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# »AN EPIDEMIOLOGICAL ANALYSIS OF OVERUSE INJURIES AMONG RECREATIONAL CYCLISTS«

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II Two-hundred and ninety-four male and 224 female randomly selected recreational cyclists responded to a mail questionnaire. Significant differences were observed between male and female cyclists‘ training characteristics. Overall, 85 % of the cyclists reported one or more overuse injury, with 36 % requiring medical treatment The most common anatomical sites for overuse injury/complaints reported by the male and female cyclists combined were the neck (48.8%), followed by the knees (41.7%), groin/buttocks (36.1 %), hands (31.1 %). and back (30.3 %). For the male cyclists, effect upon back and groinlbuttock. overuse injuries/complaints were mileslweek, lower number of gears, and less years of cycling. For female cyclists, training characteristics which had the most significant effect upon groin/ buttocks overuse injury/complaints were more non-competitive eventslyear and less stretching before cycling. The odds of female cyclists developing neck and shoulder overuse injurylcomplaints were 1.5 and 2.0 times more. respectively than their male counterparts.

Cycling. overuse. injuries, epidemiology

## INTRODUCTION

The most common risks associated with exercise are musculoskeletal injuries from repetitive motions on the body joints and soft tissues (18). A review of the literature on overuse injuries reveals considerable research in the popular activities of running and aerobic dance, but little effort has focused on recreational cyclists. The purpose of the present study was to 1) describe demographic and behavioral characteristics of recreational cyclists, 2) delineate equipment and training profiles. 3) delineate epidemiological injury risk and associated training factors. Recrearional cyclist was defined as any individual who reported cycling regularly at least one day per weekand did not participate in competitive race events. The Bicycle Institute of America (3) estimates there are 52 million Americans involved in cycling. This number includes 27.5 million adults who cycle regularly (at least once a week). 4 million cycle commuters, 240.000 competitive cyclists, 20 million mountain cyclists. 1.5 million cycling tourists, and 3.5 million who participate in recreational events. A review of cycling injury research indicates that most data are oriented to serious traumatic conditions (Davis et al. [7], Bolhman 141. Kiburz [12]) and injury prevention (Mellion 1161, Dickson [8]). Hopkins and McKenzie (10) summarized overuse injuries among 30 elite cyclists. Kulund and Brubaker (14) and Weiss (20) investigated overuse injuries among recreational cyclists engaged in long distance touring. No definitive epidemiological studies focusing on overuse injuries and related risk factors among general recreational cyclists have been conducted.

## METHODS AND MATERIALS

[Subjects]

Participants for the study were obtained from northern and southern Califomia, through a representative of the Bicycle Ride Directors Association, which organizes and conducts sponsored non-competitive events. The Association member provided a computer list of 25,000 names from which a random numbers table was utilized to generate 2,500 cyclists for questionnaire mailing. Budgetary limitations restricted the survey to only one mailing.

[Questionnoire]

A review of the sports mediane epidemiology literature identified the need to develop a questionnaire which would address both the training characteristics and overuse injuries among recreational cyclists. A questionnaire was developed and a pilot study was conducted on a local cycle group (n = 26) to determine the clarity and appropriateness of the individual questions; from which a final questionnaire evolved. The questionnaire was designed with both multiple choice and short answer questions. The questionnaire was divided into three areas: 1) demographics including age. gender, height, weight. education, smoking history, and diet (e.g. low fatlcholesterol, low salt. decreased calories, high carbohydrate, or other dietary intake) 2) training characteristics, including years of cycling. warm up - cool down, pace, frequency, intensity, duration, cycle event participation, other sport participation, terrain, and cycle equipment (e.g. number of gears, handle bar type, pedal system, saddle type, use of helmet and padded shorts) 3) traumatic and overuse cycle injury history including cause. type, frequency, and severity. An overuse injury was operationally defined as any self-reported injurylcomplaint; described as discomfort, pain, swelling, bruising, or any other symptom in any of the described body sites, which occurred before, during, or after cycling. A scale of one to three was also used to determine the severity of the overuse injury: mild (score of 1) was characterized by continued cycle training despite symptom(s), moderate (score of 2) reduced cycle training due to symptom(~) a,n d severe (score of 3) stopped cycle training temporarily due to syrnptom(s).
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[Statistical unalysis]

BMDP Statistical Software program (2) was used to itemize descriptive statistics for the 100 variables from the questionnaire. Two-tailed t-tests were used to determine if there was a significant difference between genders for training characteristics and anatomical sites of overuse injuries. Chi-square was used to determine if there was a relationship between training characteristics and cycling overuse injuries. Z test were used to determine if there was a difference in proportions between male and female anatomical sites for overuse injuries and response rate. Odds ratios were calculated to assess risk of injurylcomplaints for male and female cyclists. Bonferroni procedure was applied to adjust for multiple comparisons (Afifi and Clark 11 l).

**Table 1 a** Mean and SD for cycle training characteristics categorized by gender.

| | male (n = 294) | female (n = 224) | p | adjusted p level (<) |
|---|---|---|---|---|
| miles/week | 85.5 (± 59.2) | 64.1 (± 56.8) | 0.0001 | 0.007 |
| days/week | 3.3 (± 1.6) | 2.7 (± 1.4) | 0.0000 | 0.007 |
| years/cycling | 8.2 (± 5.9) | 6.8 (± 5.1) | 0.005 | |
| average pace (mph) | 17.4 (± 3.0) | 15.4 (± 3.0) | 0.0000 | 0.007 |
| number of gears | 15.0 (± 7.4) | 14.4 (± 3.6) | 0.27 | |
| stretch before (mins) | 5.8 (± 5.0) | 6.9 (± 4.8) | 0.14 | |
| stretch after (mins) | 5.0 (± 5.3) | 6.8 (± 6.5) | 0.03 | |
| events/year (noncomp) | 2.9 (± 2.0) | 2.9 (± 2.0) | 0.82 | |

p values = t-test results

**Table 1 b** Comparison of male and female cycle training characteristics.

| | male (n = 294) | female (n = 224) |
|---|---|---|
| **intensity** | | |
| easy | 0.7 % | 0.9 % |
| mild | 4.1 % | 7.8 % |
| moderate | 43.5 % | 68.5 % |
| hard | 47.3 % | 21.9 % |
| very hard | 4.5 % | 0.9 % |
| (chi-square [4, n = 518) = 44.9, p < 0.0000, adjusted p < 0.007) | | |
| **terrain** | | |
| flat | 10.2 % | 14.7 % |
| rolling hills | 24.1 % | 32.1 % |
| hills | 15.3 % | 13.4 % |
| combination | 50.3 % | 39.3 % |
| **other sports** | 71.8 % | 87.0 % |
| (chi-square [1, n = 518] = 18.3, p < 0.0000, adjusted p < 0.007) | | |
| **interval training** | 42.2 % | 25.0 % |
| (chi-square [1, n = 518] = 17.3, p < 0.0000, adjusted p < 0.007) | | |

## RESULTS

The questionnaire was sent to 1250 male and 1250 female cyclists. Two-hundred ninety four male and 224 female cyclists (total 518) responded to the questionnaire. The difference in gender sample size was significantly different (2 = 3.09, p<0.01) with males more likely to respond than female. No follow up mailing or other communication was directed at the non-respondent subjects.

[Demographics]

The mean age, height, and weight for the male cyclists were 40.4 (f 10.7) years. 70.2 (f 3.2) inches, and 171.4 (k 24.2) pounds respectively. Female characteristics were 36.6 (k9.1) years, 65.6 (k2.9) inches, and 134.2 (k17.9) pounds. Predictably, significant (p < 0.007) differences were found between male and female cyclists in both height and weight.

[Clinical charocteristia]

The cyclists reported non-smoking with only one percent currently smoking. The majority of the cyclists reported following a low fat/cholesterol (50.4%) diet; 27.2% low sodium. and 29.5% high carbohydrate diet. Eighty-five percent of the cyclists reported undergraduate or graduate levels of education. Nearly 10% of the cyclists reported a serious medical problem (e.g. heart disease, diabetes), with another 10 % reporting other less serious medical problems (e.g. arthritis, obesity).

[Equipment characteristics]

The majority of the cyclists reported owning a tourlracing (87.8%) and/or mountain cycle (38.6%) with handle bar type consistent with cycle type. The newer clipless pedal systems were preferred by the cyclists (57.1 %). Appropriate cycling attire was worn by the cyclists, which included padded shorts (90.5 %) and protective head gear (92.5 %). Training characteristics Twelve training characteristics (miles/week dayslweek, years/cycling, average pace, number of gears, stretching before and after cycling, number of non-competitive eventslyear, intensity, terrain, interval training, and participation in other sports) which the cyclists responded to are summarized in Table 1 a and b. Significant differences (p < 0.007) were found between male and female cyclists in miles/week, dayslweek, average pace, intensity, use of interval training, and participation in other sports.

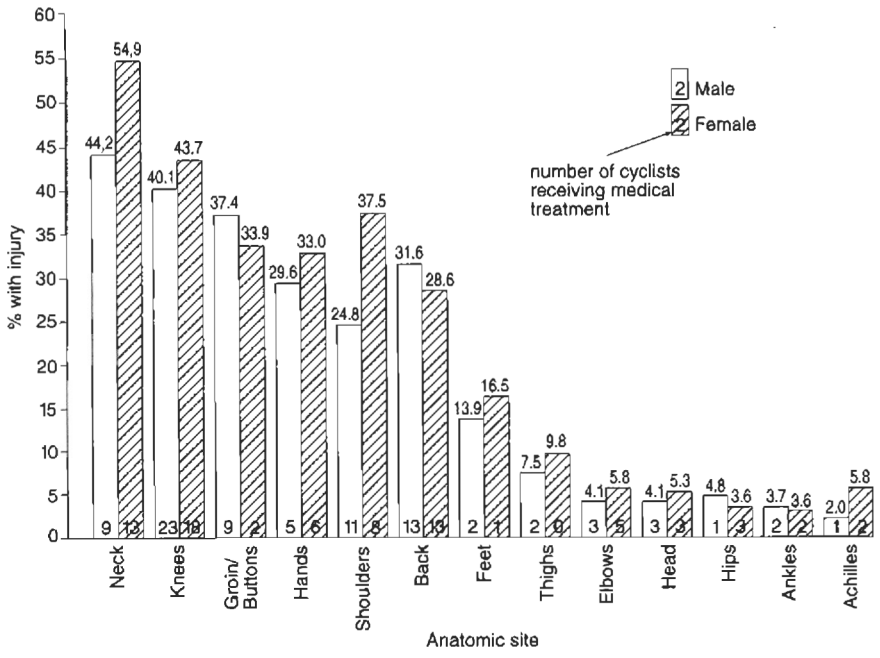


**Fig. 1** Percent injury by anatomical site and number receiving medical treatment, categorized by gender.

[Participation in other sports]

The majority of the cyclists participated in other sports such as runljogging. weight training, swimming and walking. A significant (p c 0.007) difference was found between male and female participation in other sports (71.8 % vs 87.8%. respectively).

[One year traumatic injury history]

Although the primary focus of the study was overuse injuries, acute traumatic injuries and hazards encountered while cycling were also investigated. One hundred twenty-seven (24.5%) of the cyclists reported an acute traumatic injury in the past year. The most common traumatic injuries involved a lone rider incident (34.6%), a collision with a motor vehicle (25.2%), or a collision with another cyclist (22.0%). Medical treatment was required for 80 of the 127 injured cyclists (63.0%). Hospital care was required for 61 of the injured cyclists (76.2 %).

[Hazards encountered while cycling]

In the past one year, one-third of the cyclists reported an encounter with a hazard while cycling: with 44.4% reporting being hit by a foreign object. Other common hazards reported by the cyclists included wet pavement, traffic. pedestrians and objects in the road.

[Severity of overuse injury]

Of the 440 cyclists who experienced one or more overuse injury/ complaints. 74.5% were rated as mild (score of 1), 14.0% as moderate (score of 2), and 11.5 % as severe (score of 3).

[Overuse injury anatomic sites and related training factors]

Thirteen anatomic sites were listed for the cyclists to report overuse injury/complaints (Fig. 1). The most common anatomical sites for overuse injury/complaints reported by the male and female cyclists combined were: neck (48.8 %), followed by the knees (41.17 %), groin/buttocks (36.1 %), hands (31.1 %), and back (303 %). The male and female cyclists reported the same six anatomical sites for overuse injury, but in slightly different descending order (males-neck, bees, groin/buttocks, back. hands. and shoulders; females-neck knees, shoulders. groin/buttocks. hands, and back). Among the cycle respondents, no significant differences were found between males and females with respect to reported anatomical sites for overuse injurylcomplaints. The neck as the most common site of overuse injury/complaint, was characterized by „stiff“. „score“, „aching“, tightness and/or numbness in the related musculature. Among the cyclists who reported a neck overuse injury/complaint, 91.3% rated it as mild. The odds of female cyclists to develop a neck overuse injury/ cornplaint was 1.5 times more than male cyclists (95% confidence interval, 1.08,2.17). The second most common site of overuse injury/complaint (knee) was characterized by painlsoreness. aching, stiff or swelling, wjth some cyclists reporting crepitus or tendonitis. Almost one-half (47.7 %)of these cyclists reported the knee discomfort as mild.

Groin/buttocks was the third most common site for overuse injury/complaint characterized by painlsoreness, numbness, swelling of soft tissues, skin irritations, or a „pain in the butt!“. The majority (68.4%) reported these complaints as mild. Asignificant effect was found between the number of yean of cycling experience (4.4 vs 8.3 years. $p < 0.007$) on those male cyclists who sought medical treatment for these groin/buttocks injury/complaints. The number of non-competitive events/ year (2.0 vs 2.9. $p< 0.007$) and stretching before cycling (1 vs 2 minutes, $p<0.007$) had a significant effect on those female cyclists who sought medical treatment for groin/buttocl<s conditions (Table 2).

Hands were the fourth most common anatomical site of overuse injurylcomplaint, characterized by numbness in one or both of the hands during cycling. The majority (88.8%) of the cyclists reported this discomfort as mild.

Shoulders. the next most common site of overuse injurylcomplaint, was characterized by stiff, sore, or muscle spasms of the shoulder area. The majority (84.7 %) reported this discomfort as mild. The odds of female cyclists to develop a shoulder overuse injury/complaint was 2.12 times more than their males counterparts (95 % confidence interval. 1.44.3.11). The back was the sixth most common site of overuse injurylcomplaint, characterized by lower back discomfort with the majority (73.2 %) reporting this discomfort as mild. Statistical significance was found among male cyclists who reported more mileslweek (104.4 vs 77.1 miles, p i 0.05) and fewer mean number of gears (13 vs 15. p < 0.05) (Table 2) being associated with back overuse injury/complaints. Much lower incidence of injury/complaints were reported in the remaining anatomical sites for: feet, thighs, elbows, head, hips, achilles, and ankles.

[Overuse injury effects on training]

Cyclists who reported a severe overuse injury/complaint (‚11.5 %) stopped cycling for a mean of 42.8 (264.1) days, and 14 quit cycling due to injury. Of the cyclists (n = 160) who sought medical treatment for overuse symptoms, the mean length of time symptoms persisted was 3.7 (f 8.4) months.

[Discussion]

Previous studies of overuse injuries on recreational cyclists were conducted with males and females engaged in long distance tours. The most common anatomical sites of overuse injury by cross-country (4500 miles) tour cyclists (mean age 25.7 years) reported by Kulund and Brubaker (14) were the knees (65.2 %), followed by the hands (40.0%), and back (14.6%). Injuries to the knees were associated with hilly terrain, use of high gears, and hyperflexibility in the hips. Hand injuries were related to road vibration or decreased padding in gloves or handle bars. They reported that older cyclists had fewer complaints, perhaps due to their less intense pace and better equipment. Weiss (20) reported on male and female cyclists (mean age 39.5 years) who participated on a shorter distance tour (500 miles), with the most common anatomical sites of overuse injuries: neck/shoulders (66.4%). buttocks (64.0%). and knees (35.4%). The neck/shoulder injuries were related to road vibrations, hyperextension of the neck, and weight of helmet. Groin/buttocks injuries were characterized by pain and ulceration. Those cyclists in Weiss‘ research (20) who reported less yean of cycling experience had more buttock complaints, suggesting there may be a „training effect“ the longer one cycles. Weiss (20) reported younger tour cyclists (32.5 [*9.5] years vs 41.7 [f 11.31 years) were more likely to develop medial knee discomfort, and the knee was the only anatomical site where significant gender differences were noted (females 37% vs males 12 %). The present study of overuse recreational cyclists injurylcomplaints (Fig. 1) reflected a somewhat different pattern than presented by Kulund and Brubaker (14). It seems logical from an epidemiological perspective that cyclists participating in long distance tours (4500 miles) would experience more acute overuse injuries. This may be indicated by the high percentage of knee injuries (65.2%) and neck/shoulder (66.4%) and groinlbuttocks (64.0%) overuse injuries reported by Kulund and Brubaker (14) and Weiss (20) respectively.

**Table 2** Effects of training characteristics on overuse injury/complaints for anatomic sites, categorized by gender.

| training characteristic | anatomic site | p | adjusted p level (<) |
|---|---|---|---|
| **Males** | | | |
| miles/week | back | 0.0008 | 0.05 |
| gears | back | 0.0008 | 0.05 |
| years/cycling | groin/buttocks | 0.0000 | 0.007 |
| **Females** | | | |
| event/year | groin/buttocks | 0.0000 | 0.007 |
| stretching before cycle | groin/buttocks | 0.0000 | 0.007 |

A similar injury pattern was found between the shorter tour (500 miles) cyclists reported by Weiss (20) and the present study (Fig.1). The same three anatomic sites (neck, knee, groinlbuttocks) were reported but in slightly different order (Weiss - neck/shoulders, groinlbuttocks, knee), but with much higher rate of injury reported by Weiss for neck/shoulder (17.6 %) and groinlbuttocks (27.9 %) injury. These differences were undoubtedly related to their eight consecutive days of touring and total mileage. Similar mean age and weekly training mileage was noted between Weiss cyclists' (39.5 years and 95.8 mileslweek) and our study cyclists (38.5 years and 76.4 [&59] mileslweek). I<ulund and Brubaker (14) cyclists were much younger with a mean age of 25.7 years. Weiss (20) reported significant gender differences for overuse injuries to the knees (females 37% vs. males 12 %, p = 0.0098). The present study found no significant differences between male and female anatomic sites of overuse injuries, although significant differences were found for related training characteristics (Table 1 a and b). The odds of a female cyclist developing a neck or shoulder injury was 1.5 and 2.2 times more, respectively than male cyclist, perhaps due to weaker upper body strength function. Our results showed higher groin/lJuttock complaints in cyclists with less years of cycling experience, as did Weiss (20). The present study indicated 440 of the cyclists reported one or more overuse injury complaints resulting in an 85 % overall injury rate, with 36% seeking follow up medical treatment (Fig.1). Bovens et al. (5) reported the same injury rate (85%) among his male and female runners who were preparing for a marathon race, with 39 % subsequently treated for injuries at a sports medicine clinic. Koplan et al. (13) reported ,1, of his runners sustained an overuse injury within one year after the Peachtree 10-km race, with 13% of the males and 17% of the females obtaining follow-up medical treatment. Marti et al. (15) and Jacobs et al. (11) reported an overall overuse injury rate of 45.8% and 47.0% among runners (Marti et al. - males only. Jacobs et al. - males and females), with medical treatment sought by 14.2% and 70.0% respectively. Richie et al. (17) reported overuse injury rates among male and female aerobic dance instructors and students of 75.9% and 43.3% respectively with 93% requiring medical treatment for these injuries. A similar injury rate of 76.3 % among male and female aerobicdance instruaors was reported by Francis et al.(9) with no follow up medical treatment information reported. For our male cyclists, a significant effect was found upon back overuse injury/complaints and increased mileslweek (Table 2). Running epidemiological research has shown that increased mileage is the most common factor associated with risk for overuse injury (Koplan et al. [131; Jacobs et al. [Ill; Marti et al. (15); Bovens et al. 151). Whereas, aerobic dance research has shown that increased intensity and frequency were most strongly associated with increased overuse injuries (Vetter et dl. 1191; Richie et al. 1171; Francis et al. 191). The cyclists in the present study reported having temporarily stopped cycling 42.8 (k64.0) days as a result of severe overuse injuries. Mam et al. (1988) and Jacobs et al. (1986) reported a mean curtailment of running training of 4.8 and 9.6 weeks respectively; due to overuse injuries. Vetter et al. (19) reported aerobic dance instructor's had symptoms an average of 4.8 months before medical trea-ment was sought The cyclists in our study indicated that symptoms persisted 3.7 (+ 8.4) monthsbefore medical treatment was sought.

## SUMMARY

The major anatomical sites of overuse injury/complaints reported by male recreational cyclists were: neck knee. groin/burtocks. back hands and shoulders; and for females: neck knees, shoulders. groin/buttocks. hands and back. The clinical severity of these injury/complaints is best described as mild. The training characteristics which had the most significant effect on these injury/complaints were: miles/week, years/cycling, mean gear number, prior stretching and cycle events/year. Although there were significant gender difference training characteristics. these did not significantly influence injury/ complaint rates. Also, the 25% incidence of traumatic injuries appears to be a relatively high sport specific risk Data interpretation and generalizability of the findings were limited by the sample response (518 of 2500)and lack offollow up mailing to non-respondents. Although the non-respondents may have represented a somewhat different injury rate within the cycling population, we are reasonably confident that the results are valid; given that the pilot study sample, a subset of the fi nal group reflected the same injury rate (84.6% vs 85.0%) and a very similar injury profile. The recreational cycle mode is not without inherent risk reflected by the overuse and traumatic injury rates. which were higher than running and aerobic dance. The present study represents a beginning delineation of the public health implications for this popular mode of physical activity. A larger epidemiological data base needs to be developed, using multiple geographic sites; as well as longitudinal assessment. Such research information should eventually lead to more specific recommendations for cycle injury prevention, through improved equipment design and more efficacious training methods. Acknowledgements This project was partially funded by a grant from California State University, Northridge, Center for Sports Medicine.

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