ISMJ
International SportMed Journal

Original research article

Health conditions and injury patterns in avid US cyclists

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Abstract

Background: There is a paucity of data on the health risks and benefits of recreational cycling. **Research question:** Describes the injury patterns, health risks and benefits of recreational cycling. **Type of study:** Internet-based retrospective self-reported data. **Methods:** Web based study of cyclist behaviours, injuries and medical conditions. **Subjects***:* The *s*tudy was open to subjects over 18 years of age, who cycled at least 2 times a week with internet access. **Experimental procedure:** Conducted using DatStat® software. **Main outcome measurements:** Self-reported injuries and health conditions. **Results:** In this study, 4792 subjects were $\geq$18 and met the authors' definition of a cyclist. The majority of injuries were taken care of by the cyclist with no effect on their ability to continue with their job or activities of daily living. At least 7.0% reported the use of performance-enhancing drugs. There were reductions in obesity (76.2%), cholesterol (66.1%), hypertension (50%) and asthma (58.7%) after cycling. There were increases in musculoskeletal complaints. Hand pain and numbness increased by 420%. Urologic complaints increased by 310%. There were decreased reports of all mental health diseases reported. Abrasions were the most common injury (53%). The most injured body parts were the pelvis/hip (15.5%), knee (14.8%), and shoulder (13.6%). The least injured body parts were the abdomen (0.4%), foot (0.5%) and upper arm (0.7%). **Conclusions:** There is encouraging data that cycling results in reductions in obesity, high cholesterol, diabetes, asthma and hypertension. The greater health risks of cycling appear to be related to compressive forces on the perineum and the hand/wrist. Injuries are common to cycling, although the majority of injuries are minor. **Keywords:** cycling, sports injury, performance-enhancing drug, bicycle competition, preventive medicine, exercise

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Introduction

Bicycle-related injuries are a common cause of morbidity and mortality in the United States[1]. There were over one million non-fatal cyclist injuries and 675 deaths reported in 2011[2,3]. Major contributors to mortality in cycling are lack of helmet use and use of alcohol. Of fatally injured cyclists, 25% had blood alcohol levels at or above 0.08%, 67-85% were not wearing helmets, and 38% were riding between the hours of 18h00 and midnight[3].

Whilst concerning, these statistics appear representative of high-risk users of bicycles, such as intoxicants, and not of individuals who ride bicycles for health and recreation. In the United States the bicycle is most commonly used for health and recreation with 10.3 million (53%) reporting cycling for these reasons.[4]

It is not unusual for cyclists to log thousands of kilometres in a year in a variety of road and weather conditions. Cyclists may also engage in either competitive or non-competitive cycling events. USA Cycling (USAC) issued 70 829 racing licenses in 2011, sanctioned 3 026 events and registered 2 569 clubs.[5] There are no data on the number of non-competitive cycling events each year but it is likely in the hundreds to possibly thousands of organised events(i.e. Ride for the Cure, Livestrong, AIDS Life-Cycle, Centuries, Grand Fondos). The largest event in the US, the Five Borough Bike Tour had 32 000 participants in 2012.

Cyclists are exposed to the potential of significant trauma, as well as repetitive use injuries, the incidence and severity of which is not known. The health benefits of cycling are known to outweigh the risks in terms of mortality[6]. Regular cardiovascular exercise has significant dividends in managing and preventing a wide range of diseases such as hypertension, obesity, diabetes and heart disease in populations over 50-years-old[7].

The purpose of this study is to describe the health risks and benefits of cycling. This study is primarily of US road cyclists, the majority of which engage in cycling competitions.

Methodology

The Cyclist Health and Injury Survey was a web-based study of cyclist behaviours, injuries and medical conditions. The authors gathered demographic information, reported medical conditions and injury data. For the purpose of the study, a *cyclist* was defined as an individual who cycles an average of at least twice a week and only these respondents were included in this study.

Demographic information included, age, gender, lifetime duration of cycling, frequency of cycling, cycling type, and geographic location.

Cyclists characterised themselves based on the highest level that they competed at. The authors used the classification systems of the USA

Cycling Association, the governing body for competitive cycling in the US.

Respondents were also asked to report on a number of health issues, whether they currently had these issues, and if they had any of them before they started cycling. Examples of these health conditions included hypertension, diabetes, asthma, heart disease, high cholesterol, obesity, urologic problems, substance abuse, and depression. They were also asked if they currently had any chronic musculoskeletal complaints, such as knee, foot, elbow, neck, hand or back pain, and/or previously to starting cycling. Respondents were also asked whether they had ever used performance-enhancing drugs.

Respondents were asked to describe any injuries they had had in the last year; if protective equipment was used, weather conditions, type of cycling (road, mountain, cyclo-cross, commuting, delivery/messenger) and whether they were competing when the injury occurred. For competition injuries they were asked what type of competition they were engaged in (road, cyclo-cross or mountain). For injuries incurred while road racing respondents were asked to indicate whether this occurred in a criterium, road race or time trial/triathlon. Figure 1 lists and defines traditional bicycle competitions. The respondents identified the mechanism of their injury (ex. collision with another rider, car, obstacle, animal, equipment failure etc.) Subjects were asked the form of injury suffered (ex. abrasion, fracture, concussion etc.) body part(s) injured, care provided, and any disability associated with the injury.

Mountain Bike Racing:-Off road racing

Downhill- Akin to a ski race where contestants start at intervals and must negotiate a downhill course.

Cross Country- Contestants start en masse and compete on a course of variable length and terrain.

Cyclo-cross Racing- Participants ride multiple laps on an off road closed course. Course features a variety of barriers that they must negotiate, often dismounting and running through/over the obstacles.

Road Racing- Contestants compete on pavement.

Criteriums- Cycling event where contestants ride multiple laps around a short closed loop. Typically shorter distances at high speed with closely spaced riders and sharp corners.
Road Race- Cycling event on a course of variable length. In non-professional events are generally open to motor vehicle traffic and event staff will regulate intersections and limit traffic exposure
Time Trials/Triathlons- In time trials and the cycling leg of triathlons participants are not allowed to use other riders for aerodynamic drafting or pacing. Time Trial participants start alone and are required to ride separate from one another.

Figure 1: Bicycle race types

The survey was conducted using DatStat® software. Subjects were recruited through a variety of US cycling-specific and mass media. The study was open to all with Internet access who could respond to questions in English. Press releases referred the respondents to a website which informed the subjects about the study and provided a link to the actual survey. Respondents who responded that they were less than 18 years of age were excluded from the study. No personal identifying information was collected as part of this study. The study was approved through the Human Research Committee for Rhode Island Hospital. The study period was from January 2008 to January 2009.

Results

Demographics

There were 5818 respondents, 5600 of which were $\geq$ 18, and 4792 met this study's definition of a cyclist, namely as cycling on average ≥ twice a week. Of the 4792 subjects included in this study, 4306 (90%) started the health questions and 2287(48%) reported at least one injury. The survey took approximately between 5 to 10 minutes to complete.

The mean age of the respondents was 43.7 (SD= 11.8 yrs.), with the range being 18-85, 56% were 35-54-years-of-age. At least 96% were from North America. These cyclists rode on average 9.2 hours a week (SD=36.6 hrs) and had been cycling 19.6 years (SD=14.6 yrs.), of these years they reported cycling they rode at least twice a week 75.4% of these years. They were predominantly male with 18.3% being female.

The majority of respondents (60.1%) engaged in cycling competitions and rode on average 9.3 cycling events per year (SD=31 events). Category4/sport (21.8%) was the most common racer ability and 2.9% rode at a professional level. The majority (94.6%) rode road bikes either primarily or in addition to other types of riding.

Performance-enhancing drugs (PEDs)

Out of the respondents, 324 reported the use of performance-enhancing drugs, giving an overall prevalence of 7.0% for lifetime use. This study's results also show a trend of increasing use corresponding to the highest level competed at (see Figure 2).

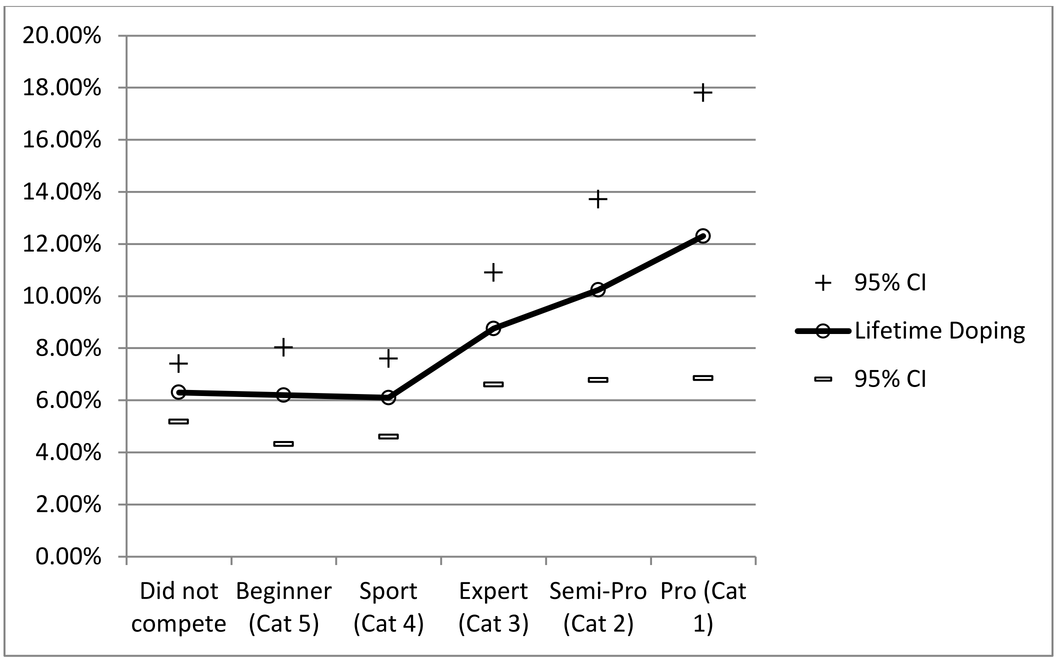

Figure 2: Lifetime use of PEDs by level of competition riding

Cycling health

There were reductions in reported health conditions, before and after cycling, in obesity, high cholesterol, hypertension and asthma (see Table 1). There was, however, an increase in reports of coronary heart disease. There were decreased reports in chronic back pain after cycling. For the most part, there were increases in musculoskeletal complaints, most dramatically for hand pain and numbness, which saw an increase of 420%. Urologic complaints increased by 310%. There were decreased reports of all mental health diseases reported in the study after cycling. Cycling did appear to significantly reduce smoking (86%) and substance abuse (76%).

Table 1: Self-reported health conditions

Health Condition	Pre Cycling	Currently	Percent change
HTN	6.38	3.21	-50
DM	2.1	1.8	-14.1
Asthma	39	16.1	-58.7
CAD	1.0	1.6	+60
High Cholesterol	12.1	4.1	-66.1
Obesity	8.0	1.9	-76.2
Urologic Disease	15.2	62.3	+309.8
Knee Pain	22.9	25.9	+13.1
Foot Pain	6.1	10.0	+63.9
Elbow Pain	1.9	3.94	+107.4
Neck Pain	6.3	12.3	+95.2
Hand Pain/Numbness	3.5	18.2	+420
Chronic Back Pain	40.2	29.9	-25.6
Substance Abuse	4.2	1.0	-76.1
ADHD/ADD	4.2	2.1	-50
Depression	12.2	6.1	-50
Other Mental Illness	1.0	0.5	-50
Smoking	10.6	1.5	-85.8

Cycling injuries
Close to half (53%) of the respondents reported having had one cycling related injury within the last year, only data on their first injury were included. The majority (98%) were wearing helmets and typically had eye protection (84%) and gloves (88%). Most of the injuries occurred in dry road/trail conditions (81%). These injuries

occurred mostly on the road (60%), with 21% mountain bike riding, 16% while commuting and 13% occurred while engaged in cyclo-cross.

Of the reported injuries, 25% of road biking injuries occurred during a competition. Most injuries occurred in criteriums (51.3%) and road races (42.8%), and a minority occurred in time trials/triathlons (5.9%). These injuries were more likely to occur in the middle (44.9%) or at the end of the event (41.7%), and be the result of a collision with another rider (67%).

Of injuries sustained out of competition, these were most frequently the result of collision with an obstacle (26%), another rider (20%), cars (13%), or the result of an unclassified mechanism (19%). Examples of unclassified mechanisms included rail road tracks, ice or gravel. Most of these injuries occurred when the riders were alone (44%), 32% were injured riding in a group of four or less and 24% in a group greater than four riders. Equipment failure was reported as contributing to the injury in 6% of the reported incidents, most commonly due to tyre failure (26%), drivetrain malfunction (24%), pedals (18%), or wheel malfunction (8%).

The majority of injuries (65%) were taken care of by the cyclist and they did not seek medical care. Similarly, 65% of the reported injuries had no effect on the cyclist's ability to perform their job or activities of daily living. While a small overall number (1%) reported they were unable to return to work for longer than six months, and of these 0.4% were permanently unable to work or perform their activities of daily living.

Abrasions were the most common form of injury (53%); while fractures (15%) and ligamentous injuries (15%) were also commonly reported. Concussions were infrequently reported (1.3%) as was penetrating trauma (1.6%).

The most injured body parts were the pelvis/hip (15.5%), knee (14.8%), and shoulder (13.6%). The least commonly injured body parts were the abdomen (0.4%), foot (0.5%) and upper arm (0.7%). The most commonly injured body region was the lower extremity (42.8%). There were 69 anatomically unclassified injuries (7.2%) (Figure 3).

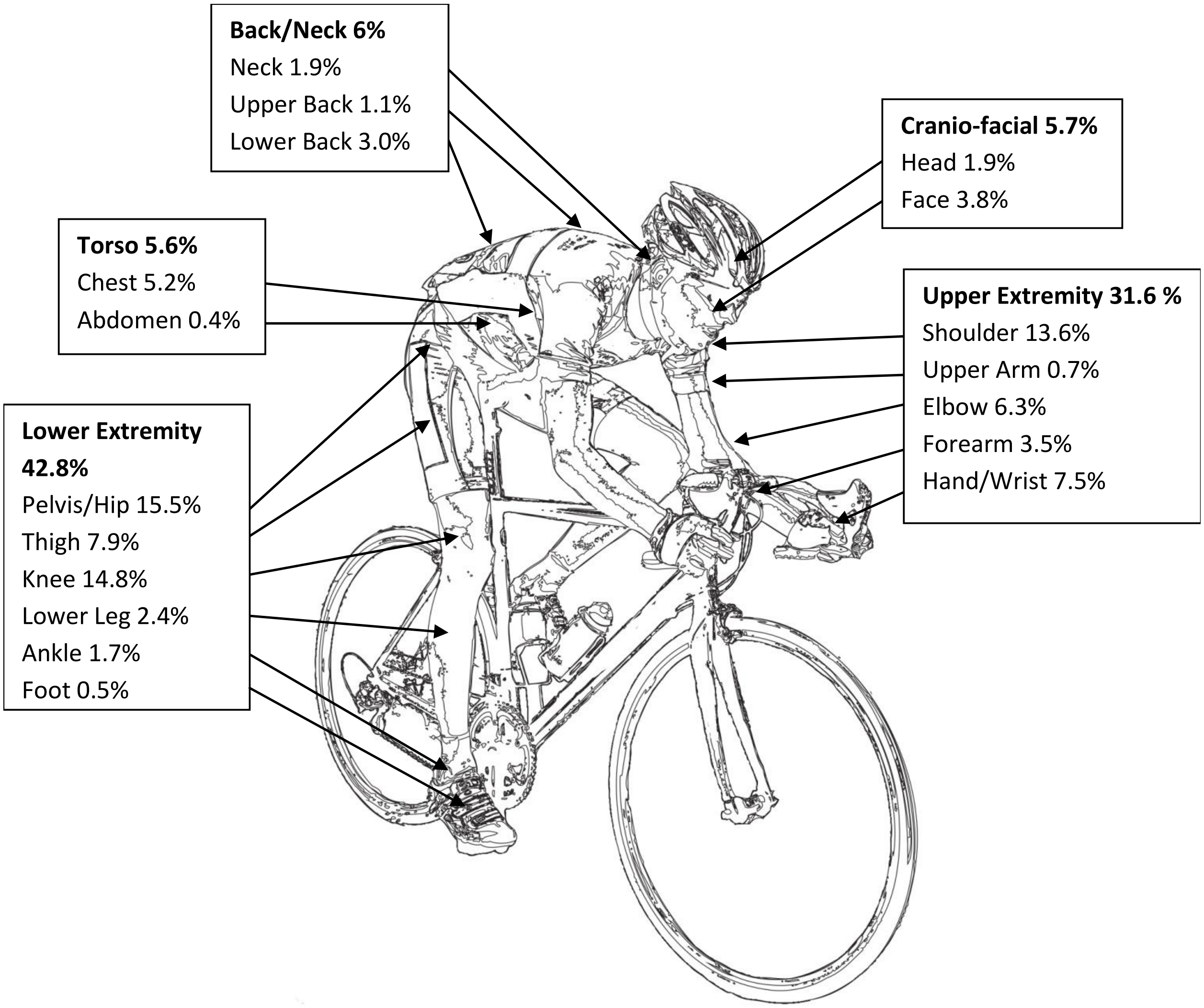

Figure 3: Schematic drawing of reported injured body parts

Discussion

Limitations

This study involved self-reported illness and injury during cycling. These have inherent limitations in reliability and whether they were self-diagnosed or diagnosed by a medical professional. There can be assumed to be recruitment bias as those who had sustained injury or experienced health changes due to cycling would be more likely to respond. There are no data on the mortality of cycling injuries, and a likely bias against those with severe morbidity that would limit their ability to participate in the study. The mean length of cycling in this present study was over 19 years. In this time it would be expected that there would be health changes regardless of cycling, and likewise it should be assumed that the respondents had other activities and behaviours that could have a positive or negative effect on their health. Overall, these authors cannot quantify a dose/response relationship of cycling to health, or establish that these changes were due entirely to cycling.

This study's population does not appear to be representative of the general population as reflected by their reported health conditions *a priori* to cycling. These subjects had lower reported rates of obesity, high cholesterol, diabetes and hypertension at baseline when compared to national averages.[8,9] There was a higher report of asthma (39%) before starting cycling than the national reported average of 7.7%.[8]

This study's participants reported a much higher use of helmets than in other studies, which most likely reduced the incidence of head injuries.

The study has a biased population towards competitive cyclists, particularly road cyclists.

The respondents were asked to only report on injuries that they sustained in the last year. Thus the authors cannot verify that it was definitely within this time period and in some of the optional information they provided it was demonstrated that at least some of these injuries occurred outside that time period. These authors did not consider this information reliable enough to establish injury rates. Most cycling injuries impact multiple parts of the body. The respondents were asked to primarily report their main injury and hence limited a more comprehensive description of their injuries.

Conclusions

This study's population was largely road cyclists and features a large number of competitive cyclists.

There appears to be very encouraging data indicating that cycling has health benefits in this group of cyclists as reflected in reductions of reported obesity, high cholesterol, diabetes, asthma and hypertension after they had become cyclists. This is consistent with general trends with regard to the benefits of cardiovascular exercise. It is notable that there was an increase in reports of coronary artery disease (CAD) after cycling. But this study's reported incidence of 1.6% CAD while a cyclist is far below the reported national averages of 7%.[10] The reduction in asthma reporting after cycling may be due to aerobic training, which lowers asthma exacerbation rates and improves VO2Max.[11]

There also appear to be benefits in mental health and decreasing substance abuse, including decreasing tobacco use. Exercise has been demonstrated to have positive effects on mental health, particularly outdoor exercise.[12]

It is notable that PED lifetime use was reported at all levels of the sport, with increasing use according to the highest level they competed at. While not reflective of ongoing use, this does indicate that the use of PEDs is not isolated to professional cyclists.

The greater health risks of cycling appear to be related to compressive forces on the perineum and the hand/wrist.

There was a 310% increase in urologic disease from 15.2% to 62.3%. This study's reported sample was dramatically higher than the reported national incidences of benign prostatic hypertrophy, erectile dysfunction and prostate cancer.[13] Cycling is a recognised risk to urogenital health[14] and this study's data appear to collaborate this. There have been significant changes in the design of bike saddles with efforts to reduce the compressive forces on the perineum.[15,16] Thus far there have been no longitudinal studies to assess whether they are effective in reducing the incidence of urologic disease in cyclists. Such studies may help in identifying effective interventions.

Hand pain and numbness was reported in 3.5% prior to starting cycling and 18% after cycling, an increase of 420%. Compressive forces on the wrist are most commonly associated with ulnar neuropathy, or cyclist's palsy.[17,18] There are ways that cyclists can mitigate the compressive forces on the hand and wrist. Cycling gloves generally feature a padded area on the palm that may diffuse some of these forces. Likewise the handlebars can be padded with handlebar tape, and padding can be added at strategic areas to further reduce these compressive forces. Lastly, the amount of force placed on the hands and wrist can be reduced by having the cyclist frequently change hand positions and/or ride in a more upright position shifting the weight distribution.[19]

Injuries are common to cycling. While selection bias obscures the actual rate of injury more than half of this study's respondents reported injuries. The majority (65%) of these injuries appear to be minor, not requiring medical attention or resulting in the loss of work. But a considerable number of injuries did result in significant morbidity. Fortunately, nearly all these subjects used helmets and other protective equipment.

In cycling competitions, collisions with other riders was the mechanism of injury in 67% of reported injuries. This is also demonstrated by the low incidence of injuries (6%) in triathlons/time trials where riders are required to ride at greater distances from each other. The greatest risks to cyclists during competition appear to be other cyclists.

Considering the frequency and duration of training versus competing and the reported incidence of competitive injuries versus non-competitive injuries, injury in competitions appear to be approximately ten times more likely to occur than non-competitive injuries.

Competition does appear to be one of the more significant injury risks to cyclists. Much of this is likely inherent to the sport, but there may be opportunities to mitigate this risk and improve the safety of the sport. One of the more obvious interventions would appear to be reducing the field size in mass starts. Also, a more robust system for tracking competitive injuries could identify problematic courses and/or conditions and reduce injury further.

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