

# NEUROLOGICAL BULLETIN

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## Orthopedic Injuries in Multiple Sclerosis Patients: Incidence and Patterns of Injury Types in this Vulnerable Population

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### Abstract

#### Background

Because of the high degree of disability in multiple sclerosis (MS) patients, minimizing injury occurrence is essential for preserving quality of life.

#### Objectives

By documenting the incidence of particular injuries, establishing relative risks of particular injuries in different subsets of MS patients and analyzing when the injuries occurred following diagnosis, we aim to provide information to encourage injury prevention recommendations and to provide preliminary data for further clinical research.

#### Methods

This study utilized a questionnaire consisting of 40 fill-in-the-blank or multiple choice questions. It was administered to previously diagnosed MS patients at office visits, infusion center visits, hospital stays, MS clinic visits and MS support groups.

#### Results

The years following definite MS diagnosis with the highest injury rates (injuries/people years lived) were 25 years or more (0.0594 injuries/year, 95% CI [0.0771 - 0.0449]). In addition, people below the age of 40 have nearly a doubled risk of injury compared to people above the age of 40 ( $p=0.033$ ). Primary progressive MS patients had the greatest past incidence of fractures, 55.6% (5/9) ( $p=0.033$ ). Patients reported that only 17.4% (19/109) of injuries occurred during exercise.

#### Conclusions

Overall, risk factors for injury include male gender, living longer with MS, being younger and having the diagnosis of primary progressive MS. Patient education, along with specific treatments and regimented physical activity, can lead to a more robust and injury free lifestyle in this patient population.

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## Introduction

Multiple sclerosis (MS) is a disease characterized by demyelination in the central nervous system leading to variable motor, sensory, vestibular, and ophthalmic symptomatology as well as variable cognitive impairment.<sup>1</sup> The combination of systemic and cognitive dysfunction among MS patients has the potential to severely limit the ability to live a full and productive life,<sup>2,3</sup> particularly as the disease progresses. On top of the range of disabilities this patient population experiences, injuries also detract from quality of life and day to day functioning. A small number of studies thus far has focused on documenting injuries among MS patients,<sup>4-8</sup> none of which has detailed the patterns and types of injuries that occur in this patient population.

While extensive research exists on the etiology and physical and cognitive symptomatology of MS, there is very little evidence indicating central nervous system trauma has anything to do with MS.<sup>9</sup> In fact, head trauma has been shown to have no significant correlation with subsequent development of MS later in life.<sup>10,11</sup> Although no cure for MS currently exists, quality of life is an important factor in analysis of MS progression as evidenced by the quality of life scales that currently exist (such as the MSQOL-54, MusiQoL, and the MSQLI scales). While a curative therapy may exist in the future, it is important to consider the quality of life of patients living with the disease now. Moreover, there is a lack of scientific evidence available at this time for the construction of injury prevention and quality of life improvement strategies for MS patients.

It is known that MS patients have difficulty maintaining balance and strength and that this may lead to a high rate of falls and injuries.<sup>4,12</sup> It has been previously suggested that

the variables most correlated with falls are balance, proprioception, use of a walking aid, and ability to walk.<sup>13,14</sup> Additionally, it has been previously shown that patients with spinal cord disease, including MS, suffer from a higher rate of fractures.<sup>5</sup> This could be due to the high rate of falls compounded by poor bone health in MS patients,<sup>15-20</sup> in one recent study up to 27% of MS patients reported low bone density.<sup>21</sup> MS patients frequently have severe gait abnormalities, even early on in the disease.<sup>22-24</sup> Another recent study showed that there were significantly more hip fractures in MS patients compared to the general population, using a novel fracture risk score calculator.<sup>25</sup> The combination of poor bone health, gait disability, and diminished coordination suggests both a susceptibility to bone breaks and poor bone healing.

Preventing injuries, particularly bone breaks, is an important part of improving the quality of life among MS patients. Keeping patients active increases their quality of life<sup>26</sup> and benefits them in the long term by keeping them in better physical shape and preserving muscle strength and flexibility.<sup>27-30</sup> In combination with traditional treatment strategies, preventative lifestyle changes will likely ease the management of the disease, better the long-term prognosis, and decrease the number of injuries which could occur in MS patients.

In this study we focus on the types, patterns, and incidence of orthopedic injuries occurring in MS patients from central Massachusetts who are actively being treated or are attending support groups for the disease. By documenting the incidence of particular injuries, establishing relative risks of particular injuries in different groups, and analyzing when the injuries occurred following diagnosis, we aim to provide information to help encourage injury prevention recommendations and to provide preliminary data for fur-

ther clinical research. Due to the lack of clinical research in this area of injury incidence and prevention in MS patients, this study should be considered for future reference and for patients' and doctors' education in terms of maintaining patients' quality of life and avoiding unnecessary injuries.

## Materials and Methods

This study utilized a hard copy paper questionnaire constructed by the primary investigator. The research design and questionnaire were approved by the University of Massachusetts Medical School Internal Review Board to meet exemption requirements. Because of the anonymity of the questionnaire and the minimally invasive nature of the study, no consent forms were deemed necessary from the respondents.

The questionnaire consisted of 40 fill-in-the-blank or multiple choice questions. Measured variables included sex, body mass index (BMI), MS classification based on standard assessments, age at diagnosis, active treatment type, ability to ambulate, cause of injury, site of injury, and treatment of the injuries which included bone fractures, ligament injuries (sprains), muscle injuries (strains), cartilage injuries, and head trauma.

There were two means by which the questionnaire was administered to the MS patients. If the setting permitted enough privacy, the primary investigator or attending neurologist would personally ask the patient respondent the questions on the sheet, clarifying any questions the respondent might have as the questionnaire was systematically filled out. Secondly, if the setting did not have enough patient privacy to talk aloud, the patient was handed the questionnaire and asked to fill it out to the best of his/her ability. In most settings the primary investigator was present to answer any questions the respond-

ents might have.

Settings at which the questionnaire was administered included office visits, infusion center visits, hospital in-patients, MS clinic visits, and MS support groups. To avoid selection bias within this patient population, any previously diagnosed MS patient present at these places during the time at which the questionnaire was being administered was offered the chance to participate. It was made known to the potential respondents at that time that the research was anonymous and that their participation was completely optional and would in no way affect their visit or treatment.

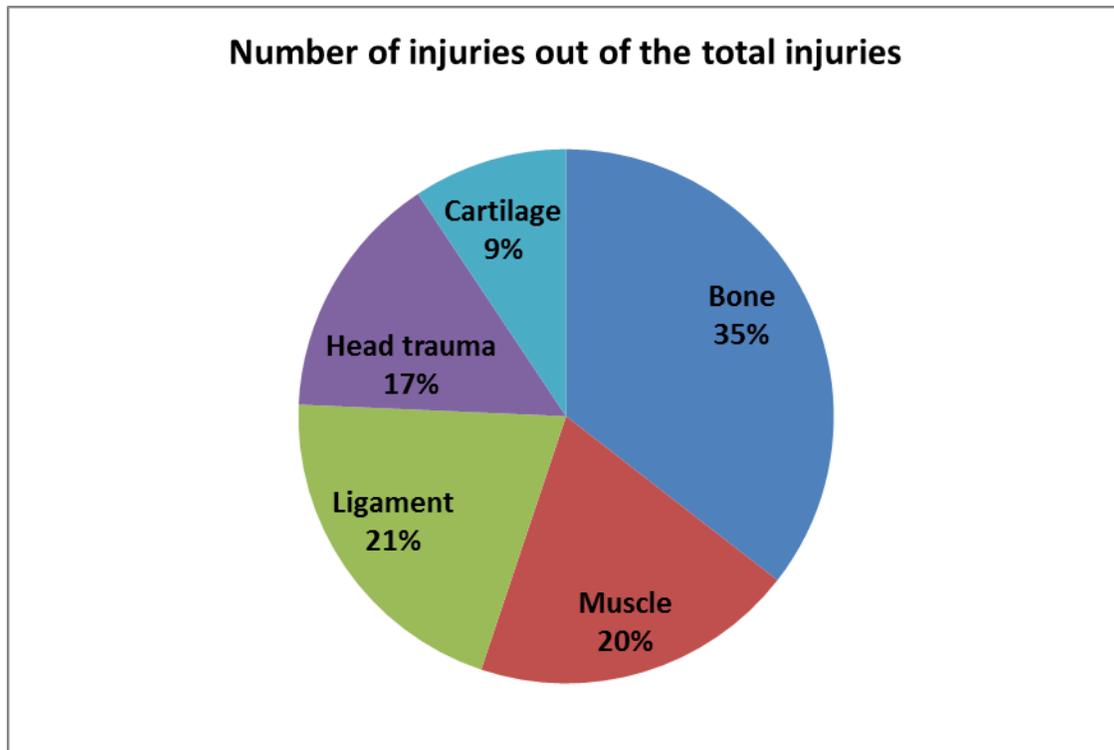
Statistics are reported with two tailed binomial 95% confidence intervals (CI a-b%) and 95% p values. 2 by 2 tables were calculated using Fisher exact tests. Fisher Freeman Halton exact (FFH) or Kruskal Wallis (KW) tests were used for 3 by 2 tables.

## Results

The questionnaire was administered to 105 patients during an eight week period, all of whom filled out at least some of the first page of general information.

This study found that 56% of patients reported having suffered at least one orthopedic injury at some point after diagnosis with MS. 27% of respondents reported having suffered multiple orthopedic injuries since their diagnosis with MS. The most common injury was a bone fracture (35% of all injuries) while the least common was a cartilage injury (Figure 1). 75% of injured people said they were undergoing active treatment at the time of injury, and 86% of all respondents had undergone active MS treatment at some point in their lives.

Of the 23 men who responded, 52% reported

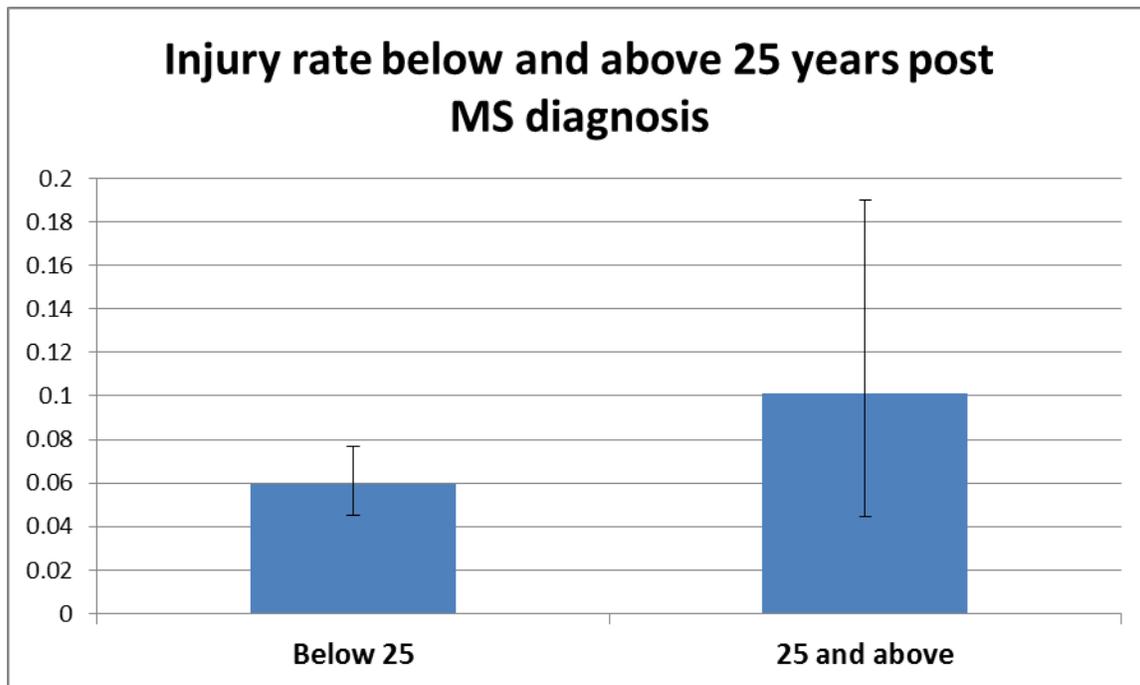


Injury Totals			
Injury Type	Count	Percentage	Total
Bone	38	34.86%	109
Muscle	21	19.27%	
Ligament	22	20.18%	
Head trauma	18	16.51%	
Cartilage	10	9.17%	
<b>Total</b>	<b>109</b>	<b>100.00%</b>	

Figure 1

having suffered an injury; among the 79 females, 57% reported having suffered an injury at some point after their diagnosis with MS. Gender was not a statistically significant prognostic indicator of overall injury risk. The male/female ratio, 0.291, generally approximated the percentage of males and females with MS. Gender was close to sig-

nificantly correlated with the risk of injuries due to falls. Compared to females, males had a 4.8 [p=0.082, 0.96-28.42] relative risk of having a bone break or head injury due to a fall. Males also had a 2.2 [p=0.069, 1.05-4.13] relative risk of muscle injury compared to females.

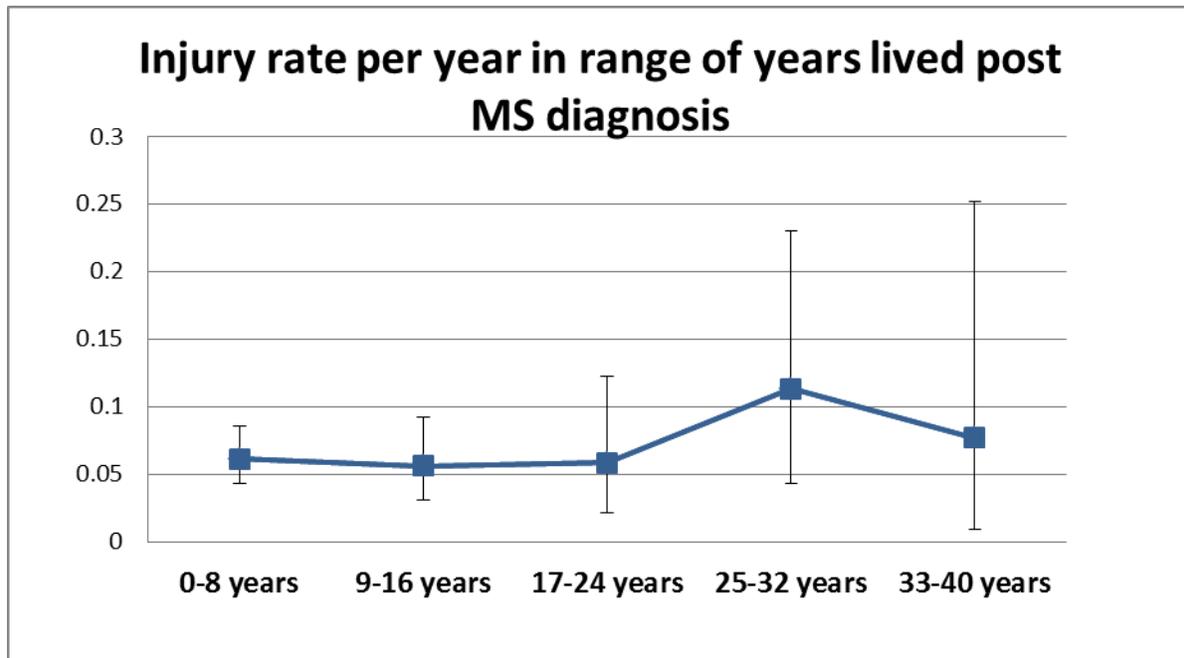


Years with MS Range	People Years Lived	Injuries	Injuries/Year in Range	95% CI
Below 25	891	53	0.059483726	[0.0771 - 0.0449]
25 and above	79	8	0.101265823	[0.190 - 0.0447]

Figure 2

Injuries in people who were ambulatory at the time of their injury were not significantly correlated with falls compared to injuries which occurred in non-ambulatory people. This is shown by an injury due to fall relative risk of 1.02 [p=1.00, 0.88-1.34] for people who were ambulatory compared to people who were not. This suggests that people who are ambulatory (with or without an assistive device such as canes or walkers) are at no more of a risk for a fall injury than people who could not ambulate. The falls in people who cannot ambulate may result from brief episodes of attempted ambulation at home, transferring injuries or other situations in which they tried to maneuver without the ability to use an assistive device.

The status of MS diagnosis had no statistical significance as a predictor of whether or not the patient had suffered any injury in the past, up to the date of the study. The bulk of participants (71%) reported that they had relapsing/remitting MS (RRMS) at the time of the study. 12% reported to have secondary progressive MS (SPMS) at the time of the study. Only 9% reported being diagnosed with primary progressive MS (PPMS) and 8% said they did not know what type they had. 36 of 72 people (50%) with RRMS reported to have suffered an injury at some point since their original diagnosis. 6 of the 9 (67%) PPMS respondents and 8 of the 12 (78%) SPMS reported an injury had occurred since their diagnosis with MS.



Years with MS Range	People Years Lived	Injuries	Injuries/Year in Range	95% CI
0-8 years	538	33	0.0613	[0.0426 - 0.0851]
9-16 years	250	14	0.0560	[0.0309 - 0.0922]
17-24 years	103	6	0.0583	[0.0217 - 0.122]
25-32 years	53	6	0.113	[0.0427 - 0.230]
33-40 years	26	2	0.0769	[0.00946 - 0.251]

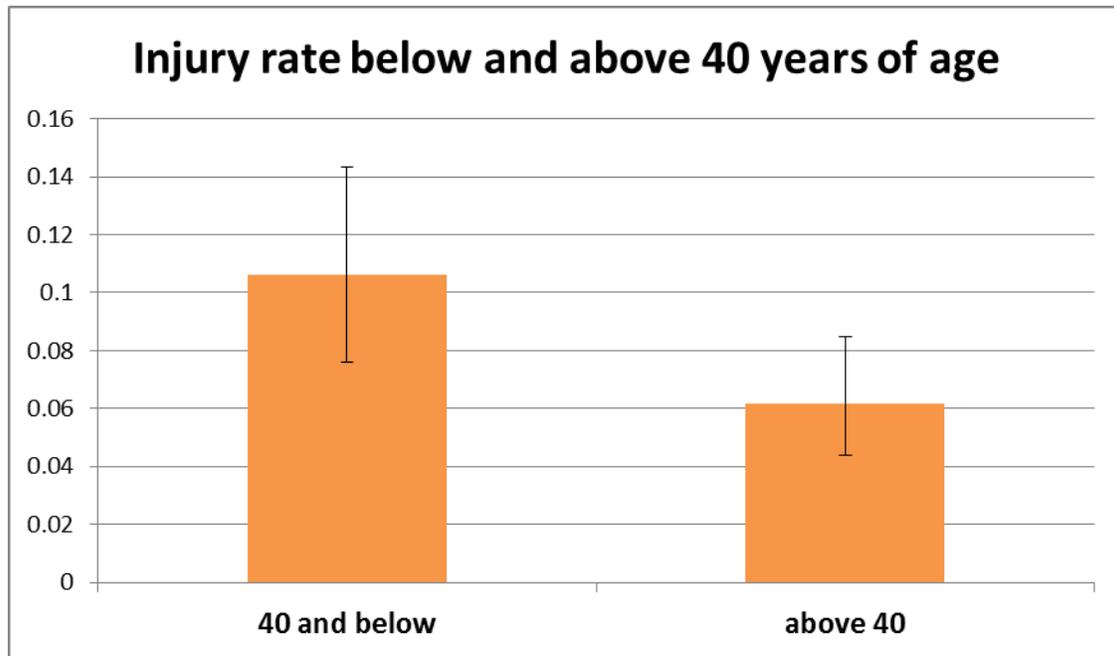
Figure 3

Within bone fractures, the type of diagnosed MS did have a significant correlation with whether or not the patient had been injured in the past, up to the date of the study. PPMS patients had the greatest past incidence of fractures, 55.6% (5/9) (FFH  $p=0.033$ ). Of the RRMS patients, 23% (17/72) had suffered a fracture. Of the SPMS patients, 50% (6/12) had suffered a fracture at some point during their MS disease course.

PPMS patients also had a higher past incidence (KW  $p=0.068$ ) of ligament injury (3/9, 33%), than RRMS (9/72, 12.5%) or SPMS (3/12, 20%) patients.

The years after diagnosis with the highest injury rates (injuries/people years lived) were 25 years and up (8 injuries occurred in 79 total lived-years) (Figure 2). The injury rate per years after diagnosis showed a general trend of increased relative risk above 25 years with the disease (Figure 3).

The analysis of injuries which occur at different age ranges suggests that injuries occur more often when patients are younger. People below the age of 40 have almost a doubled risk of injury compared to people above the age of 40 (Figure 4). There is a general decrease in incidence until sometime in the



Age Range	People Years Lived	Injuries	Injury Rate in Range	95% CI
Below 40	349	37	0.106	[0.0757 - 0.143]
Above 40	582	36	0.0618	[.0437 - .0846]

Figure 4

50s when the risk of injury increases again (Figure 5).

Patients reported that only 17.4% (19/109) of injuries occurred during exercise. 65% (71/109) of the injuries occurred during day-to-day activities which were listed as at work, at home, out of the house doing errands, or out of the house socially.

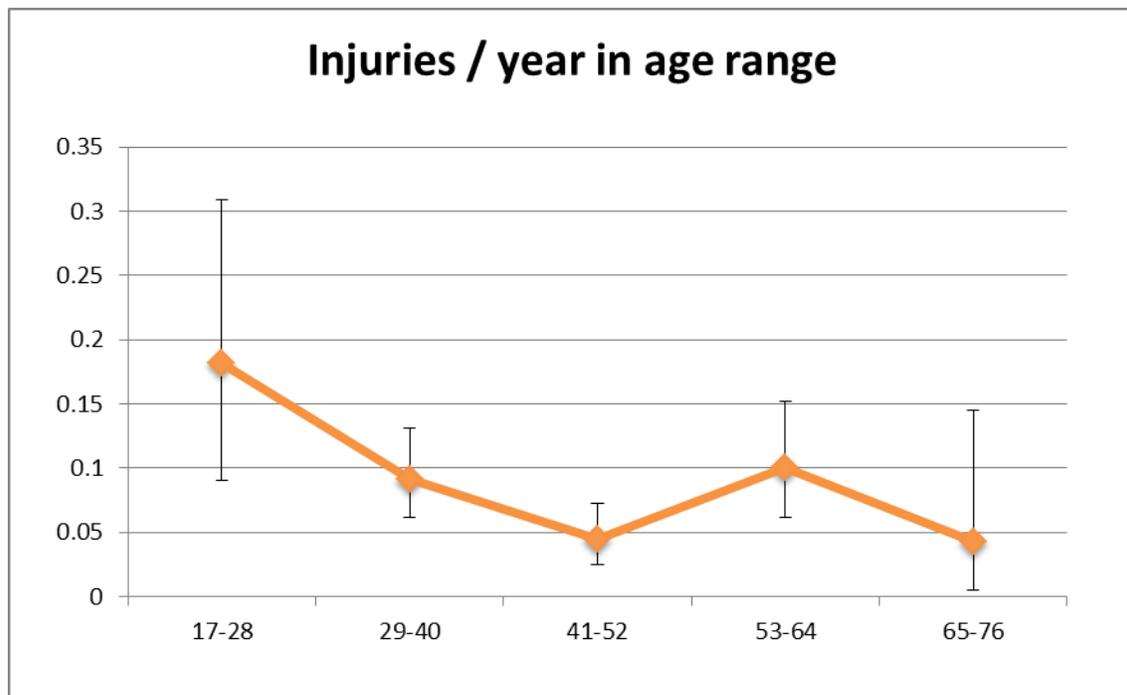
Patients reported a variety of medications that they were currently taking. The questionnaire did not allow for specific timeframes of injuries correlated with medication use.

BMI, height, and weight had no significant

correlation with injury risk or frequency overall.

### Discussion

MS patients are an at-risk population for suffering injuries to bone, muscle, ligament, and cartilage. This is due to a hampered ability to balance correctly, decreased strength, sensory loss, and impaired cognition. Shown in Figure 3, injuries in MS patients occur with an increased frequency as the disease progresses. This increased risk may reflect the cumulative increased axonal damage present during the later stages of MS disease progression.<sup>31-33</sup> With increased axonal damage, patients are less able to balance and ambulate



Age Range	People Years Lived	Injuries	Injury Rate in Range	95% CI
17-28	55	10	0.182	[0.0908 - 0.309]
29-40	294	27	0.0918	[0.0614 - 0.131]
41-52	336	15	0.0446	[0.0252 - 0.0726]
53-64	189	19	0.101	[0.0616 - 0.153]
65-76	47	2	0.0426	[0.00519 - 0.145]

Figure 5

well, possibly leading to a greater risk of injury.

The analysis of occurrence of injuries within age ranges shows that younger patients are more at risk than older patients. It is difficult to ascertain the exact causes of this increased risk, but it is almost certainly multi-factorial. Physical activity level, lifestyle, and employment may all play a role in putting the younger population at a higher risk of injury. This may indicate that this younger age range could benefit from injury prevention education and directives for stopping accidents

from occurring at work and at home. The second rise in injury risk in the age range of 53 – 64 years of age may be indicative of increased disease progression as discussed previously. This increased risk may be less preventable due to greater disability that goes hand in hand with disease progression.

The risk of fractures and head injuries due to falls is greater in men than it is in women. This increased risk suggests that these injuries in males may be avoided if fall rates could be decreased.

The data also indicate that PPMS patients may be at a higher risk of fracturing bones and injuring ligaments compared to RRMS and SPMS patients. Since these data take into account any injury which has occurred before the study, SPMS patients could have had injuries during a period of time when they had RRMS. PPMS patients, however, show an increased risk over both of these other two groups, perhaps reflecting the more severe nature of this subtype. Since there is no diagnostic stage of MS preceding PPMS, the injury rate within this group is an accurate estimate.

Supervised exercise programs may help reduce injury rates and enhance quality of life.<sup>26-30</sup> A Cochrane Database review published in 2005 indicated that exercise therapy in MS patients could improve stamina, muscle strength, overall mobility, and potentially mood in some cases. In addition, the Cochrane review found no negative effects of exercise on MS patients.<sup>34</sup> Since our study showed that the percentage of injuries which occurred during exercise is less than 20%, the benefits of exercise most likely outweigh the inherent risks. In addition to exercise, preventative measures such as monitoring bone health with bone density scans, obtaining vitamin D levels, and supplementation when necessary may reduce risk of fractures by doing everything possible to maintain bone health.

There are several shortcomings inherent within this study. The use of a questionnaire allows for a large range of reported information which can introduce non-differential bias. Since all of the information is patient recall, the accuracy of the raw data could be questioned. The size of the study is relatively small, which decreases the overall power and generalizability. Fatal injuries were not counted in this study due to the methodology employed. It has been previously shown that

MS patients suffer fatal injuries at a higher rate than the general population.<sup>6</sup> Although the frequency of fatal injury is probably very low compared to the frequency of all other injuries, it should be noted that those injuries may be missing.

Further large scale prospective studies evaluating potential co-morbid and co-incident injury associations with MS treatments may be warranted. This study found that BMI had no significant correlation with injury risk. Also, there is little written about the potential for MS drugs possibly being comorbid with increased risk of injury or changes in quality of life. Research into this area is essential to provide MS patients with the most sensible and safest options for treatment. Specific drugs that could be studied include steroids, interferons, glatiramer acetate, and natalizumab as potential comorbid factors associated with injury risk among MS patients. Although this study did document whether or not the patients were on active drug regimes at the time of injury, not enough specific chronological data were collected to determine the risks of injuries for each treatment. Alternatively, future studies to directly assess exercise and/or physical activity correlated with injury risk may be appropriate.

## Recommendations

- 1) Injury prevention education for patients less than 40 years of age may help reduce the risk of trauma associated with MS.
- 2) Men in particular should be assessed for fall-risk and should be encouraged to use assistive devices in the home and at work.
- 3) Caregivers should be wary of any MS patient diagnosed with PPMS, as they are at a higher injury risk.
- 4) Exercise should be strongly encouraged in MS patients since the benefits seem to far outweigh the risks of concurrent injury.
- 5) Vitamin D levels and bone scans

may help reduce the risk of fractures in MS patients through early intervention strategies.

## Conclusion

The injury rates detailed here show that MS patients suffer many types of orthopedic injuries, predominantly bone fractures. Overall, the risk factors include the male gender, living longer with MS, being younger, and having the diagnosis of PPMS. If a patient falls into any of these categories, clinicians and caregivers must take extra care in helping patients avoid potential injury risks and in educating those patients about the debilitating aspects of living with MS.

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