from each person, who is evaluated as a result of a medical condition, an estimate of the number of miles driven per year. A random survey of licensed Oklahoma drivers would give an estimate of the driving exposure of the average Oklahoma driver by age and sex. It would then be possible to compare the driving experience of medically restricted drivers with drivers not known to be affected on the basis of driving exposure.

4. The accident and violation rates of Oklahoma's medically restricted drivers may not be reflective of the rates that could be expected in other states. The literature and the results of this study seem to substantiate this conclusion. One problem encountered in comparing rates between states has been the difference in definitions of medical categories.

It is recommended that all states adopt a standard procedure for categorizing and evaluating chronic medical conditions.

5. Drivers with some chronic diseases apparently are able to compensate for their medical condition and drive in a normal manner. Oklahoma drivers with cardiac or circulatory conditions may be in this group.

6. Drivers with some chronic diseases apparently are unable to drive as well as the average driver because of their medical condition.

This may be true of persons in the other neurological category.

7. Regardless of the medical condition, males have higher accident and violation rates than females.
8. Based on the experience of other states (23), it is apparent that the majority of Oklahoma drivers suffering from a medical condition, that could affect driving, have not been brought to the attention of the OMAC.

It is recommended that a procedure be initiated by the Department of Public Safety requiring all persons to answer a questionnaire regarding medical conditions at the time a request is made for renewal of the drivers license. This would bring those persons who have held an Oklahoma drivers license for a long period of time, and who are affected, to the attention of the OMAC.

9. In Oklahoma, physicians are responsible for referring very few persons to the OMAC. Historically, physicians have been reluctant to refer patients to medical advisory committees for fear of violating a patient's confidence. Waller and Thunen (69) have reported that, "The physician who examines a patient for impairment to driving must consider the welfare of the community which will be exposed to the patient's driving in addition to the welfare of the patient himself."

It is recommended that legislation be initiated requiring physicians to report any person suffering from a chronic medical condition that could affect driving to the OMAC. This law could be similar to the California epileptic reporting law

which has been responsible for referring 75 per cent of all epileptic drivers to the Department of Motor Vehicles (16).

10. Additional study of the driving experience of Oklahoma's medically restricted drivers is indicated. It is felt that a study based on driving exposure and larger numbers of medically restricted drivers would yield data that would be statistically significant. A study of all persons in each chronic disease group since the program was instigated in 1967 seems warranted.

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APPENDIX

TABLE 6

ACCIDENT RATES FOR DRIVERS WITH EPILEPSY

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Accidents	Accidents Rates per 100	Total Drivers	Number of Accidents	Accidents Rates per 100	Total Drivers	Number of Accidents	Accidents Rates per 100
14-15	0			0			0		
16	0			0			0		
17-21	23	7	30.43	15	1	6.67	38	8	21.05
22-24	5	2	40.00	5			10	2	20.00
25-44	18	2	11.11	5	1	20.00	23	3	13.04
45-64	4			1			5		
65+	1	1	100.00	0			1	1	100.00
Totals	51	12		26	2		77	14	
Crude Rates			23.53			7.69			18.18

TABLE 7

VIOLATION RATES FOR DRIVERS WITH EPILEPSY

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100
14-15	0			0			0		
16	0			0			0		
17-21	23	14	60.87	15	5	33.33	38	19	50.00
22-24	5	5	100.00	5			10	5	50.00
25-44	18	4	22.22	5			23	4	
45-64	4			1			5		
65+	1	2	200.00	0			1	2	200.00
Totals	51	25		26	5		77	30	
Crude Rates			49.02			19.23			38.96

TABLE 8

ACCIDENT RATES FOR DRIVERS WITH CARDIAC AND CIRCULATORY CONDITIONS

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Accidents	Accidents Rates per 100	Total Drivers	Number of Accidents	Accidents Rates per 100	Total Drivers	Number of Accidents	Rates per 100
14-15	0			0			0		
16	1	1	100.00	0			1	1	100.00
17-21	1			1			2		
22-24	0			0			0		
25-44	2			1			3		
45-64	13	1	7.69	5			18	1	5.55
65+	24	3	12.50	7			31	3	9.67
Totals	41	5		14	0		55	5	
Crude Rates			12.19			0.00			9.09

TABLE 9

VIOLATION RATES FOR DRIVERS WITH CARDIAC AND CIRCULATORY CONDITIONS

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100
14-15	0			0			0		
16	1	1	100.00	0			1	1	100.00
17-21	1	1	100.00	1			2	1	50.00
22-24	0			0			0		
25-44	2			1			3		
45-64	13	1	7.69	5	2	40.00	18	3	16.67
65+	24	7	29.17	7			31	7	22.58
Totals	41	10		14	2		55	12	
Crude Rates			24.39			14.29			21.81

TABLE 10

ACCIDENT RATES FOR DRIVERS WITH NEUROLOGICAL CONDITIONS

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Accidents	Accident Rates per 100	Total Drivers	Number of Accidents	Accident Rates per 100	Total Drivers	Number of Accidents	Accident Rates per 100
14-15	0			0			0		
16	0			0			0		
17-21	14	1	7.14	5	3	60.00	19	4	21.05
22-24	7			1			8		
25-44	16	2	12.50	4	1	25.00	20	3	15.00
45-64	13	2	15.38	2			15	2	13.33
65+	15	2	13.33	1			16	2	12.50
Totals	65	7		13	4		78	11	
Crude Rates			10.77			30.77			14.10

TABLE 11

VIOLATION RATES FOR DRIVERS WITH NEUROLOGICAL CONDITIONS

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100
14-15	0			0			0		
16	0			0			0		
17-21	14	10	71.43	5	2	40.00	19	12	63.16
22-24	7	2	28.57	1			8	2	25.00
25-44	16	14	87.50	4			20	14	70.00
45-64	13			2			15		
65+	15	7	46.67	1			16	7	43.75
Totals	65	33		13	2		78	35	
Crude Rates			50.77			15.38			42.30

TABLE 12

ACCIDENT RATES FOR DRIVERS WITH DIABETES

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Accidents	Accident Rates per 100	Total Drivers	Number of Accident	Accident Rates per 100	Total Drivers	Number of Accidents	Accident Rates per 100
14-15	1			0			1		
16	2			2			4		
17-21	26	2	7.69	19	1	5.26	45	3	6.67
22-24	7	3	42.86	2			9	3	33.33
25-44	8			9	1	11.11	17	1	5.89
45-64	11	1	9.09	5			16	1	6.25
65+	10			6			16		
Totals	65	6		43	2		108	8	
Crude Rates			9.23			4.65			7.41

TABLE 13

VIOLATION RATES FOR DRIVERS WITH DIABETES

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100	Total Drivers	Number of Violations	Violation Rates per 100
14-15	1			0			1		
16	2			2	5	250.00	4	5	125.00
17-21	26	21	80.77	19	4	21.05	45	25	55.55
22-24	7	4	57.14	2			9	4	44.44
25-44	8	3	37.50	9			17	3	17.64
45-64	11	2	18.18	5			16	2	12.50
65+	10	2	20.00	6			16	2	12.50
Totals	65	32		43	9		108	41	
Crude Rates			49.23			20.93			37.96

TABLE 14

ACCIDENT RATES FOR ALL LICENSED OKLAHOMA DRIVERS

Age Group	Male			Female			Male and Female		
	Total Drivers	Number of Accidents	Accident Rates per 100	Total Drivers	Number of Accidents	Accident Rates per 100	Total Drivers	Number of Accidents	Accident Rates per 100
14-15	8,728	825	9.45	2,850	207	7.26	11,578	1,032	8.91
16	20,304	3,631	17.88	17,116	1,711	9.99	37,420	5,342	14.27
17-21	117,312	17,698	15.09	98,954	7,713	7.79	216,266	25,411	11.75
22-24	72,351	7,470	10.32	61,832	3,210	5.19	134,183	10,680	7.95
25-44	311,802	26,214	8.41	283,091	12,923	4.56	594,893	39,137	6.57
45-64	255,098	16,447	6.45	222,477	7,780	3.49	477,575	24,227	5.07
65+	109,978	6,016	5.47	69,352	2,339	3.37	179,330	8,355	4.66
Totals	895,573	78,301		755,672	35,883		1,651,245	144,184	
Crude Rates			8.74			4.75			7.10