

AN OVERVIEW OF KNEE-THIGH-HIP INJURIES IN FRONTAL CRASHES IN THE UNITED STATES

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ABSTRACT

Injuries to the knee-thigh-hip complex (KTH) are a frequent, debilitating, and expensive consequence of automobile crashes. This paper examines the influence of frontal crash modes, restraint status, occupant age and gender, and vehicle body type and model year on the frequency and risk of KTH injuries and their associated loss in quality of life and societal cost.

The NASS-CDS data files for the years 1993-2001 were examined to estimate the frequency and risk of KTH injuries in real world frontal crashes. The crash mode was defined by the direction of impact and the vehicle crush profile. The injury codes of the Abbreviated Injury Scale (AIS, 1990) were used to link injury information with the Functional Capacity Index (FCI) and the economic cost of each type of injury. The loss in quality of life was estimated as Life-years Lost to Injury (LLI) that considers the life expectancy of the injured occupant and the FCI of the injury.

Injuries to the knee-thigh-hip (KTH) complex account for 18% of all AIS 2+ injuries sustained by front seat occupants involved in frontal automobile crashes and 23% of the associated LLI. The comprehensive cost of lower extremity injuries is \$7.64 billion annually with KTH complex injuries accounting for 52% of the costs. Hip injuries account for 58% of the LLI associated with AIS 2+ KTH injuries. The risk and proportion of AIS 2+ hip injuries is higher in newer vehicle models than older models of air bag equipped vehicles. Risk of AIS 2+ KTH injuries for restrained occupants is higher in air bag equipped vehicles than in no air bag vehicles.

INTRODUCTION

With the increasing use of safety belts and availability of air bags, more occupants survive serious car crashes (NHTSA, 2000). However, many people involved in frontal or offset crashes incur disabling lower extremity injuries. Though lower extremity injuries are usually not life threatening, the physical and psychosocial consequences of lower extremity injuries are often long lasting (Read, et al., 2002). Lower extremity injuries require comparatively longer periods of hospitalization and

recovery than injuries to other body regions given the same AIS rating and often result in long term or permanent disability (Dischinger, et al., 1995, Read, et al., 2002). This is because the AIS mainly considers an injury's "threat to life" and is not sensitive for classifying injuries according to the probable degree of residual impairment or functional limitation.

Lower extremities are the most frequently AIS 2+ injured body region in air bag equipped vehicles with a 5 percent risk of injury in frontal crashes (Kuppa, et al., 2001). Fifty percent of lower extremity injuries are to the knee-thigh-hip complex (Ore, et al., 1993, Kuppa, et al., 2001) that account for 45 percent of the life years lost to lower extremity injuries (Kuppa, et al., 2001).

In a detailed examination of the UK CCIS database, Pattimore (1991) noted that lower limb injury risk was very dependent on the type of impact sustained and the restraint status of the occupant. For restrained occupants, 68% of lower limb skeletal injuries occurred below the knee, while for unrestrained occupants, 51% of skeletal injuries involved the hip/pelvis.

Huelke, et al. (1991) examined the incidence of knee-thigh-hip injuries sustained by drivers and front seat passengers in frontal impacts in relation to other lower extremity injuries. Hip injuries accounted for 15%, thigh for 18%, and knee for 22% of all lower extremity injuries. The proportion of KTH injuries among all lower extremity injuries sustained by younger drivers and passengers (16-50 years of age) is greater (55%) than that sustained by older drivers and passengers (61+ years). Contacts with the instrument panel and steering wheel rim and column were the major source of knee-thigh-hip injuries in frontal crashes.

Ore, et al. (1993) examined knee, thigh, and hip injuries in relation to the age and gender of the front seat vehicle occupant. The effect of age on knee-thigh-hip injury risk was more prominent for female occupants than male occupants. Ore et al. noted that among the ten most cost-intensive injuries of inpatients, injuries to the hip joint, pelvis and femur are the highest.

In spite of the high frequency of knee-thigh-hip injuries in frontal impacts and their associated high societal cost, there has been less attention paid to

them. Air bags have been shown to reduce the frequency of severe head and chest injuries and therefore significantly change the injury profile of front seat occupants involved in frontal crashes. However, the influence of air bags on lower extremity injuries, and in particular injuries to the knee-thigh-hip complex, has not been examined effectively in previous field studies since they lacked sufficient number of air bag equipped vehicles in their real world crash dataset. Therefore, a detailed examination of knee-thigh-hip injuries and their relation to injuries to other body regions in frontal vehicular crashes was undertaken in this study.

METHODS

The NASS/CDS data files for the years 1993-2001 were examined to determine the risk, frequency, and proportion of knee-thigh-hip injuries in relation to other body regions for the driver and front seat outboard passenger involved in frontal non-rollover crashes. The age of occupant, restraint condition, the DeltaV of the vehicle, the impact angle, vehicle type, and model year were used as covariates influencing the risk and frequency of injury. The following criteria were used to extract information from the NASS-CDS files.

Frontal Crashes: Impact direction 11-1 o'clock or 10 - 2 o'clock with general area of damage in front or forward of A-pillar (Kuppa et al. 2001). Left offset, right offset, and full frontal crashes were defined by damage distribution and object contacted in similar manner as that in Kuppa, et al. (2001). Frontal crashes with a rollover component were not considered.

Occupant: Driver and front seat outboard passenger at least 15 years of age and not ejected from vehicle. Age of occupant was categorized into four groups - 15-30 years, 30-45 years, 46-60 years, and 60+ years.

Vehicle: Passenger cars, utility vehicles, and light truck/van of weight less than 10,000 lbs, grouped into pre 1993, 1994-1996, and 1997-2001 vehicle model years

Restraint: 3-point belt restrained and unrestrained occupants in air bag equipped and no air bag vehicles were considered and grouped into "bag+belt", "bag only", "belt only", and "unrestr" categories. If only a driver side air bag is available, the driver is considered to be in an air bag equipped vehicle while the passenger is considered to be in a no air bag vehicle.

DeltaV: The change in velocity of the subject vehicle was categorized into 6 groups <15 km/h, 16-30, 31-45, 46-60, 60-75 and 75+ km/h.

Injuries: Injuries, coded according to the Abbreviated Injury Scale (AIS, 1990), were categorized into head/face, neck, thorax/abdomen, upper extremity, and lower extremity. The lower extremities were further separated into injuries to the KTH complex and below knee injuries.

For detailed analysis of knee-thigh-hip injuries, the AIS codes were used to categorize the injuries into knee, thigh, and hip as shown in Figure 1 (Rupp, et al., 2002). For the detailed KTH injuries, AIS codes regarding skin, blood vessels, or the nerves were not considered. Only skeletal injuries, injuries to the joint, and muscle and ligament injuries were considered. Hip injury included fracture of the acetabulum (coded under pelvis fracture), femoral head and neck, and hip joint injury, hip dislocation. Thigh injury included fracture of the femoral shaft, subtrochanteric regions, and the supra condylar region. Knee injury included fracture of the patella and femoral condyles, knee ligament and tendon injuries.

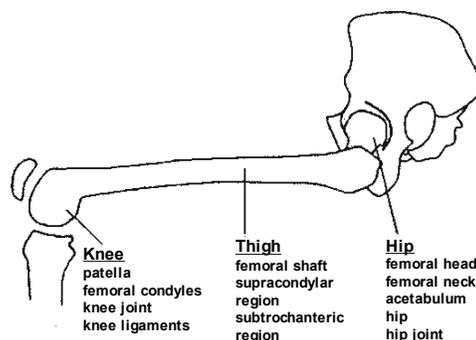


Figure 1. Classification of Knee-Thigh-Hip injuries

The highest AIS level injury to a body region was used to estimate the risk of injury to a body region. All injuries to a body region were used to estimate the number of injuries in a body region. The occupant age, gender, restraint condition, and DeltaV and type of crash were used as covariates influencing the risk and frequency of injury.

FCI and LLI: The Abbreviated Injury Scale was originally conceived as a weighted assessment of injury severity based on its threat to life. Thus injuries that are associated with high mortality but low morbidity are associated with high AIS scores, whereas injuries associated with low mortality yet high morbidity and long term impairment are assigned low values of AIS. The Functional Capacity Index (FCI) was developed to better quantify the long-term individual and societal consequences of non-fatal injuries (MacKenzie, et al., 1996). FCI is

an estimate of the long-term effects of injury, based on the functional state of an injured individual one-year post injury. FCI values vary from 0 for no loss to 1.0 for complete loss of function. Luchter (1995) developed the LLI (Life Years Lost to Injury) with FCI as the “impairment” score to represent the years lived at a reduced level of functioning. The LLI for an injury is defined as the product of its FCI and the life expectancy of the injured individual. The life expectancy for the given age and gender of the injured person is determined from the standard life tables. The total LLI represents the overall effect on society of a particular injury, and the average LLI (total LLI due to a particular injury divided by incidence of such injury) represents the effect on the “average” injured individual.

The AIS 90 code for the highest AIS level injury in each body region for occupants with non-fatal outcome was mapped to its corresponding Functional Capacity Index (FCI). If a body region had more than one injury at the highest AIS level, then the injury with the greater FCI was used. The FCI for a fatally injured occupant was considered equal to 1 and assigned to the MAIS injury (maximum AIS injury sustained). Since detailed injury information is missing for many fatally injured occupants, the distribution of MAIS injury into different body regions for fatal outcomes was assumed to be the same as the distribution of AIS 4+ injuries in non-fatal outcomes. The Life Years Lost to Injury (LLI) was computed by multiplying the life expectancy of the injured individual with the FCI. The total LLI to a body region was computed as the sum of the LLI for all occupants due to the most severe AIS 2+ injury in that body region.

Injury Costs: The comprehensive cost of injury to the lower extremities was estimated using the nonfatal injury unit cost by body region published by NHTSA (Blincoe, et al., 2002) which represent the harm caused by US motor vehicle crash injuries. The unit costs are listed according to the injured body region and the AIS threat-to-life severity score of the maximum severity injury. Comprehensive cost of injury includes economic cost and cost of “intangible consequences” such as pain and suffering, loss in quality of life, and loss of life. The economic costs are based on year 2000 cost estimates and include medical costs, emergency services costs, property damage losses, lost productivity, workplace costs, legal and insurance costs and the costs associated with travel delay. The total cost of injury to a body region is the sum of the product of the number of injuries at a given AIS level in a body region with the corresponding unit cost of injury for that AIS level severity.

All results presented are weighted by weighting factors in NASS/CDS to represent national estimates of towaway crashes. No adjustments were made to include estimates of non-towaway crashes or to equate the average annual number of fatalities of outboard front seat occupants involved in frontal crashes to that reported in the FARS database. Cost estimates presented in this paper are based on year 2000 dollar value and no adjustment has been made to reflect current dollar value.

Comparisons made in the paper are based on point estimates, some of which are based on small sample size. Further work would be needed to determine the statistical significance of the comparisons.

RESULTS

There were an annual average of 1.3 million towaway frontal crashes categorized into full frontal, left offset and right offset crashes as shown in Figure 2.

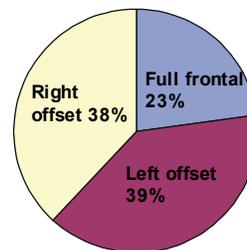


Figure 2. Distribution of frontal crashes into different crash modes.

Eighty percent of outboard front seat occupants were drivers and 20% were passengers. The belt use rate in air bag equipped vehicles was 88% while that in vehicles with no air bags was 74%. Forty percent of the front seat occupants were in air bag equipped vehicles. The number of AIS 2+ injuries in different body regions for different crash conditions is shown in Figure 3.

The lower extremity injuries in Figure 3 are grouped into injuries to the knee-thigh-hip complex (KTH) and below knee injuries. Lower extremity injuries are the most frequent injured body region in all frontal crashes accounting for 36% of all AIS 2+ injuries sustained by front seat occupants. Approximately half of these lower extremity injuries are to the knee-thigh-hip (KTH) complex and the other half are below knee injuries. The number of injuries in right offset crashes is less than that of left offset since 80% of the occupants are drivers.

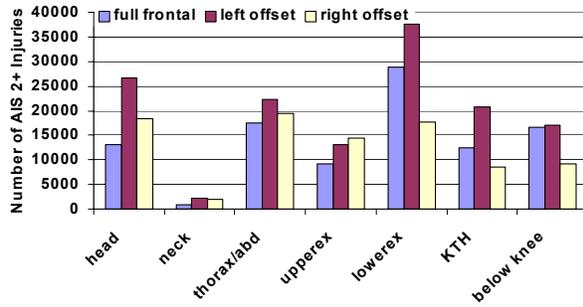


Figure 3. Annual number of AIS 2+ injuries in different body regions for different crash conditions. (lowerex = KTH+belowknee)

The average annual life-years lost to AIS 2+ injuries in all frontal crashes in air bag and no air bag equipped vehicles is presented in Figure 4. The annual estimate of LLI associated with AIS 2+ lower extremity injuries in air bag equipped vehicles involved in frontal crashes is 128 thousand years. Though head/neck and thoracic injuries have higher threat to life consequence, they account for a lower proportion of life years lost to injury than the extremity injuries. While lower extremity injuries account for 36% of all AIS 2+ injuries sustained by front seat occupants, they represent 46% of the Life-year Lost to AIS 2+ Injury (LLI). The LLI associated with KTH injuries in frontal crashes is 55% of the total LLI due to AIS 2+ lower extremity injuries. While 40% of front seat occupants in this data set were in air bag equipped vehicles, they represent less than 15% of the total LLI associated with head injuries indicating the effectiveness of air bags in reducing head injury and its associated impairment. Such a significant reduction in LLI associated with injuries to other body regions in air bag equipped vehicles was not observed.

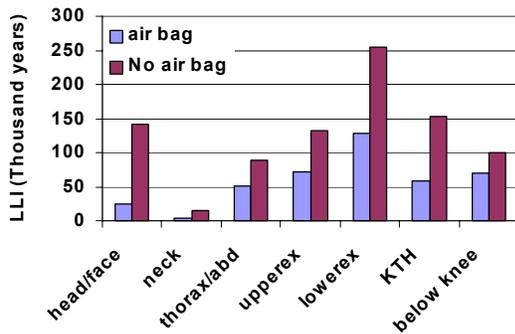


Figure 4. Annual life years lost to AIS 2+ injury for outboard front seat occupants air bag and no air bag equipped vehicles involved in frontal crashes. (lowerex = KTH+belowknee)

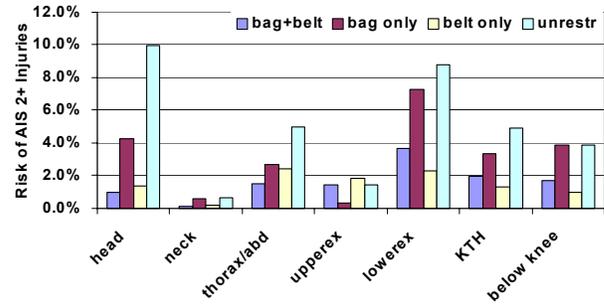


Figure 5. Risk of AIS 2+ injuries in different body regions for different restraint environments in frontal crashes. (lowerex = KTH+belowknee)

The risk of AIS 2+ injury to different body regions for different restraint environments is presented in Figure 5. The risk of AIS 2+ injuries is higher for the unrestrained occupant than for the belted occupant in both airbag and no air bag equipped vehicles. The risk of head, thorax and abdominal injuries is significantly reduced in air bag equipped vehicles compared to no air bag vehicles. However, there is no concomitant reduction in the risk of upper and lower extremity injuries in air bag equipped vehicles. In fact, the risk of lower extremity injuries (both KTH and below knee injuries) is higher among belted occupants in air bag equipped vehicles than those with no air bag. This observation is similar to that found by Rupp et al. (2002). The risk of AIS 2+ injuries is highest for the lower extremities compared to any other body region for air bag equipped vehicles. The risk of injury to the KTH complex is approximately the same as the risk of below knee injuries.

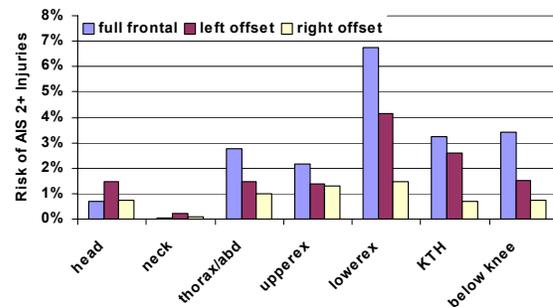


Figure 6. Risk of AIS 2+ injuries in different body regions for restrained occupants in air bag equipped vehicles involved in different frontal crash modes. (lowerex = KTH+belowknee)

The risk of AIS 2+ injury to different body regions for belted occupants in air bag equipped vehicles involved in different crash modes is shown in Figure 6. The risk of AIS 2+ injury to different body regions is, in general, higher for full frontal

crashes compared to offset crashes. Figure 6 indicates a higher risk of KTH complex and below knee injuries in the full frontal crash condition than in the offset crashes in spite of the higher level of intrusion associated with offset crashes.

The risk of AIS 2+ injuries in air bag equipped vehicles involved in frontal crashes as a function of vehicle body type is shown in Figure 7. 78% of the vehicles in the data set were passenger cars, 7% utility vehicles, and 15% light trucks and vans. The risk of AIS 2+ upper body injuries in frontal crashes is similar for all vehicle body types. However, the risk of AIS 2+ injuries to the KTH complex is higher in utility vehicles than in passenger cars and light trucks and vans.

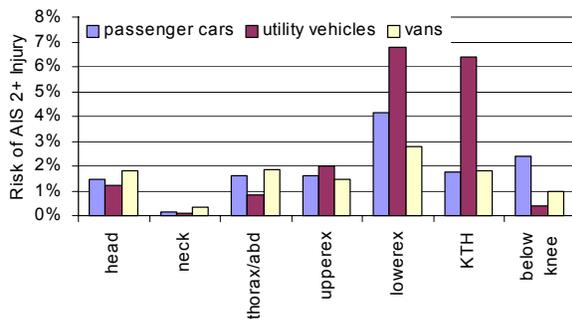


Figure 7. Risk of AIS 2+ injuries to different body regions of air bag equipped vehicles in frontal crashes for different vehicle body types.

The risk of AIS 2+ injury to different body regions by age for air bag equipped vehicles is presented in Figure 8.

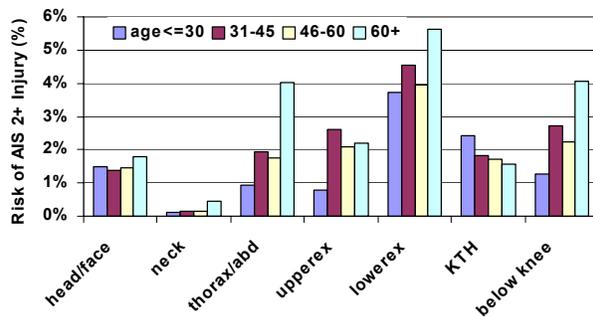


Figure 8. Risk of AIS 2+ injuries in frontal crashes of air bag equipped vehicles as a function of occupant age in years. (lowerex = KTH+belowknee)

In general, the risk of AIS 2+ injury increases with increase in occupant age. Occupant age has significant influence on thoracic/abdominal injuries but does not have the same influence on head and KTH complex injuries. The risk of below knee injuries increases with increase in occupant age while the risk of KTH injury does not change significantly in the different age groups. Perhaps, other factors

such as restraint condition and DeltaV have greater influence on injury to the KTH complex than occupant age.

Next, results of the analysis using the detailed AIS 90 codes are presented. As indicated earlier, only skeletal injuries, injuries to the joint, and muscle and ligament injuries were considered. AIS codes regarding skin, blood vessels, or the nerves were not considered since it is not possible to classify them into the detailed knee, thigh, or hip categories. Additionally, currently available anthropomorphic test devices cannot address these injuries. Knee sprain is coded as a joint injury of AIS 2 severity according to the 1990 Abbreviated Injury Scale while hip and ankle sprains are coded as AIS 1 severity. However, knee sprains are associated with an FCI of 0 just as hip and ankle sprains. In order to be consistent with the impairment level associated with these injuries, knee sprains were considered to be of AIS 1 severity in this analysis.

The risk of AIS 2+ knee, thigh, and hip injuries as a function of age and gender was examined for occupants in air bag equipped vehicles using the detailed injury information of the KTH complex from the AIS 90 code (Figure 9). The influence of age on hip and thigh injury risk is not evident while knee injury risk increases with increase in occupant age for male and female occupants.

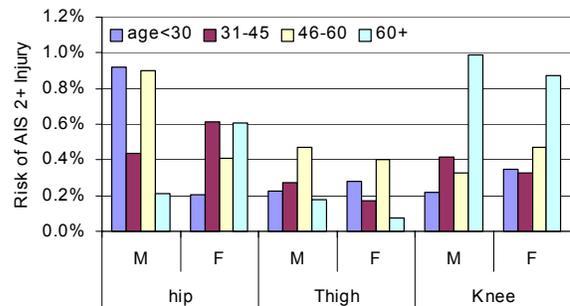


Figure 9. Risk of AIS 2+ KTH skeletal, joint, and ligament injuries in frontal crashes as a function of age and gender of occupant (in air bag equipped vehicles).

The risk of AIS 2+ injuries to the KTH complex in air bag equipped vehicles involved in frontal crashes as a function of DeltaV is presented in Figure 10. The risk of knee injuries dominate for DeltaV < 45 km/h. For frontal crashes with DeltaV > 45 km/h, the risk of hip and thigh injuries is greater than that of knee injuries.

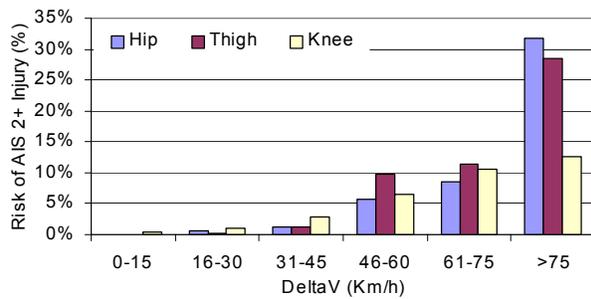


Figure 10. Risk of AIS 2+ KTH skeletal, joint and ligament injuries in air bag equipped vehicles involved in frontal crashes as a function of DeltaV.

In the detailed analysis of KTH injuries, the risk of hip and knee injuries is greater for restrained front out board occupants in air bag equipped vehicles compared to those in no air bag vehicles (Figure 11). This finding is similar to that shown in Figure 5 where risk of AIS 2+ KTH complex injuries is higher in “bag+belt” restraint than “belt only” restraint condition.

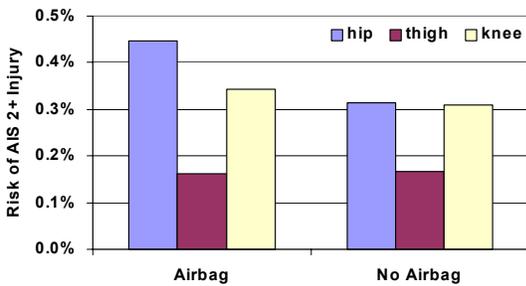


Figure 11 Risk of AIS 2+ knee, thigh, and hip (skeletal, joint and ligament injuries) for restrained occupants in air bag and no air bag equipped vehicles in frontal crashes.

The risk of AIS 2+ knee, thigh, and hip injuries has increased in the newer models of air bag equipped vehicles compared to those before 1993 (Figure 12). The proportion of AIS 2+ hip injuries among other injuries to the KTH complex is greater in newer vehicle models than earlier models of air bag equipped vehicles (Figure 14). Assuming that the average DeltaV and occupant characteristics are not significantly different between air bag and no air bag vehicles and between the different vehicle model years, the higher risk of KTH injuries and the higher proportion of hip injuries in air bag equipped vehicles and newer vehicle models may be attributed to design changes in the vehicle interior components. Since the sample sizes in the air bag and no air bag categories and in the vehicle model year categories are large, an assumption of invariant DeltaV and occupant

characteristics between the various categories is not unreasonable.

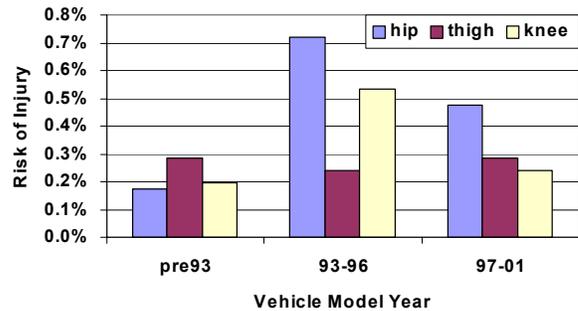


Figure 12. Risk of AIS 2+ knee thigh and hip (skeletal, joint, and ligament) injuries in different model years of air bag equipped vehicles involved in frontal crashes.



Figure 13. Proportion of AIS 2+ knee, thigh, and hip (skeletal, joint, and ligament) injuries in different model years of air bag equipped vehicles.

The AIS 90 codes were used to determine the distribution of detailed AIS 2+ injuries to the KTH complex as well as the associated LLI to these injuries in air bag equipped vehicles and no air bag equipped vehicles (Figures 14 and 15). The most common KTH injuries are hip, femur, and patella fractures. The proportion of hip injuries (46%) as compared to knee injuries (32%) in air bag equipped vehicles is higher than the proportion of hip injuries (35%) in non-air bag vehicles. However, the LLI associated with hip injuries is approximately the same in air bag and no air bag vehicles. This is because many hip joint injuries in air bag equipped vehicles are associated with low FCI values. The life years lost to injury due to hip injuries accounts for almost 65% of all life years lost due to AIS 2+ KTH injuries. The proportion of LLI due to hip fracture is almost 60%. This indicates the high disability level associated with hip injuries.

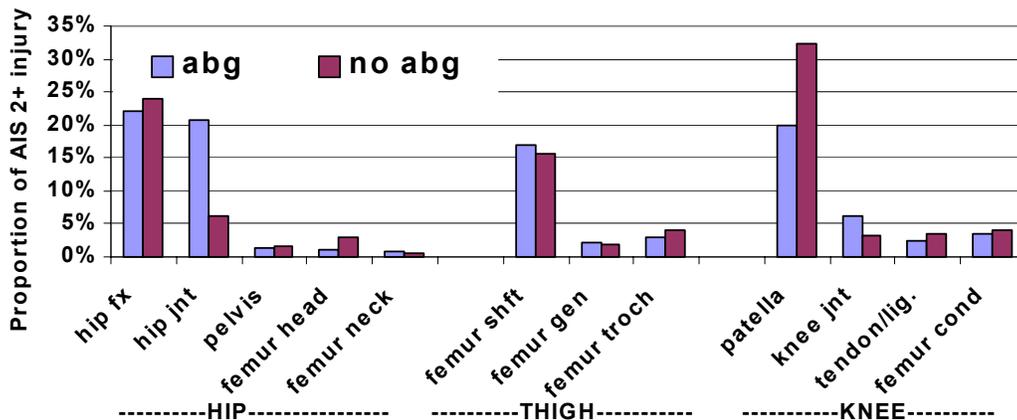


Figure 14. Proportion of different AIS 2+ injuries to the KTH complex.

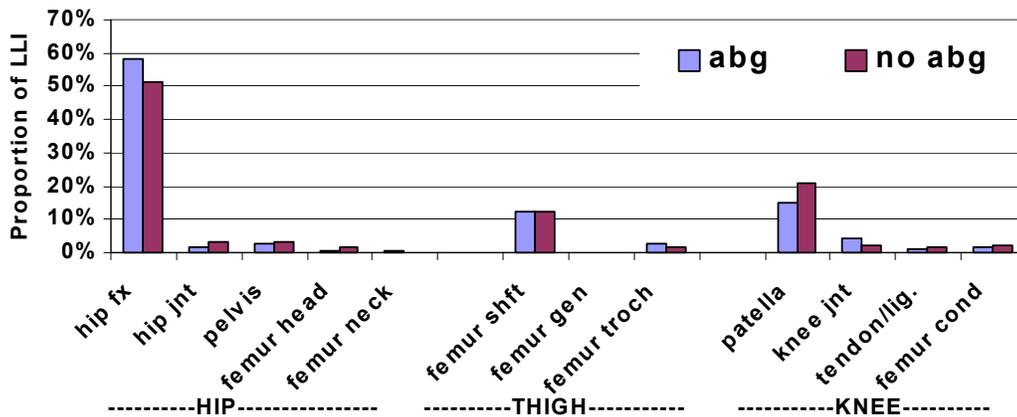


Figure 15. Proportion of Life years Lost to Injury (LLI) for AIS 2+ KTH injuries

Table 1.
Annual estimate of comprehensive costs of lower extremity injuries in air bag equipped vehicles involved in frontal crashes (2000\$ value).

Body Region	AIS Levels			Total cost (billion \$)
	1	2	3	
knee	596	6854	36	1.75
thigh	0	11	1839	1.23
hip	489	2543	467	0.97
lowerleg	8	1607	1343	1.29
foot/ankle	3724	8613	26	2.39
Unit Cost (\$)	66467	246660	668333	

The average annual comprehensive cost of lower extremity injuries for air bag equipped vehicles was computed using the nonfatal injury unit cost based on year 2000 dollar value in Economic Impact of Motor Vehicles Crashes (Blincoe, 2002). The average annual number of lower extremity injuries at different

AIS levels along with the unit cost of injury by AIS level and the total cost for each body region is shown in Table 1. The total annual cost of lower extremity injuries is \$7.64 billion of which knee-thigh-hip injuries account for 52% of the total economic cost of lower extremity injuries. The comprehensive cost includes the economic cost as well as an estimated cost of pain and suffering and loss in quality of life.

The unit costs of lower extremity injuries are based only on the AIS levels of the lower extremity injuries and no differentiation is made between the injured lower extremity regions. Further improvement in cost estimates can be made by using unit costs, if available, that are based on the region of the lower extremity injury as well as the on the severity of the injury.

SUMMARY

The NASS/CDS database for the years 1993-2001 was examined to better understand the rate and frequency of injuries to the knee-thigh-hip complex in frontal crashes.

The current analysis only used the NASS/CDS data for towaway crashes and the results have not been adjusted to represent all frontal crashes (including non-towaway) crashes. Comparisons made are based on point estimates, some of which are based on small sample size. Analysis has not been conducted to determine the statistical significance of the comparisons.

Forty percent of front seat occupants were in air bag equipped vehicles. Eighty percent of front outboard occupants were drivers and the belt use rate in air bag equipped vehicles was 88% while that in no air bag vehicles was 74%.

The risk of AIS 2+ injuries to the KTH complex for belted occupants in air bag equipped vehicles is relatively high compared to the risk of AIS 2+ injury to the upper body.

Lower extremity injuries are the most frequent injured body region in all frontal crashes accounting for 36% of all AIS 2+ injuries sustained by front seat occupants. Approximately half (18%) of these lower extremity injuries are to the knee-thigh-hip (KTH) complex. The estimate of annual Life-years Lost to Injury (LLI) associated with AIS 2+ KTH injuries in air bag equipped vehicles involved in frontal crashes is over 60,000 years and approximately 23% of LLI associated with all AIS 2+ injuries sustained by occupants in frontal crashes. The high proportion of LLI associated with KTH injuries indicates the high level of functional limitation associated with KTH injuries.

The risk of AIS 2+ KTH injuries among restrained occupants is higher in air bag equipped vehicles than no air bag vehicles. The KTH injury risk is also higher for the unrestrained occupant than the restrained occupant. Similar observations were made by Rupp, et al. (2002).

The risk of AIS 2+ injuries in air bag equipped vehicles involved in frontal crashes is not significantly different between different vehicle body types. However, the risk of AIS 2+ KTH injuries are higher in utility vehicles than in passenger cars and light trucks and vans. This difference in risk of injury may not be significant since only 7% of the vehicles in the data set were utility vehicles.

The risk of AIS 2+ KTH injuries has increased in the newer models of air bag equipped vehicles compared to those before 1993. The proportion of AIS 2+ hip injuries among other injuries to the KTH complex is greater in newer vehicle models than

older ones as well as in air bag equipped vehicles compared to no air bag vehicles. The statistical significance of these differences in risk needs to be examined.

Assuming the average DeltaV of the crash and the average occupant characteristics remain invariant between air bag and no air bag vehicles, the higher risk of AIS 2+ lower extremity injuries and in particular KTH complex injuries in air bag equipped vehicles than in no air bag vehicles could be attributed to design changes in the vehicle interior components such as the knee bolster. Such design changes may also be associated with the observed higher risk of KTH injuries in newer vehicle models than in older vehicle models. Further research needs to be conducted to better understand the performance of various knee bolster designs in different restraint environments.

The results of the analysis do not indicate a strong influence of age and gender on the risk of KTH injury. This finding is similar to that noted by Ore, et al. (1993).

A detailed examination of KTH injuries in NASS using the AIS 90 codes indicates that hip, femur and patella fractures are the most frequently occurring AIS 2+ KTH injuries. While hip injuries account for 46% of all AIS 2+ KTH injuries, they account for 65% of the associated life years lost. This indicates that the disability and impairment level associated with hip injuries is higher than other KTH injuries.

The average annual comprehensive cost of KTH injuries is approximately \$4 billion. These costs include both economic costs as well as an estimate of the cost of pain and suffering and loss in quality of life. The unit costs of lower extremity injuries are based only on the AIS levels of the lower extremity injuries and no differentiation is made between the injured lower extremity regions. Further improvement in cost estimates can be made by using unit costs, if available, that are based on the region of the lower extremity injury as well as the on the severity of the injury.

The current analysis of the NASS/CDS data files indicates the high levels of disability and functional loss as well as the societal costs associated with injuries to the knee-thigh-hip complex. Due to the increasing use of safety belts and the availability of air bags, the risk of head, neck, thoracic, and abdominal injuries has reduced significantly. However, concomitant reduction in the risk of lower extremity injuries has not occurred. The change in restraint status has changed the injury profile of front seat occupants in frontal crashes. The overall societal cost of lower extremity injuries is increasing in proportion to upper body injuries. Therefore more

efforts need to be made in mitigating KTH complex and below knee injuries.

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