HETA 2000-0305-2848
City of Long Beach Police Department
Long Beach, California

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Steven M. Schrader, Ph.D. and Michael Breitenstein of Biomonitoring and Health Assessment Branch (BHAB) and Brian Lowe, Ph.D., Organizational Science and Human Factors Branch (OSHFB), Division of Applied Research and Technology (DART). Field assistance was provided by John Clark, Laboratory Technician, BHAB. Desktop publishing was performed by Nichole Herbert. Review and preparation for printing were performed by Penny Arthur.

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May 2001

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SUMMARY

In May 2000, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from a representative of the International Association of Machinists and Aerospace Workers (IAM) Local 1930. The health concerns were genital numbness, sexual dysfunction, and feet problems in the Marine Bicycle Patrol, Long Beach Police Department, Long Beach, California.

From July 10 to 22, 2000, NIOSH researchers visited the City of Long Beach, California, to evaluate the Marine Bicycle Patrol officers and the possible health effects associated with biking. Twenty-nine biking officers participated in at least part of the study. Five non-biking men from the Long Beach area were used as the comparison group.

Fourteen of the fifteen (93%) bikers responding to questions on genital numbness indicated that at times they experienced numbness in their buttocks, scrotum, testicles, or penis during or after riding their bicycles. This numbness occurred after 10 minutes to 3 hours of riding and lasted from 5 minutes to 24 hours.

Blood hormone levels and semen quality were normal in the officers providing samples.

The male study participants were asked to wear a Rigiscan® erection monitoring device for 2 nights. The number of sleep erections was not affected indicating the basic neurophysiology of erectile function was intact in biking officers. However, measures of erection quality were lower in the biking officers. The percent of the sleeping time a man had an erection was statistically reduced ($p=0.0097$) in the biking police (26.2%) compared to men (42.8%) not riding bicycles. As the measured pressure between the officer and the bicycle seat increased, the percent sleeping time the individual had an erection was decreased. Similarly, as the average number of hours per day an officer was on his bike and the average number of days a week the officer rode his bike increased, the percent sleeping time with an erection decreased.

This study indicates that the pressure between the biking officer and the bicycle seat is related to numbness in the genitals and subclinical impairment of erectile function. Blood hormone levels and semen quality were normal in the officers providing samples. Recommendations to minimize or eliminate these specific problems reported by biking officers include minimizing pressure to the perineum from the bicycle seat nose. This can be achieved by taking rest periods off of the bicycle saddle and enuring proper bicycle fit. The police department is encouraged to investigate the feasibility of using bicycle seats without a nose or other extension.

Keywords: SIC 9221 (Police Protection). Bicycle, bike, seat, erectile dysfunction

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INTRODUCTION

In May 2000, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from a representative of the International Association of Machinists and Aerospace Workers (IAM) Local 1930. The IAM expressed two health concerns among the Marine Bicycle Patrol, Long Beach, California. The first concern was numbness and pain of male genitals associated with bicycle riding. The second was numbness and pain of the foot while pedaling. From July 10 to 22, 2000, NIOSH researchers visited the City of Long Beach, California, to evaluate these problems. Bicycle riding activities were monitored, personal seat and foot pressure measurements were measured, and erectile dysfunction and semen quality were assessed.

Each study participant received a copy of their bicycle seat pressure measurements, erectile function measurements, hormone concentrations, and semen analyses results, along with a letter of explanation, in December 2000.

BACKGROUND

In 1998, the Occupational Health Clinic for the City of Long Beach, California, reported that 15 of 23 biking policemen answered a self-administered questionnaire indicating they had some symptoms of genital numbness, groin pain, or impotence. There have been scientific reports indicating that biking may cause genital numbness and impotence.[1,2,3,4]

The Marine Patrol of the Long Beach Police Department is a bicycle unit of approximately 30 security officers who patrol the city-owned marinas. The primary patrol is on a bicycle. The city also employs a bicycle patrol which serves the more traditional role of bicycling policemen in the community. These officers have volunteered for this duty. The city bicycle police officers are represented by the Long Beach Police Officers Association (POA). The POA was included in the opening and closing conferences and biking officers (approximately 15) represented by the POA were asked to participate in the study. While most participated in the pressure measurements, only two men represented by the POA participated in the reproductive health assessment.

The Marine Patrol offices spent an average of six hours per day, five days per week, riding bicycles. The officers spend much of their time riding on wooded piers and ramps. Most of the riding time was slow riding, seated on the saddle. The officers often interacted with the public or conducted their work while seated and stationary on the bike, often with a hand on a pole or boat for balance. Less often, the bikers were observed in the "high speed" pedaling to get from one area to another quickly.

Mountain bikes were supplied by the city for each officer. The newer bikes had full (front and rear) suspension systems to absorb the vibrations of the rough terrain. All of the officers had been supplied with a split bicycle seat (Serfas®) in response to earlier complaints of genital numbness and sexual function problems. The officers indicated that they have had training in bicycling techniques. Each officer has his own bicycle and has adjusted it to his comfort.

METHODS

All biking police officers were assigned by their supervisor to attend one of nine presentations by NIOSH staff describing the study. The presentations were held at a hotel meeting room and all officers were assigned a meeting time by their supervisor while they were on duty. After a 15 minute presentation the NIOSH project officer met with each officer in private to answer questions and request informed consent.

All male officers were asked to participate in all aspects of the study. These included bike seat pressure measures, foot pressure measurements, foot exam, hormonal analysis, self-administered work/health questionnaire, self-administered sexual function questionnaire, and Rigiscan® Rigidity Assessment System (device to evaluate

erectile function). For men who were interested in or concerned with their semen quality a "mail-in" semen collection container was provided. Female bikers were asked to participate in the bike seat pressure measurements, foot pressure measurements, and the foot exam.

The professional staff of a local hotel were asked to participate as a comparison group.

A self-administered work and medical history questionnaire was distributed to each male study participant. The completed questionnaires were then mailed, by the participant, to NIOSH for data entry and analysis.

Follicle stimulating hormone (FSH), luteinizing hormone (LH), and testosterone, were measured, since endocrine insufficiency could affect reproductive and sexual function. The hormones were measured in a sample of venous blood collected from the participant's arm.[5]

A semen analysis kit was available to interested participants if they were concerned about their fertility. This kit contained a collection jar and shipping container. The men produced a semen sample by masturbation, at home, directly into the jar. The jar was placed into the shipping container and mailed to the contract laboratory for analysis. The analysis consisted of sperm count, sperm morphology (shape), and presence of white blood cells.

Sexual function was assessed by the International Index of Erectile Function Questionnaire[6] and the Rigiscan® Rigidity Assessment System.[7] Again, the questionnaire was self-administered and returned by mail to NIOSH for data entry and analysis. The Rigiscan® was used to assess erectile function during the normal sleep patterns of the participants. It is a computerized monitor worn on the leg, with two loops connected to the penis, one on the base the other on the tip, used to study the penis during sleep. Men have penile erections during their sleep, and the intent of the study was to compare the Marine Patrol and comparison group with respect to the number of erections and the percent of sleep time with an erection.[8] For reliable results the participants were asked not to ejaculate for one day before the test, not to drink coffee, tea, caffeinated soft drinks, or alcoholic beverages for 2 hours before bedtime, and not to take sedatives, tranquilizers, muscle relaxants, or sleeping pills the night of the test - all these have been linked with impaired sexual function.

Scientists believe that the pressure between the biker and the bicycle seat obstructs the nerves and blood vessels in the perineum (area between anus and the scrotum).[9,10] The pressure exerted between the participant and the bicycle seat was measured with a pressure assessment system (Force Sensitive Applications [FSA], Vista Medical LTD, Winnipeg, Canada). Each bicycle was placed into a stationary bicycle trainer (Magturbo Ergo, Minoura), then the pressure mat was aligned on the bike seat, and the officer mounted his bike and pedaled in a normal riding position and in a pursuit position. Each position was monitored for approximately 30 seconds.

The officer dismounted his bike and the seat pressure mat was disconnected from the FAS computer system. A foot pressure mat was then attached. The foot pressure mat was inserted into the officer's shoe. The officer again mounted his bike and pedaled in both normal and pursuit modes for approximately 30 seconds each. Cadence, intensity and resistance were self selected and not recorded The foot pressure measurements were stored on the computer system. A brief self-administered questionnaire about possible foot pain and numbness, with drawings of the top and bottom of the feet to indicate the location of these concerns, was distributed to all study participants. Arrangements were made with a local foot specialist to examine the feet of these bikers. The foot specialist was only available one day and only 8 officers were able to be examined. Subsequently, a physical therapist with expertise in bicycle biomechanics and foot pain examined the pressure measurements and foot complaints. From these data he provided recommendations for minimizing foot pain and numbness.

A convenience sample of 5 non-biking men was recruited from among city employees and hotel staff to serve as a comparison group. These men

agreed to have the Rigiscan® and hormone assessment.

Bikers and non-bikers participating in the erectile function tests were paid for their time and inconvenience.

Statistical analyses were conducted using SAS System for Windows (Version 8.01; Cary, North Carolina). Analysis of variance between the comparison group and the biking officers was calculated using the GLM procedure. Correlations between variables was calculated using Pearson correlation procedures.

RESULTS

Thirty-six biking officers from the Long Beach Police Department attended the presentation of the study across nine different sessions. Twenty-eight officers had pressure measurements taken while riding their bikes. Seventeen officers provided blood samples for hormone analyses. Rigiscan® measurements were conducted on 16 biking officers. The equipment malfunctioned and data was not recorded on 2 of these officers. Five biking officers provided semen samples; all sperm counts, WBC, and sperm morphologies were normal. Nineteen biking officers answered the Work and Medical Questionnaire and International Index of Erectile Function Questionnaire.

Fourteen of the fifteen participants responding to questions about numbness (93%) indicated that at times they experience numbness in their buttocks, scrotum, testicles, or penis during or after riding their bicycles. The numbness usually occurred after an average of 1 hour and 41 minutes of riding (range 10 minutes to 3 hours) and lasted an average of 2 hours and 35 minutes (range 5 minutes to 24 hours).

All blood hormone values were normal.

The International Index of Erectile Function Questionnaire did not identify any men (biking officers or comparison group) with overt sexual dysfunction. The Rigiscan® data did provide information on sleep erections. The number of sleep erections (non-biker 3.8 ± 1.3; biker 4.6 ± 1.7; p=0.38) was not affected indicating the basic neurophysiology of erectile function was intact in biking officers. However, measures of erection quality were lower in the biking officers.

The percent of the sleeping time a man had an erection was statistically reduced (p=0.0097) in the biking police (26.2% ± 10.15%) compared to men (42.8% ± 19.00%) not riding bicycles. The percent sleeping time a man had an erection is negatively correlated (r=-0.43; p=0.07) with the pressure between the officer and the bicycle seat. (As seat pressure increases the erection time decreases). Similarly, the percent sleeping time a man had an erection is correlated (negative) with the average hours a police officer was on his bike (r=-0.45; p=0.05) and the average number of days a week the officer rode his bike (r=-0.58; p=0.01).

The bicycle police officers sat on the saddle such that approximately 22% of the load (weight) supported by the saddle was distributed on the nose of the saddle and 78% of the weight on the saddle was distributed on the "sit bone" portion of the saddle. These percentages corresponded to average pressures of 2.3 ± 1.7 and 2.9 ± 1.0 pounds per square inch (psi) on the nose and sit bone portion of the saddle, respectively. Even though the nose supported a lower *percentage* of the load on the saddle (less than one quarter of the weight on the saddle is distributed on the nose), its smaller surface area acts to increase the localized pressure on the rider in this region. Scientists believe that pressure exerted on the nose of the saddle is most detrimental to the nerves and blood vessels in the perineum.[1,2,3]

Five of the eleven (45%) biking officers answering the questions about foot problems indicated that they had some foot pain and/or numbness.

Measures of foot pressure were taken with in-shoe pads. Measures were compartmentalized in six distinct zones. The foot was split into fore foot and rear foot sectors. The fore and rear foot sectors were then subdivided to represent distinct pressure zones of the foot. The average regional pressures were 14.1, 13.5, and 11.2 psi, for the lateral, mid-line, and medial regions of the fore-

foot and 5.9, 6.7, and 4.1 psi for the lateral, mid-line, and medial regions of the hind-foot.

DISCUSSION

The significant difference observed between the comparison group and the biking officers for the percent of sleep time a man has an erection would indicate that the biking officers have reduced erectile function. This interpretation is limited, however, by the self-selected nature of the comparison group. Because this measurement is also significantly correlated with average number of hours the biker rides and the amount of pressure on the bicycle, this increases the likelihood that the subclinical erectile impairment is related to the officer's biking occupation. The observed differences are probably not due to the normal variation, because the number of sleep erections was not affected indicating the basic erectile function control by the brain was intact in biking officers.

Our research team noticed that many officers conducted much of their work unnecessarily "on the saddle." Many of the officers talked with the public, rested, and made general observations while still on the saddle. Many officers remain on the seat with their feet on the ground or the pedals and a hand supporting them against a pole, boat, or anything that would support them. This increases the amount of time that pressure is unnecessarily applied to the nerves and blood vessels of the perineum.

The average saddle nose pressure measured in this study was approximately 2.3 psi. The findings of Rogers[11] as cited by Armstrong[12] suggest that ischemic tissue injury would occur at approximately 280 minutes (< 5 hours) of exposure to localized pressure of 2.3 psi. Some officers exhibited average saddle nose pressures that exceeded 4.64 psi during the seat pressure testing. This level of pressure corresponds to a tolerance time of less than 156 min (~ 2.5 hours).

The ball of the foot and the heel bear most of the weight of the body while standing and walking. The shape and placement of the bicycle pedal moves the weight (pressure) from these anatomical structures to the entire forefoot. The use of a hard-sole shoe redistributes the weight (pressure) from the entire forefoot back to the ball of the foot. This is similar to walking and thus a "healthier posture." The hard sole shoe also allows the localization of the power of pedaling allowing optimal biking performance.

CONCLUSIONS

This study indicates that biking officers' genital discomfort is related to pressure exerted by their bicycle seats. While according to the International Index of Erectile Function Questionnaire, none of the bikers studied were impotent, the decrement in erectile quality and the high percent of men complaining of genital numbness could be an indication of a developing reproductive health problem.

RECOMMENDATIONS

Although relevant published data are not available, the use of a bicycle seat without a nose would presumably result in less pressure on the perineum and the underlying nerves and blood vessels and thereby help to prevent these symptoms.

Although a scientific study has not been conducted on the usefulness of their training, professional organizations of biking police officers (International Police Mountain Bike Association & Law Enforcement Bicycle Association) offer courses in bicycling techniques which may prove to be beneficial to biking officers.

Biking officers should be encouraged to dismount the bike when they are not riding. Other work activities and rest breaks should not be conducted while straddling the bike seat.

The proper adjustment of the bicycle seat and bicycle itself is very important.[13]

The pressure to the foot was primarily on the fore foot, but was not localized on the ball of the foot. Most officers were using soft soled shoes. Biking

shoes would redistribute the pressure to ball of the foot which should bear most of the weight. The pedaling cadences used by the officers during testing appeared to be much slower than the recommended 80-100 revolutions per minute (rpms). Increasing the pedaling cadence with a lower pedal resistance can reduce foot numbness.[13] Officers should use the gearing of the bikes to pedal at 80-100 rpms when practical.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of the City of Long Beach Police Department

NIOSH conducted a health hazard evaluation of genital numbness, sexual dysfunction, and feet problems in the Marine Bicycle Patrol, of the Long Beach Police Department in Long Beach, California.

What NIOSH Did

- We surveyed officers about their work conditions and their health.
- We measured the pressure between the rider and the bicycle seat.
- We tested blood samples for reproductive hormones.
- We measured semen quality.
- We measured erectile function.
- We measured the pressure on the foot while pedaling.

What NIOSH Found

- 93% of the biking officers reported numbness while riding.
- Blood hormone levels were normal in the biking officers.
- The men who provided semen samples had normal semen.
- Officers' erection quality was related to the number of hours he rode his bike and increased pressure between the rider and the bicycle seat was related to lower quality of the man's erection.

What the City of Long Beach Police Departments Can Do

- Consider purchasing bicycle seats which do not have a nose or other extension which may place excessive pressure on the perineum.
- Train each officer on proper riding techniques and proper dynamics between the rider and the bicycle.
- Consider providing a hard-sole mountain- or touring-style bicycling shoe.
- Consider utilizing (in-house or out-source) bicycle fit standards for bicyclists.

What the City of Long Beach Police Officers Can Do

- Dismount the bike when not riding.
- Don't straddle the bike seat during rest breaks or work activities not requiring sitting on the bike; instead dismount the bike.
- If pain or numbness occurs, get off the bike and walk the bike a few minutes until pain and numbness are relieved.
- Utilize gears that allow cadences near 90 rpms.
- Utilize frequent methods of pressure relief for feet.
- Perform regular/daily stretching excercises for calf, hamstrings, quadriceps, and gluteals.
- Know and record basic bicycle measurements to ensure proper fit to the bicycle.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report # 2000-0305-2848

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