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Concussion Knowledge in Amateur Motocross

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CONCUSSION KNOWLEDGE IN AMATUER MOTOCROSS

by

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ABSTRACT

The Center for Disease Control and Prevention estimated that there are 1.6-3.8 million sports-related traumatic brain injuries in the United States annually which occur in both mainstream and extreme sports. Many of these concussions have been associated with collisional sports, like football, but high risk extreme sports, like motocross, also have many opportunities for collisions to occur. Unlike traditional varsity sports motocross races, especially at the amateur level, do not require more than advanced life support at a race in case of emergency situation leaving the amateur rider to recognize and decide on concussion management. Purpose of this study is to assess concussion knowledge amongst motocross riders and to determine differences in knowledge based in demographic factors. Motocross riders were able to access an internet based questionnaire for two months. The respondents (N=782 age=30.6±11.9 male=85.0%) represented amateur motocross riders who currently participate in racing. The questionnaire was distributed online (host site qualtircs.com), based upon concussion literature, with the web link posted on Facebook, Twitter, and emailed to American Motorcycle Association districts and motocross tracks across America. Access to the questionnaire began on December 22nd, 2012 and stayed open for two months closing on February 24th, 2013. The mean overall score for participants on concussion knowledge score was 14.29±2.71 out of 20, and 6.76±1.35 out of 8 on recognition of correct sign and symptoms of concussion. Participants succumbed to several misconceptions; including the belief that a rider should be kept awake if suffering from a concussion was believer

by 719/782 (91.9) of participants. Confusion over terminology was shown with 408/782 (52.2) allowing a rider to continue riding during with a bell ringer, but when bell ringer is replaced with concussion only 83/782 (10.6) would allow a rider to continue. We found that while participants have a general understanding about concussions and the signs and symptoms they are still unclear on how to manage the concussions. Therefore it is suggested that an educational intervention that is aimed at the sport of motocross be created that places an emphasis on situations and management. It could include where to find the latest information regarding concussions for riders to stay informed.

INDEX WORDS: Concussion, Knowledge, Motocross, Off-road

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CHAPTER 1

INTRODUCTION

The American Motorcyclist Association (AMA) is the governing body of both professional and amateur motocross and has approximately 300,000 active members.[1] The number of participants within this sport has grown; no longer just taking place in rural areas, but becoming popular nationwide through national television syndication, which has allowed riders to showcase and gain the interest of more youth. As the sport has evolved riders now compete on tracks that are up to three miles long and ride on motorcycles that have the ability to reach up to 100mph.[2] Extremity injuries may account for 57-62% of the injuries seen in motocross.[3-5] The most common mechanism of injury (70%) comes from collision with an immobile object, such as a tree or rock, with 62.8 percent of those collisions resulting in the rider being ejected from the motorcycle.[4] When initial landing occurs for the rider the most common impact is taken by the hands/arms, followed by the shoulder, hip, and head.[3] Head and injuries account for 9-17 percent of total injuries with 50-85 percent of those head injuries being concussions with a little less than half of them being diagnosed as a grade 1 based on loss of consciousness and neurological deficits existing or missing.[3,6] While head injuries may not be the most prevalent injury in motocross they occur frequently enough and have significant consequences that an established protocol for management is necessary.

During the 2012 season, professional AMA Supercross Series, riders were asked to volunteer to do concussion neuropsychological baseline testing, and if the riders wish to continue riding during the outdoor season (motocross) they were mandated to take neuropsychological

baseline testing.[7] Recent development in professional motocross has shown progress towards an upgraded concussion management program that calls for physician evaluation at the race, physician evaluation after a graded exercise program, mandatory use of computerized neuropsychological testing, and lastly they must be evaluated by the chief medical officer (primary physician) over the next motocross race in the series schedule.[8] For an amateur motocross competition to occur, the minimum recommended level of care is an advanced life support ambulance crew whose primary objective is emergency management.[2] Therefore, primary responsibility is placed upon the rider to recognize the signs and symptoms of a concussion and to understand the importance in being evaluated by a medical professional that is well versed in concussions. This can be difficult at times because riders can fall off, and if the rider is able to get back up they are allowed to continue racing and medical personnel does not make it a point to locate the rider after competition is over. Whether a rider notes any visible signs or symptoms of injury or not they may continue to ride and finish the race, and most likely not seek any medical attention for a fall that is considered to be a part of the sport. Riders in this sport also recognize injuries are a part of the sport and may see a concussion as only getting their bell rung and not something more serious.[2]

Not comprehending the seriousness and obtaining incorrect information on concussions can result in misconceptions. Misconceptions about concussions occur in every aspect; from the terminology and definition, mechanism of injury to recovery, and long term effects surrounding them. A common misconception endorsed by the general public is that the primary sign or symptom of concussion is loss of consciousness, but this occurs in only 8 -19% head injuries that are diagnosed as a concussion; even with motocross it is only seen in 16% cases.[9,10] The general

public (33.1%) and even physicians (41.6%) hold the belief that wearing a helmet is capable of preventing a concussion; a helmet may be able to help disperse the forces of a concussion, but it cannot totally prevent one because it lacks the capability to stop the brain from moving inside the skull.[11,12] A common misconception endorsed is that in order for a concussion to occur a person must receive a blow to the head.[13] By definition a concussion a "concussion may be caused by either a direct blow to the head, face, neck or elsewhere on the body with force transmitted to the head."[14] Trusting that temporary confusion, headache, and dizziness are not to be deemed a concussion if they clear up within five minutes is a misconception believed by both a small number of physicians and the general public.[11,13] Symptom recovery, on average, does not occur until five to seven days post injury.[15] A headache alone is not typically enough for a concussion, but it is important to recognize that it is a common concussion sign occurring 86 -93% of the time.[16,17] Another commonly recognized sign and symptom, within the general public, is retrograde amnesia (41-82%) but it only occurs in only 13 - 27.7% of concussions.[18-20] The general public (41.8-83%) believes that with a second blow to the head a person who suffered a concussion can also help him remember.[18,21] Over two thirds of the general public (67.9%) and 15.3% of physicians believe that after sustaining the first concussion there is no risk for a recurrent concussion, but a person is 2-6 times more susceptible to another concussion.[11,19,22] Understanding that although concussions have several colloquial names the severity is the same and the management should be the same despite the informal names. Essentially downgrading the term concussion to "bell ringer" degrades the seriousness and the risk that's associated with this injury. By changing the term to "bell ringer", youth athletes, coaches, and even parents feel that continued participation holds no consequences.[20,23] Continued belief in these misconceptions can lead athletes to suffering many of the risks associated with concussions.

Understanding the risk associated with concussions is important for both recognition and management of the injury. Once a concussion occurs, the brain tries to auto-regulate the imbalance and demands that are placed upon it.[24] During this seven to ten day period the brain is susceptible to sustaining yet another concussion.[22] Indeed, the vast majority (75-92%) of recurrent concussions occur within seven to ten days.[22] With many sports having competitions within seven days of each other and daily practice between competitions, the possibility of a recurrent concussion is potentially increased. With this increased opportunity of a recurrent concussion second impact syndrome (SIS) becomes a possibility. SIS occurs when the physiological healing process of the first concussion is still present and a second blow is taken to the body.[25] While the brain is trying to regulate itself from the impact of the first concussion, the second blow even if minor, may prove to be too difficult for the brain to recover from with it being in an impaired state.[25,26] As each subsequent concussion occurs, the recovery time can become longer and can have a worse presentation.[27,28] Those with a history of a concussion are also more likely to experience loss of consciousness when compared to those who do not, but were also nine times more likely to present with three to four on the field markers of concussion.[28] Recurrent concussions of have been potentially linked to an increased risk of mild cognitive impairment, depression, early onset of Alzheimer's, and chronic traumatic encephalopathy.[29-31] Therefore, recognition and proper management of concussions is of most importance in all sports.

A high risk of injury, including concussions, is an inherent component of motocross. While the professional circuit is taking steps to better protect and manage concussions, the amateur circuit still receives limited medical attention. In the sport of motocross races are a week

apart from one another it is pertinent to understand that riders are susceptible to a recurrent concussion during that time.[22] This may leave many riders vulnerable to riding prematurely without taking the appropriate allotted time to recover from their concussion. Trusting in the misconceptions that concussions or "bell ringers" are a part of the sport and believing that there is minimal risk to riding prematurely following a concussion potentially leaves a rider open to second impact syndrome, post-concussion syndrome, and possible later life neuropathologies.[2] It is pertinent to provide a concussion educational intervention to better protect the riders and reduce the incidence of recurrent concussions. However, in order to conduct a successful educational intervention, the current knowledge of amateur motocross riders must be identified. To assess potential misconceptions about concussions, the purpose of this study is to assess concussion knowledge amongst motocross riders and determine differences in knowledge based on demographic factors. This study aims to answer the following research questions:

1. Can motocross riders recognize the signs and symptoms of concussions?
2. Do motocross riders know enough about concussions that they can make an appropriate informed decision about when to "return to play"?
3. Is there a difference in knowledge of sings/symptoms, return to play/general knowledge areas by demographic factors?
4. Is it possible to predict knowledge score and recognition of correct signs and symptoms with the use of demographic factors?

CHAPTER 2

METHODS

Participants:

There were a total of 1,396 responses to the online recruitment, of which 904 completed at least 90% of the questionnaire. The inclusion criterion for the study was; being 18 years of age, current participant in motocross, and must be an amateur rider. The exclusion criteria for the study was; under the age of 18 years of age, not a participant in motocross, or a professional motocross rider. However, 107 participants who completed the questionnaire were removed for not meeting the inclusion criteria; 76 were removed for being a professional motocross rider, 13 were removed for being a minor, and 16 participants were removed after determining they were not a motocross rider. Two other participants were removed for what appeared to be intentional falsified information and another 15 were removed for filling out the questionnaire multiple times; leaving the sample total of 782 respondents. The subjects provided electronic informed consent prior to participating in this study as approved by the University's Institutional Review Board.

Instrumentation:

Concussion Knowledge Questionnaire

An original questionnaire was developed for the purpose of this study. The 46-item concussion knowledge questionnaire was developed through the use of current concussion literature. Each question has been previously used by concussion knowledge surveys.[2,11,13,15,17,18,20,22-24,27,32-45] The questionnaire consisted of four components: 1) ten demographic questions that identified the participant, 2) seventeen true/false and multiple choice questions that pertained to general concussion knowledge, 3) three scenarios following a possible concussion, and 4) 16 item concussion signs and symptoms recognition. (Appendix F) The seventeen true/false and multiple choice, scenario questions, 16 item recognition did not mandate an answer in order to

continue on with questionnaire. The true/false and multiple choice questions along with three scenario questions accounted for 20 points, and the 16 item recognition was scored separately out of 16. The reliability of the concussion signs and symptoms recognition has a Cronbach's alpha=.83.[23] Content validity was also established through piloting the questionnaire with professional motocross riders. Participants were surveyed via an internet-based questionnaire (Qualtrics Labs Inc., Provo, Utah, USA).

Pilot Study

A total of 35 aerobics class undergraduate students took the questionnaire for extra credit in their class. The students were asked to report their major and if they had ever received a formal concussion education after taking the questionnaire. Of the 35 that were recruited two of the participants declined the informed consent leaving 33 remaining who participants. The mean time for completion of the survey was 7 minutes and 31 seconds (Range: 4:02-20:10). Participants did not report back any issues experienced. However, there were a few administrative issues with demographic questions not being fully completed; leaving incomplete data, which had to be removed. In order to avoid these issues during the actual study, the demographic questions were mandatory in order to begin answering the questionnaire (questions did not mandate a response to conclude the questionnaire). The following questions were answered incorrectly or participants were split on the answers.

1) A motocross rider falls off their bike and hits their head during their first moto, race. After going back to their trailer they have no headache and remember everything, but they have a nosebleed and a black eye. Should the rider continue riding that day? Correct answer is yes.
    - 18.2% said yes; 60.6% said no
2) Once a rider has suffered a concussion it is important to keep them awake. Correct answer is False.
    - 3% said false; 97% said true

3) A helmet will prevent concussions. Correct answer is False.
    - 51.5% said false; 48.5% said true

Further reliability and validity of the questionnaire was confirmed by taking a sample of motocross riders after data collection has commenced due to the pilot study not being a part of the target population for this research study. Comparing the sample of riders to the pilot study the first two questions came with similar results while the third question the riders had more participants answer correctly.

1) A motocross rider falls off their bike and hits their head during their first moto, race. After going back to their trailer they have no headache and remember everything, but they have a nosebleed and a black eye. Should the rider continue riding that day? Correct answer is yes.
    - 34.2% said yes; 65.8% said no
2) Once a rider has suffered a concussion it is important to keep them awake. Correct answer is False.
    - 6.6% said false; 93.4% said true
3) A helmet will prevent concussions. Correct answer is False.
    - 82.9% said false; 17.1% said true

Procedures:

Users of Facebook™ can create personal profiles of themselves that consist of their interests, hobbies, and contact information from there they can become "friends" with other users helping to form networks.[46] Within these networks, users can place public postings on different pages and/or send private messages.[46] Another opportunity for users is the ability to create/join Facebook™ "groups" that are based upon their shared interests, hobbies, regions, or even workplace.[46] With this in mind, the researcher placed a specific script with questionnaire link upon the Facebook™ group walls that included motocross tracks/riders/enthusiasts/sponsors, and also have the administrator of these groups post it under their name as well. Another social network system that was used was Twitter™. Like Facebook™, on Twitter™ a user can create a personal account and is

allowed to “tweet” messages that are no longer than 140 characters. The user can find other users based on their interests and follow the tweets that they say and a user can “hash tag” or send a message to a specific Twitter™ user. The researcher sent a specific tweet to motocross tracks/riders/enthusiasts/sponsors that was individually tweeted at each user found through searches of Twitter™ users. The last method of recruitment involved sending an email to AMA district representatives as well as motocross track guide representatives, which also followed a specific script, which asked them to send the questionnaire link to all the riders within their expanse. Each method had its own individualized script that it was followed. Once the participant clicked on the questionnaire link it took them to the informed consent page. Based upon their response, yes or no, it sent either the participant into the questionnaire to answer the questions or to the end of the questionnaire to the “thank you” page. The final step of the questionnaire asked the participant to place their email address in the text box to be entered into the raffle. Once all the data collection had commenced an online random number generator was used to determine 25 winners to receive $25 electronic gift card to MotocrossGiant.com. Once winners were established, the electronic gift card was sent to the winners respective email addresses. An additional e-mail was sent to all the winners of the gift cards to thank them for their time and to make them aware that they are a winner and they will receive a gift card to from MotocrossGiant.com.

Data Analysis:

The independent variables in this study included all demographic variables collected via questionnaire, as indicated below. The dependent variables in this study included an overall knowledge score, which accounted for true/false, multiple choice, and scenario questions (scores between 0 - 20) as well as recognition of correct concussion signs and symptoms (scores ranged between 0 - 8). While the 16 item symptom recognition previously has been scored out of 16 with this study, the value lied in determining exactly what amateur motocross riders knew about concussions which includes the ability to identify the concussions

symptoms and not focusing on the distractors, therefore scoring was based upon the 8 actual concussions symptoms and not on 16 which includes choosing the correct 8 and also scoring 8 distractors not chosen.

Statistical Analysis:

Frequencies and means/standard deviations were calculated to provide demographic information on the participants as well as establish the scores of the dependent variables. In order to run statistics on two specific variables, age and informal concussion knowledge, the date was collapsed into categorical variables. Age was separated into six different categories based upon previous public health study.[47] The categories are broken down into: 18-25, 26-35, 36-45, 46-60, 61-70, and older than 70 years of age.[47] Informal concussion knowledge consisted of eight options (three of which were printed materials books, newspaper, and magazine), were collapsed into a category known as "printed material". To determine potential relationships, correlations were calculated between all demographic variables, the total knowledge score, and symptom recognition score. A multiple regression was then performed for concussion knowledge scores and symptom recognition score. Separate one-way ANOVAs were performed comparing the independent variables (age, concussion history, formal concussion education, informal concussion knowledge, neuropsychological baseline testing, races per year, and years racing) with the dependent variables (knowledge score and sign and symptom score) to identify group differences. Two demographic variables (race and gender) were not assessed because the majority of the population belonged to one race and gender. All alpha levels were set at $p<0.05$ with the exception of formal concussion education set at $p<0.01$. Three fourths of the participants did not have a formal concussion education the alpha level was set lower to determine if there was significance amongst groups for both knowledge score and sign and symptom score.

CHAPTER 3

RESULTS

We recruited 782 amateur riders to participate in this questionnaire. (Appendix C, Table 1). Participants completed the questionnaire in 6.37 ± 1.54 minutes.

Knowledge Score

Participants scored an average 14.29 ± 2.71 on their overall knowledge score out of 20. (Appendix C, Figure 1) Four specific questions showed riders strongly believed the following misconceptions: 1) correct terminology surrounding concussions (60.0%), 2) understanding return to play guidelines (52.2%), 3) understanding the signs and symptoms of concussions (64.8%), and 4) acknowledging if a rider should be allowed rest after suffering a concussion (91.9%). The greatest misconception amongst riders was the belief that after suffering a concussion that the rider should be kept awake as opposed to allowing them to rest (91.9% [719/782]). Another misconception the majority of riders believed pertained to when to return to riding. While the scenario included a rider falling off of their dirt bike and hitting their head and the rider did not experience any signs or symptoms of concussions, over half of the participants (64.8% [507/782]) answered incorrectly. There is a misconception surrounding the term concussion and if it identifies with a bell ringer, ding, and mild traumatic brain injury in terms of severity. Over half the participants (60% [469/782]) could not recognize they all hold the same severity. A little over half of the participants, (52.2% [408/782]), believed that once a rider has sustained a bell ringer they should not be removed from practice or race.

There was a significant difference between participants who had baseline neuropsychological test and knowledge score ($df_1 = 3$, $df_2 = 773$, $p = \leq 0.001$) (Appendix C, Table 1). Participants who had been baseline neuropsychologically tested scored significantly higher on the knowledge score ($\overline{x} = 15.31 \pm 2.13$) than those

who weren't sure if they have been tested ($\bar{x}$ = 13.35±2.94, p = ≤0.001, *r*=.36) and those who have been tested by a neuropsychological test other than ANAM, CogSport, HeadMinder ImPACT or other types of neuropsychological testing ($\bar{x}$ = 11.00±2.91, p=.004, *r*=.64). Participants who had not been baseline neuropsychological tested scored significantly higher than those who weren't sure they have been tested ($\bar{x}$ = 14.43±2.64, p=≤.001, *r*=.19) and those who have been tested by a neuropsychological test other than ANAM, CogSport, HeadMinder, or ImPACT (p <.05, *r*=.52). Significant difference was found between formal concussion education and knowledge score (df_1 =1, df_2 = 777, p=≤0.001, *r*=.15) (Appendix C, Table 1). Those with a formal concussion education had a higher knowledge score ($\bar{x}$ = 14.91±2.52) compared to those who did not ($\bar{x}$ =14.09±2.75).

Knowledge scores were predicted with the use of demographic factors which included; years racing, races per year, concussion history, neuropsychological baseline testing, formal concussion education, informal concussion knowledge, and age. Sign and symptom score was also used to determine if it was a predictive factor of knowledge. Significant relationships, with a p-value of .05 or lower, were established through correlations and were then included into multiple regression. (Appendix C, Table 2) To determine potential predictors of concussion knowledge, the following five of seven independent variables were entered into the regression equation: correct S/S score (ρ=.350), years racing (ρ=.074), age (ρ=.153), neuropsychological baseline testing (ρ=-.174), formal concussion education (ρ=-.127). These two negative correlations are accounted for in the manner that data was coded into SPSS. Participants who said yes to baseline neuropsychological testing and formal concussion education were coded as a one, and the remaining answers increased numerically. As the coded response number increased the score of the participant decreased. Therefore, those who said yes to baseline neuropsychological testing and formal concussion education actually scored higher in both knowledge and sign and symptom recognition. Although all demographic factors were

placed into the regression the best model used five demographic variables, accounting for 16.4% of the variance in the knowledge score (adjusted R^2 value of .164).

Recognition of Correct Signs and Symptoms

With regards to recognition score, participants scored 6.76±1.35 out of 8. (Appendix C, Figure 2) Participants were able to identify 6 out of the 8 signs and symptoms with over 90% accuracy; headache (94.9% [742/782]), dizziness (94.8% [741/782]), confusion (93.2% [729/782]), loss of memory/amnesia (93.1% [728/782]), blurred vision (92.5% [723/782]), and blacked out/LOC (91.9% [719/782]). The symptom least identified out of the eight was trouble sleeping (35.7% [279/782]).

When comparing formal concussion education with recognition of the correct eight signs and symptoms there was a significant difference (df_1 =1, df_2 = 777, p =.024, *r*=.19). (Appendix C, Table 1) Those with a formal concussion education were able to identify more signs and symptoms ($\overline{x}$ = 6.96±1.16) than those who did not have a formal concussion education ($\overline{x}$ =6.70±1.40). The effect size meaningfulness amongst scores is small in value.

To answer research question number four, demographic factors that showed a significant relationship were placed into a multiple regression. The following demographic variables were entered into the regression equation: formal concussion education, baseline tested, and knowledge score. All of these predictors, R^2 value of .120, accounting for 12.0% of the variance of the dependent variable to explain by the combination of the three predictors. With knowledge score being the only predictor showing significance it was also the variable of importance. The higher the participants' knowledge scores the higher their recognition of the correct eight signs and symptoms.

CHAPTER 4
DISCUSSION

Amateur motocross is a unique extreme motorsport where, outside of emergency situations during races, riders must rely on themselves to recognize possible diagnosis of concussions and how to manage and determine when to return to riding. While the professional motocross circuit is working towards a concussion management protocol the same can't be said about the amateur circuit. With such a big responsibility placed upon the individual it is important to not only dispel any misconceptions, but also replace them with accurate and credible information. To assess potential misconceptions about concussions, the purpose of this study was to assess concussion knowledge amongst amateur motocross riders, to determine which demographic factors had the most influence on concussion knowledge, and to determine differences in groups based upon demographics factors of the participant. Participants showed an understanding of general concussion facts, but they are not able to connect that knowledge to proper concussion management. Without proper understanding of management of these injuries participants are returning to activity prematurely and are putting themselves at a risk of subsequent injury.

Participants have a basic understanding of concussions, but applying that knowledge becomes the challenge for these athletes. Compared to other studies, where coaches were surveyed on concussion knowledge, the participants can similarly recognize a concussion.[20,48] However, there is still room for improvement on management of a concussion and adequately understand how to refer to a healthcare provider for further evaluation.[21,23] Four major misconceptions were identified amongst the participants. The most commonly endorsed misconception (91.9% [719/782]) dealt with the belief that after sustaining a concussion it is important to keep the person awake. The premise behind this misconception is that by keeping the person awake they are decreasing the risk of the patient slipping into a coma.[49] Severe head injuries, like that of an epidural hematoma, have an estimated 20-50% chance of a lucid interval.[49,50] Lucid interval is, defined as, a

period of recovery after loss of consciousness from the initial concussive force, but then unconsciousness returns when the hematoma expands and increased pressure within the skull.[50,51] A concussion, like every injury, requires a period of rest to not further aggravate the injury and help manage the injury back to its pre-injured state.[52] Keeping a person who has sustained a concussion awake reduces the amount of quality of sleep, and may delay recovery. This number is much higher in comparison to what has been shown amongst the general public when surveyed.[13,19]

Understanding the equivalence of names for a concussion is also important in terms of general concussion knowledge. Injury severity, believing that a concussion was not the same as mild traumatic brain injury or a bell ringer, was misperceived by more than half (60.0% [469/782]) of the participants. This closely matches another study done with the general public that found more than half of their participants identified themselves as having a concussion, but did not endorse a brain or head injury.[13] By continually referring to concussions as "bell ringers" the seriousness of this injury is minimized.[53] In previous concussion knowledge studies on youth athletes (age range, 10-14 years), a quarter of the athletes, 13% of parents of those youth athletes, and 45% of youth coaches believed that a concussion did not require immediate removal from activity.[20,23] In a previous study Idaho football coaches, 42.4% of those surveyed, felt that it was alright for an athlete to return to play when the concussion was described as "getting their bell rung".[54] However, these statistics pertain to using the term concussion and not "bell ringer". When the term concussion is used in place of "bell ringer" the amount of participants who believe this same misconception drops. These results were similar for the current study, 10.6% of participants believing that the rider should not be removed from activity when using the term concussion as opposed to the term "bell ringer" which 52.2% believed could continue with activity. The term concussion carries a certain connotation that the public deems more dangerous than the term "bell ringer". Therefore, both the NATA position statement and the 4th CIS discourage the use of colloquial terms "bell ringer" and "ding".[14,32]

Not understanding injury severity may also lead to mismanagement of the injury. If participants do not connect that a "bell ringer" is a concussion, it could allow for them to return to riding prematurely. Close to half the participants (40.5% [317/782]) within this study endorsed the idea of not having a "bell ringer" evaluated by a health care professional. A previous study that looked at motocross riders who had symptoms of concussions had found that only 40% of riders felt it was necessary to be evaluated.[55] If close to half of riders are not finding it necessary to be evaluated, they are potentially at risk for returning to riding prematurely. Premature riding places the motocross rider under a potential risk for a recurrent concussion with the impairments affecting their ability to participate. With this study it was questioned if riders knew how long they should wait to return to riding; a third of participants (34.3% [268/782]) felt that they could return to riding in six days or less. This is comparable to the previous study done on motocross riders who said they continued riding the same day even with symptoms of a concussion.[55] However, the majority (65.7% [514/782]) of the participants in this study understood that after suffering a concussion it is not wise to return riding prematurely. The contrast in between these two studies is that the previous study assessed the actual actions of riders while this current study assessed their knowledge

While it is important to understand general knowledge about concussions it is similarly imperative to know the actual signs and symptoms. This study looked to identify if there was significant differences in recognition of signs and symptoms between groups of demographic factors. A significant difference was found amongst age groups when looking at knowledge score with those aged 36-45 scoring higher than those 18-25 year olds. This difference could be accounted for with participants being older having more years racing and by extension a potential for more experience with concussions. Also, with the difference in age those who are older potentially have a higher education. A previous concussion knowledge study, that took demographics on education, found significance amongst knowledge based on whether the participant had a high school diploma or a GED versus those who had a higher education degree.[56] Those who had previously undergone

neuropsychologically baseline testing showed a significant difference scoring higher in their knowledge score compared to those who did not know if they had been tested or those who used another neuropsychological test other than the ones listed in the questionnaire. Potential explanation is that those who have undergone neuropsychological baseline testing have been exposed to concussions more, or they could be potential riders who aspire to become professionals and are undergoing baseline testing to help secure their professional status. Participants who had also received a formal concussion education also scored higher on the knowledge score when comparing them to those who had not received one. The demographic factors helped to identify those who were doing better and potentially helped to identify where participants were receiving their knowledge.

A relationship between knowledge score and demographic factors were established. Significance was found for knowledge score with the use of symptom recognition score, the years racing, whether the rider had been neuropsychologically baseline tested, if they had received a formal concussion education, and the age group the rider fell into. As expected a positive correlation (r=.350) was identified between knowledge score and symptom recognition score; implying a positive association between the general knowledge and recognition of signs and symptoms. A positive association was also observed between the age category participants were placed in and their knowledge score. To clarify, young adults, age 18 to 25, scored lower on knowledge than the adults aged 36 to 45. A positive relationship was identified between those neuropsychologically baseline tested and their knowledge score. Those who had been neuropsychologically tested scored higher on knowledge compared to those who had not been tested, those who were not sure if they had, and those who had been tested by another type of neuropsychologically tested. A positive correlation also exists between formal concussion education and knowledge score. Participants who received a formal concussion education scored higher in knowledge compared to those who had not received a formal education. Knowledge score can be predicted with symptom recognition score, the years racing, whether the rider had been neuropsychologically baseline tested, if they had received formal concussion education, and the age group the rider fell into. These predictors accounted

for 16.4% of the variance; compared to a public health study of oral health, to determine standards, their demographic factors accounted for 21% of the variance.[57] The use of demographic factors in establishing outcome is beneficial in that it helps to identify areas that directly influence participants' knowledge score.

Recognizing whether or not to continue activity with signs and symptoms of a concussion is an important aspect of concussion education. A persistent minority or respondents are missing some of these concepts such as; 9.1% believed that a rider could return with signs and symptoms the same day of injury. Comparing this to the youth athletes (18%) and parents of those athletes (5%) surveyed, the data from this study finds our participants in between.[20] Recognition of the consequences of returning prematurely and the long term consequences associated is another aspect that all athletes need to be aware of. A small subset of participants (5.1%) felt there were no long-term effects associated with concussions. This is much lower in comparison to what the general public, with 30.4%, and physicians, with 14%, believing there are no long term effects or permanent deficits.[11,13] Within this study an even smaller persistent minority (3.5%) believe that a second concussion will heal faster than the first. This is much smaller than the 41.8% of Rhode Island general public that felt a second blow to the head would help a person remember things forgotten previously.[21] Fewer participants from this study believed this misconception in comparison to New Jersey coaches (8.2%).[48] Not only do concussions heal slower for each subsequent concussion, but each concussion presents with more on the field markers and presents with worse signs and symptoms.[22,28] Participants within this study, much like the general public, were able to correctly answer many general knowledge questions. Many of the questions that were incorrectly answered more specifically pertained to management of concussions. Participants understand the facts pertaining to what a concussion is and what it takes to diagnose it, however, their ability to understand to how manage the concussion acutely is an area that they are not knowledgeable.

Participants were able to accurately identify six out of eight correct concussion signs and symptoms with a minimum of 90% recognition. (Appendix C, Figure 2) With the participants having suffered average of 2.5

concussions, the experience of concussions could account for participants being able to do so well at accurately identifying symptoms. Previous concussion knowledge studies, that included a 16-item symptom recognition score, were consistent with the findings from this study with headache, dizziness, and confusion most commonly recognized.[20,23,58,59] The fourth most accurately recognized concussion sign and symptom in this study was loss of memory/amnesia (93.1% [728/782]). Prior studies that used symptom recognition chose to only list one of the two terms.[20,23,59] When the terminologies of these two terms were used separately they were picked less frequently with amnesia being chosen less (60.3 - 64.7%) than loss of memory (72.6 - 82.0%).[20,23,59] This study used both terms which could have attributed to so many participants choosing it compared to other studies that used both terms separately. The two accurate symptoms least identified were nausea and trouble sleeping. This is congruent with other knowledge studies that assessed symptom recognition with nausea identified (30.8 - 71.3%) more than trouble sleeping (7.7 - 56.0%).[20,23,58,59] When looking at the eight distractors included in the symptom recognition, the least chosen was chest pain, followed by black eye, and neck pain. The distractors most commonly chosen were weak neck (48.1% [376/782]) and numbness/tingling down the arms and hands (33.8% [264/782]). These distractors have been frequently chosen in other studies possibly due to the association of a head injury with secondary injuries occurring in the cervical region.[59] While these symptoms are important in detection of a cervical injury believing that they are symptoms of a concussion may lead to riders to believe that without these injuries they are no suffering from a concussion. Recognition of the accurate signs and symptoms across several studies and as well this one showed that many people are able to accurately identify most of the correct symptoms, but it is just as equally as important to ensure that they know which symptoms are not correct.

While many of the participants were able to recognize the signs and symptoms of a concussion, many struggled with taking the concussions symptoms and applying them into a scenario situation. For example, one scenario asked, "a motocross rider falls off their bike and hits their head during their first moto. After going back

to their trailer they have no headache and remember everything, but they have a nosebleed and a black eye", the majority of respondents said that the rider should not continue. While the participants answered in a more cautious method, it still brings up the question of if the participants thought they were signs/symptoms of a concussion. The answers to many of the scenario questions indicated that knowing the incorrect signs and symptoms of a concussion is just as important as knowing the correct symptoms. In a study assessing knowledge amongst parents and youth athletes, 80% were aware of the top five symptoms, but were not aware of the others and were not able to rule them out.[20] A previous study showed that 47.4% of participants believed that hearing voices and a decrease pulse were while another 43.9% of participants believed that euphoria and inability to swallow were accurate signs and symptoms.[60] By associating symptoms that are not those of a concussion can hypothetically allow a person to think the injury, such as a concussion, is not as serious due to not having suffered symptoms like numbness and tingling in the hands or a weak neck. The ability to recognize actual signs and symptoms of concussions are imperative, but it is also important to be aware of those that are not so as to diminish the seriousness of a concussion and think that it does not require immediate care.

While looking at the symptom recognition score, only two demographic variables had an association, baseline neuropsychologically tested (ρ=-.083) and whether they had a formal concussion education (ρ=-.078) had significant correlation. Participants who said they had done baseline neuropsychological testing scored were able to recognize more symptoms of concussion than those who had not been neuropsychologically baseline tested. Participants who said they have received formal concussion education accurately recognized more symptoms of concussions than those who did not have a formal education.

Understanding relationships that pertain to sign and symptom score helps to identify where the participants received the knowledge that best helped them. Symptom recognition score can be determined with the use of knowledge score, neuropsychologically baseline testing, and formal concussion education. A public health study that wished to better allocate funding for primary health care in Chile used a regression equation in

order to determine which demographic factors needed adjustment when seeking payment from poorer health and lower socioeconomic status.[61] The study found four demographic factors to adjust for with these factors accounting for 9% of the variance in their prediction equation.[61] Determining what demographic factors influence sign and symptom score helps to identify what areas most influenced their ability recognize correct signs and symptoms of concussions.

Correct signs and symptoms showed significance with only two independent variables. Those who had received a formal concussion education accurately identified (6.96 ± 1.16) more concussion symptoms than those who didn't. Participants who received concussion information from a health care professional accurately identified (6.94 ± 1.11) more concussion symptoms in comparison to those got information from the AMA. This is unlike the youth coaches who felt coaching associations provided more useful information than the health care professionals that interacted with.[21] The difference between the previous study and this current one is the participants received their information on concussions and signs and symptoms potentially after sustaining a concussion. Participants were asked, within the demographics, where they receive their concussion information from. Over a third of the participants (35.4% [263/743]) stated they received their information from a health care professional. This information in combination with the participants averaging 2.47 ± 2.36 concussions the potential seems much greater for the information to come post injury as opposed to preventatively. Very few participants (5.8% [43/743]) selected the AMA as where they receive their concussion information. This is reactive education, learning as a result of an injury that has occurred. However, the information provided to the participants proved to be informative seen by the sign and symptom score. The American Motorcycle Association is already taking a step to encourage correct management of concussions in the professional circuit with an aggressive campaign they could take their message to amateur riders.

There were several limitations to this study. One of the most important limitations was whether or not the participants were honest with their answers; not only in using their own knowledge but also in not looking

up information as they answered the questions. With responses being self-reported it was also hard to note if participants gave the socially desirable answer or were being honest. A sampling bias also exists, within this study, with data being only coming from participants who chose to respond to the questionnaire. The recruitment method for this study is fairly new. Previous health studies that used social networking as a form of recruitment also saw a bias of population based upon the frequency of participants being on Facebook and seeing the link to the questionnaire.[62,63] Not every rider "advertising" they are a motocross enthusiast, and with the potential that not every rider has a Facebook™ or Twitter™ not every rider was able to be reached. Another limitation to this study was the method in which Twitter operates. With the inability to go over 140 characters there was no accurate way to give a better description of the study to help entice the population to participate. A limitation to the use of the social networking system was that groups allow people from anywhere in the world with an interest in the sport to be a part of the group which can cause for international participants to be who may not understand all terminology used. With social networking sites being a place to advertise much of the population saw the web-link as a way of advertisement or spam. There was no way for the researcher to be able to verify that the respondent was who they stated they were in filling out the demographic section. While there were several respondents that participated within this study several groups and members of this population did not want to take part for fear of losing followers/customers by discussing a sensitive topic. A new recruitment method was used in order to attain information on a population that has exponential growth in both popularity and participants. This study aimed to ascertain what this population knew regarding concussions there is still, however, room for more research to be done.

This study is first to investigate concussions in motocross. Results from this study could be used in designing an education intervention to be implemented among this very unique population by helping to identify where athletes within this sport are lacking information and misconceptions they believe. Educational interventions have been shown to be useful in increasing athletes' concussion knowledge when administered

prior to the season when compared to post-season knowledge.[64] Important aspects to include in the education intervention would be; terminology, stressing a "bell ringer" is in fact a concussion and deems immediate removal and evaluation. It is also important to be knowledgeable of the actual correct signs and symptoms of a concussion, including a section based solely on typical scenarios that motocross riders get hurt in that can lead to a concussion, and also stressing the importance of seeing a physician or health care provider even if they believe the trauma wasn't significant enough but still elicited symptoms. Another aspect of research is the attitudes to which motocross riders have; determining if they are choosing to ignore the knowledge they have and their behavior is opposite of what they say would do given a particular situation. Taking a closer look at what knowledge is being sent out to riders via motocross magazines, websites, and the American Motorcycle Association. Overall, participants from this study understood more of the general concussion information, and are able to recognize the majority of the correct signs and symptoms of concussions than seen similar concussion knowledge studies. While participants do have this knowledge they struggle with the ability to apply the general knowledge that they have to concussion management situations. Determining how to manage recovery of a concussion and when they are allowed to return to riding is where the knowledge is missing. This is why it is important to help fill in the holes of information. Helping to dispel any misconceptions with an educational intervention that is geared towards the sport of motocross would be crucial and beneficial.

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APPPENDIX A

Limitations

- No way to identify that the respondent is who they say they are.
- Answers were self-reported and could determine if they were honest or socially desirable responses
- Sampling bias in only surveying those who chose to participate in the study
- Twitter™ only allows for 140 character messages which doesn't allow for detailed explanations

Delimitations

- Respondent is a motocross rider
- Motocross rider is considered an amateur
- Rider is at least 18 years of age

Research Questions

- Can motocross riders accurately recognize signs and symptoms of concussions?
- Do motocross riders know enough about concussions that they can make a confident informed decision about when to "return to play"?
- Is there a difference in knowledge of signs and symptoms, return to play/general knowledge areas by demographic factors?
- Is it possible to predict knowledge score and recognition of correct signs and symptoms with the use of demographic factors?

Assumptions

- The terminology will be understood
- The participants will answer truthfully and only use their own knowledge
- No participant will attempt to take the survey multiple times

APPPENDIX B

LITERATURE REVIEW

A common injury seen in both athletic and non-athletic populations, and gaining more media attention is concussions. While at one point this injury did not have much information behind it; new knowledge is continually being gained and is causing for more recognition in how it occurs, the signs and symptoms associated, and how to establish return to play protocols. A concussion is a "complex pathophysiological process that affects the brain and is induced by either indirect or direct blow to the head, neck face, or elsewhere that transmits an impulsive force to the head".[35] Like every injury that occurs to the body concussions also incurs signs and symptoms what makes it different is that signs and symptoms may not appear immediately, and the extent to which they appear is dependent upon the person. What separates concussions from other injuries is the ability to determine when a person is able to return to activity. With other injuries functional testing can still be done even if there are lingering symptoms present, but with concussions it is important to establish the patient as asymptomatic before progressing them back to injury. In order to better understand what this injury entails it is significant to understand the history behind, the current knowledge and misconceptions, and how it affects ones' future.

While the term has been more clearly defined as more knowledge is discovered, the incidence of concussions dates back many years. As medicine has advanced through time so has the understanding of head injuries and concussions. An Arabic physician, by the name of Rhazes established a clearer description of concussions.[65] He presented a distinction between a severe brain injury and that of concussion which was an alteration in a person's "physiological state". In doing so he provided the groundwork to which other physicians would build more knowledge upon. Another significant advancement made came from Berengrio de Carpi took the idea of "cerebrum commotum" and established that concussion occurs as a result of the brain, made of soft tissue, being propelled into the skull which is of rigid form.[65] Rhazes' definition still held true in the centuries

that followed and during the course of that time physicians sought to expand what they knew and began to associate specific symptoms that occurred in patients with concussions. While the medical terminology has changed, the signs and symptoms experienced are still identical today. The foundation of this injury was presented well over millennia ago, but knowledge is still being attained with copious amount of new information being presented every day.

It is imperative to understand how a concussion affects the brain physiologically and the Neurometabolic cascade that it's a result of the injury. When trauma occurs to the brain there is very systematic way the body processes the trauma and tries to react to maintain its homeostatic state. When the biomechanical trauma occurs, action potentials are sent with the resulting in glutamate, a neurotransmitters, to be released. [24] Following the release of neurotransmitters voltage gated channels, N-methyl-D-asparate (NMDA) receptor, are opened causing for an increase of potassium to leave the cell with calcium coming inside of the cell.[24] Magnesium crosses the synaptic cleft and causes for the NMDA receptors to once again be unblocked resulting in even more calcium to move into the cell.[24] The body's mechanism for this removal is to activate the sodium-potassium pumps, but the increased membrane pumping requires adenosine triphosphate, ATP, derived from glucose to keep it running efficiently, but the demands placed upon are so high that it places the brain in an energy crisis.[24] Once again, with this irregularity in ions turning into a spreading depression the demand for more glucose outweighs the storage supply.[24] Following the hyperglycolitic state, a large quantity of calcium accumulates within the cells.[24,44] With this increase in calcium the body tries to remove it to prevent it from causing further damage to the filaments.[24] The mitochondria put forth effort to seize the calcium, that is impairing the oxidative metabolism causing a decrease in the production of ATP, but results in the cells gathering up the calcium and initiating apoptosis or cellular death to decrease the accumulation within.[24,44] During this post-injury time metabolism is pushed to its limits and leaves the brain vulnerable for a second injury.[24] The potassium immediately peaks after the injury is sustained but it decreases within six to eight minutes.[24] The accumulation of calcium remains elevated for up to twenty four hours when it begins to taper off

and resumes normal levels by day five.[24] Following a concussion the magnesium levels immediately reduce and remain low up to four days post injury.[24] During this time the cerebral blood flow still remains depressed, up to fifty percent of its normal value, up until day ten where it is restored to a hundred percent efficiency.[24] Once resolution of these physiological symptoms has occurred at ten days post injury brain is thought to be returned back to its homoeostatic state.

A physiological understanding of what incurs during concussion provides only one piece of the puzzle another significant piece of knowledge is the understanding of the biomechanics of impact behind a concussion. Football provides exceptionally educational data in trying to understand concussions biomechanically because it is a high collision sport that provides both direct and indirect impacts. In order to understand the significance behind the forces applied during collision in football one must appreciate the minimal amount of forces it takes to cause death. One G force is equivalent to 9.8m/s^2 (while sitting) the minimal requirement in order to succumb to death is three to five G forces, dependent upon the duration of time of force applied.[66] While highly debated, possible threshold for sustaining a concussion lies between seventy to seventy-five G forces. With football being a heavy collisional sport the impact sustained has produced average impacts of 9.3 m/s while the head velocity, observed a change of 7.2m/s.[66] Head acceleration produced a force of 98g (this force is equivalent to a 35mph car crash) with a peak rotational acceleration of 6,432 radians/s^2 which is estimated at 368,000 degrees/ sec with the duration of impacts lasting fifteen milliseconds.[66] Translational acceleration illustrated to be more significant in the reason for the concussions; even more evident when a struck player absorbed the impact at an oblique angle against the facemask.[66]

Although understanding the forces that are applied and absorbed into a player are significant in helping to develop better protective equipment it is also beneficial to understand where the most common locations of impact are made. When a football player is struck and then incurs an impact with a ground as a result of the tackle experiences the lowest velocity is experienced, 6.1m/s, but it sustains the greatest change in velocity, 8.4m/s, and resultant translational acceleration of 117.1g.[67] The athlete sustains a greater force due to the

ground not providing any dispersal of the force of his head impacting the ground unlike the other three conditions where their force was transferred from one body, the striking/opposing player, to another, the struck player.[67]

There are a substantial amount of concussions sustained at both the high school and collegiate level and it is important to acknowledge the biomechanics of concussions at these levels. Collegiate football players sustained linear acceleration forces of 20.9g-22.25g.[68] Impacts sustained at lower impact than the "threshold" present higher symptom change scores, and collegiate football players were 6.5 times more likely to sustain an impact of over 80g. When assessing high school football players it was observed that most athletes were sustaining more linear acceleration as the they lowered their head and the top of the helmet took an upwards of 24.76g in linear acceleration and attaining the greatest impact force magnitude.[68] This not only increased their risk for sustaining a concussion, but also made them even more susceptible to a cervical injury. [68] By absorbing the impact at the top of their head the athlete is six and a half to eight and a half times more likely to sustain an impact greater than 80g.[69,70] The amount of linear acceleration created by these athletes, albeit practice or game, was greater than what is seen at the collegiate level.[68]

Concussions are exceedingly prevalent. According to the Centers for Disease Control and Prevention there are ten million traumatic brain injuries, TBIs, occurring each year in the United States that are severe enough to result in hospitalization or death.[9] There is also an estimated 300,000 TBIs involving loss of consciousness, LOC.[9] Of these ten million 1.4 million of them are occurring within the United States these can be broken down as followed; 1.1 million of these are emergency room department visits, 235,000 result in hospitalizations, and unfortunately 50,000 of these end in death.[9] In the world of sports there are 1.6 to 3.8 million TBIs occurring annually.[9] Demographically speaking males are twice as likely to sustain a TBI as females.[9] Children between the ages of 0-4 and older adolescents 15-19 are more likely to sustain a TBI.[9]

When assessing the amount of concussions that occur annually it is important to analyze sports that sustain a significant amount of contact and collision. When looking at concussions in sports football is more

closely analyzed. Understanding the football injuries in the United States helps determine the types of injuries that are most common and the frequency to which they occur.[71] When comparing the statistics high school football players sustained a greater amount of head and face injuries,11.5%, to which of those 96.1% were determined to be concussions.[71] More concussions were also sustained during competition when compared to practice, but this could be plausible because both collegiate and high school players had a risk of injury five times greater during competition in comparison to practice.[71] It is estimated 57,000 concussions occurring annually in high school.[71] The normal rate of concussion sustained is five percent with high school football players at the higher end (5.6%) of this number in comparison to every collegiate level, Division I through III (4.4-5.5%).[16] Although this rate has been steadily growing over the last few years due to many factors; athletes have become stronger, faster, and bigger and even the sports to which they participate have evolved.[72] Of those aforementioned 57,000 concussions that occur annually in high school, it is relevant to understand that not all solely occur in the sport of football. While football is the most popular sport participated in several other varsity sports were studied including; girls' and boys' basketball and soccer, softball/baseball, wrestling, field hockey, and volleyball, each of which had a mild traumatic brain injury occur amongst the injuries that were recorded. [73] Looking at 1000 athlete exposures, football with its immense amount of contact has the highest incidence of concussion amongst male sports having 773 concussion cases while wrestling and soccer follow closely behind, 128 and 69 concussions recorded respectively.[73] Looking at the opposite gender the popular female sports show the highest incidence rates of concussion occurring to soccer players with 76 concussions over a 1000 athlete exposures followed by basketball with 65 concussions and then softball with 25 concussions.[73] The amount of contact or collision that is seen within the sport, whether male or female, coincides with the rate of concussion within that sport.[73] When looking beyond the varsity sports and focusing on recreational activity, activities like skateboarding have an incidence of concussion at 13.6 percent while recognition is not of a concussion but of having bell rung.[74] These two recreational activities are can be classified as extreme sports with the inherent risk that is associated with them.[74]

Extreme sports and varsity sports are frequently participate in by children under the age of seventeen. Determining what sports captures their interest and pursuing it to their fullest ability. While the passion and the drive for the sport is there the risk of injury, and particularly concussions is also present. Concussions are one of the most common injuries reported by children 16 years and younger.[75] Its estimated that United States children between the ages of 10-14 account for 629 per 100,000 cases of traumatic brain injuries while 814 per 100,000 cases are reported for 15-19 year olds.[76] The most common mechanism of injury for pediatric concussions is a fall,32-91%.[77] However, when focusing upon the severity of the concussion children adolescents are nearly six times more likely to suffer a severe concussion when playing an organized sport as opposed to leisurely activity which makes the mechanism of injury a collision as opposed to a fall.[13,78] It should be kept in mind that younger athletes' have a "greater head-to- body ration, weaker neck musculature, and undeveloped cranial bones" with a brain that is still maturing.[20,79] In order for a child to suffer a concussion it takes a force of 2-3 times greater impact than an adult to produce symptoms.[78]

There are many signs and symptoms that an athlete can complain of when experiencing a concussion. Signs and symptoms fall under several different categories. There are somatic, cognitive and emotional symptoms, physical signs, behavioral changes, and cognitive impairments.[35] The most common sign and symptoms experienced is a headache which occurs 86-93.6% of the time.[16,17] Cognitive symptoms leave the feeling of disorientation and/or feeling in a fog, 15.3-83%.[17,80] While an athlete can suffer through depression as a result of concussion this emotional instability resolves, within a week's time, and a faster rate than coping with severe musculoskeletal injuries.[81] Some physical symptoms seen are both loss of consciousness and amnesia. Experiencing loss of consciousness and amnesia are not required in order to be suspected of sustaining a concussion nor does it predict to what severity the sustained concussion is.[35,36] Previously the use of grading scales determined the grade of concussion and at the time the experience of loss of consciousness would automatically make the concussion a grade three.[41] The use of grading scales is no longer in use especially with loss of consciousness only being linked to concussions 8.9-25.5% of the time.[16,17] With amnesia, retrograde or

anterograde, occurring in 13-27.7 percent of concussions appeared to be indicative of neurocognitive deficits concussion revised grading scales were made.[36,41] Irritability falls under a behavioral change that can occur due to concussion.[17,35] Cognitive impairment, for instance a decreased reaction time speed, has also been an increasingly common symptoms experienced. Mental confusion, assessed when testing an athlete during serial sevens, has been involved in 8.6-59 percent of concussion injuries.[16,80] Each symptom can last longer depending on concussion history as well leaving some with symptoms experienced well over two weeks.[35,45] Children who sustain concussions are equally likely to suffer the same symptoms that are discussed; however, the length of time that they are experienced may take longer, up to five weeks post injury.[76]

Recognition of concussion signs and symptoms is imperative. Knowing the seriousness of concussions, and having the ability to recognize common signs and symptoms theoretically would help an individual in management by reporting them to an allied health care professional. Reporting of signs and symptoms that are associated with concussions do not happen frequently within the athletic population. [82]A plausible idea for why many think that concussions or "dings" are not serious enough to report are due to the lack of knowledge that they have about even a minor concussion, and when one sustains a minor concussion there are not always physical symptoms that appear.[2] There is no specific biologic marker that a sports medicine clinician could analyze to determine if one had sustained a concussion.[82] This puts responsibility upon the player to speak up and let someone know that they are experiencing symptoms and for them to be honest. While that it is ideal for an athlete to speak up some athletes will recognize that they sustained a head injury, but will choose to continue to participate anyway even if they are continuing to experience symptoms.[83] Some athletes may have concussion knowledge and still choose to ignore it and continue to play.[83] Under reporting occurs frequently at varsity high school football, it was found that 15.3 percent of the players knew they had sustained a concussion but only 47.3 percent of those athletes went on to report it.[82] Athletes may have believed that it was not a serious enough of an injury to have to report it.[82] Players' not equating the seriousness of these impacts to concussions shows the gap in education and knowledge that needs to be filled. Players recognize and experience

the symptoms and still continue to play then they are lacking the knowledge to make an informed decision or deciding that playing is worth the risk then they are not distinguishing the jeopardy they are placing themselves into.[84] As more information has come to the light about the consequences of concussions it has become even more imperative to teach athletes, coaches, and parents of the seriousness of this injury. Assessment of these injuries truly must start with the athlete and in order to get them to understand the significance of reporting they need to be educated and deterred away from trusting common misconceptions.[85]

Misconceptions are believed not only by players, but by parents, coaches, and some health care physicians. One of the common misconceptions believed by the general public and some physicians are that if a person is careful and they take necessary precautions, like the use of a helmet, then it can be prevented.[11,18] Possibly the most highly believed misconceptions are those surrounding two signs and symptoms, loss of consciousness and amnesia. Many trust that in order for one to suffer from a concussion they must suffer loss of consciousness and as long as the person wakes quickly there are no lasting effects. [13,19,23] Amnesia is a common recognized concussion symptom however the belief that a second blow to the head will return memory is the fallacy.[18,21] While a person may suffer from retrograde amnesia it is believed that it does not affect one's ability to learn new things.[18,19] There are misconceptions surrounding other not commonly recognized signs of symptoms of concussions as well. For instance, the belief that confusion, if cleared within five minutes, is not a concussion; some physicians even claim that dizziness and headache lasting for five minutes is not a concussion but if it persists up to thirty minutes than it is.[11,13] Post-traumatic sequelae such as cognitive, emotional, or behavioral changes were believed to not be associated with a brain injury but rather a psychological disorder. [18,86] Coaches, who even recognized an athlete had a concussion, would still allow a player to participate even if symptomatic.[21,23] While some physicians have expressed that if the symptoms decrease in less than 15 minutes than the athlete should be able to return to play.[11] There are several misconceptions about the treatment of concussions ranging from the belief that one should stay awake during the acute phase to the effect of age on recovery.[13,43,87] One common misconception is that children are able to recover better, but there is also a belief

that the speed of recovery is equivalent across all age groups.[13,43] The inconsistency of this misconception displays the need for education amongst athletes, parents, coaches, general public, and allied health care professionals. Education needs to not only focus on prevention, recognition, an management of concussions, but also focus on establishing a uniform definition that cannot be reduced to colloquialism.[20]

By providing everyone with a uniform term allows for a unified understanding and leaves no room for people to create their own interpretation of the dangers and seriousness of this injury.[20] Usage of terms "dinged" or "getting your bell rung" only lead athletes, coaches, and parents to believe that these forces are not able to cause any damage, which is quite the contrary.[13] The use of these terms allows for interpretation of the name and therefore belief that it may not to be reported causing uncertainty if they have previous concussion history.[74] Some athletes may report they have suffered concussion, some may report being knocked out, while others may say they suffered a ding or had their bell rung.[74] These terms, used mostly by media and coaches, can place an idea into the athletes' mind that these are just minor bumps and bruises that come with the sport they participate in. By witnessing how these injuries (occur not always displaying physical symptoms) affect professional players and how they continue to play may give the idea to a younger athlete that it is alright to minimize the symptoms that they could be experiencing.[88] The media, whether intentional or not, frequently provides concussion education.

With technology so advanced many athletes, coaches, and parents all look towards the internet for their answers to their concussion questions. Athletes, especially those of the adolescent age, look more towards social media. The combination of lack of education and free opinion makes it a minefield of potentially incorrect information for athletes to see amongst these social media websites.[87] The content upon social media sites can lead an athlete taking an advice from a complete stranger to actually finding relevant information. The problem lies in that they may not have any basis to which they distinguish a truth from a lie. The internet, as a whole, is the same. The websites that contain information on concussions while some are good others are grossly misleading and offer advice that is not from a reliable source.[89] One of the most popular forms of social media

is *Twitter*.[87] *Twitter* is a social networking site that allows users to post brief messages online.[87] Of the posts that discuss concussions most users wrote based on their experience and of what the person chose to do for management.[87] While some of the content may prove to be valid and helpful the best thing for any athlete, coach, or parent to do is discuss the injury with sports medicine clinician.[89] Choosing to trust in these misconceptions or opinion based posts can possibly increase the likelihood of suffering from one of the many consequences associated with concussions.

After an athlete has suffered from their first a concussion they are three times more likely to suffer a concussion within the same season.[16] Those who have a history of a concussion are found to be six times more likely to suffer a concussion when compared to those without a concussion history.[42] After sustaining the first concussion the time it takes for the brain to return to homeostasis is done in seven to ten days.[24] During that seven to ten day window there is an increased susceptibility with 75% of recurrent concussions occurring within seven days and 92% occurring within ten days.[22] Recovery for children and adolescents require more length of time when compared to collegiate and adult athletes due to they are still undergoing brain development.[43,44] Resolution of cognitive deficits occur at different and slower rates then what it is typically seen with the clinical signs and symptoms of concussions.[90] Memory impairments have been to know last beyond seven days in high school athletes while collegiate athletes resolve in 24 hours.[27,43] [25] Children who have sustained a concussion have been found to suffer from persistent deficits in processing intricate visual stimuli, even three months post.[44] Children and adolescents must also face academic difficulties and psychosocial adjustments after sustaining concussion.[90] [91] It is hypothesized that children and adolescents, with immature brains, are up to 60 times more sensitive to the NMDA making their brains more susceptible to the ischemic and harmful effects of excitatory amino acids, EAA that occur after a concussion.[43]

While the brain works to return back to equilibrium the athletes' symptoms decrease over a seven to ten day period, however, there are times when some after an athlete has been declared asymptomatic that some symptoms can persist and which known as post-concussion syndrome. Some of the most common symptoms

experienced are headache, dizziness, depression, anxiety, and memory and attention impairment.[27,92] According to the Diagnostic and Statistical Manual of Mental Disorders (4th ed.) three or more symptoms must be linked to a head injury, must be discernible from any pre-existing symptoms, and must have persisted for a minimum duration of three months. During this time of vulnerability there is a possibility of the athlete sustaining a recurrent concussion which can lead to permanent brain injury or even death with a 50% mortality rate.[26,38,92] When an athlete returns to participation prior to being asymptomatic and they sustain a second impact, minor blow to the chest, side, or back making the head to snap back that causes an indirect (rotational) acceleration to the brain, it is known as second impact syndrome.[27,38] While the athlete will remain conscious enough to walk themselves off the field the athlete can become semiconscious with pupils dilating rapidly, and experiencing respiratory and brain failure.[27] The length of time from second impact to brain stem failure is between two to five minutes.[27,37] Several factors play a role in reasoning behind pediatric and adolescent athletes being at a high risk for suffering second impact syndrome which include; age, type of sport, and prior history of concussion.[27] Minor head trauma produces more brain swelling in children than it does in adults. Age can be seen as a risk factor due the frequency of head injuries increasing as children get older, beginning at the age of 12.[93] The type of sport participated in is a risk factor due to there being sports that have an increase likelihood of repetitive head injuries; tackling in football, going for headers in soccer, and boxing.[27] Having a history of prior concussions amplifies the risk of slower recovery and abnormal responses making an athlete susceptible for second impact syndrome.[27] Having a history of previous concussions signifies that signs and symptoms experienced are magnified and result in a longer recovery. [28] Those with a previous history of concussion are three times more likely to have prolonged post-injury mental status when compared to those who have no history.[28] Athletes who have a history of concussion are six times more likely to experience loss of consciousness compared to those with no history.[28] Athletes suffering three concussions or more are nine times more likely to exhibit three or four on-field markers when they experience the subsequent concussion.[28] Pediatric and adolescent athletes suffering from two or more concussions that have not suffered another

recurrent concussion within six months produce similar results when compared other athletes of the same ago who have no history of concussion but sustained one within a previous week.[44] Athletes with a history of two or more concussions also have a statistically significant lower grade-point average.[44]

There are risks that can occur with concussions not only just acutely but also ones that have long term effects in the way one will live and function. Athletes with a history of concussions show a chronic subclinical motor system dysfunction that can be linked to intracortical inhibitory system abnormalities.[94] The cortical silencing period is significantly prolonged in athletes with a history of recurrent concussions, and any subsequent concussions beyond that can result in exacerbated abnormalities.[94] A direct consequence of suffering recurrent concussions has been linked to mild confusion and "Parkinsonian" cognitive deterioration.[95] Chronic TBI or dementia pugilistica is the combined symptoms of abnormal and performance on memory tests, increased motor and speech dormancies, tremors in the head and upper extremities, and behavioral changes.[95] Former football players have been studied tying a connection between recurrent concussions and cognitive impairment.[30] Suffering from recurrent concussions has not only led to cognitive impairment, but to early onset of dementia and Alzheimer's.[30] Those who have suffered multiple concussions have been linked to an increased risk of being diagnosed with clinical depression.[29] Those who have suffered from three or more concussions are three times more likely to be diagnosed, and those who with one or two are 1.5 times more likely to be diagnosed. [29] One long term effect that is being to be linked to concussions is chronic traumatic encephalopathy, CTE. Chronic traumatic encephalopathy is a neurodegenerative disease that is degeneration of brain tissue with accumulation of defective tau protein.[31,39] Tau proteins are used to stabilize the microtubules during a traumatic brain injury the brain and spinal cord undergo shear deformation producing a transient elongation of the axons resulting in the tau protein being defective leading to Alzheimer's, dementia, and CTE.[31,96] Traumatic axonal injury can also help in acceleration in the tau protein accumulation locating within the cytoplasm and enhancing the neurotoxicity.[96]

A concussion is one of many serious injuries that can take place in sports. Understanding what signs and symptoms are associated with concussions allows for better recognition and management of the injury. Not trusting in every misconception and attaining knowledge on the consequences of this injury when not handled properly helps athletes, parents, coaches, and the general public. When a concussion occurs the parent or caregiver, or the athlete themselves have to decide what is best for them in that situation, to get medical treatment or not. If the choice is going to be not at the moment then it is wise to gain enough accurate and valid knowledge as possible to know if the symptoms does exacerbate than one can seek medical attention, no matter if they participate in a varsity sport like football or an extreme sport like motocross.[13]

Motocross, or off-road racing, is becoming an increasingly popular action sport with 80 professional and 4000 amateur American Motorcycle Association, AMA, sanctioned events taking place and many more participants taking part in them every year. It has begun to gain national attention and has found its way in becoming the second most popular motorsport in the United States, the amount of viewers has increased from .46 to 1.5. Whether it is a novice four year old riding for the first time, a sixteen year old deaf female going from amateur to professional status, to a weekend warrior who participates for the enjoyment of the sport; motocross has millions of people intrigued and participating around the world.

In the sport of motocross several riders, determined by experience, line up the beginning of a starting gate and race to the finish line. In their race to become the first to cross the line riders must endure many obstacles; some which are natural and others artificially imposed upon the one and a quarter mile length track. These obstacles can include a whoops section, a series of ten three feet tall jumps placed together that can be the most tumultuous section, berms, a banked turn of dirt created by riders continually going past a particular corner. With so much taking place on a track and the sounds of the race going on one of the most important senses the rider has is their vision. When a rider is behind another there are times when their vision is comprised due to the rider in front of them roosting them, or when dirt/debris being forced into the air due to a back spinning tire. All of these obstacles are just what the riders can come into contact with solely from the track this is not even

taking into account the other riders and the heavy machinery to which they are competing on. The current evolution of technology is evident in the motorcycles used within this sport. Riders are now capable of attaining speeds as high as 55-60 miles per hour and reaching vertical heights to surpass thirty foot jumps.[2]

With the ever growing popularity of this sport and the amount of risk factors associated with it there is room for accidents to occur. Understanding the biomechanics behind the injury occurring is relevant for health care professionals so that they understand how the forces are applied upon the individuals when an injury occurs. Knowing the biomechanics of concussion helps one to understand the location and the magnitude of the force applied.[97] While it has not been studied within the sport of motocross, the force of impact on road motorcyclists has been assessed.[97] From the research conducted consideration of helmet construction needs to focus more upon the lateral sides of the head due to the weakness that is present there and its lack of tolerance to impact.[97] When assessing the rotational acceleration it was deduced that it is between 4,500 to 5,000 radians/sec squared with accompanying angular velocity estimated to be close to sixty radians per second.[97] Previous research looking at the biomechanics and impacts of upon football helmets has shown that the average peak rotational acceleration to be 6,432 ± 1813 radians/sec squared.[66] While motocross shows less rotational acceleration it still falls within one standard deviation of the rotational acceleration found with football impacts. When these motocross injuries were sustained it was determined the speed at which the riders were estimated to be traveling at the time of injury ranged from, 2.78 to 8.1 m/s.[3] The average velocity found in the football data 9.3 ± 1.8m/s.[66] Understanding the impact of the forces that are placed on the body when a rider is in an accident allows for better recognition of injuries for both the rider and the healthcare professional that will be providing medical care.[98]

When assessing the injuries among elite motorcycle racers a comparison was done among three groups of riders; road racers, motocross racers, and trail bike riders.[99] A total of sixty injuries were observed and a little over half of them had occurred within the sport of motocross.[99] A third of the injuries sustained were from collisions made with another rider with fifty-four of the injuries being the results of "negotiating curves, bumps,

or steep slopes" which are known as berms.[99] Another relevant detail is the injuries did occur amongst road racers and motocross riders the primary mechanism came from the riders being thrown from their motorcycle and the common injuries sustained were all upper extremity injuries.[99] The sport of motocross when compared to the two other forms of bicycle racing, showed a significantly higher risk of injury being 1.5 times higher than road racing and 21 times higher than trail biking .[99] While unexpected both road racing and motocross showed a higher risk of injury rate during practice as opposed to the actual competition.[99] While this proved to be contradictory to previous beliefs possible reasons for this would include that the rider is more aggressive on the bike during practice to determine how far it can push the bike prior to the start of the race.[99] Another belief is positioning; having a better practice run and small lap time allows for the rider to have choice of which gate they want to line up behind.[99] However, when children are taking place in motocross races they are 2.7 times more likely to incur and an injury during the race than at practice.[100] With injuries frequently occurring within a bend or over a jump on the track.[100]

Focusing upon enduro riders, which is a form of motocross racing with the objective being to reach certain checkpoints in a specific amount of time, during the 2005-2007 season explored the most common injuries sustained by anatomic regions, mechanism of the fall, and the location of the fall upon on the track and how they occurred. Many injuries resulted in the head becoming injured when the fall occurred during a curve and the majority being sustained with the front tire sliding. Ninety percent of the riders who were injured would fall during their maximum deceleration when entering into a curve or berm. Only five riders suffered a head injury from falling while in a curve.[101] Many riders who attempted to accelerate out of the curve would lose traction and the bike would shift causing accounting for five head injuries that occurred. [101] Fifty five of the reported injuries sustained were due to fault of braking maneuvers. When the rider would lose control of their motorcycle they endure the most common mechanism for which riders to sustain their injuries; being sent forward over the handlebars which occurs forty-five percent of the time.[3,101] Riders were also sent off of their bike either right (30%) or left (22%) of it and a small percentage of riders were sent backwards (3%).[4] Upon

collision the most common thing the riders would come in contact with is an immovable object like a rock or a tree, in research it has been shown to happen seventy percent of the time.[3] When classifying the injuries occurring in this sport, ligamentous occurs at 47%, and fractures and dislocations occur at 46% which are the most common. The most common injuries that occur in motocross are to the extremities, with over half sustained to the upper extremity. Shoulder girdle injuries, particularly acromioclavicular dislocations are common, fractures to the hand, wrist, and clavicle are also accounted closely follow.[4] Lower extremity injuries are suffered at the knee with a sprain to a ligament with the foot and ankle most frequently fractured.[4] Ligamentous injuries, 75 percent grade 1, accounted for 47 percent of the injuries most commonly occurring to the acromioclavicular joint and collateral ligaments of the knee. Second most common type of injury to occur to the extremities is fractures, 35.85 percent.[3] In the upper extremity fractures commonly occur at the wrist, 23 percent, followed by the humerus and clavicle at 18 percent.[3,4] The lower extremity fractures occur at the foot and ankle of 36 percent with 50 percent occurring to the phalanges and metacarpals.[3,4] External injuries to the skin, abrasions, accounted for 23 percent of injuries seen with 75 percent of them being seen as minor.[3]

Observing the injury patterns and mechanisms of off-road motorcyclists head injuries accounted for 9-17 percent of head injuries with 47-85 percent being diagnosed as a concussion majority of which being a grade one, based on degree of consciousness and absence of neurological deficits.[3,5] Of those nine percent of head injuries eighty-five percent of them had supportive diagnostic findings showing the rider had sustained a concussion to which forty-seven were determined to be grade one.[3] Though the incidence of concussions is smaller than the injuries to the extremities it is still significant to note that with the injuries to extremities a rider is for the most part able to determine when something is sprained, dislocated, and or fractured. Misconceptions are believed not only amongst mainstream sports, but also among extreme sports. Loss of consciousness is thought to be the sole indicator of a concussion, but this sign/symptom occurred in only 16.3% of 86 cases of head injuries that were diagnosed as a concussion seen in a motocross race, and 3.5 percent resulted in the rider in a coma.[10,102] It is imperative to understand that after suffering the first concussion, whether it comes from

direct or indirect impact, there is an increased risk of future concussive injuries.[22] Many riders believing in the misconception of an altered state or loss of consciousness is required, may not believe they are without suffering from a concussion and are able to continue riding even after falling off the motorcycle.[2] This leaves many riders vulnerable to riding prematurely without taking the appropriate allotted time to recover from their concussion. The rider may not experience the symptoms immediately, but they can be delayed and when the rider does present symptoms it is important for them to understand that they are not to continue racing and it is wise to seek medical treatment.[2] These injuries can become of grave concern especially when working with a younger population like that of many amateur motocross riders. Some children begin riding as young as the age of four and continue riding up until they turn professional and go beyond that until their late twenties until early thirties.[98] All amateur riders, especially those from age twelve to nineteen are exposed to a greater risk of suffering a concussion.[9,6] Riders are allowed to enter the amateur circuit in motocross at the age of twelve and at this time they are allowed to begin racing for prizes, money, and sponsorship. Looking at non-fatal injuries suffered by children and teenagers from 2001-2004 those placed in the age group 12-15 (43.8%) and 16-19 (30.1) suffered injuries with 70 percent occurring due to motocross.[5] Comparing the data from this study to a study previously done researchers found the amount of emergency room visits has increased for those who are 15 and older.[5]

Riders, like the general public and other athletes, may not recognize other signs and symptoms of a concussion.[2] In fact riders just like other athletes may think of a concussion as simply getting their bell rung and only see it as a part of the sport.[2] Many times a rider can go throughout a race and not be ejected from their motorcycle, but simply fall off due to bad timing, tire slip, or curve. In the course of them falling the rider could incur an indirect force that could have translational impact towards the head. Thinking that the primary sign or symptom of a concussion is loss of consciousness a rider may get back up on their bike and continue racing. Upon sustaining the first concussion the likelihood of receiving a recurrent becomes three to six times more likely[16,42] With motocross races being a week from each other a rider could find it plausible that they would be

clear of all symptoms from the impact, but the seven to ten day window is still open and due to not knowing the severity of the initial concussion the rider may not take the necessary time to rest their brain and allow for it to heal. When dealing with younger riders who are still honing their skills and taking bigger risks they may ignore or not recognize the symptoms of a concussion and continue to ride which is why it is imperative for parents knowledge of concussions be accurate.

The management of care for these young riders should be far more conservative than how you would manage an adult (a rider over the age of eighteen).[35] It would behoove the motocross community to develop a protocol for how to handle riders who go through this situation. [2] In the beginning of the 2012 Supercross season, indoor motocross, riders have been asked to volunteer to do baseline testing with the use of the Immediate Post-Concussion Assessment and Cognitive Testing, ImPACT. Following the Supercross season all professional riders who wish to continue competing will be mandated by the American Motorcycle Association, AMA the governing body for both series, to do the baseline testing in order to maintain their license. Prior to a professional rider being permitted to continue racing in future races they must be cleared by a physician with inclusion of neurocognitive testing.[103] While the AMA is making advancement in protecting the riders on the professional circuit is has yet to place any policies in place for the amateur circuit. The primary medical policy they have placed on this circuit is to have advanced life-support personnel and ambulance at motocross track.[2] These health care professionals are there for the more life-threatening situation, and while yes mild TBIs can be life threatening the minor TBIs are not in the repertoire of these personnel. If they were to continue to be the central health care providers at the race than providing them with additional knowledge upon concussions and how to both assess for them and the symptoms and management of them would prove both wise and beneficial to not only the track owner/promoter, but also to the rider, the families, and even the motocross community. Taking the time to have riders fill out their concussion history, specifically if they sustained one in the previous week's race and having staff on hand that is equipped and knowledgeable enough to know when a rider should

be disqualified if they are still symptomatic. Determining the type of symptoms that rider has also experienced prior to may give the medical staff more insight into what the concussion could present itself as.

Concussions are an inevitable part of any sport, whether it is football or motocross, its occurrence is promising. Unlike all other injuries that people are able to witness this injury is not possible to see which only adds to its frustration of determining when the brain has actually healed and defining when and how long one should rest before progressing back into one's sport. A great deal of knowledge has been acquired over the years since the time of Rhazes, and there is still much more to be learned. The pertinent information learned in biomechanics of impacts has allowed for a better perception of human tolerance and has also enabled manufacturers to build better protective equipment. The signs and symptoms an athlete can experience and how it can affect those who sustain a concussion allows for better insight into an injury that is not visible. Symptoms may not always appear immediately, but it is important to comprehend that once an athlete is showing symptomatic signs it is better to be cautious and to seek medical attention. Medical attention helps to decrease the likelihood of sustaining a recurrent concussion. This is not to state that it will place eliminate the possibility, but with proper management the susceptibility of recurrent concussion, second impact syndrome, and early onset of Alzheimer's can be reduced. By decreasing the trust in misconceptions and increasing the knowledge of not only athletes, but coaches and parents can allow for everyone to better understand the symptoms and decrease the likelihood of a recurrent concussions and risk and consequences associated with it.

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APPENDIX C

TABLES AND FIGURES

Age	Gender		Race						
30.64±11.96	Male 665 (85.0)	Female 117 (15.0)	White 745 (95.3)	Black 3 (.4)	American Indian/ Native Alaskan 5 (.6)	Asian 3 (.4)	Hispanic 18 (2.3)	Native Hawaiian/Pacific Islander 2 (.3)	Other 6 (.8)

Years Racing	Races per Year	Concussion History	Neuropsychologically Baseline Tested			
12.20±9.87	14.08±12.78	2.47±2.36	Yes 42 (5.4)	No 604 (77.2)	I Don't Know 126 (16.1)	Other 5 (.6)

Formal Concussion Education		Informal Concussion Knowledge							
Yes 188 (24.0)	No 591 (75.6)	Website 94 (12.0)	TV Show 82 (10.5)	Books 19 (2.4)	Magazines 58 (7.4)	Newspapers 7 (.9)	Health Care Professional 263 (33.6)	AMA 43 (5.5)	Other 177 (22.)

Table 1. Demographic Information. Majority of Participants were White Males with 12 years of riding experience.

	Knowledge Score				Eight Concussion Symptoms			
	M	SD	F	p-value	M	SD	F	p-value
Age N=782	14.29	2.71	1.836	.001	6.76	1.35	1.253	.130
Baseline Test N=777	14.29	2.71	10.326	≤.001	6.76	1.35	2.082	.101
Concussion Education* N=853	14.29	2.71	12.972	≤.001*	6.76	1.35	5.087	.024*
Concussion Knowledge N=817	14.29	2.71	1.801	.084	6.76	1.35	2.606	.012
Years Racing N=782	14.29	2.71	1.384	.062	6.76	1.35	1.100	.314
Races per Year N=782	14.29	2.71	1.116	.282	6.76	1.35	1.020	.439
Concussion History N=782	14.29	2.71	1.251	.254	6.76	1.35	1.516	.129

Table 2. One way ANOVAs ran comparing the dependent variables against demographic factors. $p<.05$, $*p<.01$

	Knowledge Score	8 S/S	Years Racing	Races Per Year
Knowledge Score	-			
8 S/S	**.350****	-		
Years Racing	**.074***	.058	-	
Races Per Year	-.009	.003	.028	-

	Knowledge Score	8 S/S	Concussion History	NP Baseline Test	Concussion Education	Concussion Knowledge	Age
Knowledge Score	-						
8 S/S	**.350****	-					
Concussion History	-.041	.064	-				
NP Baseline Test	**-.174****	**-.083***	.081*	-			
Concussion Education	**-.127****	**-.078***	-.095**	.027	-		
Concussion Knowledge	-.044	-.026	-.003	.059	-.206**	-	
Age	**.153****	.042	-.061	-.097**	.135**	-.156**	-

Table 3. Correlations for knowledge and symptom recognition score and demographic factors. Relationships between the dependent variables (knowledge and symptom recognition score) and demographic variables. Significant variables are bolded. ** $p<0.01$ *$p<0.05$.

	True	False
Being blacked out or LOC is required to sustain a concussion. (False)	15.0% N=117	**85.0% N=665**
Showing S/S of a concussion should not be allowed to return to riding that same day. (True)	**91.0% N=712**	9.0% N=70
Youth riders suffering a concussion are more at risk of second impact syndrome. (True)	**84.5% N=661**	15.5% N=121
There are no long term effects after sustaining a concussion. (False)	4.9% N=38	**95.1% N=744**
Once a rider has sustained a concussion they are at a higher risk for another concussion. (True)	**81.5% N=637**	18.5% N=145
A concussion requires immediate removal from a practice ride or race. (True)	**89.4% N=699**	10.6% N=83
Memory loss, post-traumatic amnesia, is required for a rider to sustain a concussion. (False)	14.7% N=115	**85.3% N=667**
A bell ringer requires immediate removal from a practice or race. (True)	**47.8% N=374**	52.2% N=408
A helmet will prevent concussions. (False)	13.4% N=105	**86.6% N=677**
Children with concussion take less time to heal than adults. (False)	27.7% N=217	**72.3% N=565**
A second concussion will heal faster than the first concussion. (False)	3.8% N=30	**96.2% N=752**
A rider is still at risk of suffering a second concussion even 10 days after the concussion. (True)	**88.7% N=94**	11.3% N=88
Once a rider has suffered a concussion it is important to keep them awake. (False)	91.9% N=719	**8.1% N=63**
A rider can get a bell ringer in the first moto and be okay to continue riding as long as they rest before the second moto. (False)	36.3% N=284	**63.7% N=498**

Table 4. Concussion Knowledge: True and False Questions and Correct Answers. (Correct answers in bold)

	Correct	Incorrect
Which of the following injuries is most severe? (All of the above same severity)	**40.0%** **N=313**	60.0% N=469
Direct blow from another rider has a headache and is dizzy; continue riding? (No)	**83.8%** **N=655**	16.2% N=127
Hit to the head during practice, feels fine at rest but riding BMX bike gives a mild headache; continue riding? (No)	**69.9%** **N=547**	30.1% N=235
Rider suffered a concussion, how many days until you continue return to riding (7 days or greater)	**65.7%** **N=514**	34.3% N=268
Should a physician or health care provider check/evaluate a bell ringer? (Yes)	**59.5%** **N=465**	40.5% N=317
Hit to the head, has a headache and remembers everything and have a nosebleed and a black eye; continue riding? (Yes)	**35.2%** **N=275**	64.8% N=507

Table 5. Knowledge Test: Multiple Choice and Correct Answers. (Correct answers in bold)

Symptom*	Current Study N=782	Saunders N=150	Valovich McLeod et al N=156	Broglio et al N=26	Gourley et al. Athlete N=73/ Parent N=100
Black Eye	21.7	90.0	79.5		
Blacked Out/LOC	**91.9**	**90.7**	**80.1**	**82.6**	**68.5/81.0**
Blurred Vision	**92.5**	**93.3**	**53.8**		**69.9/86.0**
Chest Pain	6.8	91.3	88.5		63.0/56.0
Confusion	**93.2**	**94.0**	**89.1**	**61.5**	**69.9/88.0**
Dizziness	**94.8**	**94.7**	**88.5**	**76.9**	**75.3/88.0**
Feeling Sick	**80.4**	**71.3**	**55.8**	**30.8**	**50.7/82.0**
Headache	**94.9**	**96.7**	**77.6**	**80.8**	**78.1/87.0**
Loss of Memory/Amnesia	**93.1**	**64.7**	**60.3**		**72.6/82.0**
Nosebleed	33.2	70.7	95.5		47.9/26.0
Numbness/Tingling in the Arms or Hands	33.8	49.3	82.7		38.4/27.0
Sharp Burning Pain in the Neck	25.8	64.0	89.7		47.9/20.0
Trouble Sleeping	**35.7**	**55.3**	**12.8**	**7.7**	**35.6/56.0**
Unusual Sense of Smell	32.0	74.7	5.8		49.3/32.0
Unusual Sense of Taste	30.8	75.3	7.1		50.7/34.064.7
Weak Feeling when Moving Your Neck	48.1	57.3	10.9		31.5/20.0

Table 4. Knowledge Test: Percentages of Correctly Identified Symptom Recognition. The most recognized concussion symptoms from this study are headache, dizziness, and confusion.*Note: Items in bold reflect true concussion symptoms.

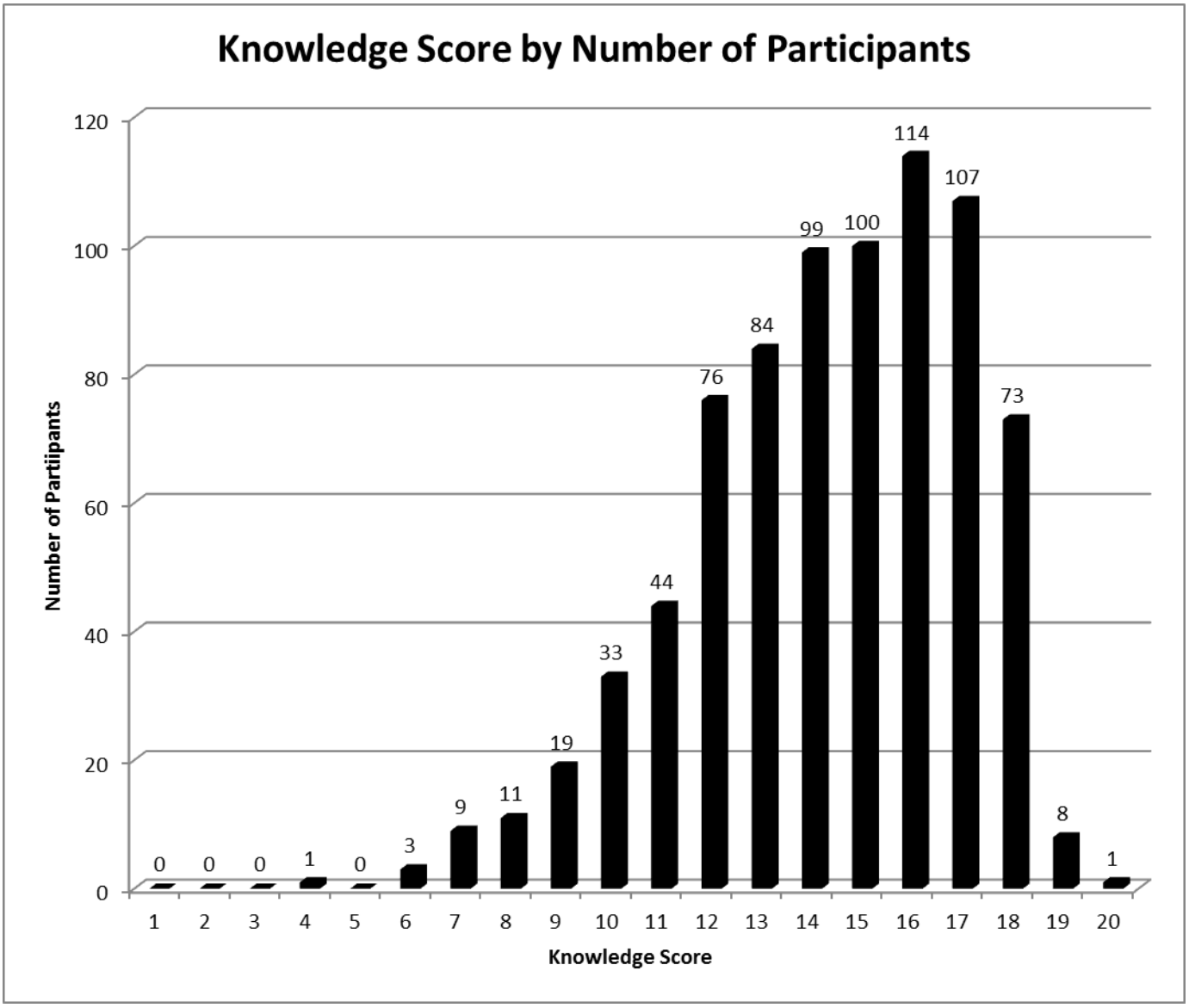

Figure 1. Number of Participants and their overall score on Knowledge.

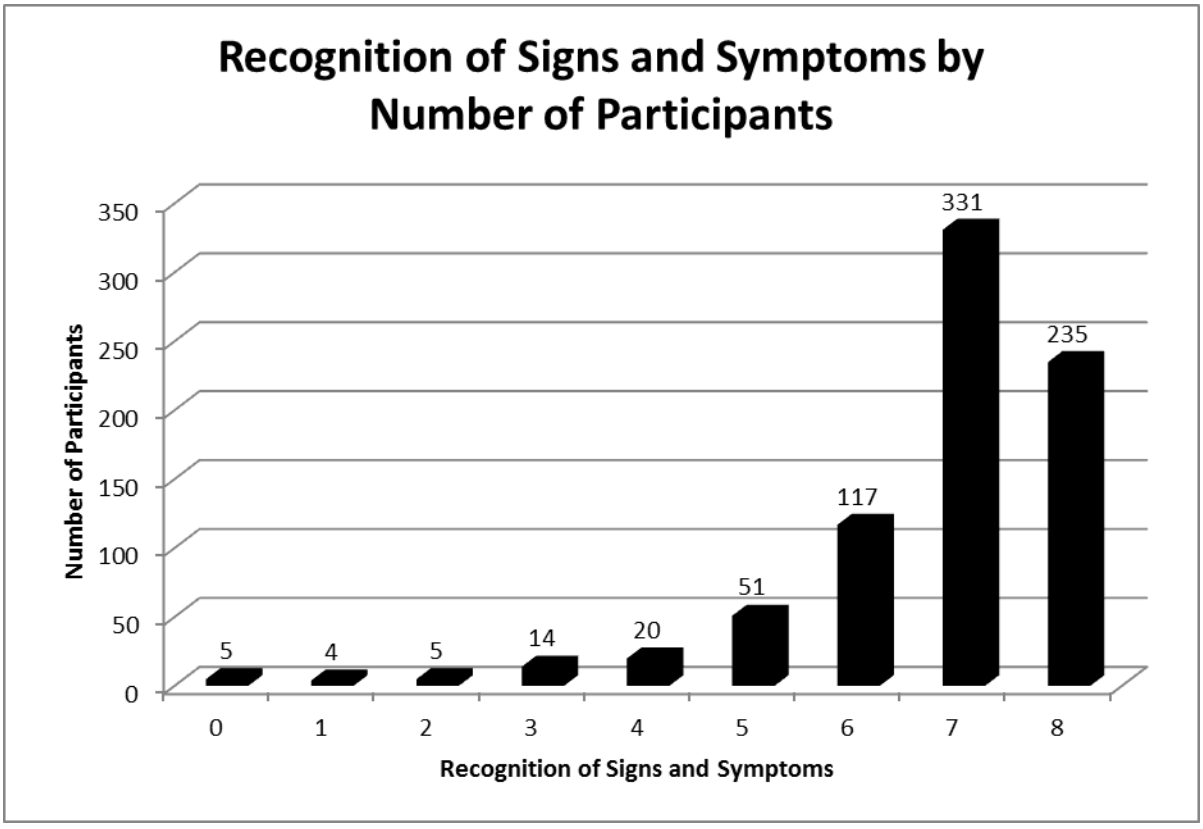

Figure 2. Recognition of Correct Signs and Symptoms Scores by Number of Participants.

APPPENDIX D

SCRIPTS

Facebook™

Hello to all Motocross Riders:

My name is Kristina Miller and I am graduate student at Georgia Southern University. Like you I am an avid fan of motocross and rider. My passion for the sport of motocross has me focusing on a concussion knowledge survey for the sport in hopes of building an educational intervention. I would greatly appreciate it if you would take 5-7 minutes to fill out the survey, and as a show of appreciation you will entered into a raffle to win one of twenty-five electronic gift cards worth $25. If you are interested please click on the web link below. Thanks for your time.

Kristina Miller

Survey Link:

http://bit.ly/Vdek6C

Twitter™

Please retweet the link to my survey about concussions & mX 4 my master's thesishttp://bit.ly/Vdek6C

Email

Hello there:

My name is Kristina Miller and I am a graduate student at Georgia Southern University. I am contacting you to seek your help with my research study. I am both an avid and motocross rider, and I have decided to combine my love for motocross with my current education. I am conducting a 5-7 minute survey on concussion knowledge amongst motocross riders. The survey consists of a demographic section, followed by multiple choice, true/false, and motocross based scenario questions. Riders have the option to stop at any point in the survey with no further contact from the researcher. If the rider completes the survey they will be entered into a raffle to win one of twenty-five electronic gift cards worth $25. If you could provide the web link to pass out to the riders I would greatly appreciate it. I thank you for your time and consideration. If you have any questions or concerns feel free to contact me at any time through the contact information listed below.

Kristina Miller, ATC/L

Km05088@georgiasouthern.edu 757-268-2920

Survey Link: http://bit.ly/Vdek6C

APPENDIX E

FACEBOOK™ GROUPS CONTACTED

Facebook Contact (picture description)
100% Motocross
101 Mx
211 Motocross
3 palms action sports
304 Moto
33Motosports Park
451Graffx
4Strokes.com
6D Helmets
800 mx Park
A Day in the Dirt
Abbott Motocross Park
Academy 18 Motocross
Accelerated Motocross
Ace Motocross
Action Sports Medicine Foundation
Active Dirt Riders
Airway MotoCross Park
Albany mx
Alberta Dirt Riders Assocation
Allsport Dynamics
Alpha Moto Motocross
AMA Distict 29 MX
AMA Supercoss (AMA Monster)
ama supercross
AMA Supercross & Motocross
AMA Supercross (ama symbol)
AMA Supercross (ama symbol2)
AMA Supercross (darker ama symbol)
AMA Supercross (dirt and monster)
AMA Supercross (small monster)
Amateur Motocross
American Motorcyclist Association
ampMX Motocross
ampMX-Alabama
AMSOIL Racing
Amxa Motocross
Andrews Motocross
Angel Ridge Race Park
Angelton Motocross
Aonia Pass Motocross
Archview MX Park
Area 330 mx
Area 51 motocross
Area 51 mx park
Argyll MX
Arizona Cycle Park
Arkansas Dirt Riders
Arkansaw Cycle Park
Ascot Park Motocross
AST-MX.com Advanced systems tech
At Motocross
Atmore motocross park
Austin Parks
Austin-Del Valle Motocross
Australian Women's Motocros
AV Motoplex
AV Motoplex M2X race
Back 40 Mx
Badlands mx park
Badlands Off road park
Baja Acres Motocross Park
Ballancemotox Balance
Bar 2 Bar MX
Barnett Photophography
Barnwell Mountain Rec
Barona Oaks Mx
Barona Oaks MX Park
Bartow Motocross
Battle Creek Motocross
BattleCreek Motorcycle Club
Bbt MX
Beans Bike Park
Berm Benders Raceway
Big Air Motocross
Big Red Off0raod park
Big Sky mX Challenge
Bigdirt Racewear
Birch Creek
Bithlo Motorsports
Blackfoot MX Park
Bluebonnet M Park
Bmc Motocross
BNC mx Park
Bnc mx park
Boots' mx II
Bostwick Creek mX Park
Bowers Mx
Bowie Bottoms Motocross
Braap Supply
Brainerd Lakes Detail
BrapCap Motocross
Breezewood, PA
Bremen Race Park
Briarcliff Motocross
BROtocross
BRRP
Brushy Mountain Moto Sports Park
BTOsports.com
BuckChilly MotocrossR
Budds Creek Motocross
Buffalo MotocrossPark
Buffalo River Race Park
Buffalo Valley
Bunkerhill Mx Park
Burleson Mx Park
Burnt Ridge Mx
Cache Valley mx Park
Cadillac Ranch MX rainier
Cahuilla Creek Motocross
Cal City MX Park
Camp Chuck
Canyon Motocross
Capeway Rovers Mx track
Carlsbad Oldtimers Motocross
Carolina Adventure World

Casper Dirt Riders
Cedar Valley Trail Riders
Central Cycle Club Inc
Champions Powersports
Chattanooga Motocross
Chicago Dirt Riders
Chilli Town Mx LLC
Chris Kasavage Mx School
Christian Brothers Motocross
ChronicMx
Chuck Shirley
Claverack Motocross
CLMX County line mx
CLMX*
Clovis MX
Clubmoto Motocross
ClubMx Motocross
ClubMX Training Facility
Cmc Motocross
CMJ Raceway
Cmx Clovis MX
Cocr Motocross
Colorado Dirt Riders
Colorado Motocross Academy
Colorado Motocross Medics
Competitive Edge mx Park
Corner Mx Park
Cornerstone Motocross Park
County Line MX
Cowbranch mx park
Creekside Motocross
Creswell Motocross Cmx
Crossroads MX
Crow Hill MX
Crystal Ocast Motocross
Cycle Ranch-Floresville
Cycleland Speedway
D Track Motocross
D.A.D's Motocross Park
Dade City Motocross
Dan Harris
Daniel Boone Motocross
Daniels Ridge MX
Danny West
Daytona Dirt Riders
Daytona Supercross
DCMX
Devil's Ridge Motocross
Direct Motocross
Dirt Bike Addicts
Dirt Bike Pages
Dirt Bike Rider Magazine
DIRT BIKE RIDERS
Dirt bike riders
DIRT BIKE riders
Dirt Bike Riders
Dirt Bike Riding
Dirt Bike riding and racing
Dirt Bike Supply
Dirt Bikes Unlimited
Dirt biking
Dirt Farm Motocross Park
Dirt Mx Race Park
Dirt Rider Magazine
Dirt Riders
Dirt Riders (kawasaki bike)
Dirt Riders (organe writing)
Dirt Riders (raiders logo)
Dirt riders (several riders)
Dirt Riders (silver circle)
Dirt Riders of Colorado
Dirt Slingers Motocross Park
Dirt Track World Championsships
DirtCandy Graphics
Dirtfarm Motocross
Dirtworld Motocross park
District 13 MX/ATV
DMXS radio
Dohm Cycles, Inc.
Doniee Hansen Motocross
Downhill/Motocross=life
DSMX-Donald Solley
Dunn's Playground
Durhamtown Plantation
Dutch Sport Park MX
Dutchmen Mx park
E Street MX
Earlywine Racing
Eassc Motocross
East Bay Motocross
East Bend Motorsports
Echo Valley Motocross Park
Edge Powersports
Electric City Dirt Riders
EnduroCross
Endurocross
Ephrata Raceway Park
Espy Motocross & ATV
ET Motopark Arizona Speedway
Euro Raceway-Moto
Evansville Mx park
Evergreen Speedway
Extreme Sports
Faction MX
Fantasy Supercross
Fast Farms mx Park
Fast Traxx Racing
FCA Motocross
FCA motocross-illinois/michigan
FCA mx Arizona
FCA mx Kentuckiana
FCA mx Michigan
FCA mx Oklahoma
FInalLapMoto.com
Fist City Mx
Fiveight Motocross
Florida Motoplex
Fly Racing
FMX
Fmx Motocross
Fossil Bowl
Fouroeight Mx
Fox Hill Supercross 2012
Fox Motocross*
Fox Racing
Freelin MX
Freestone County Raceway

Freestyle Motocross	Honey Lake MX	JPMX Training
Freestyle Motocross (one hand seat grab)	Hoosier Hilltoppers	Kahoka Mx
geico honda	Horn Rapids Motocross Complex	Kansas Motocross Riders
GetDIrtyMX	Horseshoe Bend Motocross	Kawasaki dirt bikes
Girls of Motocross	Hot Shot MX	Kawasaki Dirt bikes! (:
Glen Helen Raceway	Hurricane Hills	Ken Roczen #94
Glory Hog	Hwy 65 mx	Kevin Johnson MX Training
Go Motocross	I love dirt bike riding	Ki Tracks MX
Go Motocross (red outline on go)	I love dirt bikes/ride dirt	KMC Private MX training
Goons at the MX Track	I LOVE DIRTBIKING	Knobby Hill MX Park
GP MX	I Love Motocross (grey blue sky)	Ktm Dirtbikes
GPF (georgia Practice facitility aka MTF	I Love Motocross (rider in white helmet)	KTM scott racing team
Gramma's mx park	I love motocross (rider on berm)	Lake Elsinore Motocross
Grand National Cross Country series	I Love Motocross (rider sitting on couch)	Lake Gaston Motocross Park
Green Acres Motocross	I love Motocross (roosting)	Lake Sugar Tree Motorsports
Greenacres Motocross Gamx	I love motocross (suzuki bike)	Lakeside Mx
GreenValley Motocross	I Love Motocross (with heart)	Lemoore Motocross Park
Hangtown Motocross Classic	I Love MotoCross and Dirt Racing	Letz Go Nutz Off Road
Happy Ramblers Motocross	I Love Motocross.	Limerick Motocross Mcc
Hard rock mx	I-35 Motocross Park	Lincoln Trail Motorsports
Hardrock Motocross	I-77 Raceway Park	Lineman mx
Harleyville Motocross	I-81 Motorsports Park	Little Egypt Off Road
Harrier's Super Motocross	I-81 Motorsports Park	Livfast Exit 28
Haspin Acres Off-Road & Motocross Park	Idaho Supercross	Lobos MC
Hatfield McCoys Trails	IMI Motorsports	Log Road MX
HD MoToCrOsS PiCtUrEs	Inmotion Motocross	Lonesome Valley Mx
HeadQuarters Moto Facility	Iowa Motocross Riders	Long Island Motocross
Hickory Hill Motocross	J27 MX	Loretta Lynn MX
Hidden Acres Mx Track	Jacob Priest Motocross	Los Frenos Motocross Park
Hidden Hills Offroad	Jaydan Timmy Mitchell Motocross	Lost Creek Park-DirtBike
High Altitude Motocross	J-Fix Independent Motocross	Lucas Oil mX Park
High Mountain Dirt Riders	JGRMX	Lusk Dirt Riders
High Voltage Motocross	Jim Gibson	M^2 Motocross Ministry
HLR Motorsports Park	Jim Neese Rider Development	Mad-Brothers Racing Motocross
Hog heaven	Jimmy Decotis	Made for Play MX
Holeshot Racing Motocross	Jimmy Weinert Training	Mages Mx Training
Hollister Hills Off-Road	Joey Chanel	Malvern Motocross Park
Honda Dirtbike	Joey Savatgy	Mammoth Motocross
Honda Dirtbikes (2bikes)	John "Junkyard" Dowd	MapleShade Mx
Honda Dirtbikes (logo)	Joining to all the riders	Mapleshade mx
Honda Motocross team	Joliet Mx	Marty Smith Motocross Park
Honey Lake Motocross	JPMX motocross team	Matthew Gosling

Maui Motocross Association	Motocross (honda picture)	Motocross Training
Mb Motocross Breakers	Motocross (MX) riders	Motocross Training System
McLarty mX	Motocross (number 4)	Motocross, because other sports are..
Meadow Creek Mx	Motocross (sand)	motocrossathlete.com
Meadow Valley Motocross	Motocross (suzuki picture)	Motocrosscoach.com
Mesa Park	Motocross (suzuki whip picture)	MotocrossGear.com
Mesquite Mx	Motocross (trees)	Motocrossgiant.com
Miami motocross park	Motocross (yamaha picture)	MotocrossMatixMx
Mid Atlantic Motocross Association	Motocross 4 life	MotocrossNeeds.com
Mid-America Motocross	Motocross 4 March of Dimes	MotocrossTracks.com
Middle Creek Mx Race	Motocross Academy	Motokazie
MidSouth Motocross	Motocross Action	MotokazieLand
Midwest ATV Extreme	Motocross Best Sport	MOTOLAND
Midwest Extreme Park	Motocross Bike Rental	MotoLand MxPark
Midwits Motocross	Motocross Brain Training	Motomom Motochik
Miles Mountain Motocross	Motocross Enduro	Motomomentum Offroad
Milestone Motocross Park	Motocross Files	Motopark
Milestone MX Park	Motocross Freestyle	MotoPlayground
Milford Riders Club	Motocross freestyle Red Bull X fighters	Motorcyclemax.net
Millcreek MX park	Motocross Georgia	MotoSeat
Millsaps Training Facility	Motocross Girls	MotoSport
Miracle Motocross	Motocross group (fist)	MotoThump
Miss Motocross MX1	Motocross Headquarters	Mototown USA
Molly Motocross	Motocross Images by A.J.	MotoTown Usa RIP
Monster energy drink: motocross team	Motocross Ladies	Motovision Goggles
Monster Energy motocross	Motocross Masters	MotoX
Monster Mountain mx park	MOTOCROSS MOTOCROSS	Moto-X
Morelands MX & SX Park (two sites)	Motocross MX1	Moto-x 338
MOTO 2 the movie	Motocross MX1 World	MotoX LLC
Moto 60 Sports Park	Motocross Necessity	Motox Maidens
Moto Byron	Motocross of Marion County	MOTOX!!!!
MOTO CITY Race Park	Motocross Park Failraki Rhodes	moto-x363.com
Moto Grande X	motocross passion forever	MotoXAddicts
Moto Ministry	Motocross Practice Tracks	MotoXcinema.com
Moto Tassinari	Motocross Race for a Cure	MotoXCity
MOTO THERAPY	Motocross Racing	MotoXDream
Moto X Kinex	Motocross Racung	MotoXL.com
Motocity Raceway	Motocross Riders	MotoXotica
motocross	Motocross Riders 4 Life	Moto-Xperts
Motocross & Supercross	Motocross Riders Association	motoxsports.com
Motocross (ama picture)	Motocross SA	MotoXtreme Clothing
Motocross (blue badge)	Motocross should be a Olympic game	MotoXXX
Motocross (gray clouds)	Motocross Song Motocross	

Mountain Motocross	Noah's Motorsports Park	Pleasure Riders Motorcycle Club
Mountain View MX Park	Nocona Mx	Pocatello Motocross
Mountaineer MX Park	North Dakota Motocross Association	Podium Motoplex
MPX Racing Motocross	North Florida Motocross	Podium mx
MSU mx	North Texas FCA Motocross	Ponca city mx
MT3 MXTraining	North West Motocross	Ponca city MX (captain America shield)
Muddy Creek Raceway	Northcarolina Motorsportspark	Portaland Trail Riders
MudGoose Motocross	oak hill raceway	Posey County mx
MX 207 Motocross Park	Off Road Vixens	Possum Kingdom Supercross
MX 573 Practice Track	Offroad Motocross	Powder Basin Motocross
Mx Bike Rental	Oklahoma Dirt Riders	Precision Cycle Tech
Mx Bike Rental	Oklahoma Motocross	Pro Motocross Training
MX for Children	Oklahoma Motosports	Pusheta Creek Mx
MX Hot Shots-Pro Action	Okmotocross.com	Pymatuning Holeshot Raceway
MX Insight	Old Bridge Township Raceway	Pyramid Valley Motocross
MX Legends	Only Two Strokes	Queen Bees: Women Riders
mx Memes	Onlyfour Strokes	Quick-Track Mx
Mx Perks	Oregon Dirt Riders	Rabbit Run MX
MX Stuff Forsale	Outback Adventure Track	Race Parts Online
MX Track Builders	Owyhee Motorcycle club	Racer X Illustrated
MX track guide	Pala Raceway	Racer X Vitrual Trainer
MX Training Events	Palm Beach International	Racetown Motocross
Mx Training Journal-Unique software	Palmetto Dirt Riders	Racing is not a sport.
MX1	PAMX Association	Rafter F motocross school
MX101	PanicRev Ministries	Ram Jam Sportsplex
mx101	Panther Creek Mx	Rankmore Training Program
Mxfamily Motocross	Paradise Moto-Park	Rausch Creek Offroading
Mx-Motocross	Paradise Offroad Park	Razor's Edge MX
MXParents.com	Parker MX	RCM Marketing Motorsports
MXPTV	Pavilion mx	realMotocross.com
MxRewing Motocross	PaxTrax Motocross Park	Red Bud MX 2012
MXTrader.net	Peril Ind	Red Creek Off Road
MXWEBSITES.com	Perris Raceway	Red Rock Dirt Riders Motocross
MyMotoXStuff	Piedmont Motocross	Redbud MX
NCSC Motocross	Pima Motorsports Park	Redding Dirt Riders
Nebraska Cornhusker Motocross	Pine Grove Practice	Reid Law Mcmotopark
NEMX- Northeast Motocross	Pine Ridge Raceway LLC	Ricky Carcmichael
NEMXC	Pink Dirt	Ride Free Day Motocross
NESC Motocross	Pink Dust Motocross Racing	Ride HMA (kahuku motocross)
Nevade Motocross Park	Piru Motocross Park	Rider 2 Rider Motocross
New Vienna Motorsports	Pittsburgh Raceway Motocross	Rider Hill
NJ Motocross	Pleasant Valley Raceway	RiderDown Foundation

Risk Racing Motocross
River City Dirt Riders
Riverdale Raceway
Riverfront MX Park
RiversEdge Outdoor
Riverside Motocross
Road 2 Recovery
Roaring Hills ATV park
Rock Hard MX
Rock Springs Motocross
Rocketraceway Motocross
Rockstar Energy Drink
Rockwood Moto-X
Rocky Mountain ATVMC
Rocky Mountain Raceway
Rocky Roost Offroad
Rogue Valley Motocross
Romey Racing Service
Ron Turner Motocross Training
RPM Sports
RXMA (Rocky Mountain)
Ryan Surratt MX
Sacramento Raceway
Sandbox MX
Sandhill Motorsports Park
Sandridge mx
Sanger, CA Motocross Park
Savage MX
Savannah mx
Save Mallory motocross
Scrubbing makes the bitches wet
Seven Acre MX Motocross
SGMX Motoproving Ground
Sherwood Motocross
Shogun mx park
Skeeter Motocross Park
Skunk Factory Motocross
Sky High Motocross Park
Sleepy Hollow MX Park
Slippery Rock Dunes
Smr Motocross
Snakecreek mX
So Cal Motocross Training
Sob MX
Sooner Cycles and Power
Souhegan Valley Motocross
South 75 MX
South Florida Motocross
South Florida Motocross Organization
South Fork Dirt Riders
South of the Border MX
South Valley Motorsports
Southeast Fellowship of Motocross
Southern Maryland Dirt Riders
Southern Motocross
Southern NJ Motocross
Southwick Motocross
Speed Compound MX
SpeedWorld Mx
Splendora Motocross Park
Splinter Creek Dirt Riders
Spring Creek Motocross (general sign)
Spring Creek Motocross (national sign)
Springtime Motocross Park
St. Croix Valley Youth Motocross
Starvation Ridge
Stateline Motocross (honda rider)
Stateline Motocross (stateline in red)
Steel City mx
Steffy MX-Professional
Stirin Dirt Racing
Stone County MX
Stop Arm Pump for Dirt
Sunset Ridge Mx
Sunshine Motocross
supercross (dark background)
Supercross (five riders)
Supercross (kawasaki rider)
Supercross (two riders)
Supercross (yellow and checkered flag)
Supercross 24/7
Supercross MX1
Supercross.com
Supercross/Motocross
Superior Dirt Riders
Suzuki Dirt Bikes
SUZUKI DIRTBIKES
Swain Mountain Motocross
Sweeney Cycle Park
SX Tour 2010
Talking Rock Arena
TDOC 674
Team EPIC Motorsports
Team Faith
Team Pro-Action of Florida
Texas FCA Motocross
The Armenian Dirtbike Riders
The Farm Club/Motocross
The Glebe MX Track
The Motocross Spot
The Motocross Spot
The Motocross Track
The Racers Edge
The Ranch
The Ridge off Road Riding
The Rock Pile Motorsports
The Tennessee Fellowship
The Track at Holzhauers
TheFarm Training Complex
Throttle Mx Park
Thunder Hollow MX
Thunder Raceway AZ
Thunder Ridge Mx
Thunder Valley Motocross
Thundercross Okeechobee
Thursday Night Motocross
Tidewater Dirt Riders
Timberhill Motocross Park
tmx park
TNT Motorsports
Toe's Motocross Park
Tomahawk Motocross
Tony Moto Motocross Park
Total mX
Trackmasters MX
TransWorld Motocross
Trax North Mx

Treaty City Motorcycle	Vans	Winchester Speedpark
Tri-State Dirt Riders	Vermont Motocross Association	Windy Hill Sports
Troy Motocross Wheeler	Vermont Motocross Associations	WMX-FIM women's world motocross
Truth MX/MB1/FLY/PanicREV	Veterans Motocross Park	WMX-I Support Women's Motocross
Tsrmx Motocross Break Park	Vice Versa Mx	Woman Dirt Bike Riders
Ttwo Moto	Village Creek Motocross	Womens Motcross and Supercross
Tulare MX cycle park	Vintage Factory	Womens Motocross
Twister Valley Sorts	Vital Mx	Woodland Motocross Park
Two Stroke Motocross	Vmp mx	Wormwodd mx Park
Two Two Motorsports	Vurb Moto	WSMX-Womens School of Motocross
TwoStroke Motocross	WA dirt bike riders	WW Motocross Park
Tyler Gantt	Walden MX	Wynma Motocross
Tyler Mountain Motocorss	Ward Creek Mx	X Treme mx Series
UintaMoto	Washougal Motocross	X-Park Motocross
Ukiah Speedway	Watkins motocross track	X-pro Motocross
Unadilla Motocross- Home of Horsepower	We LoWe MotocrosS	Xtreme MX Track
UNI Racers	We need a Motocross/Supercross only	Xtreme Toys Inc.
United Cycle of Summersville	We want AMA supercross: the game	Yamaha dirtbikes
Urban Motocross Riders	West Coast Dirt Riders Club	Yamaha Dirtbikes
USA Mx Training Camp	West Monroe Motocross	Yamaha Motocross
Utopia Motocross Park	Wheeler Motocross Park	Yamaha Motor Corp
Valley Dirt Riders	Whip Industries	Z Racing Motocross Track
Valley Motocross	Wildride Motocross	Zaca Station MX Park
Valley Motocross	Wildwood Lake Raceway	
Valley Motocross (orange and blue letters)	Williams Hill Pass OHV	
	Wilmington Dirt Riders	

APPENDIX F

TWITTER™ USERS

Ehracing541

MotoxMan_131

dKota89

danandmoore

moto_addict

TheMotoGirlLife

BradLong39

Rockstar_Moto

BenchRacingMx

AMAmotocross

Dcshoes

Foxracing

Foxheadinc

TravisPastrana

AdamCianciarulo

Dmxsradio

Jbonejgr

JoleneNitroGirl

Ivantedesco

AshleyFiolek67

JP_Money250

SaraPriceMXcom

AlexahPearson

ErinBatesTV

E_bash_33

AshleyGrant33

GLTR

Js7

shitMxracerssay

APPENDIX G

MOTOCROSS TRACKS IN AMERICA

Track Name
5 Points mX Park
A Place to Ride mX
Abbott mX Track
Ace mX
Ace mX Park
Action mX
Action mX Park
Actiontown USA mX Park
Adelanto Motor plex
Adrenaline Motorsports Park
Air Mountain mX
Airway Heights mX
Albany mX Park
Aonia Pass mX
Archview mX Park
Area 330 mX
Area 51 mX
Area 51 mX Park
Argyll mX Park
Arizona Cycle Park
Arizona OHV Parks
Arkansaw Cycle Park
Atco Motocross Park
Austin/ Del Valle mX Park
AV motoplex mX ride
Aztalan Cycle Club
Aztec Family Raceway
Back 40 mX
Backwoods Motorsports
Badlands mX Park
Badlands Offroad Park
Baja mX
Balance Moto-X
Bar2Bar mX Park
Barnwell Mountain
Barnyard Mug Boggers
Barona Oaks Raceway
Battle Creek Motorcycle Club
Beans Bike Park
Beartown State Forest
Beaver Junction mX
Berm Benders Raceway
Big Air mX
Big Red Offroad Park
Big Rock Offroad Park
Birch Creek Motorsports Park
Bithlo Motorsports Park
Black Rock mX
Blackjack mX
Blue Diamond
Bluebonnet mX
Boise d' Arc Trails
Bonnet Carre Spillway
Boogerwoods mX Park
Bostwick Creek mX park
Bowers mX
Boyd County Sx
Branson USA mX
Breezewood Proving Grounds
Bremen Race Park
Briarcliff mX
Broken Spokes
Broome-Tioga Sports Center
Brushy Mountain Motorsports Park
Bucks Run mX and ATV
Budds Creek mX Park
Buffalo Valley mX
Bufflao mX
Bufflao Range Riding
Bufflao River Race Park
Burleson mX Park
Burnt Ridge mX
Byron's Motorsports Park
Cabool mX Racing
Cadillac Motorcycle Club
Cahuilla Creek mX
Cal City mX park
Camp Coker mX Park
Capeway Rovers mX
Carolina Adventure World
Casper Dirt Riders
Catheys Creek mX
Center Road mX
Central Cycle Club
Challenge Trax
Challenger mX Park
Cherokee Cycle Park
Chris Cross Mx
Claverack mX Track
Clay Peak Motorcycle Park
Clovis mX
Club Moto mX
Clutch City mX
CMJ Raceway
Cohocton mX
Competitive Edge mX Park
Connecticut River mX
Cooters Hole mX
Corner Mx
County Line mX
County Line mX
Cow Branch mX
Creekside mX
Creswell mX
Crooked Creek Cycle Park
Croom Motorcycle Area
Cross Bar Ranch
Cross Creek Cycle Park
Crossroads mX
Crow Canyon mX

Crow Hill mX
Crystal Coast mX
Cub Run mX playground
Cycle Ranch mX Park
Cypress Creek mX
D Track mX
Dade City
Daniel Boone mX
Daniels Ridge mX
Delmarva Motorsports
Devils Ridge mX
Diamondback mX
Dirt Farm
Dirt mX race Park
Dirt World mX
DNA Motocross Park
Doublin Gap mX
Dragoon Creek mX Park
Dry Hill Raceway
Dunn's Playground mX
Durhamtown Plantation
Dutch Sport Park mX
Dutchmen mX Park
Eagle Creek mX Park
Eagles Roost mX Park
Earlywine Racing Indoor mX
East Bay mX
East Bend Motorsports
East Fork mX
Eaton Mountain mX
ECDR mX Track
Echo Valley mX Park
Eddieville mX Park
Elizabeth City mX
Elko Speedway
Englishtown Raceway
Ephrata Raceway Park
E-Street mX
ET Motopark
Euro Raceway
Evansville mX Park
Evergreen Speedway mX
Fan Ridge mX
Fast Farms mX Park
Fast Track mX
Fast Traxx Motoplex
Fenton Indoor mX
Fiddler Creek mX Park
Florida Motoplex
Fly mX Park
FMX Paradise
Fond Du Lac OHV Park
Fossil Bowl mX
Fox Run mX
Fox Valley Offroad
Freedom mX Park
Freelin mX
Freestone County Raceway
Frozen Ocean mX
FV Moto X
Gary Semics mX School Track
Gatorback Cycle Park
Georgia Practice Facility
Glen Helen
Golden Pine Raceway
Good Evening mX
Good Evening Raceway
Grand Junction Motor Speedway
Grassroots mX
Grattan mX
Great Lakes mX
Green Acres mX
Green Acres mX Park
Green Ridge State Forest
Greenville mX Park
Grinding Stone Sports Park
Halfmoon mX
Hangtown mX
Hannegan Speedway
Happy Rambers Motorcycle Club
Happy Track mX
Hard Knox Park
Hardrock Cycle Park
Harleyville mX Facility
Harrier mX
Haspin Acres mX Park
Hatfield-McCoy Trails
Hawkeye Downs mX
Headquarters Moto Facility
Heaven Motorsports Park
Hemonds mX Park
Hidden Hills mX Park
Hidden Hills Offroad
High Altitude Sport Riders Club
High Falls Sx
High Voltage mX Park
Highlands mX Park
Highway 47 mX
Highway 65 mX
Hill Top mX
Hilltop Lodge mX Farm
Hindsight mX
HLR Motorsports Park
Hogback Hill mX Park
Holeshot Valley mX
Hollister Hills offroad
Honda Hills
Hoosier Hilltoppers mX
Horn Rapids mX Park
Hot Rods mX Racing
HotShot mX
Hurricane Hills mX Park
I-20 Motorsports
I-81 Motorsports Park
ICRMX
IMI Motorsports Complex
Inman mX
Interlincs mX
Interlincs Sx
Irish Valley mX
IRMXA
Iron City Motorsports Park
Irvington Motorsports Park
Island mX
Jacksonville mX Park
JB Motocross
Jeeps Cycle Club
Jet Mountain-X and Camping
Jodhpur Motocross Track

Johnny Nash Indoor Arena
Joliet mX
Jolly Roger's Motorsports Park
Jordan mX
Jordan River OHV Park
Just for Kids Cycle Park
Kahoka mX
Kahuku mX Track
KC Race Promotions
Keiki mX
KI Tracks
Lake Bailee mX Park
Lake Draper Off-Road
Lake Elsinore mX
Lake Gaston mX
Lake Sugar Tree mX
Lake Whitney mX Park
Lakeside mX
Lamoni mX Track
Legends Raceway mX
Leisure Time GP
Lembo Lake ATV Park
Letz Go Nutz
Lincoln Trail Motorsports
Little Egypt Off Road
Little Falls Raceway
Little Sturgis Motoplex
Little Valley mX Park
Livfast Exit 28 mX and FMX park
Lodgepole Valley mX
Log Road mX
Log Road mX (2)
Lonesome Valley mX
Los Fresnos mX Park
Lost Creek Park
Lower AL Mx Park
LV Raceway
Made for Play mX
Madras mX
Mammoth mX
Mankato mX
Maple Shade mX
Mason County mX
MC Motopark
McCulloch's Pro mX
McLarty Mx
Meadow Creek mX
Meadow Valley mX
Meadowlarks mX Club
Mesquite Hills mX Park
Mesquite mX Park
Miami mX Park
Mid-America mX Park
Middle Creek mX
Midsouth MotoX
Midway mX
Midwest Extreme Park
Miles Mountain mX
Milestone Ranch mX
Milford Riders Club
Mill Creek Motocross
Millsaps Training Facilty
Monster Mountain MX park
Montalba mX
Mooreland mX
Moriarty mX
Moto City Race Park
Moto Grande MX
Moto Masters Park
MotoCity Raceway
Motocross of Marion county
Moto-Dome
Motoland
Motoland MX Park
Moto-Topia mX
Mototown USA
Mountain Parkway Offroad
Mountain View mX Park
Mountaineer Raceway
MPX Racing
Mt. Pleasant mX
Muddy Creek Raceway
Mule Ridge Park
Muskegon Sandbox
Mustang Motorplex
Mustang Sallys Park
MVP mX
mX 101
mX 207
mX 338
MX 573 Practice Track
Mx Riverside
MX886
Myrtle Beach Motorsports Park
New Jersey Offroad Vehichle Park
Noah's Motopark
Nomads Motocross & ATV
North Carolina Motorsports Park
North East mX Complex
North Florida mX
North Texas mX Park
Oak Hill mX
Ocotillo Raceway
October Mountain State Forest
Ogemaw Sport and Trail
Ohio International Raceway
Oklahoma Motorsports Complex mX
Olympic mX Park
Orangeburk Motoplex
Outback Adventure Track
Outback Motorsports Complex
Outback mX Park
Owyhee Motorcycle Club
Palm Beach International Rcwy
Panther Creek mX
Paradie Motopark
Paradise Offroad Park
Pawnee Cycle Club
Pax Trax mX
Perris Raceway
Pima Motorsports Park
Pine Grove mX
Pine Ridge Raceway
Piru mX
Pittsfield State Forest
Platte Valley Dirt Riders
Platter Hill mX Park
Pleasant Hill Mx
Pleasant Valley Raceway

Pleasue Riders M/C
Plumcreek Valley mX
Podium One mx
Ponca City Grand National mX
Posey mX
Possum Kingdom mX
Prineville Adventure Park
Pro Source Indoor mX
Pusheta Creek mX Park
Pymatunig Holeshot Raceway
Pyramid Valley Raceway
Quick Track mX
Racers Edge mX Park
Racetown 395
Ram Jam Sportflex
Rausch Creek mX and ATV Park
Razors Edge mX
Red Bud USA
Red Creek Offroad
Red River Motorcycle Trails
Revolution mX Park
Rider Hill mX
Ridge Riding Park
River City mX Park
River Ridge mX
River Valley mX
Riverdale Raceway
Riverfront ATV Park
Rivers Edge Campground and ATV Park
Riverside Mx
Roaring Hills ATV Park
Robins Ridge Motorsports Park
Rock Creek Race Track
Rock Pile mX Park
Rock Run ATV Park
Rocket Raceway
Rocky Mountain Raceways
Rocky Roost Offroad Park
Rogue Valley mX
Rollin Haven
Rolling Hills Cycle Park
Ross mX Ranch Resort
Royal Mountain mX
Running Water Draw mX
Salem Arenacross
Sand Hill mX
Sand Valley mX
Sandbox Arena
Sandbox mX
Sandia mX Park
Sandstone mX
Sandy Corners mX
Santa Clara mX
Santa Rosa mX
Scenic Highlands mX Park
Seminole mX
Semo Raceway
SGMX Moto Playground
Sherwood Motocross
Shiloh mX Park
Silver Springs moto park
Silver Springs mX Park
Sioux Valley Cycle Club
Skeeter mX Park
Sky High mX Park
Sleepy Hollow mX Park
Slippery Rock Dunes
Snake Creek mX
Soaring Edge mX Park
Sooner State Cycyle Park
South 75 mX Park
South Central mX
South Fork Dirt Riders
South Woods mX
Southern Maryland ATV Park
Southern Sx Park
Southwest mX Park
Speed Compound
Speedtown mX
Speedworld Raceway Park
Speedzone Raceway Park
Splendora mX Park
Split Rails Sx
Spring Creek mX
Spring Ranch mX
Starvation Ridge
Starwest mX Park
Stateline mX
Stone County mX
Stone Creek Park
Strawberry Hill mX
Sun Valley mX
Sundance Motocross
Sunset Ridge mX
Sunshine mX
Sweney Cycle Park
Switchback mX
Talking Rock Arena
The Corner Lot Resort
The Landing mX
The Lost Trails ATV Park
The Motoplex
The Mountain mX
The Wilderness Trails
Thomaston Dam
Three Palms mX
Thunder Hollow mX
Thunder Motorsports
Thunder Raceway
Thunder Ridge Cycle Park
Thunder Valley Motopark
Thunder Valley mX
Thunder Valley mX
Thunderbird Race Park
Thursday Night mX
TMX Park
TNT Motorsports Park
Toes mX Park
Tolland State Forest
Tomahawk mX
Track at Holzhauers
Tulare Cycyle Park
Tulie mX
Turkey Creek mX
Turtle River mX Park
Twin Peaks mX
TwisterValley Sport Complex
Ukiah Speedway
Unadilla mX

Utopia mX Park
Valley Dirt Riders
Valley Motorsports Park
Valley mX
Victory Creek mX
Village Creek mX
VMP mX
Walden mX Track
Waldo Motorsports
Ward Creek mX
Washougal mX
Waterman Indoor mX
Weekend Warriors Riding Club
West Monro mX Park
West Texas mX Park
Wheel Crazy Motorsports Park
Wheeler mX Park
Whiplash Offroad Racing
White Knuckle Racing
White Sands Raceway
Wide Open mX Park
Wild Creek mX
Wild Ride mX and Quad Track
Wildwood Lake Raceway
Williams Hill Pass OHV
Winchester Speedpark
Woodland mX park
Xtreme mX Track
Zaca Station mX
Zambons mX pArk

APPENDIX H

AMA DISTRICT REPRESENTATIVES

AMA District: Location	Email Adress
1: Maine	
2: New Jersey	Butchdella@aol.com
3: Central NY	fast5325@aol.com
	mxmike42@hotmail.com
4: Western NY	ironwd@frontiernet.net
	wingnut53@frontiernet.net
5: WV/Western PA	nick581@verizon.net
	mx756732@yahoo.com
6: Eastern PA	
7: MD, DC, DE	adecarlo3@msn.com
	kenhs416@verizon.net
8: Florida	
9: Georgia	
10: Kentucky	
11: Southern OH	pluggy@juno.com
	jcollinsoh@msn.com
	district-11@hotmail.com
12: Northern OH	info@dirtworldmx.com
13: Virigina	lshaia@comcast.net
	jsaunders@aol.com
	MXCRZY@cox.net
14: Michigan	briankidner@aol.com
	tdunn976@yahoo.com
	eihavens@hotmail.com
15: Indiana	nick@race2acure.net
	district15vicepresident@yahoo.com
	jonesracing@mchsi.com
	barberj720@aol.com
16:WI and upper MI	mx195ss@yahoo.com
	e21racing@yahoo.com
	davemx@wi.rr.com
17:IL and Western IN	ajwaggoner@sbcglobal.net
	mxdirector@amadistrict17.com
18: Missouri and S. IL	tomwidman@yahoo.com
19: AL, MS, and AR	
20: S. TX	
21: OK and KS	
22: Iowa	mxkingdom@aol.com
	bwalton@cfu.net
23: Minnesota	mquinn401@gmail.com
	d23armca@msn.com
24: MT and ID	
25: CO and WY	info@rmxa.com
	laureenpruitt@yahoo.com
26: UT and NV (80%)	
27: Washington	ebushlbush@verizon.net
28: Oregon	wayne@assomgt.com
29: NC and SC	ljbeckett@coastalnet.com
30: ND and SD	
31: Arizona	
32: Tennessee	sam@victory-sports.com
33: Nebraska	
34: NY, NJ, PA	hurricanehillsmx@yahoo.com
35: Mid CA	
36: Northern CA	d36lao@volcano.net
	dircomp@ama-d36.org
	funkay4district36@comcast.net
37: Southern CA	superBNasif@aol.com
38: S. Tip of CA	
39: Hawaii	
40: Alaska	
41: Central TX	info@buffalocreekmx.com
42: Western TX	
43: Alabama	
44: Puerto Rico	
45: New Mexico	

APPENDIX I

RAFFLE WINNERS

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Ctopworks@gmail.com

Willingham.outdoor@gmail.com

bballard376@yahoo.com

boxx620@gmail.com

kuschl42@aon.at

stumblingfreak@gmail.com

cole_344@hotmail.com

xxxmeyer269xxx@ gmail.com

welderad@hotmail.com

APPENIDX J

RIDER CONCUSSION QUESTIONNAIRE

Rider Concussion Questionnaire
Please Complete the Following Questions as Best You Can. Your answers will remain confidential and your name is NOT to be written anywhere on the form.
Age:_____ Gender: **M / F** Ethnicity: _____ Years Racing: _____
Are you a professional or amateur rider? **_____**
On average how many races do you compete in per year?_____
Have you ever had a concussion, Yes or No;_____ If so how many? _____
Have you been baseline tested through a computerized neuropsychological test, like ImPACT, ANAM, CogSport, HeadMinder? **Y / N**
Have you ever had any formal concussion education? **Y/N**
Where have you learned the most about concussions, please be specific (e.g. what websites, TV shows, books, magazines, newspaper, health care professional, AMA) _____
_____

Please answer the following questions to the best of your knowledge.
1) Which of the following injuries is most severe?
a.) Having your bell rung
b.) Sustaining a ding
c.) Sustaining a concussion
d.) Sustaining a mild traumatic brain injury
e.) Same severity

2) Being "blacked out" or loss of consciousness is required to sustain a concussion.
a.) True
b.) False

3) A concussion requires immediate removal from a practice ride or race.
a.) True
b.) False

4) A rider showing any signs or symptoms of a concussion should not be allowed to return to riding that same day.
a.) True
b.) False

5) Youth riders (age 3-19) suffering from a concussion are more at risk of second impact syndrome.
a.) True
b.) False

6) There are NO long term effects after suffering a concussion.
a.) True

b.) False

7) Once a rider has sustained a concussion they are at a higher risk for another concussion.
a.) True
b.) False

8) A motocross rider receives a direct blow to the side of the head from another rider and falls to the ground. As they get up they are dizzy and have a headache. Should the rider continue riding?
a.) Yes
b.) No
c.) I don't know

9) A motocross rider falls off their bike and hits their head during their first moto. After going back to their trailer they have no headache and remember everything, but they have a nosebleed and a black eye. Should the rider continue riding that day?
a.) Yes
b.) No
c.) I don't know

10) A motocross rider receives a hit to the head during a practice ride. As the rider is checked out it is found that they are awake, have no memory loss, and feel fine at rest. When asked to ride their BMX bike they have a mild headache. Should the rider return to riding?
a.) Yes
b.) No
c.) I don't know

11) Memory loss, also known as post-traumatic amnesia is required for a rider to sustain a concussion.
a.) True
b.) False

12) A bell ringer requires immediate removal from a practice or race.
a.) True
b.) False

13) When a rider has suffered a concussion, how many days should they wait before returning to riding? Please fill in the blank. _____

14) A helmet will prevent concussions.
a.) True
b.) False

15) Should you have a physician or healthcare provider check/evaluate a bell ringer?
a.) Yes
b.) No
c.) I don't know

16) Children with concussions take less time to heal than adults.
a.) True
b.) False

17) A second concussion will heal faster than the first concussion.
a.) True
b.) False

18) A rider is still at risk of suffering a second concussion even 10 days after the first concussion.
a.) True
b.) False
19) Once a rider has suffered a concussion it is important to keep them awake.
a.) True
b.) False
20) A rider can get a bell ringer in the first moto and be okay to continue riding as long as they rest before the second moto.
a.) True
b.) False
Please check which of the following symptoms you recognize as a sign of concussion
Black Eye
Blacked Out/Loss of Consciousness
Blurred Vision
Chest Pain
Confusion
Dizziness
Feeling Sick
Headache
Loss of Memory/Amnesia
Nosebleed
Numbness/Tingling in the Arms or Hands
Sharp Burning Pain in the Neck
Trouble Sleeping
Unusual Sense of Smell
Unusual Sense of Taste
Weak Feeling when Moving your Neck

Thank you for completing the survey. Are you willing to be contacted for a follow-up interview?
a.) Yes b.) No

Thank you for completing the survey. Please enter your email address below to be entered into the raffle to win an electronic gift card

to MotocrossGiant.com

APPENDIX K

CORRECT ANSWERS

Rider Concussion Questionnaire

Please Complete the Following Questions as Best You Can. Your answers will remain confidential and your name is NOT to be written anywhere on the form.

Age:_____ Gender: **M / F** Ethnicity: _____ Years Racing: _____

Are you a professional or amateur rider? **_____**

On average how many races do you compete in per year?_____

Have you ever had a concussion, Yes or No;_____ If so how many? _____

Have you been baseline tested through a computerized neuropsychological test, like ImPACT, ANAM, CogSport, HeadMinder? **Y / N**

Have you ever had any formal concussion education? **Y/N**

Where have you learned the most about concussions, please be specific (e.g. what websites, TV shows, books, magazines, newspaper, health care professional, AMA) _____

_____

Please answer the following questions to the best of your knowledge.

1) Which of the following injuries is most severe?

a.) Having your bell rung

b.) Sustaining a ding

c.) Sustaining a concussion

d.) Sustaining a mild traumatic brain injury

e.) Same severity

2) Being "blacked out" or loss of consciousness is required to sustain a concussion.

a.) True

b.) False

3) A concussion requires immediate removal from a practice ride or race.

a.) True

b.) False

4) A rider showing any signs or symptoms of a concussion should not be allowed to return to riding that same day.

a.) True

b.) False

5) Youth riders (age 3-19) suffering from a concussion are more at risk of second impact syndrome.

a.) True

b.) False

6) There are NO long term effects after suffering a concussion.

a.) True

b.) False

7) Once a rider has sustained a concussion they are at a higher risk for another concussion.
a.) True
b.) False

8) A motocross rider receives a direct blow to the side of the head from another rider and falls to the ground. As they get up they are dizzy and have a headache. Should the rider continue riding?
a.) Yes
b.) No
c.) I don't know

9) A motocross rider falls off their bike and hits their head during their first moto. After going back to their trailer they have no headache and remember everything, but they have a nosebleed and a black eye. Should the rider continue riding that day?
a.) Yes
b.) No
c.) I don't know

10) A motocross rider receives a hit to the head during a practice ride. As the rider is checked out it is found that they are awake, have no memory loss, and feel fine at rest. When asked to ride their BMX bike they have a mild headache. Should the rider return to riding?
a.) Yes
b.) No
c.) I don't know

11) Memory loss, also known as post-traumatic amnesia is required for a rider to sustain a concussion.
a.) True
b.) False

12) A bell ringer requires immediate removal from a practice or race.
a.) True
b.) False

13) When a rider has suffered a concussion, how many days should they wait before returning to riding? Please fill in the blank. _____7 Days or greater_____

14) A helmet will prevent concussions.
a.) True
b.) False

15) Should you have a physician or healthcare provider check/evaluate a bell ringer?
a.) Yes
b.) No
c.) I don't know

16) Children with concussions take less time to heal than adults.
a.) True
b.) False

17) A second concussion will heal faster than the first concussion.
a.) True
b.) False

18) A rider is still at risk of suffering a second concussion even 10 days after the first concussion.
a.) True
b.) False
19) Once a rider has suffered a concussion it is important to keep them awake.
a.) True
b.) False
20) A rider can get a bell ringer in the first moto and be okay to continue riding as long as they rest before the second moto.
a.) True
b.) False

Please check which of the following symptoms you recognize as a sign of concussion

Black Eye
Blacked Out/Loss of Consciousness
Blurred Vision
Chest Pain
Confusion
Dizziness
Feeling Sick
Headache
Loss of Memory/Amnesia
Nosebleed
Numbness/Tingling in the Arms or Hands
Sharp Burning Pain in the Neck
Trouble Sleeping
Unusual Sense of Smell
Unusual Sense of Taste
Weak Feeling when Moving your Neck

Thank you for completing the survey. Are you willing to be contacted for a follow-up interview?
a.) Yes b.) No

Thank you for completing the survey. Please enter your email address below to be entered into the raffle to win an electronic gift card

to MotocrossGiant.com