Alterations in Body Composition and Injury Patterns with Aging

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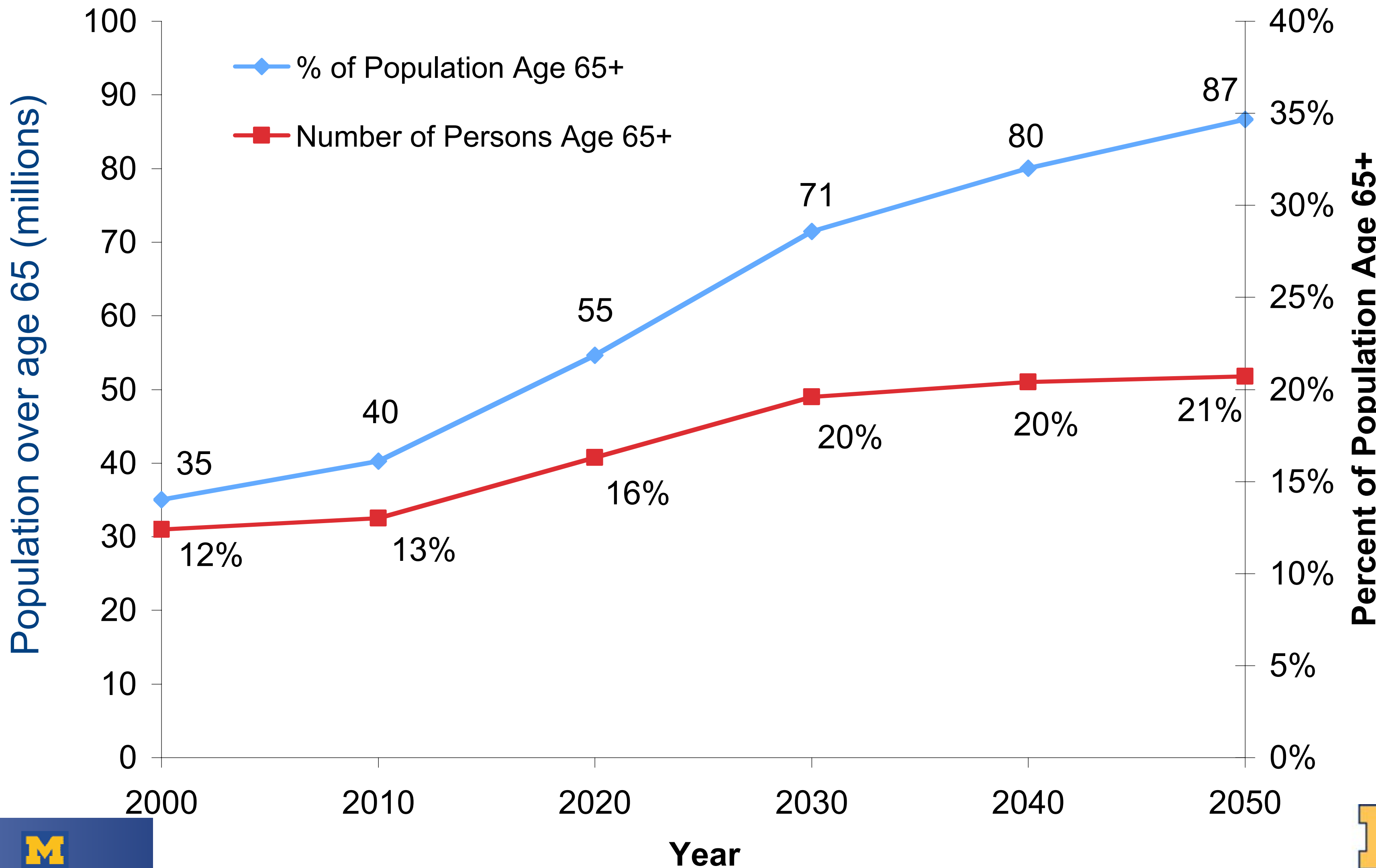
Motivation

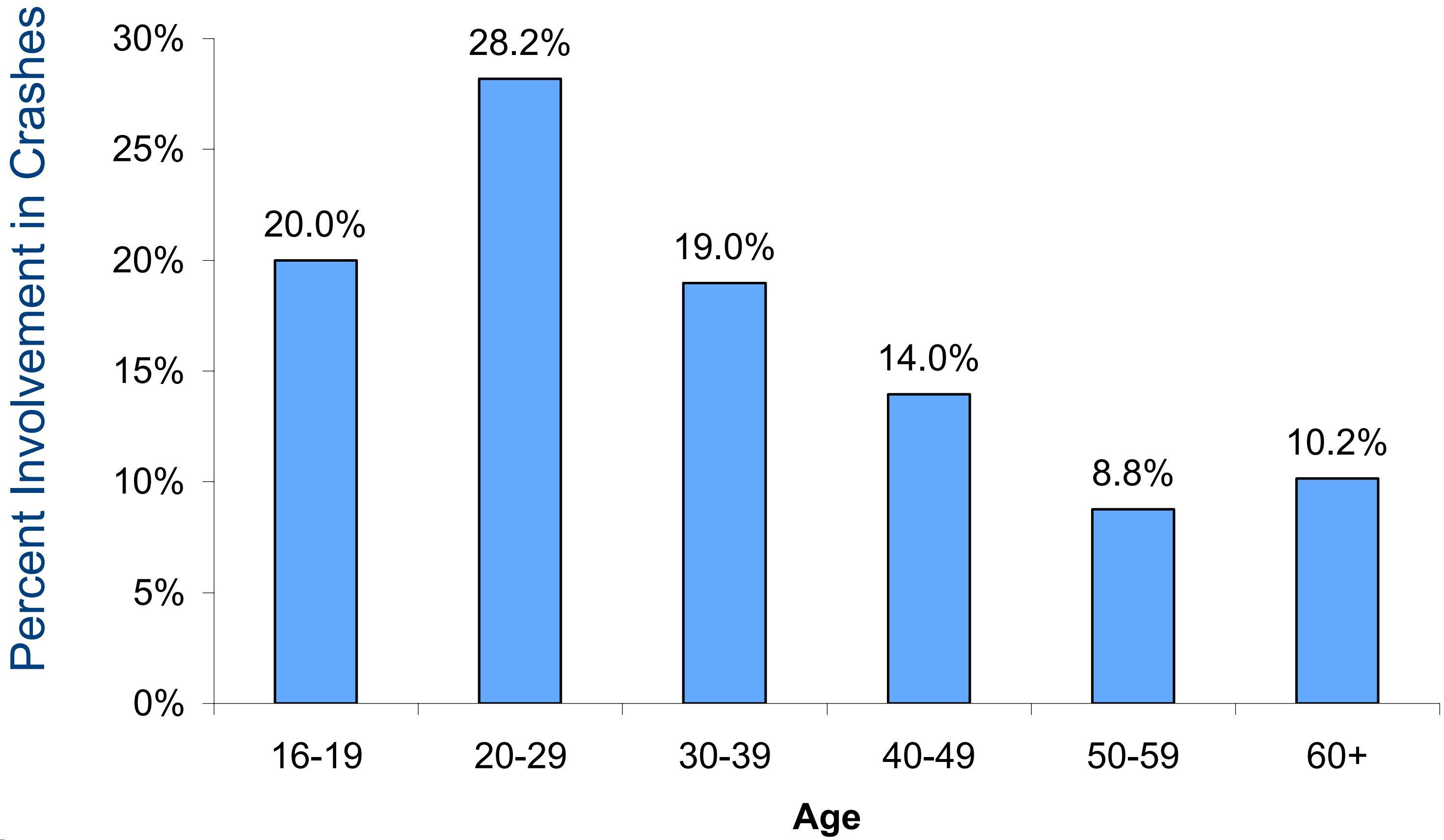


Source: US Census Bureau, 2004

Dataset Characteristics

- NASS 1998-2004
- All crash types
  - split into Frontal, Side, Rear, and Rollover based on CDC code of most severe event
  - side impacts further split into near side and far side based on occupant location relative to struck side
- Ages 16+
- All seat locations, unless otherwise specified
- MY $\geq$ 1985

Distribution of Ages of Occupants Involved in Crashes (All Crash Types)



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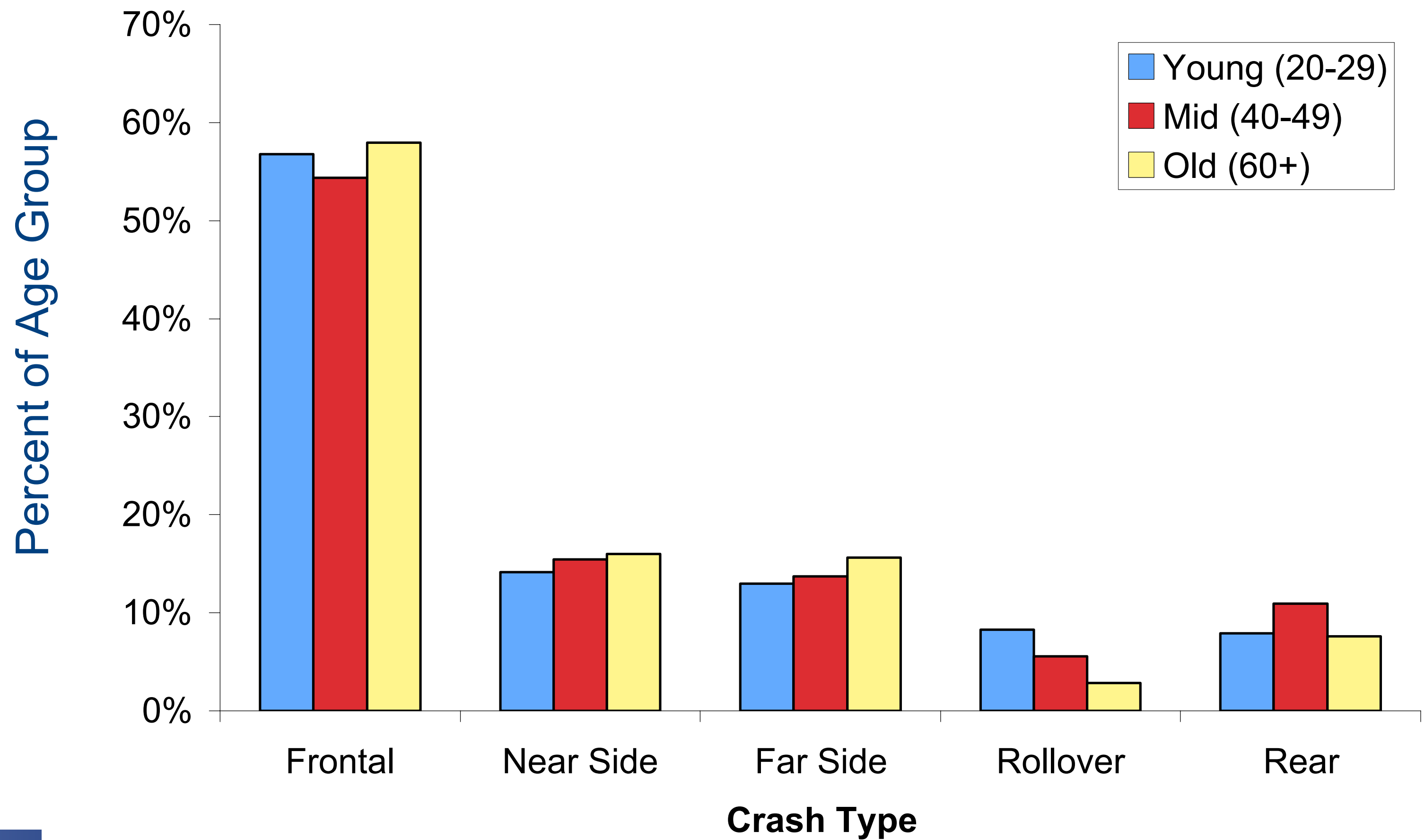
Distribution of Crash Types for Young, Middle Aged, and Elderly Age Groups (All Seating Positions)



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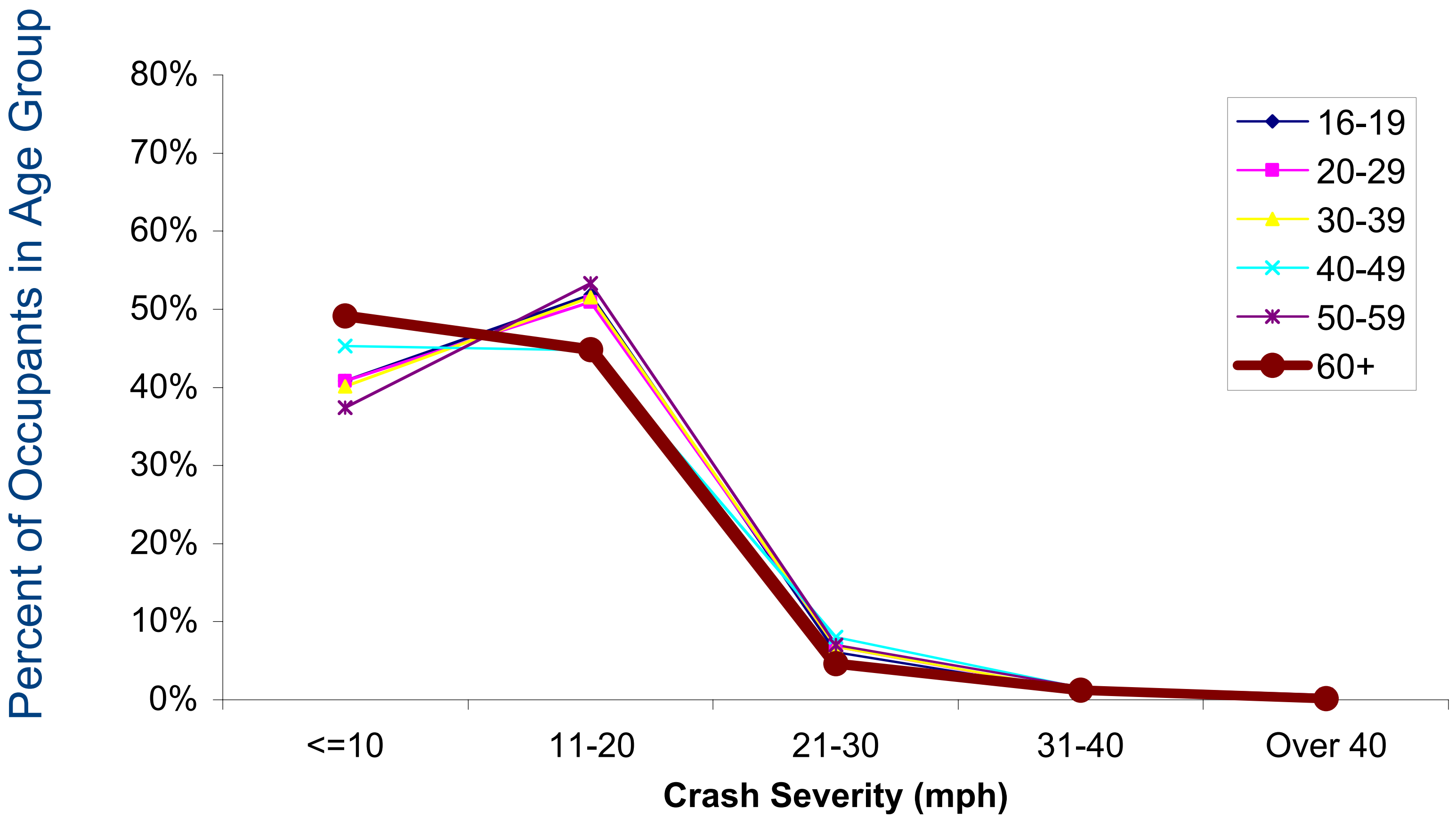
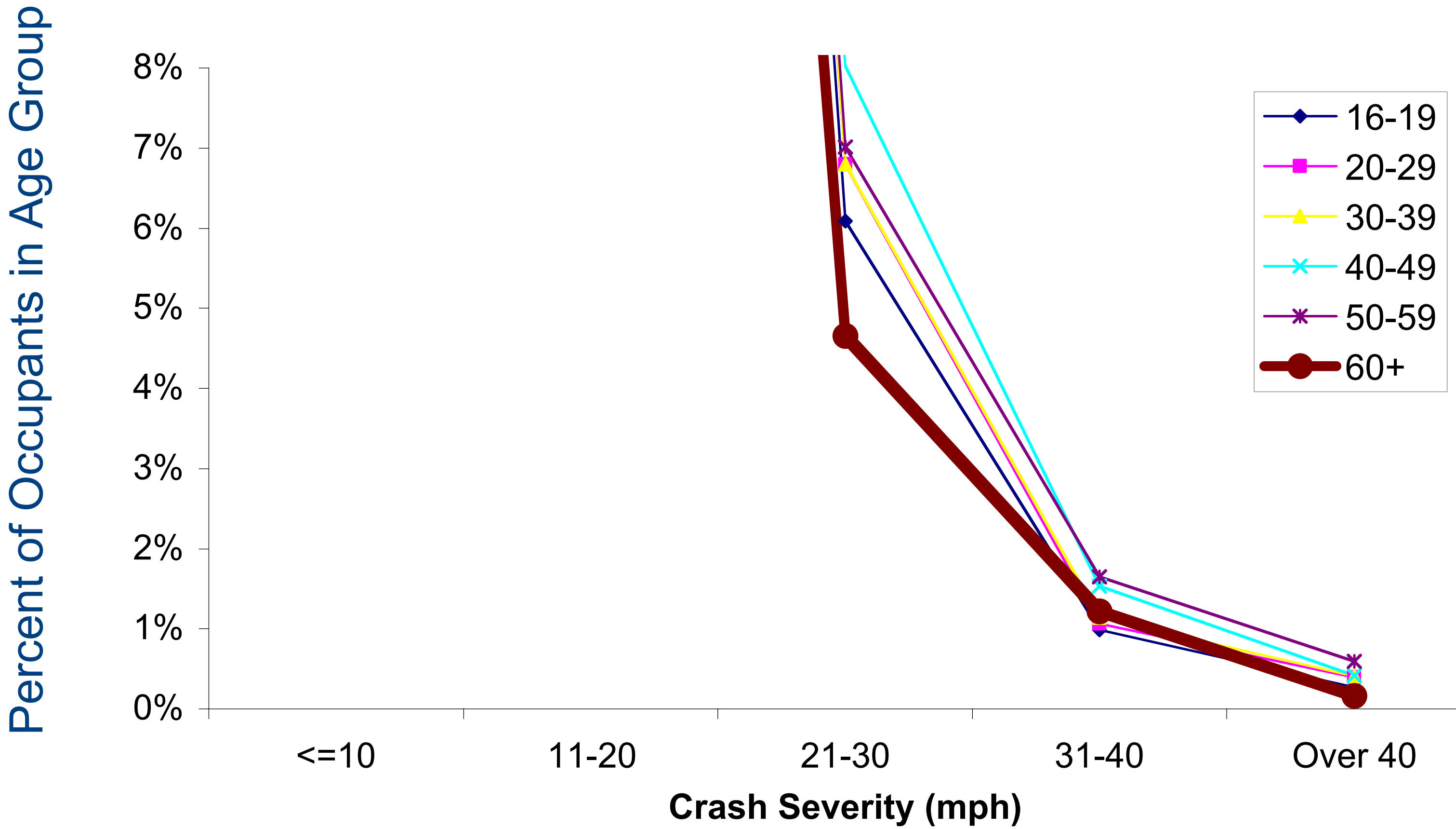
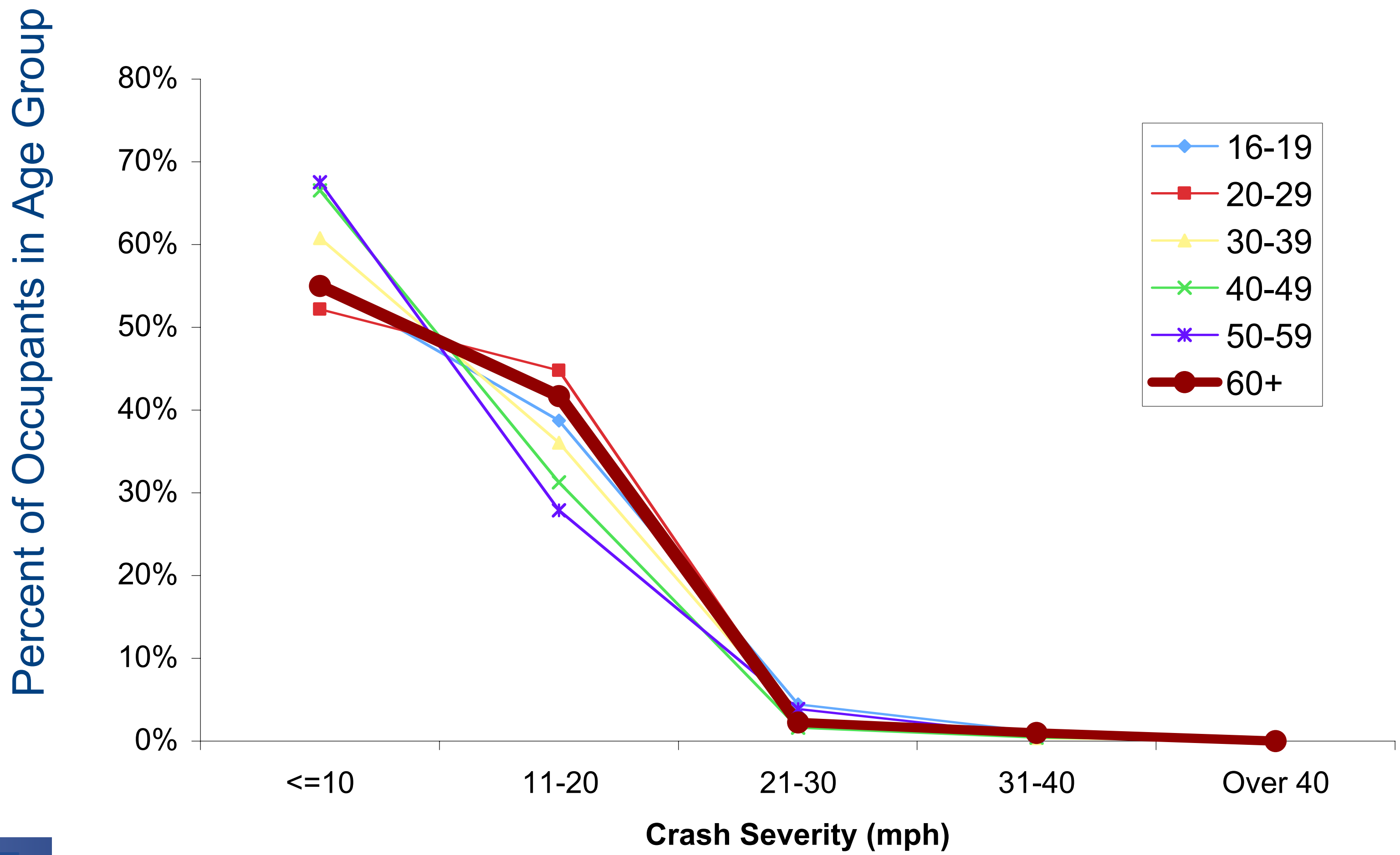
Crash Severity Distribution by Age Group (Frontal Crashes)



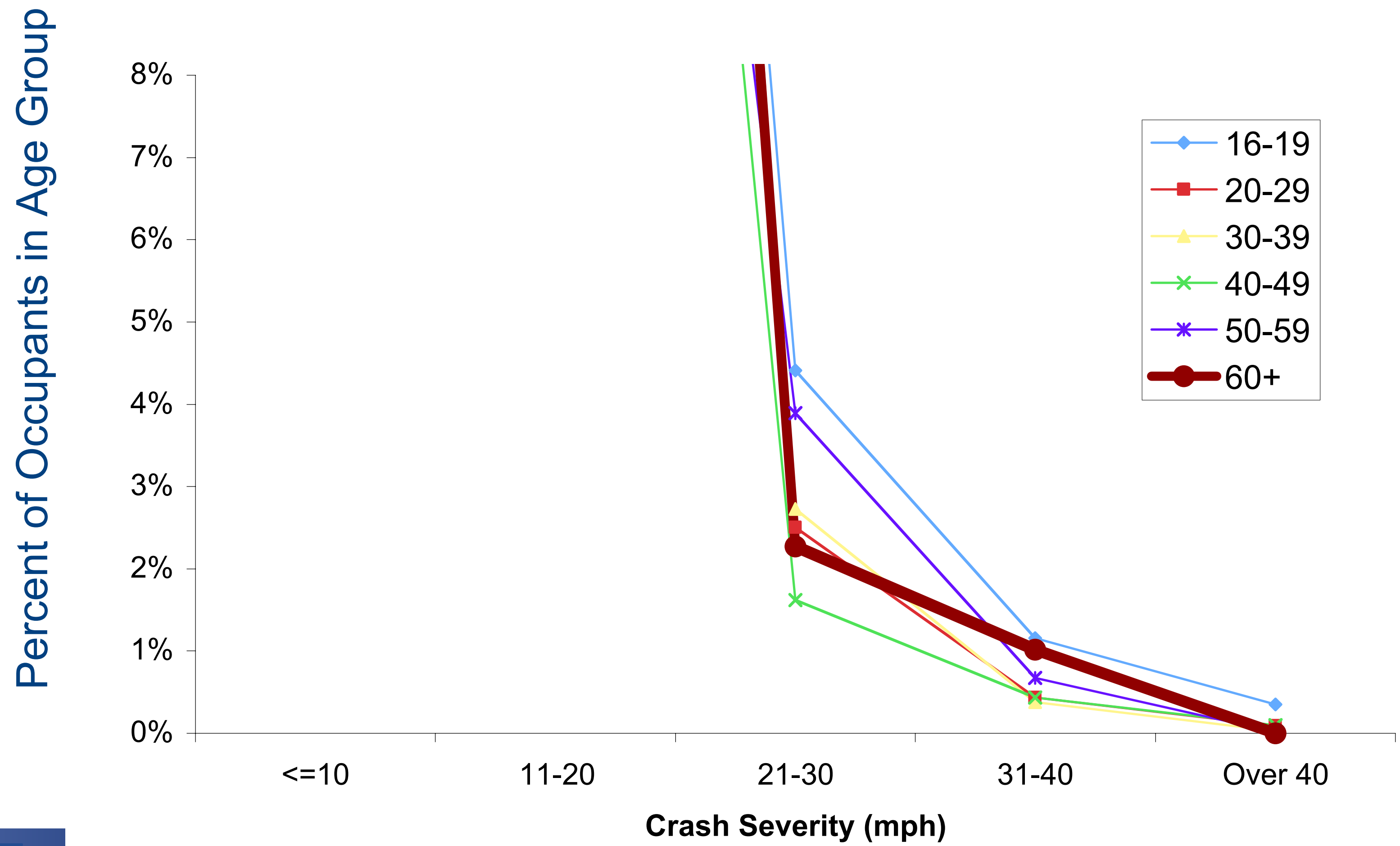
Crash Severity Distribution by Age Group (Frontal Crashes)



Crash Severity Distribution by Age Group (Near-Side Crashes)



Crash Severity Distribution by Age Group (Near-Side Crashes)



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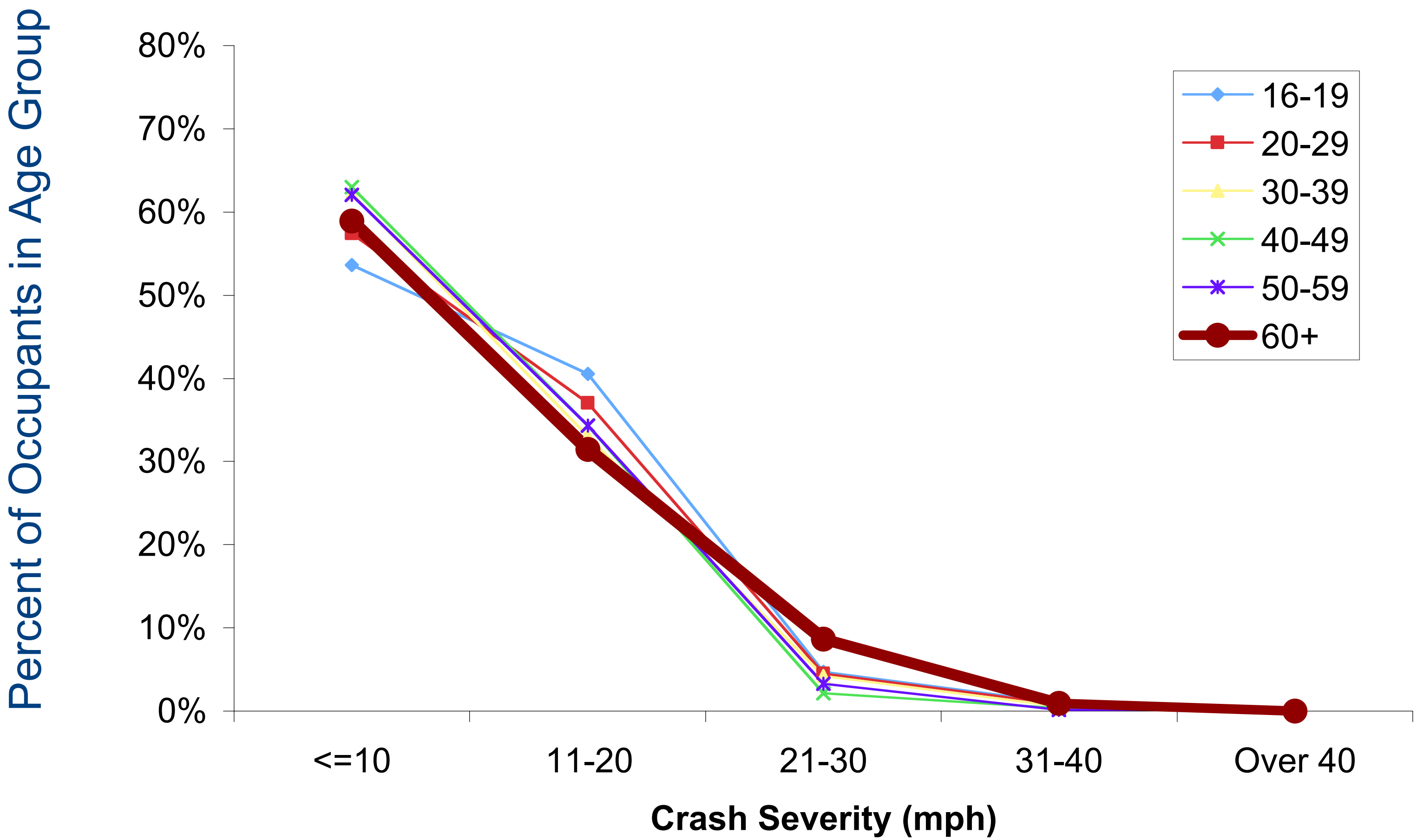
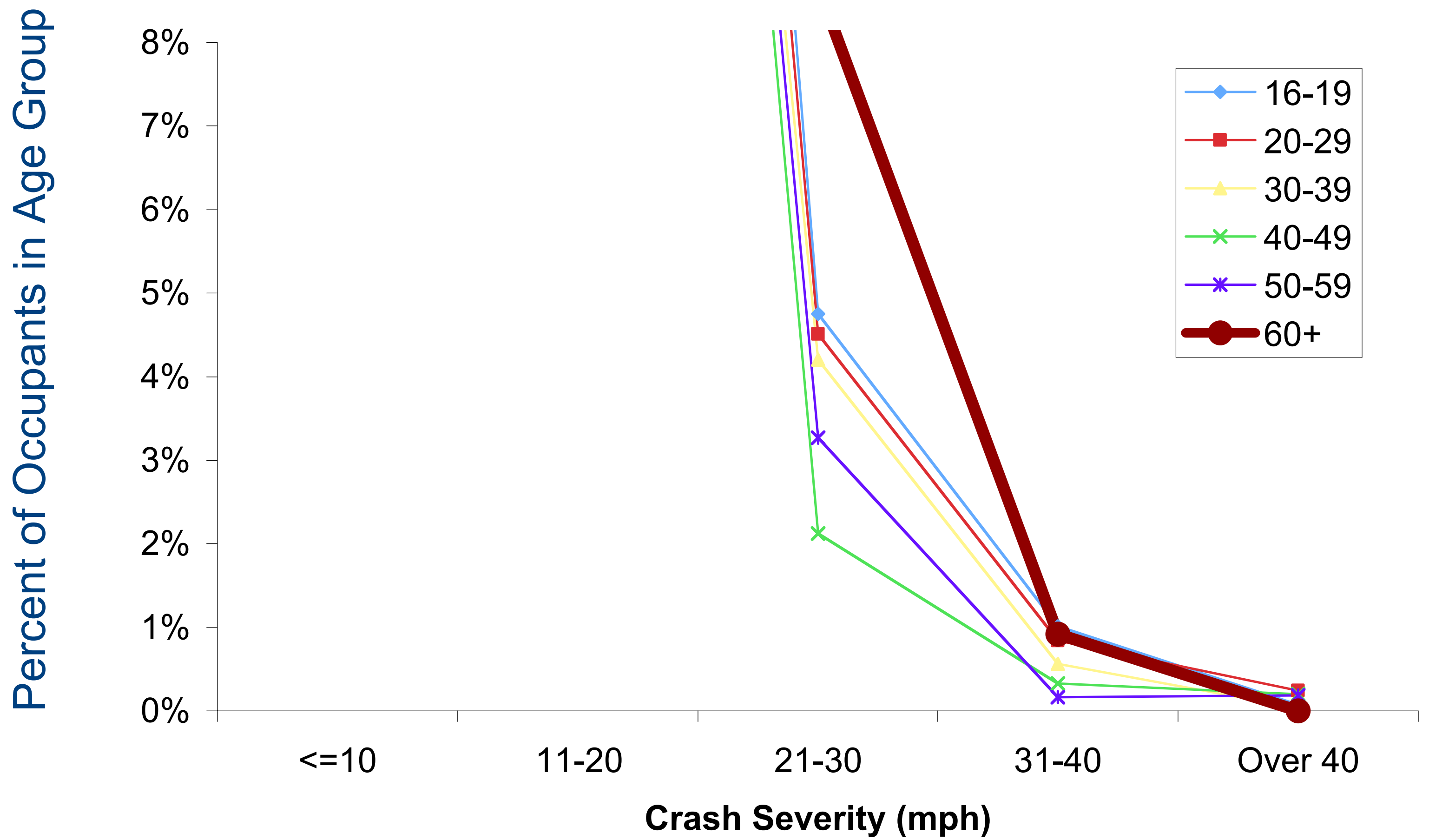
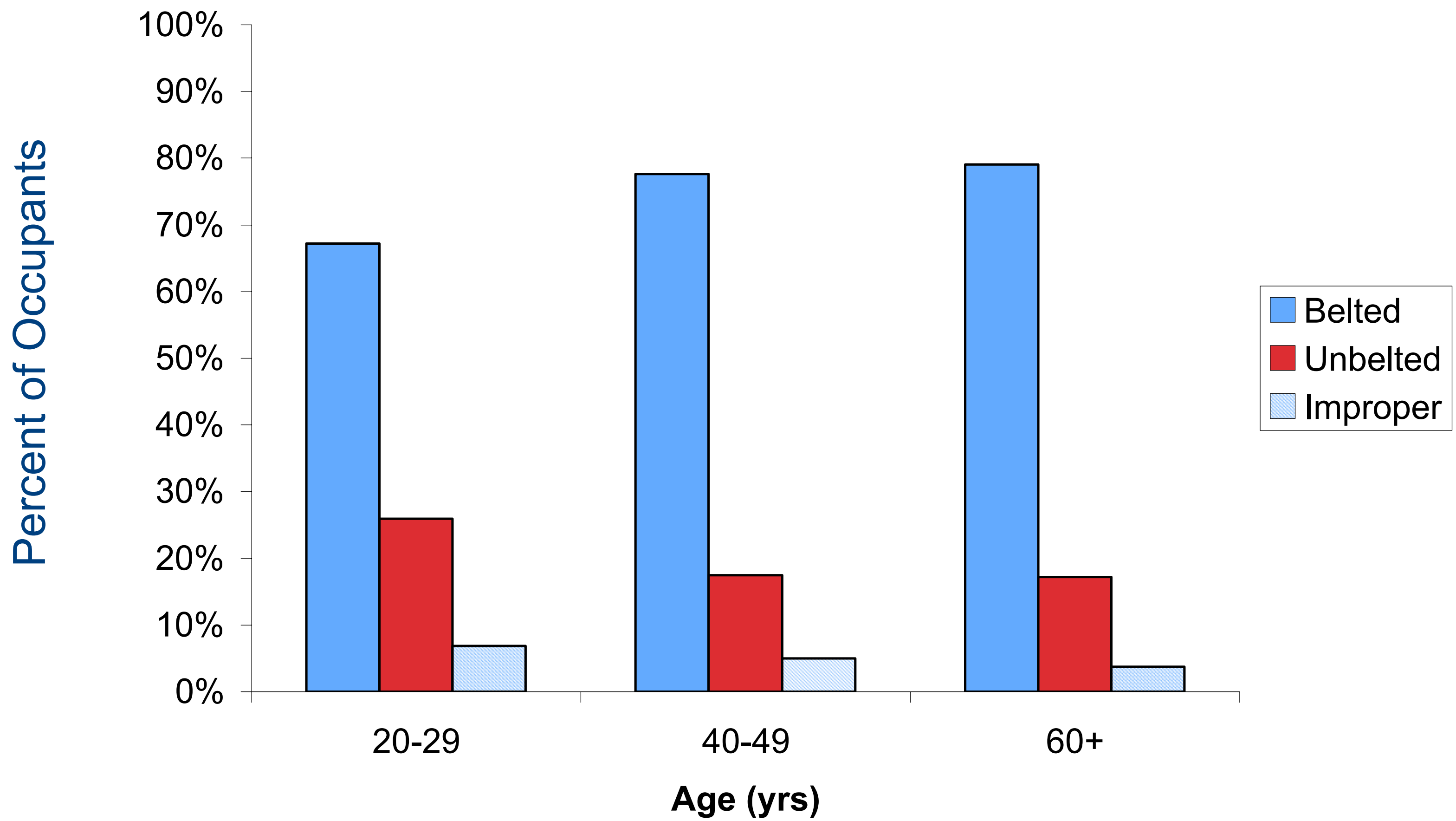
Crash Severity Distribution by Age Group (Far-Side Crashes)



Crash Severity Distribution by Age Group (Far-Side Crashes)



Belt-Use Rates for Young, Middle Aged, and Elderly Age Groups (All Crash Types)



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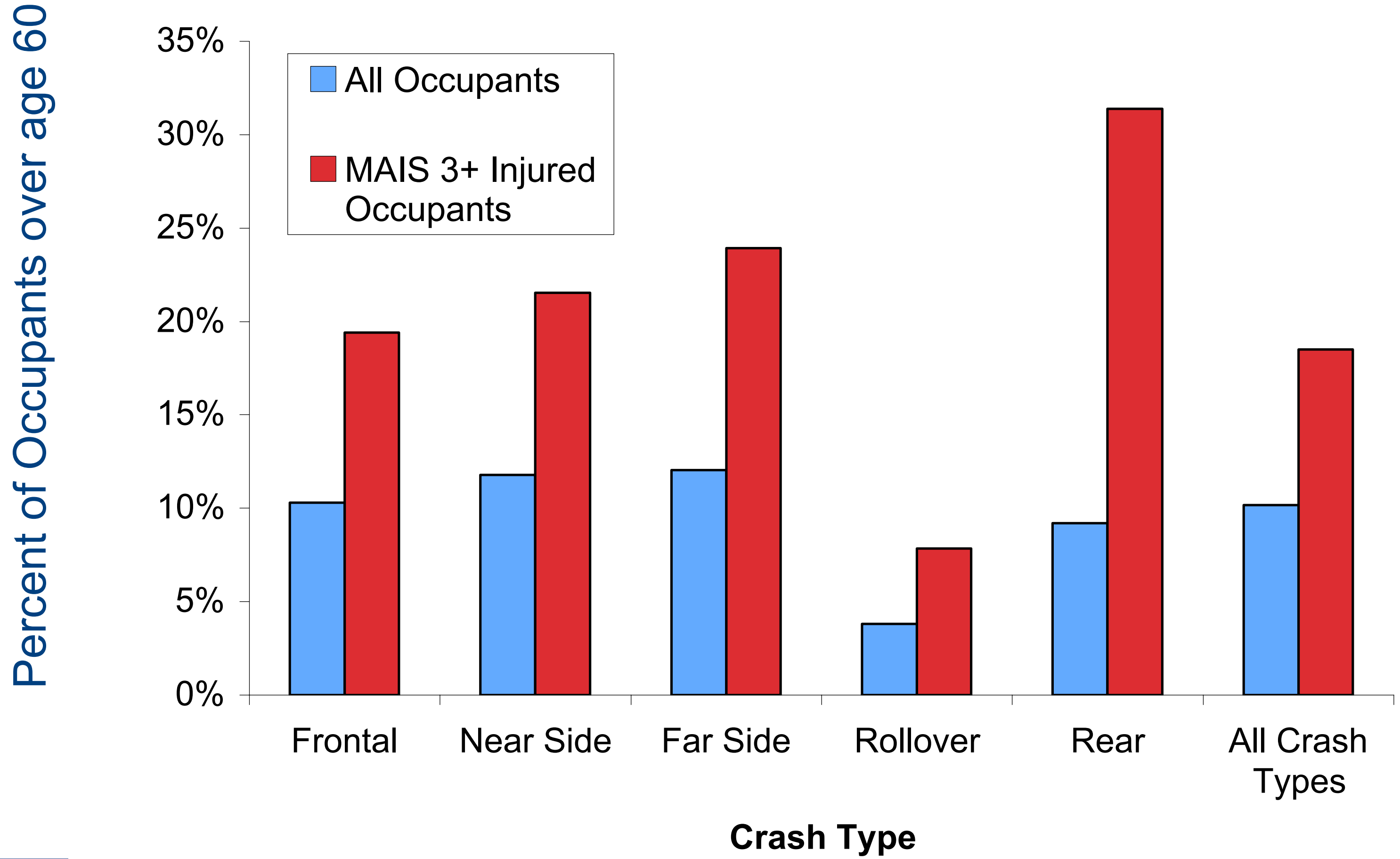
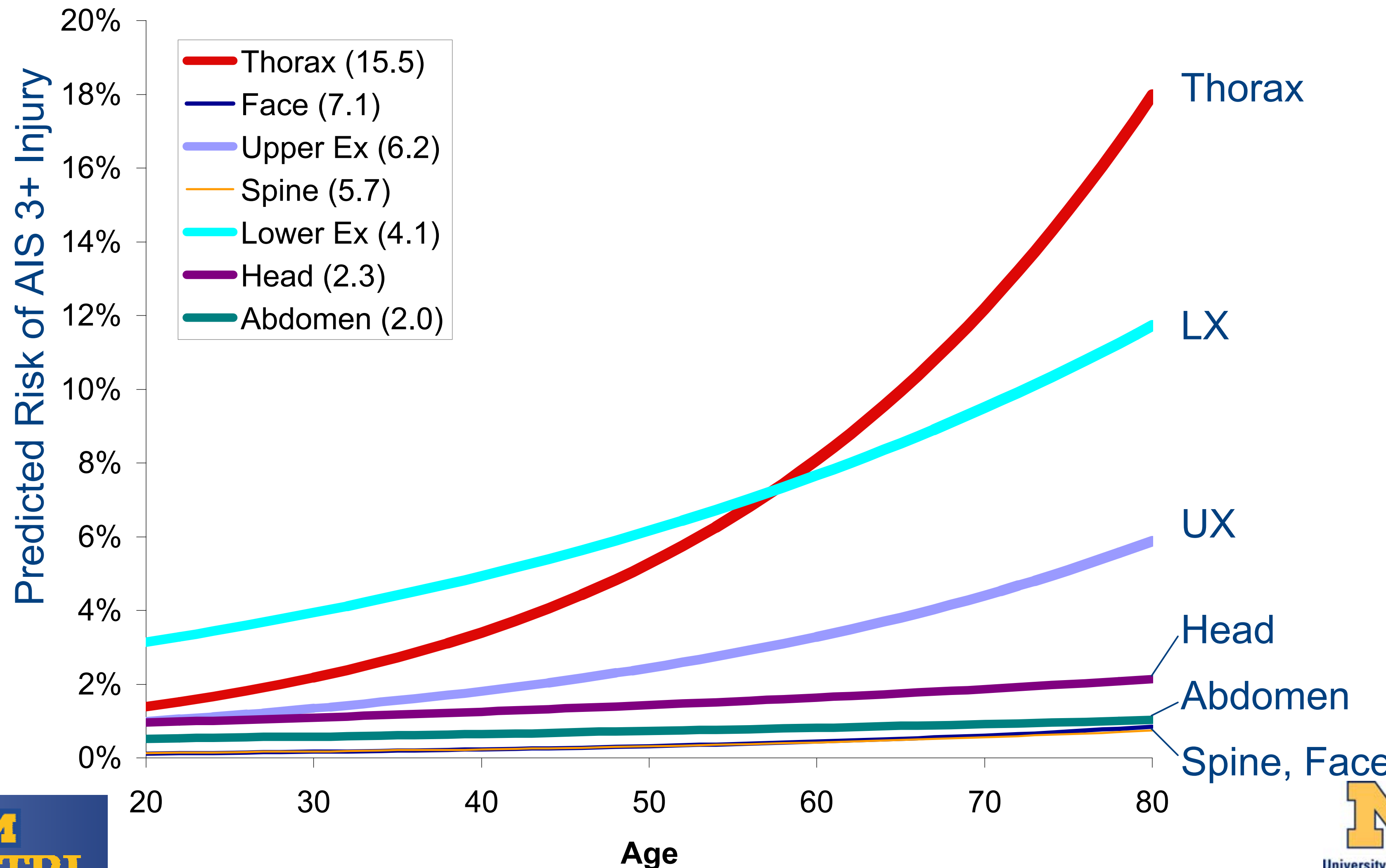
Elderly Occupants as Proportion of All Occupants and Proportion of MAIS 3+ Injured Occupants



Relationship Between Age and AIS 3+ Injury Risk by Body Region in **Frontal Crashes**
(Belted Drivers, 30 mph Crash Severity)



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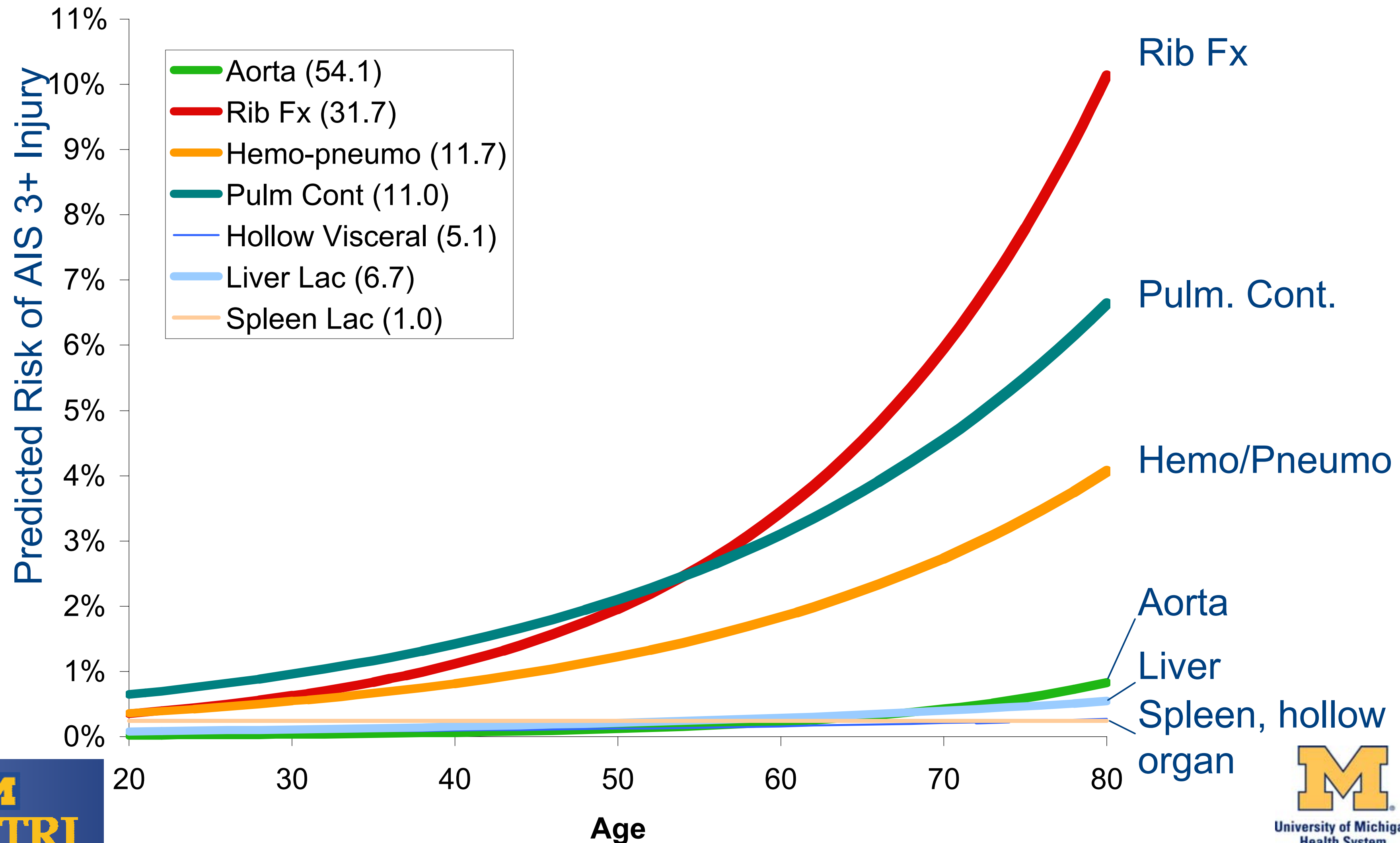
Relationship Between Age and Risk of Common AIS 3+ Thoracic and Abdominal Injuries in **Frontal Crashes** (Belted Drivers, 30 mph Crash Severity)



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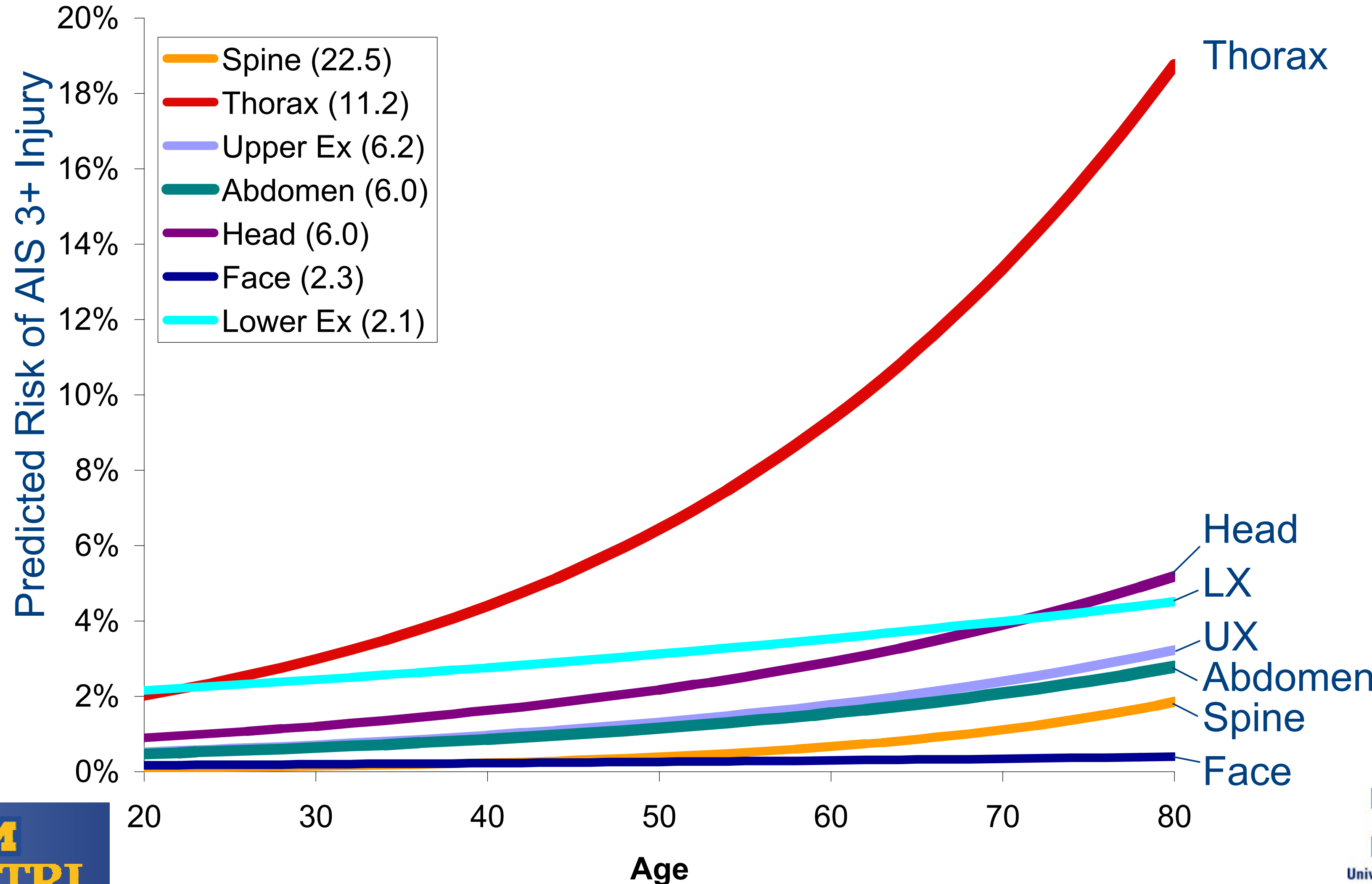
Relationship Between Age and AIS 3+ Injury Risk by Body Region in **Near-Side Crashes**
(Belted Drivers, 20 mph Crash Severity)



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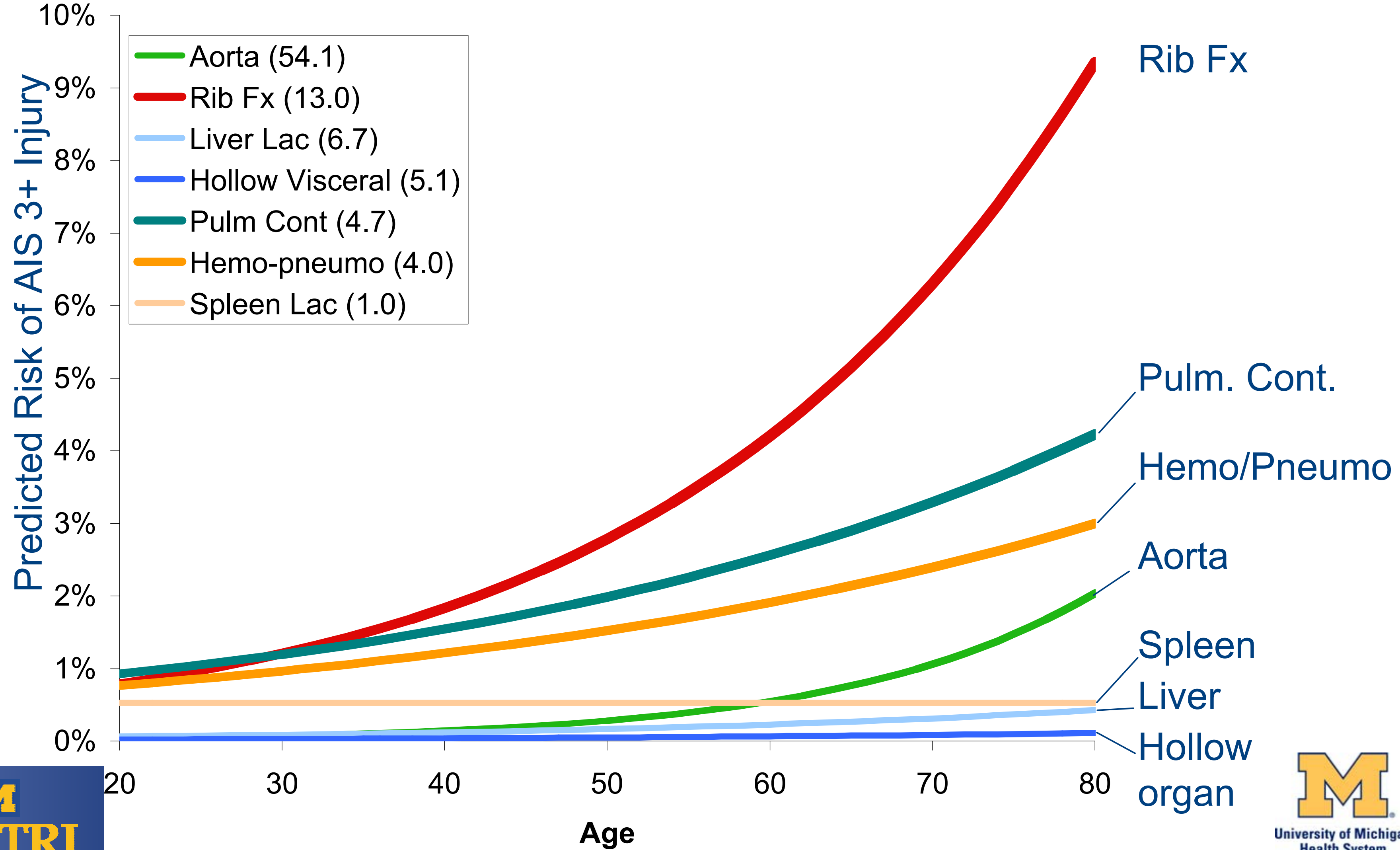
Relationship Between Age and Risk of Common AIS 3+ Thoracic and Abdominal Injuries in **Near-Side Crashes** (Belted Drivers, 20 mph Crash Severity)



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Relationship Between Age and AIS 3+ Injury Risk in **Far-Side Crashes**
(Belted Drivers, 20 mph Crash Severity)

Trends in injury risk with age in far side crashes are similar to those presented for near-side and frontal impacts

- Age effect for thoracic injuries is large and is small for abdominal injuries
- Absolute increase in injury risk with is greatest for thoracic injuries and, in particular, rib fx.

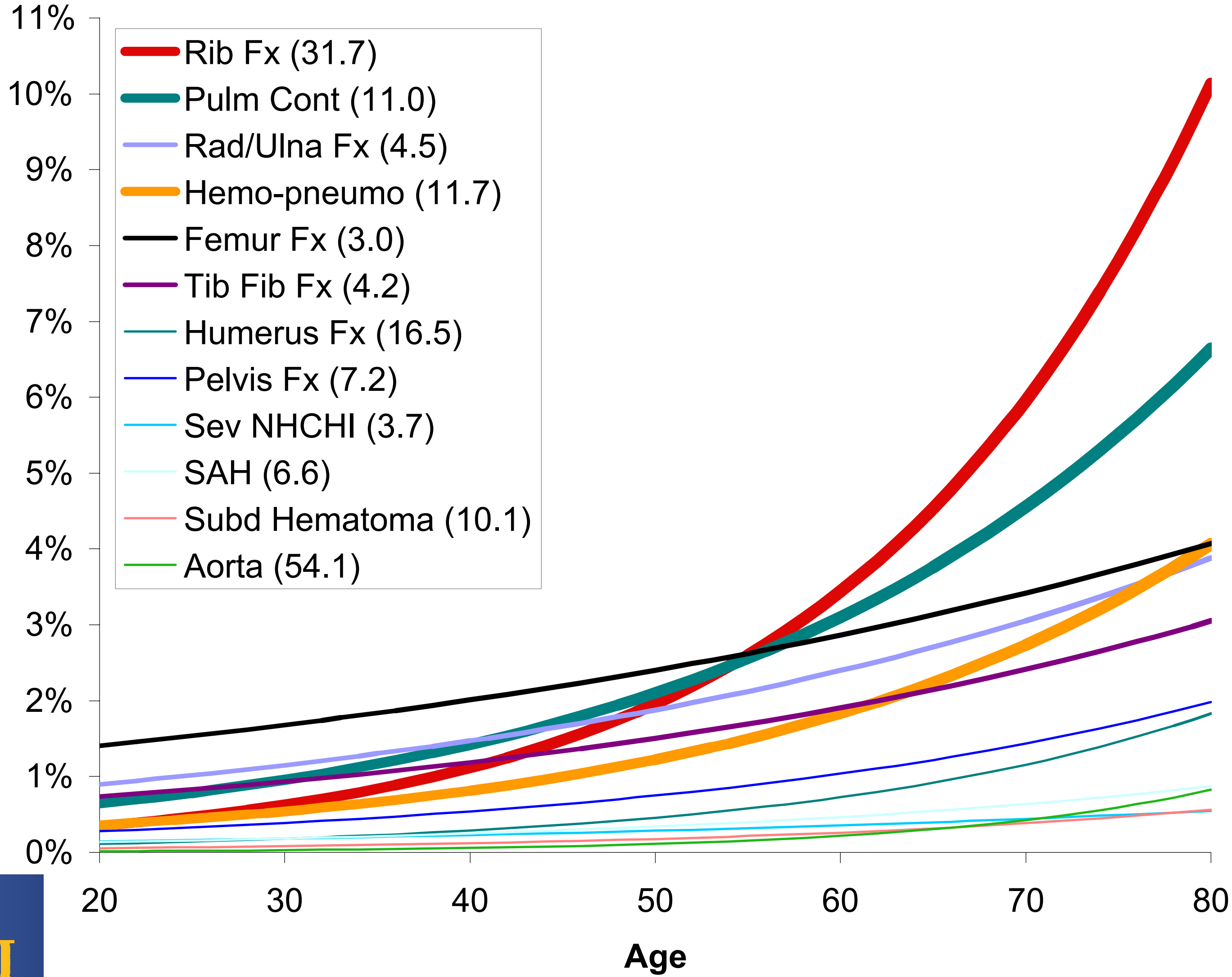
Biomechanics of Common Thoracic Injuries

- Top thoracic injuries are rib fx., hemo/pneumothorax and pulmonary contusions
- Injury mechanisms
  - Rib fractures: chest compression
  - Hemo/pnuemothoraces and pulmonary contusions: compression and rate of compression
- Observed age effects
  - Decreased amount of chest deflection required to cause rib fractures and rib breaking strength
  - Reduction in rib BMD and cross-sectional area
  - Decreases in lung elasticity

Biomechanics of Common Abdominal Injuries

- Top abdominal injuries are liver and spleen contusion/laceration
- These injuries typically occur from:
  - Abdominal compression (spleen/liver compressed against other anatomic structures)
  - Compression and rate of compression (high rate loading causes over pressure that leads to a tear/rupture)
- Less common mechanisms of spleen/liver injury include:
  - Acceleration
  - Laceration caused by displaced rib fractures
- Likelihood of abdominal injuries has not been shown to increase with age in the biomechanical literature

Relationship Between Age and Risk of Common AIS 3+ Injuries in **Frontal Crashes**
(Belted Drivers, 30 mph Crash Severity)



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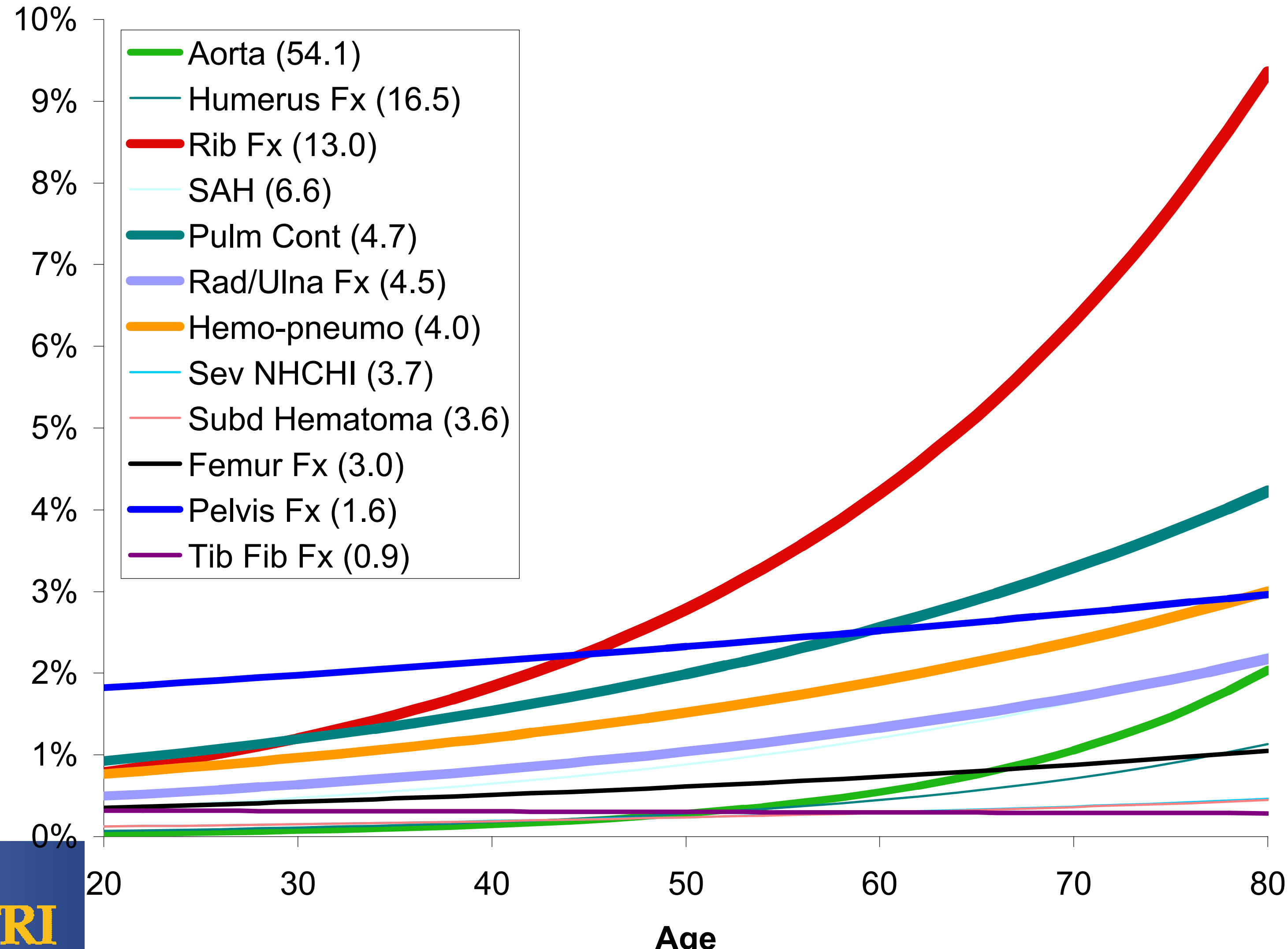
Relationship Between Age and Risk of Common AIS 3+ Injuries in **Near-Side** Crashes (Belted Drivers, 30 mph Crash Severity)



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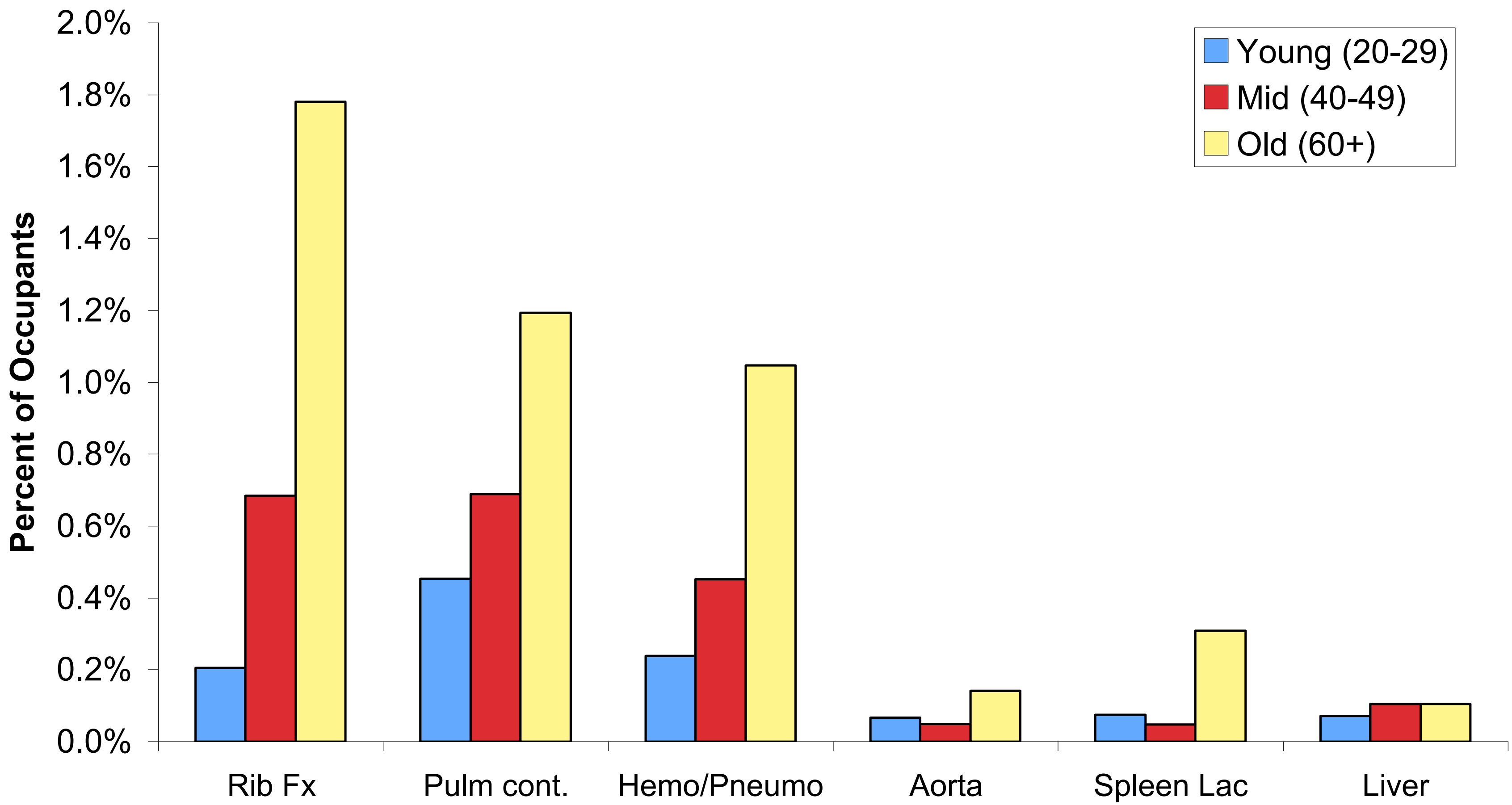
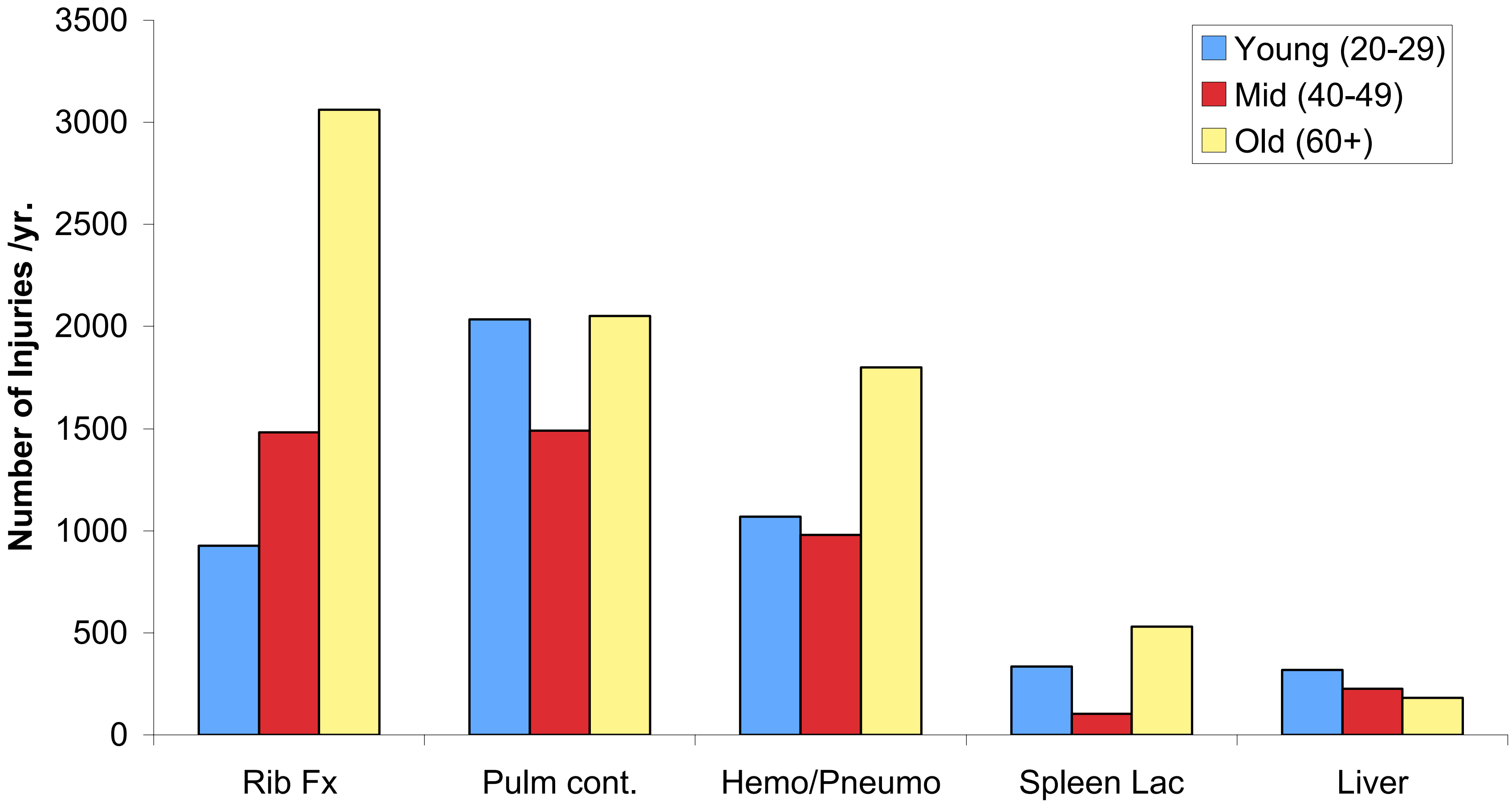
Rates of AIS 3+ Abdominal and Thoracic Injuries for Young, Middle Aged, and Elderly Age Groups (Frontal Crashes)



Annual Incidence of Select AIS 3+ Thoracic and Abdominal Injuries for Young, Middle Aged, and Elderly Age Groups (Frontal Crashes)



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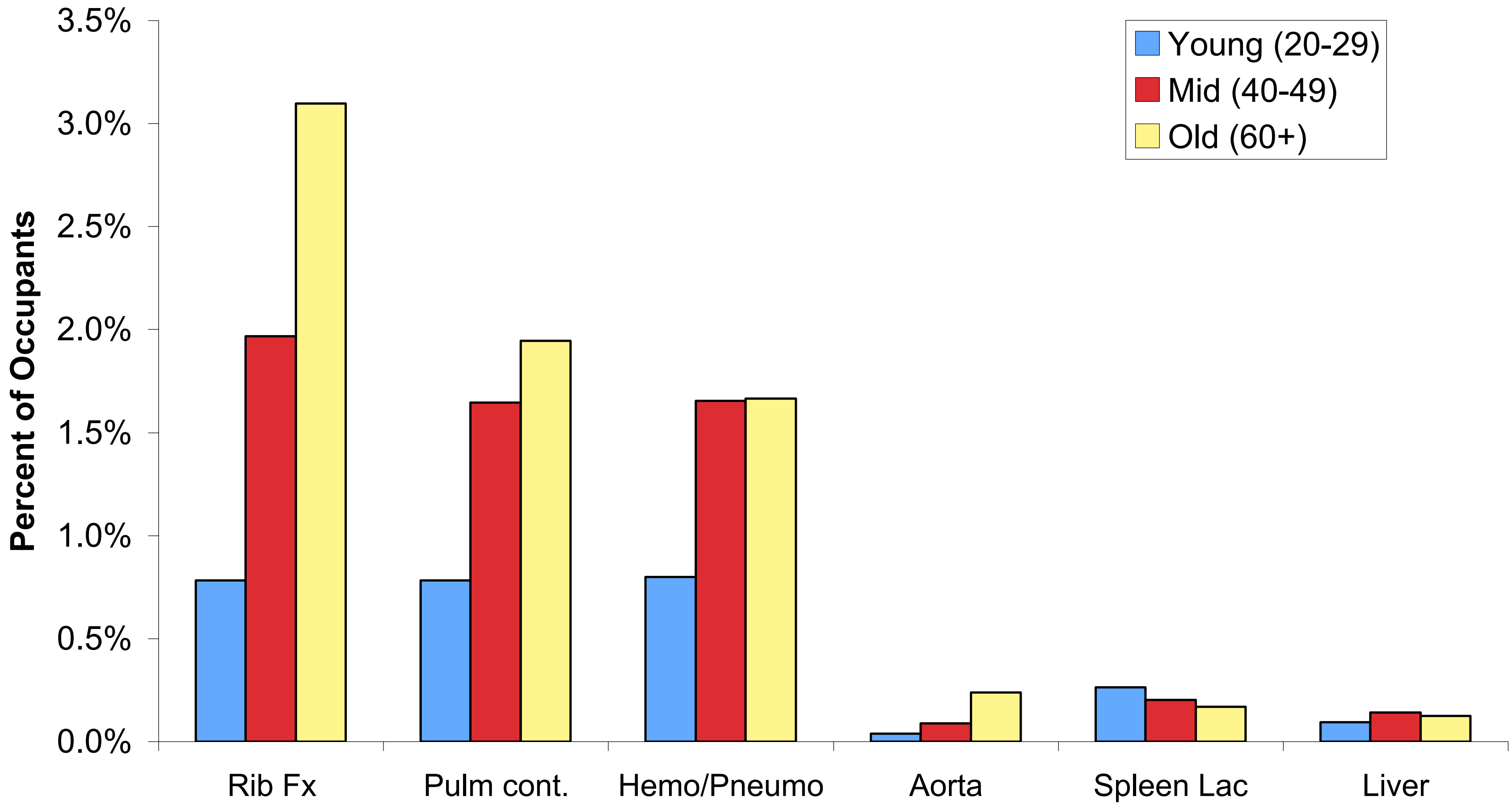
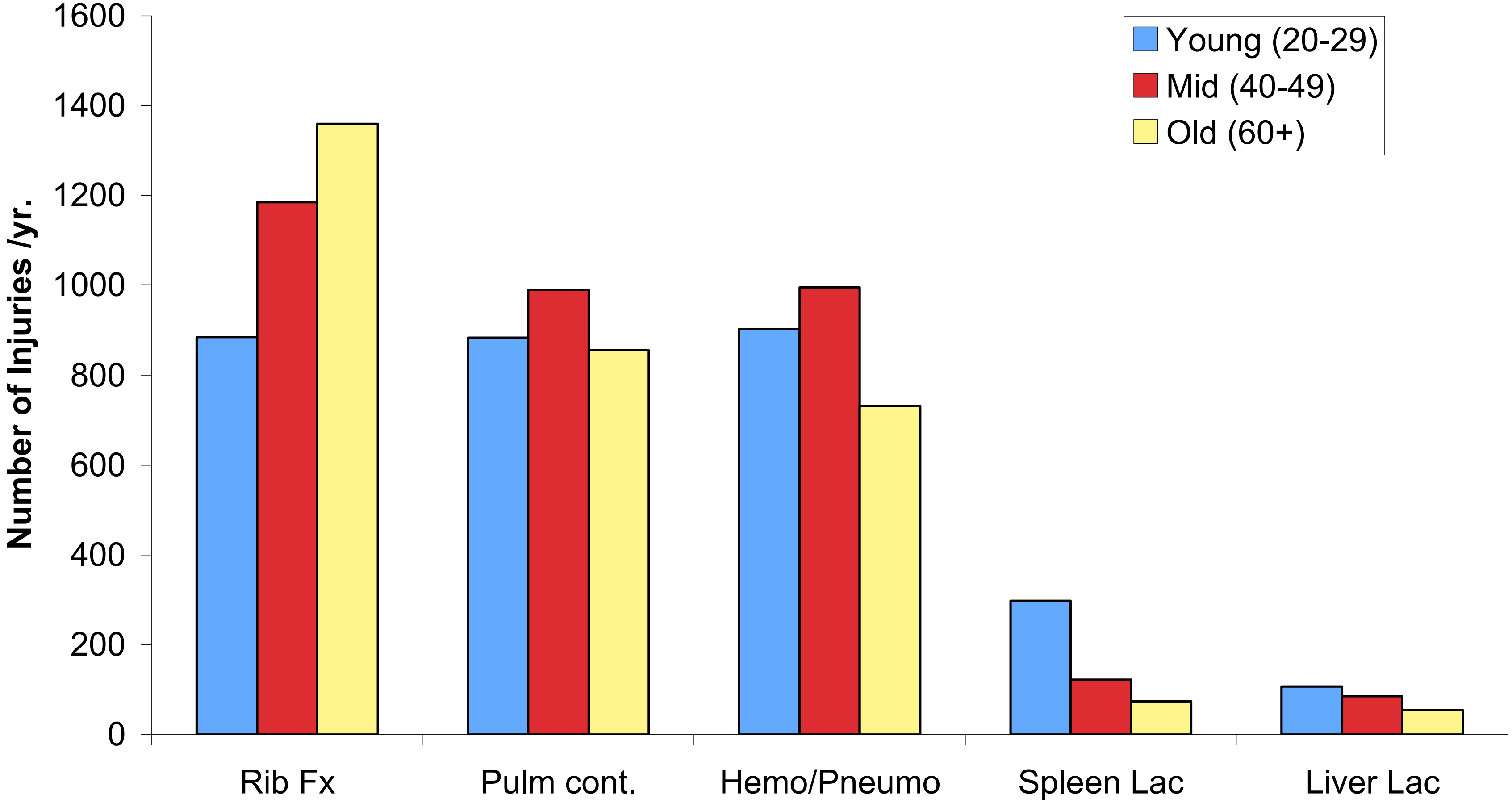
Rates of Select AIS 3+ Abdominal and Thoracic Injuries for Young, Middle Aged, and Elderly Age Groups (Near-Side Crashes)



Annual Incidence of Select AIS 3+ Thoracic and Abdominal Injuries for Young, Middle Aged, and Elderly Age Groups (Near-Side Crashes)



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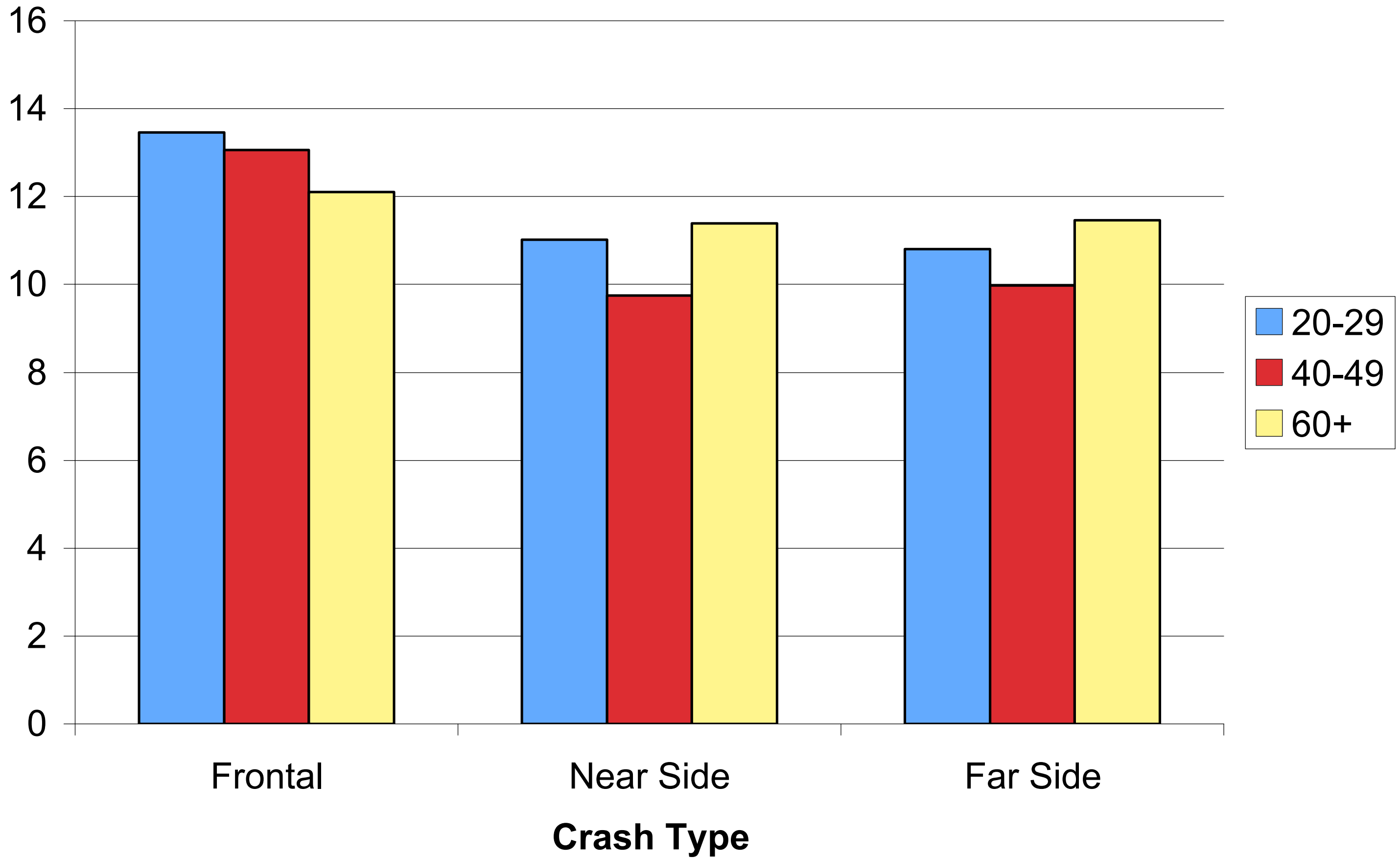
Mean Crash Severity for Young, Middle Aged, and Elderly Occupants



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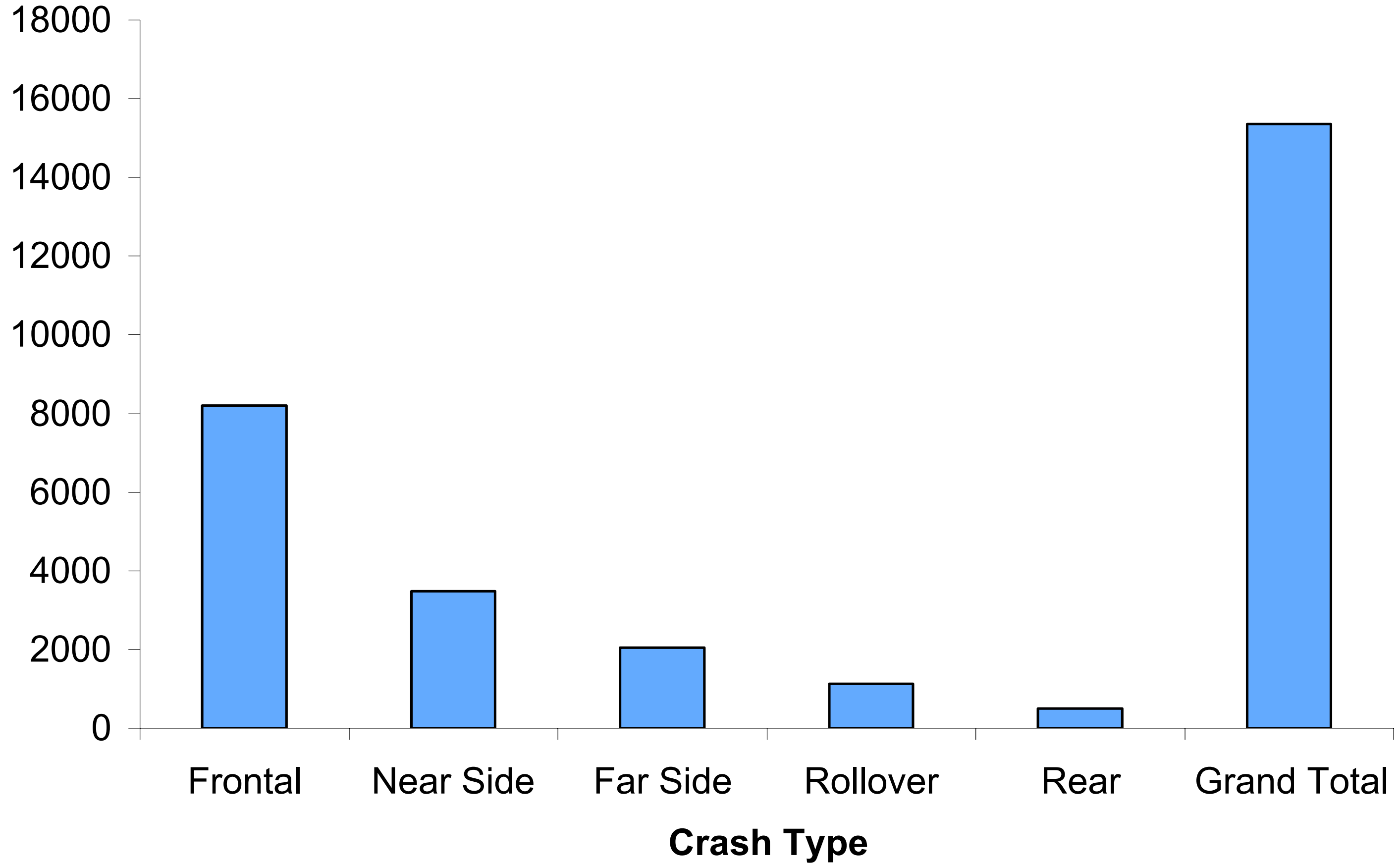
Number of Elderly (Age 60+) Occupants with MAIS 3+ Injuries by Crash Type



What is Age?

How do you put age into an ATD or a model?

Can we change Age from a confounding factor into something that provides insight into how the body responds to traumatic forces by analyzing how differences in the body with aging affects injury tolerance?

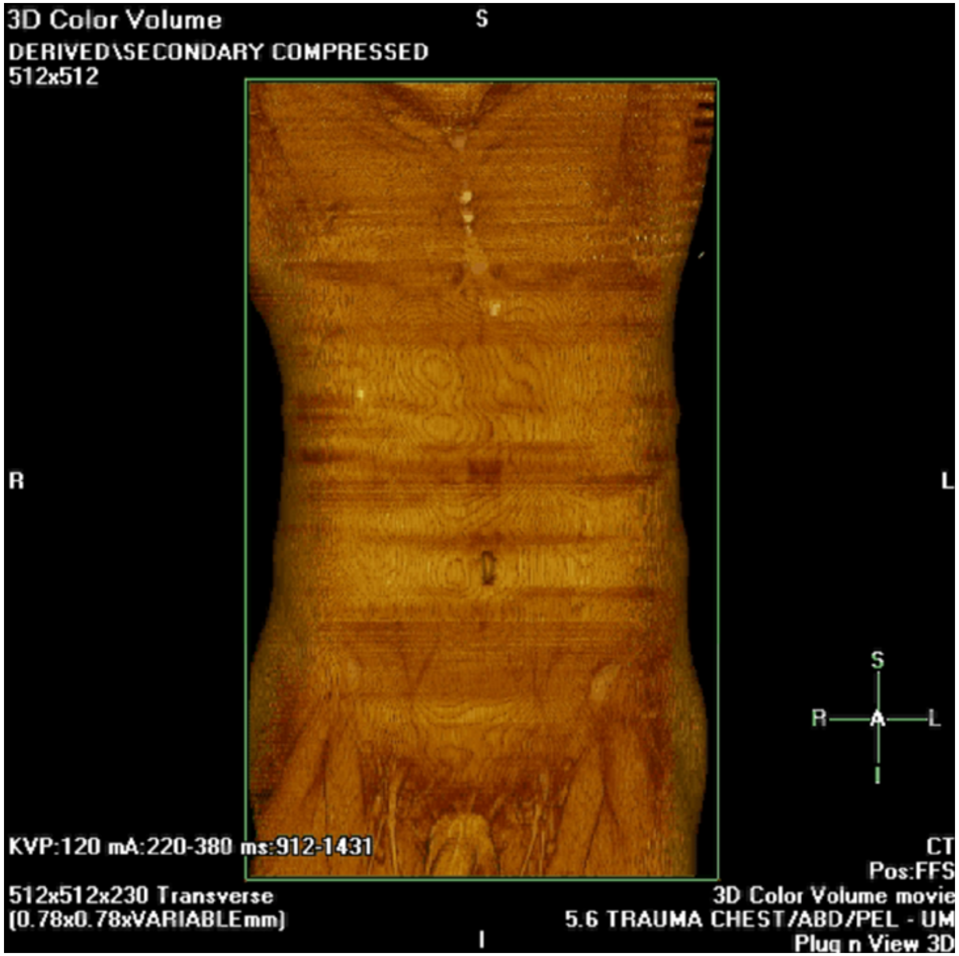
Hypotheses

- The geometry of the human body as well as the volume and nature of different components that comprise it change as an individual ages.

- Changes in body composition and geometry with aging result in altered injury tolerance in MVCs.

Study Methods

CT scans from CIREN subjects as well as control populations were analyzed



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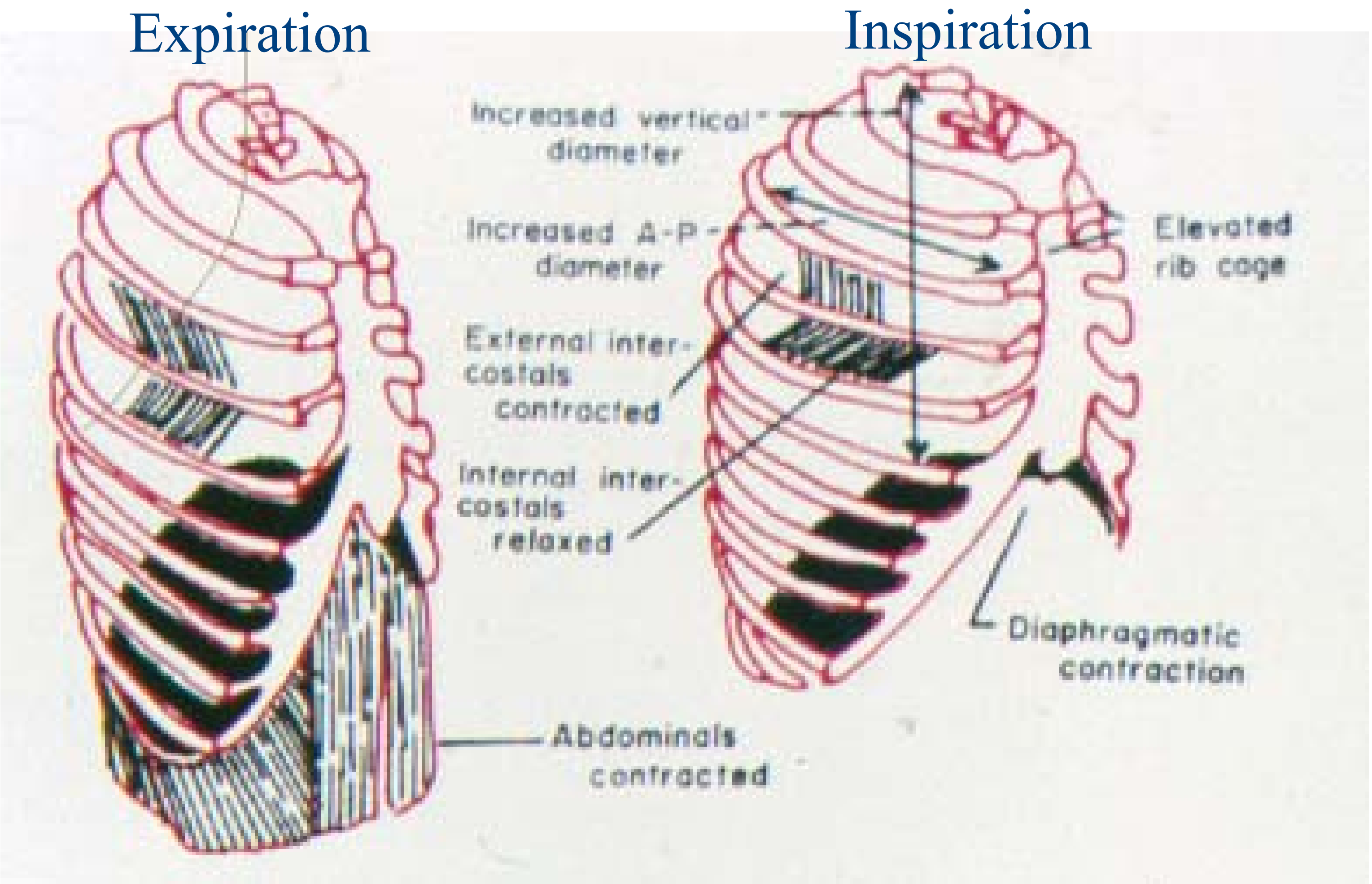
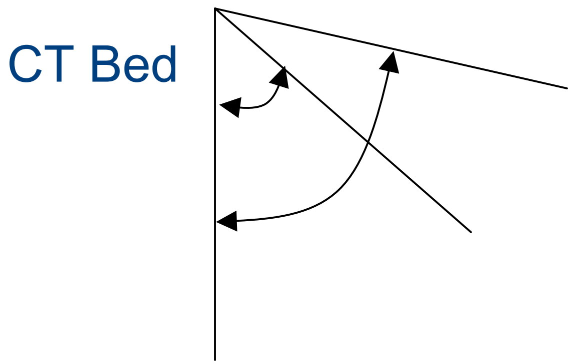
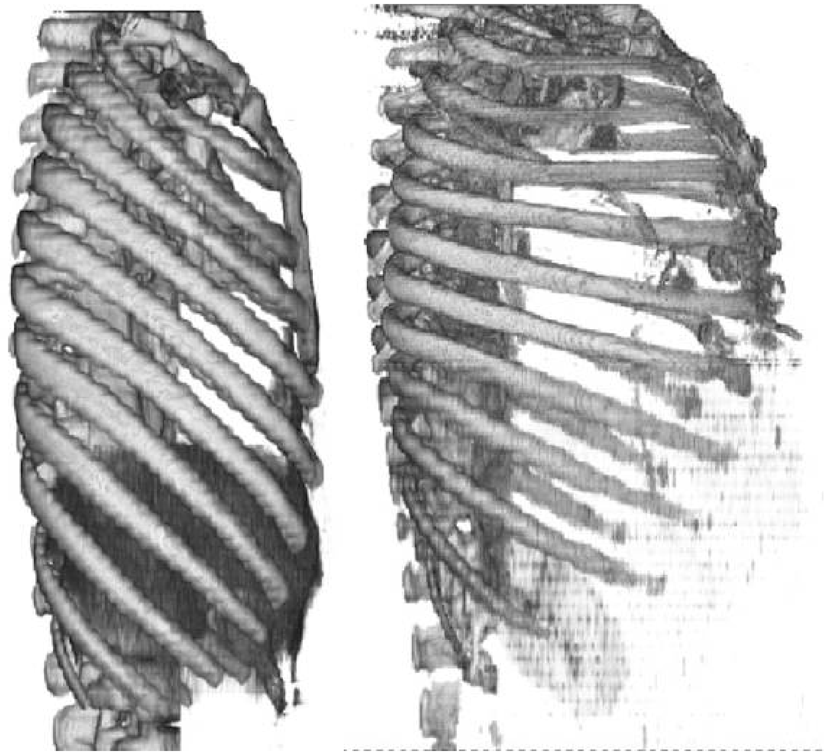


Expansion and contraction of the thoracic cage during expiration and inspiration, illustrating especially diaphragmatic contraction, elevation of the rib cage, and function of the intercostals.

Rib Angle Measurement





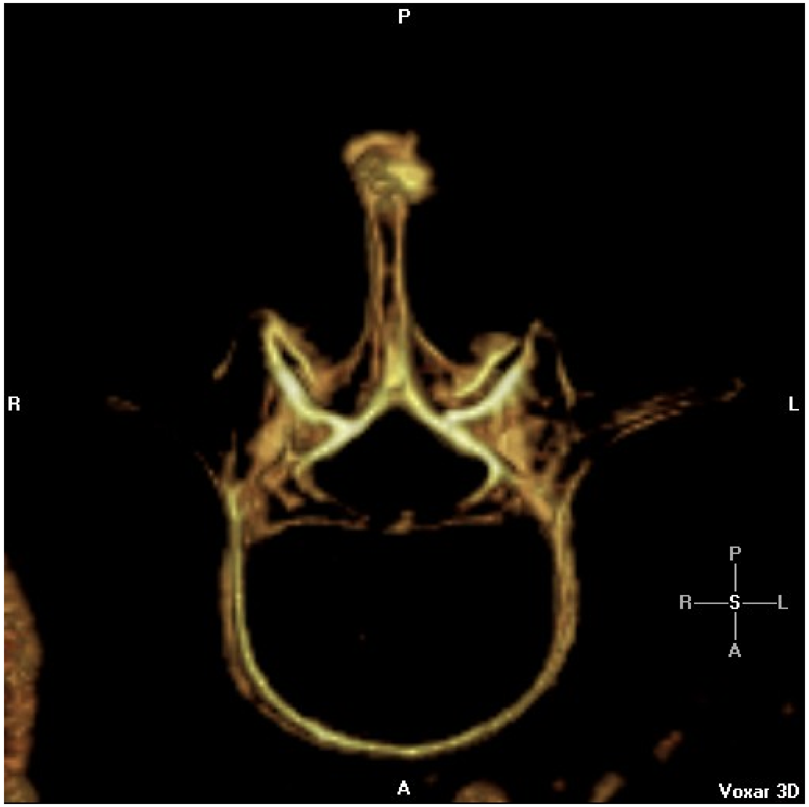
Bone Changes with Aging

- McCalden, et al (1993) found a linear regression relation between the ultimate stress and age which demonstrated a 30% drop from age 20 to 80. It was also concluded in the same analysis that the ultimate strain decreases 55% from age 20 to 80.

- Both cortical and cancellous bone exhibit a decrease in elastic modulus and other changes in material response beyond adult middle age. (Yamada 1970, Cowin 2001, Carter and Spengler 1978)

- There is a general increase in the porosity of cortical bone with advancing age, with an accompanying decrease in cortical bone density. (Evans 1975, Lindahl and Lindgren 1967)

L4 Density



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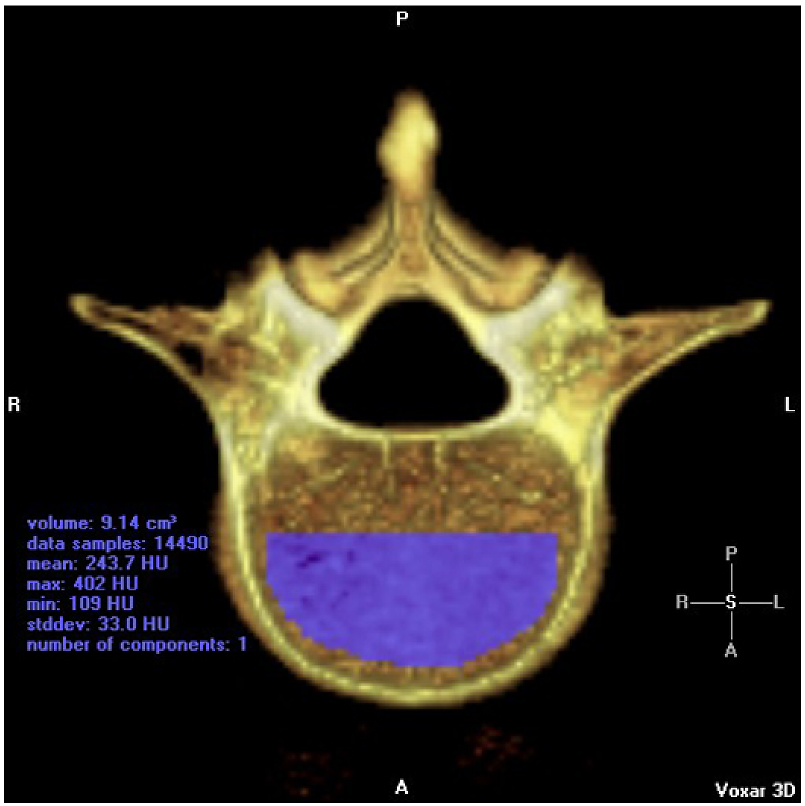
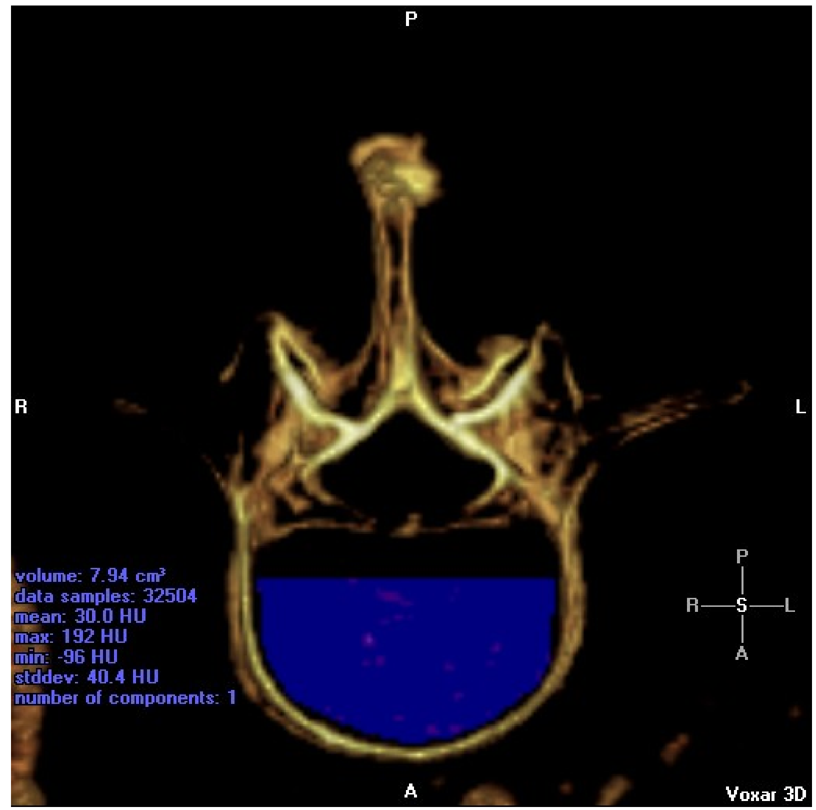
L4 Density





244 HU

30 HU

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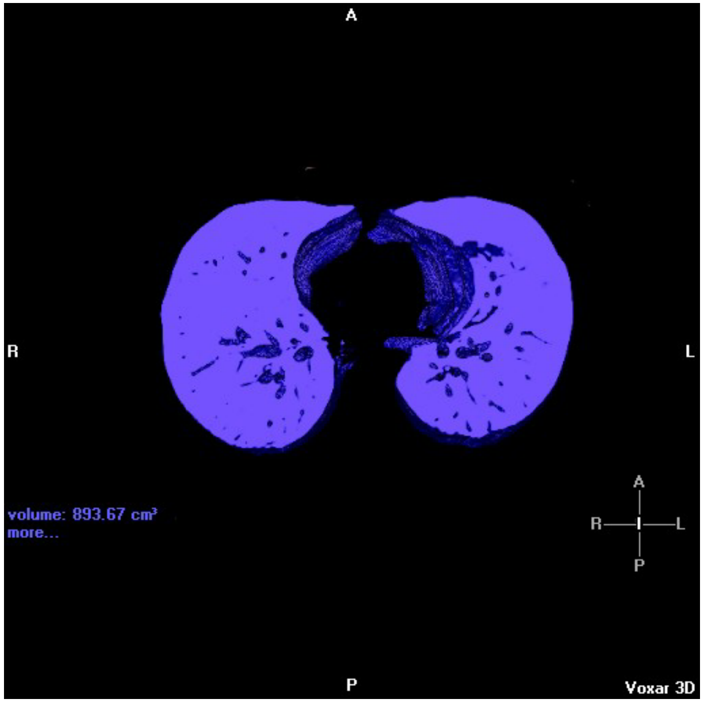
Effect of Soft Tissues on Chest Injury Tolerance

- Verriest and Chapon (1985) found that the resistance offered by the rib cage alone is by far lower than the resistance of the intact thorax. Although soft tissue elastic moduli and ultimate strengths might be much lower than those of bones, soft tissues significantly affect the body's overall resistance to applied forces by coupling with the bony structures.

- Like bones, the reductions in ultimate tensile strength of the soft tissues start between 30 to 40 of age (Yamada, 1970).

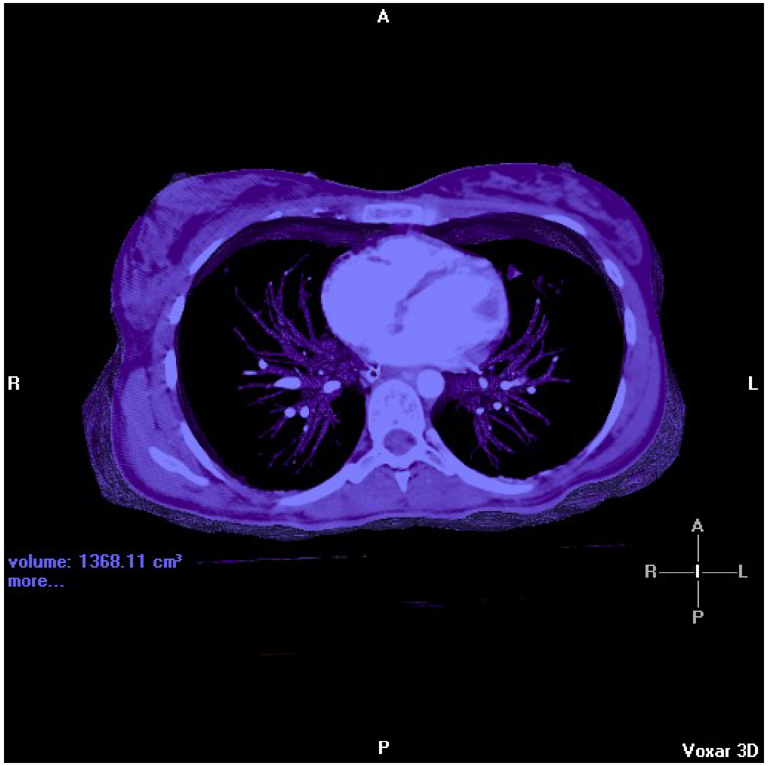
- Zhou, Rouhana & Melvin (1996) found that the reduction of tolerance with aging observed under blunt loading and side impact loading are more comparable to the reductions of the soft tissue strengths…blunt frontal impact loads and side impact loads are more dynamic so the reductions are more likely governed by soft tissues, which have greater rate dependence and inertial effects than bones.

Chest Tissue Volume



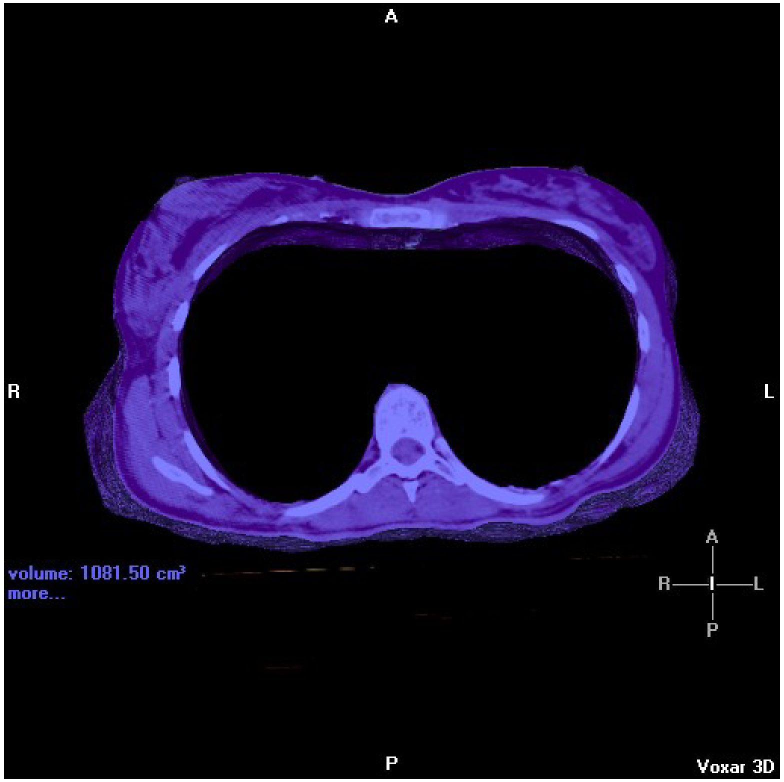
Switch to the "Lung (solid)" contrast setting and take the volume of the lung tissue.

Chest Tissue Volume



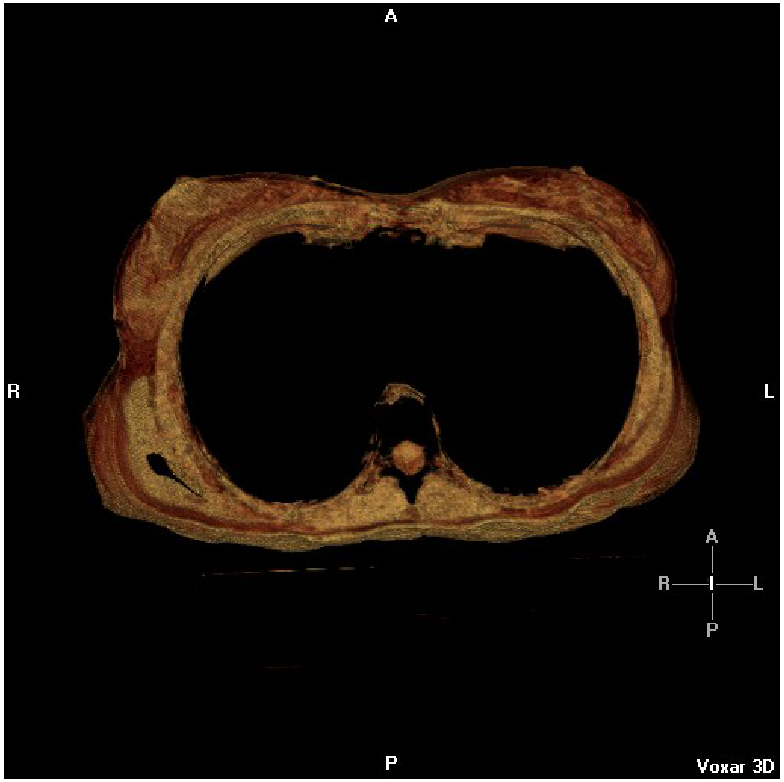
Switch to "Muscle" contrast setting and take the volume of the rest of the tissue. These two volumes equal the total tissue + lung volume.

Chest Tissue Volume



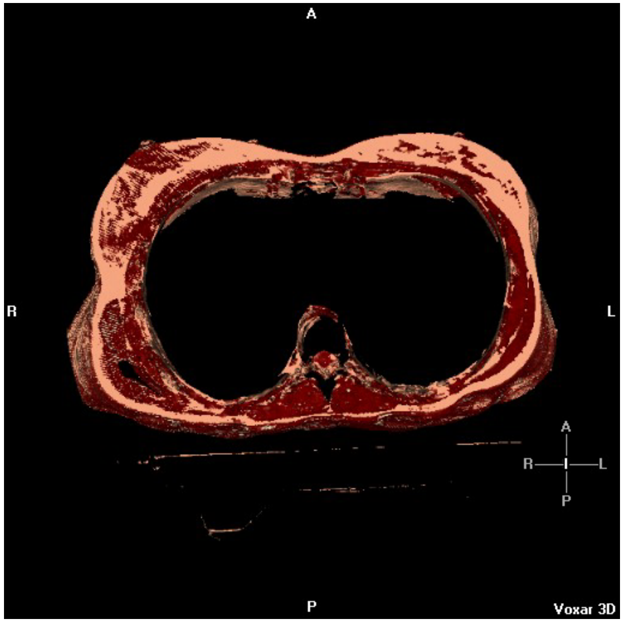
Sculpt out the internal organs so that only the chest wall is remaining and measure this volume.

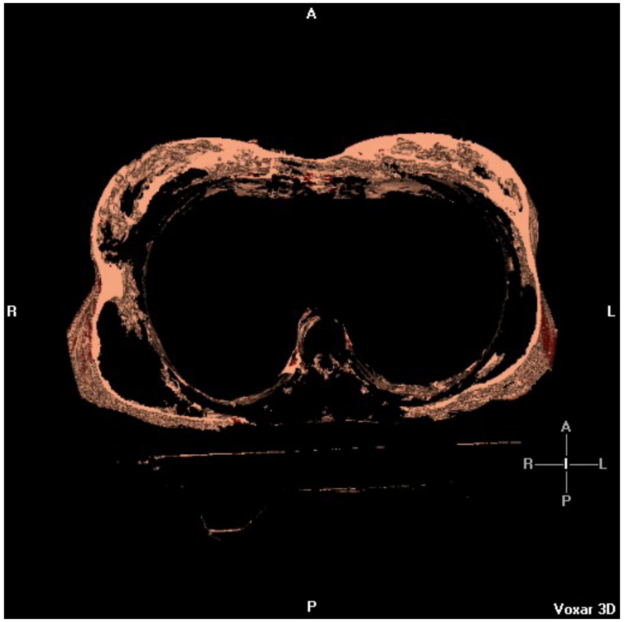
Chest Tissue Volume



Switch to “Bone (general)” contrast setting, highlight and delete all of the bone. Then switch back to the “muscle” contrast setting and select the remaining volume measured as “chest wall soft tissue”.

Chest Tissue Volume





Switch to "Skin" contrast setting, highlight and delete all of the muscle, which appears bright red in this contrast. Then switch back to "Muscle" contrast setting and take the "fat" volume.

Study Methods

2 inch slab selected at L3

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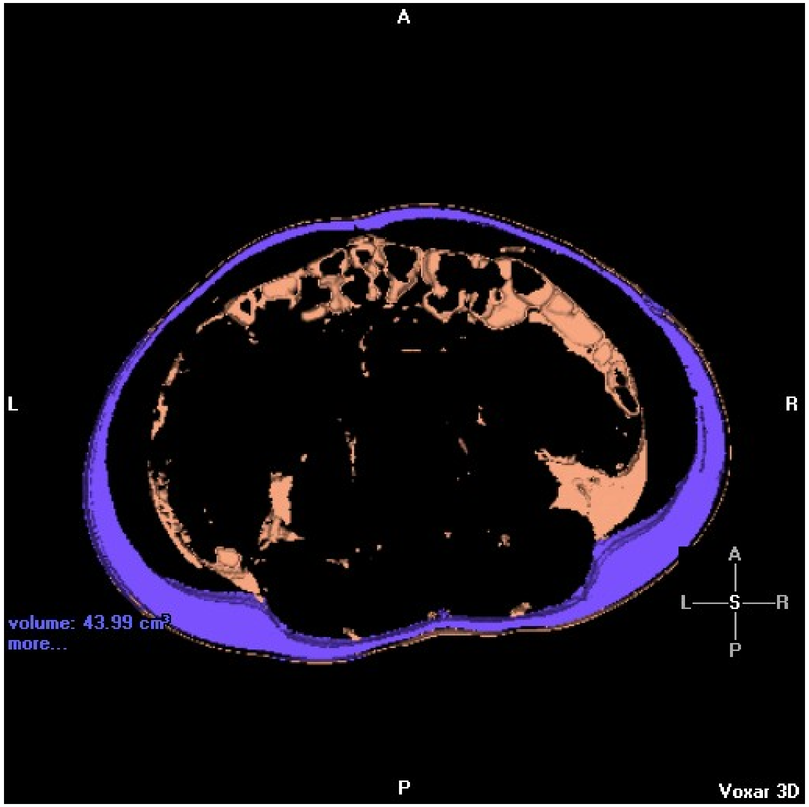
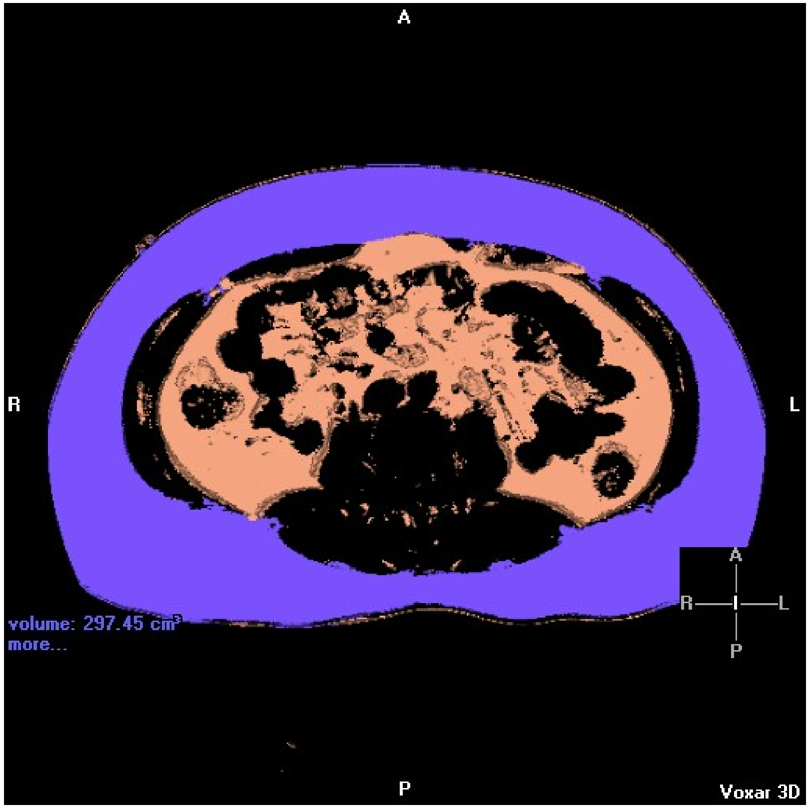
Abdominal Fat - Subcutaneous



44 cubic cm



297 cubic cm

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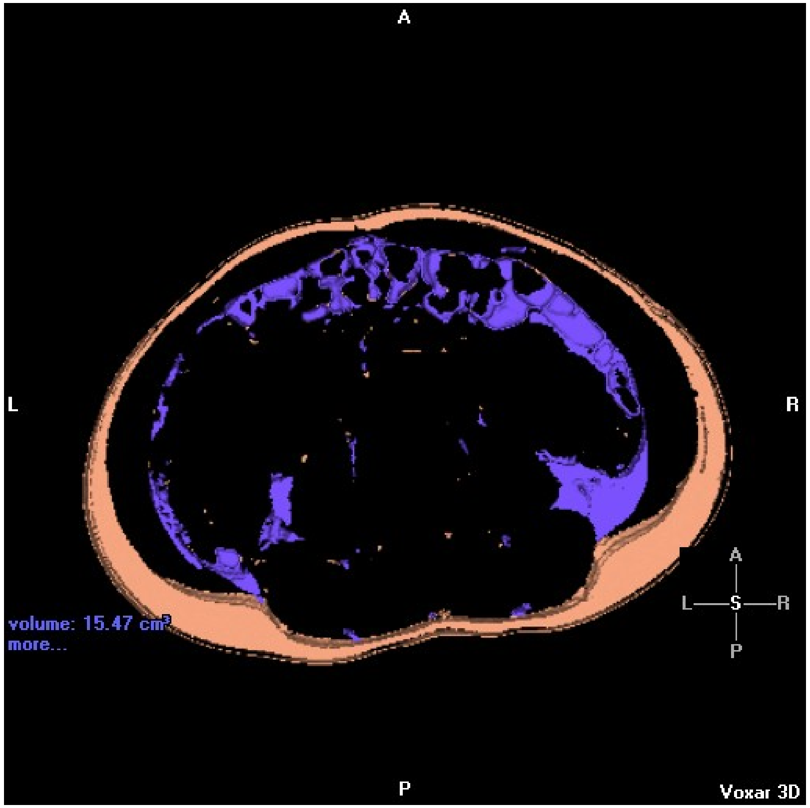
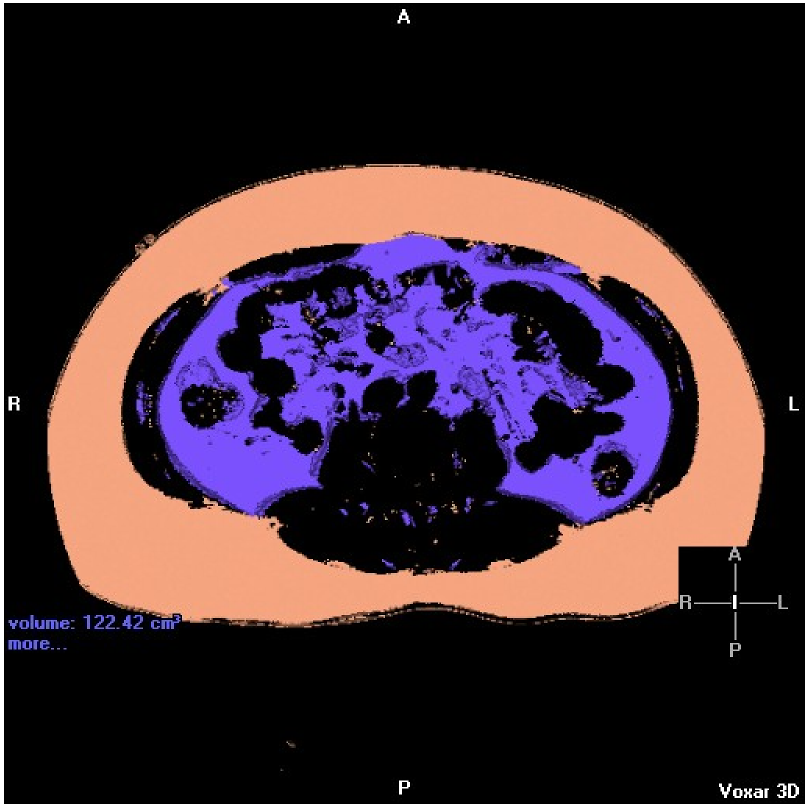
Abdominal Fat - Visceral





15 cubic cm

122 cubic cm

Age vs. Rib Angle

154 Michigan CIREN Cases (Adult 18+)

Male

	Correlation	Count	Z-Value	P-Value
Age, R6	.429	56	3.337	.0008
Age, R7	.305	61	2.399	.0164
Age, R8	.280	62	2.206	.0274
Age, R9	.335	66	2.761	.0058
Age, L6	.486	55	3.828	.0001
Age, L7	.274	61	2.142	.0322
Age, L8	.278	62	2.191	.0284
Age, L9	.309	67	2.557	.0106

Female

	Correlation	Count	Z-Value	P-Value
Age, R6	.136	64	1.068	.2856
Age, R7	.105	68	.852	.3943
Age, R8	.100	80	.879	.3792
Age, R9	.218	87	2.032	.0422
Age, L6	-.033	64	-.261	.7938
Age, L7	.061	67	.490	.6238
Age, L8	.093	80	.820	.4125
Age, L9	.199	87	1.851	.0642

Rib Angle differs between Males and Females ($p < .008$)

Group Info for R7

Grouping Variable: Sex

	Count	Mean	Variance	Std. Dev.	Std. Err
F	66	57.242	66.956	8.183	1.007
M	60	61.033	58.236	7.631	.985

Chest Aspect Ratio

Michigan CIREN Cases (Adult 18+)

	Correlation	Count	Z-Value	P-Value
Age, Chest Width (mm): Total	-.128	158	-1.600	.1095
Age, Chest Width (mm): F	-.296	84	-2.745	.0061
Age, Chest Width (mm): M	.086	74	.725	.4683
Age, Chest Depth at Xiphoid (mm): Total	.221	159	2.806	.0050
Age, Chest Depth at Xiphoid (mm): F	.231	84	2.116	.0344
Age, Chest Depth at Xiphoid (mm): M	.396	75	3.558	.0004

Chest Width differs between Males and Females ($p<.0001$)
Chest Depth differs between Males and Females ($p<.0001$)

Age vs. Rib Angle

229 Non-CIREN Chest CTs with at least 6 ribs on either side measurable.

Male

	Correlation	Count	Z-Value	P-Value
Age, R2	.325	116	3.586	.0003
Age, R3	.186	126	2.084	.0372
Age, R4	.212	131	2.436	.0149
Age, R5	.211	127	2.384	.0171
Age, R6	.257	128	2.941	.0033
Age, R7	.276	128	3.169	.0015
Age, R8	.250	122	2.786	.0053
Age, R9	.283	126	3.231	.0012
Age, R10	.272	123	3.052	.0023
Age, R11	.153	117	1.644	.1001

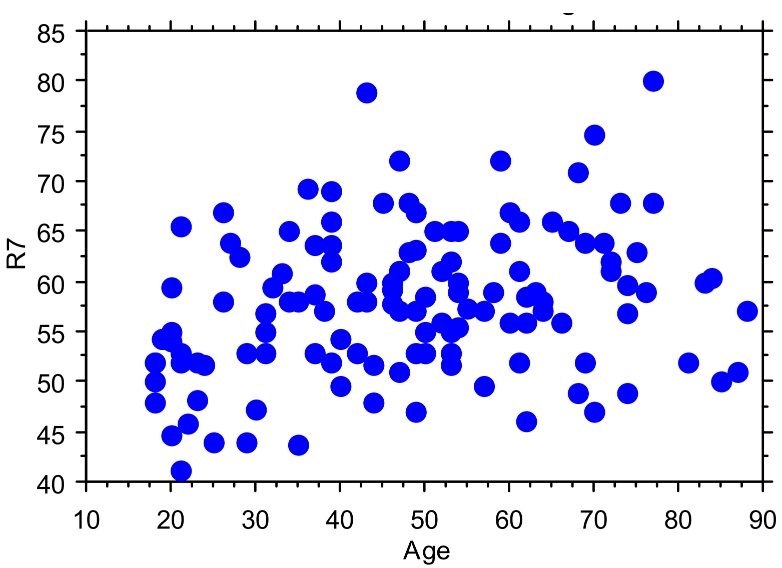
Female

	Correlation	Count	Z-Value	P-Value
Age, R2	.101	77	.874	.3821
Age, R3	.018	84	.159	.8739
Age, R4	.006	90	.055	.9565
Age, R5	.001	91	.006	.9953
Age, R6	-.079	91	-.741	.4584
Age, R7	.009	89	.086	.9316
Age, R8	.019	87	.174	.8617
Age, R9	.080	88	.736	.4614
Age, R10	.093	81	.827	.4083
Age, R11	-.043	78	-.371	.7103
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

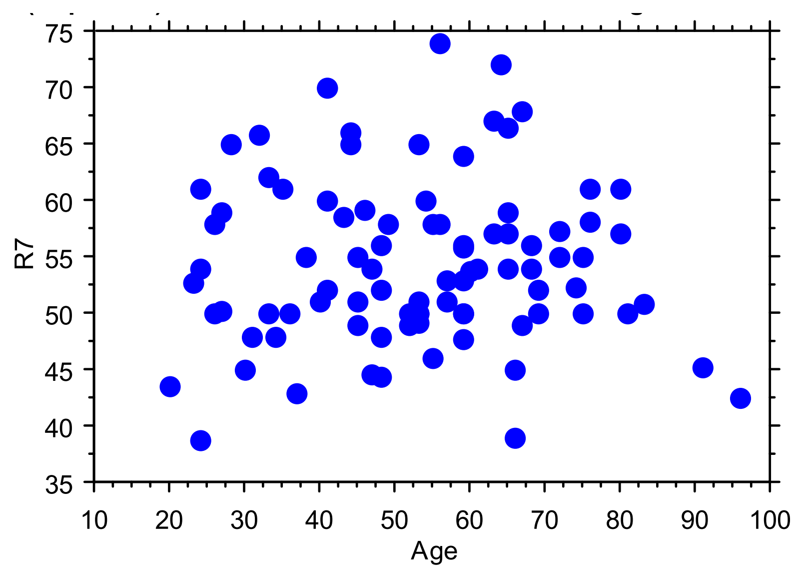
Age vs. Rib Angle

229 Non-CIREN Chest CTs with at least 6 ribs on either side measurable.

Male



Female



Rib Angle differs between Males and Females (p<.0005), t-test

Group Info for R7
Grouping Variable: Sex

	Count	Mean	Variance	Std. Dev.	Std. Err
F	89	54.420	52.298	7.232	.767
M	131	57.929	53.505	7.315	.639

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Age vs. Rib Angle

34 chest CTs on all 2004 trauma patients with ISS<8

Male

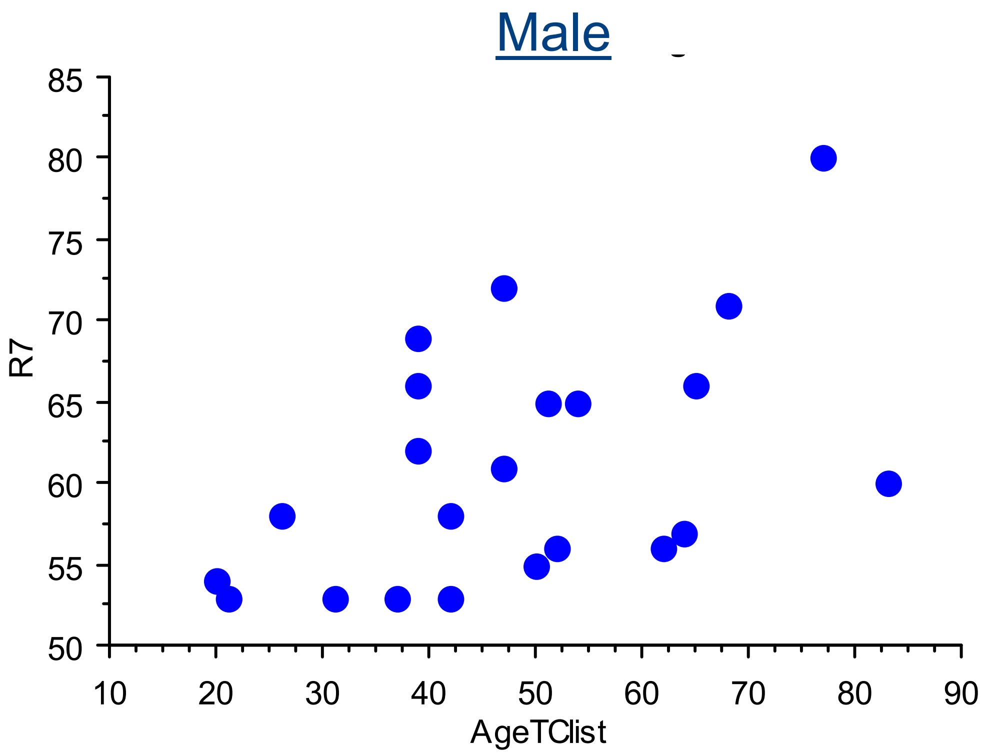
	Correlation	Count	Z-Value	P-Value
AgeTClist, R2	.137	22	.600	.5485
AgeTClist, R3	.124	23	.559	.5762
AgeTClist, R4	.262	24	1.228	.2193
AgeTClist, R5	.316	24	1.501	.1333
AgeTClist, R6	.385	23	1.818	.0691
AgeTClist, R7	.495	22	2.364	.0181
AgeTClist, R8	.443	20	1.962	.0497
AgeTClist, R9	.469	19	2.033	.0421
AgeTClist, R10	.443	18	1.845	.0650
AgeTClist, R11	.384	17	1.513	.1302

Female

	Correlation	Count	Z-Value	P-Value
AgeTClist, R2	.557	10	1.664	.0961
AgeTClist, R3	.501	10	1.458	.1449
AgeTClist, R4	.415	10	1.167	.2432
AgeTClist, R5	.205	9	.510	.6099
AgeTClist, R6	.128	9	.315	.7528
AgeTClist, R7	.207	9	.514	.6072
AgeTClist, R8	.280	8	.642	.5206
AgeTClist, R9	.421	8	1.004	.3156
AgeTClist, R10	.382	7	.805	.4208
AgeTClist, R11	-.011	7	-.022	.9822

Age vs. Rib Angle

34 chest CTs on all 2004 trauma patients with ISS<8



Aging Trends

197 Michigan CIREN Cases (Adult 18+) with Chest or Abd CTs

	Correlation	Count	Z-Value	P-Value
Age, L4 Mean HU	-.777	197	-14.439	<.0001
Age, Fat Vol (4)	.240	102	2.440	.0147
Age, Muscle Vol (4)	-.264	102	-2.688	.0072
Age, Bone Vol (4)	-.040	102	-.400	.6893
Age, Lung Volume (4)	-.096	101	-.948	.3429
Age, Total Volume (4)	.018	102	.180	.8574
Age, ABD subQ Fat cm3	.104	196	1.446	.1481
Age, ABD visceral Fat cm3	.451	196	6.757	<.0001

Aging Trends

197 Michigan CIREN Cases (Adult 18+) with Chest or Abd CTs

Male

	Correlation	Count	Z-Value	P-Value
Age, L4 Mean HU	-.765	87	-9.229	<.0001
Age, Fat Vol (4)	.310	50	2.194	.0282
Age, Muscle Vol (4)	-.237	50	-1.659	.0972
Age, Bone Vol (4)	.027	50	.184	.8541
Age, Lung Volume (4)	-.026	50	-.180	.8574
Age, Total Volume (4)	.040	50	.275	.7834
Age, ABD subQ Fat cm3	.068	88	.626	.5316
Age, ABD visceral Fat cm3	.566	88	5.914	<.0001

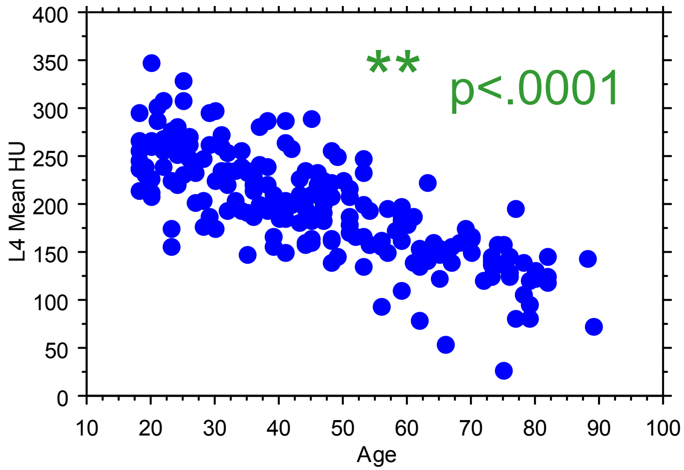
Bone Density loss in both
Chest Fat gain greater in males
Chest Muscle Loss greater in Females
Visceral Fat gain in both

Female

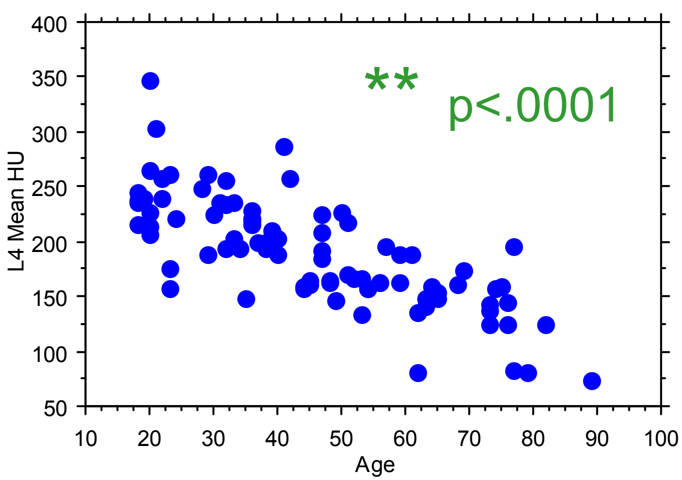
	Correlation	Count	Z-Value	P-Value
Age, L4 Mean HU	-.802	110	-11.423	<.0001
Age, Fat Vol (4)	.227	52	1.615	.1062
Age, Muscle Vol (4)	-.458	52	-3.465	.0005
Age, Bone Vol (4)	-.157	52	-1.109	.2675
Age, Lung Volume (4)	-.179	51	-1.253	.2102
Age, Total Volume (4)	.003	52	.018	.9853
Age, ABD subQ Fat cm3	.121	108	1.248	.2119
Age, ABD visceral Fat cm3	.450	108	4.960	<.0001

Age vs. Bone Density

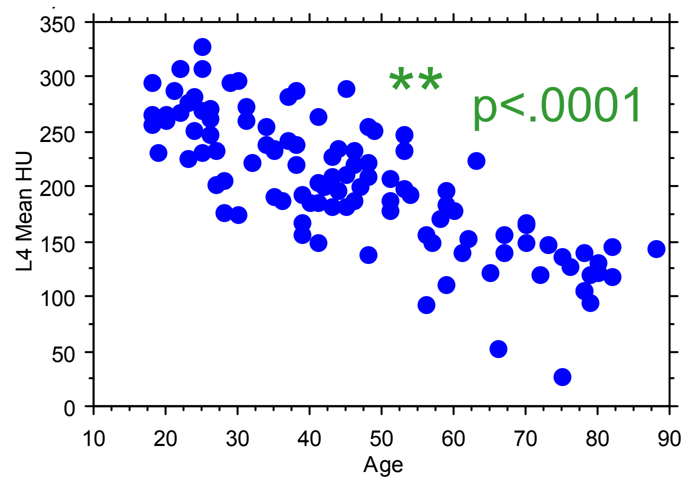
197 Michigan CIREN Cases (Adult 18+) with Abd CTs



Male



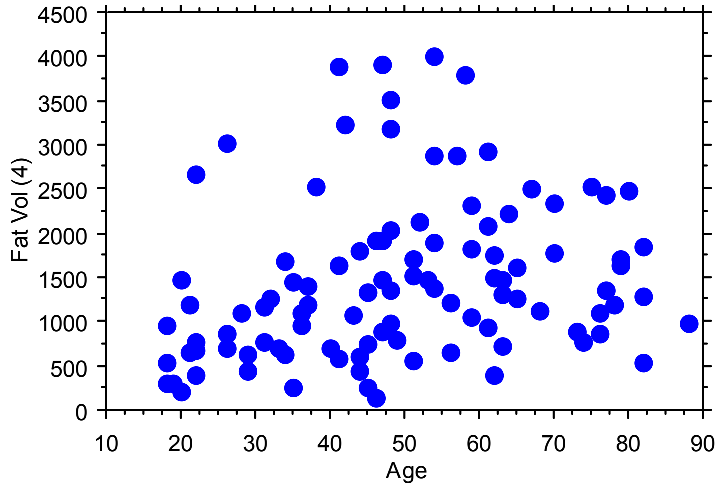
Female



	Count	Mean	Variance	Std. Dev.	Std. Err
F	110	203.544	3677.244	60.640	5.782
M	87	190.069	2482.059	49.820	5.341

Chest Fat Volume Vs. Age

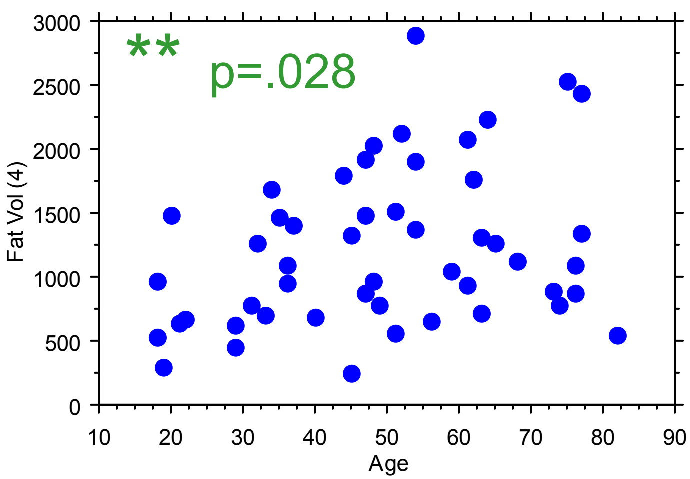
102 Michigan CIREN Cases (Adult 18+) with Chest CTs

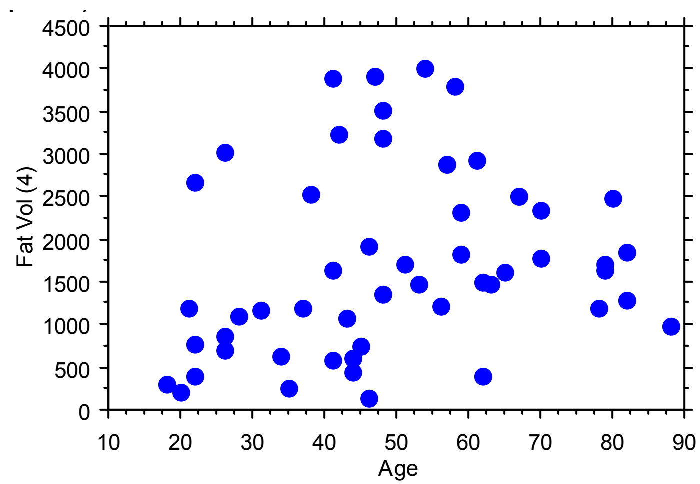


** p=.015

Male

Female





	Count	Mean	Variance	Std. Dev.	Std. Err
F	52	1697.559	1160612.839	1077.317	149.397
M	50	1223.373	379424.119	615.974	87.112

* p=.0078

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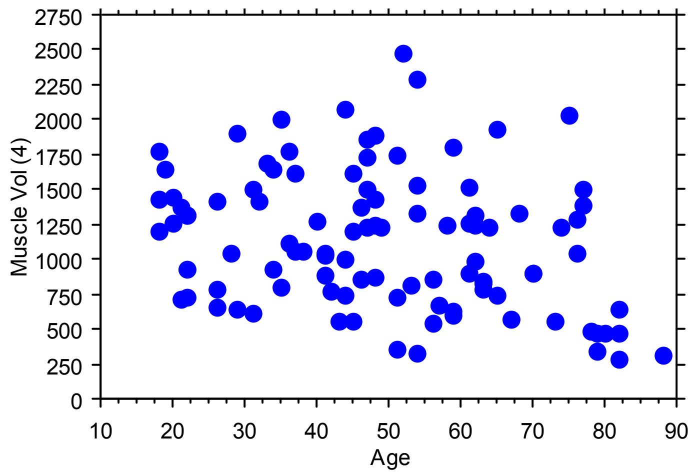
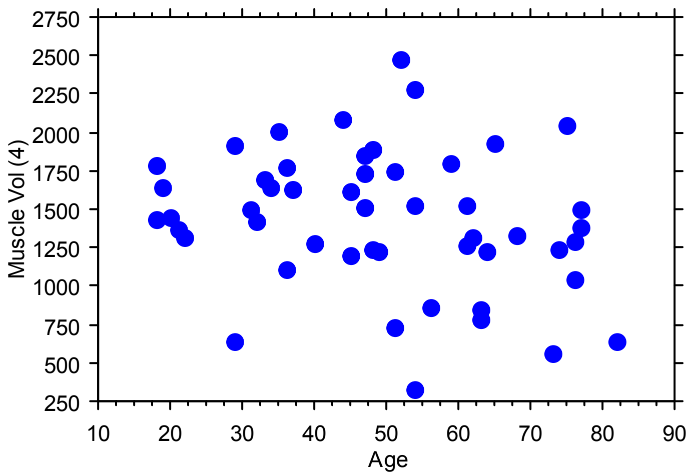
Chest Muscle Volume vs. Age

102 Michigan CIREN Cases (Adult 18+) with Chest CTs



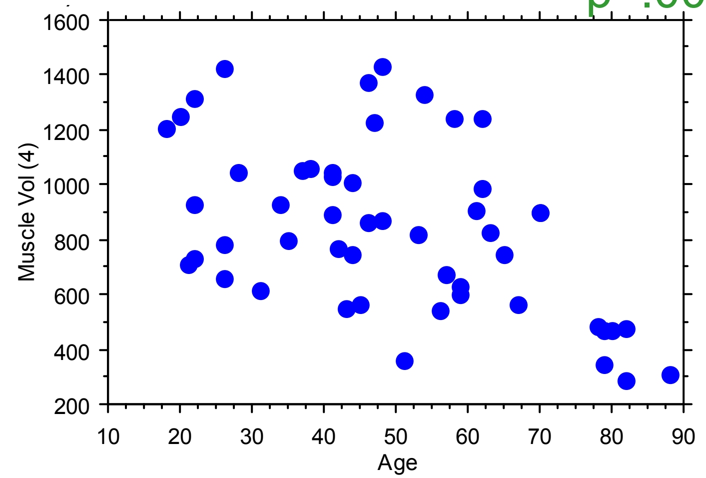
** p=.0072

Male



Female

** p=.0005



	Count	Mean	Variance	Std. Dev.	Std. Err
F	52	824.537	110554.855	332.498	46.109
M	50	1433.190	204861.411	452.616	64.010

* P<.0001

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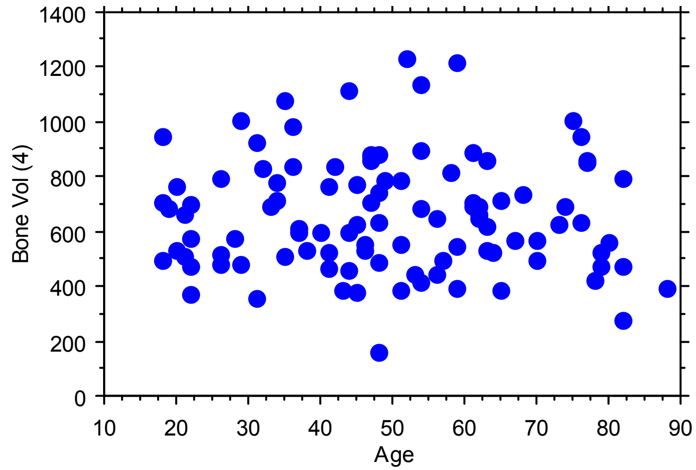
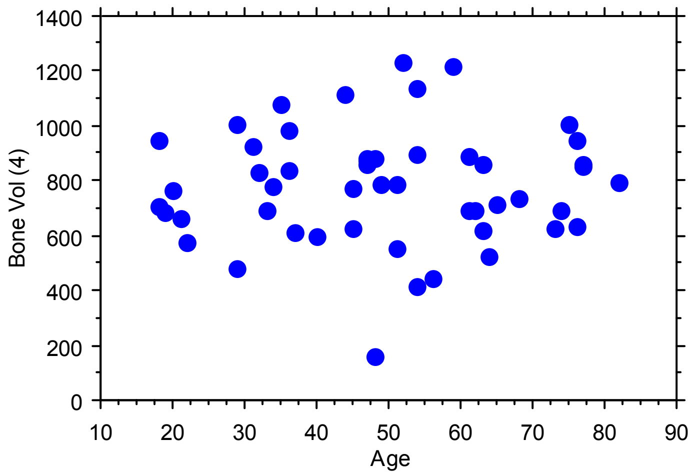
Chest Bone Volume vs. Age

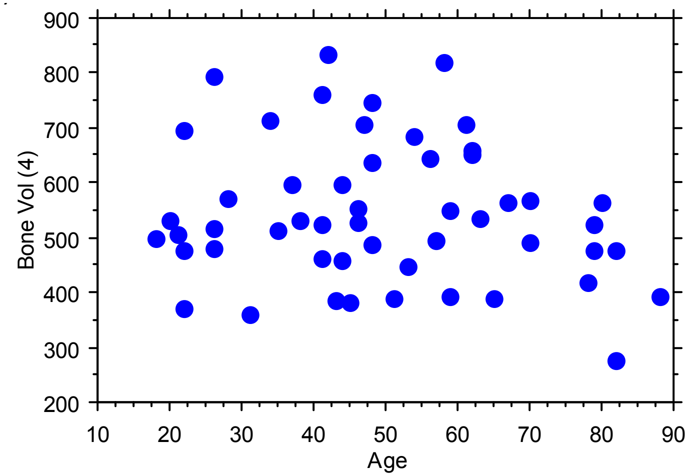
102 Michigan CIREN Cases (Adult 18+) with Chest CTs



Male



Female



	Count	Mean	Variance	Std. Dev.	Std. Err
F	52	545.303	16491.640	128.420	17.809
M	50	779.408	43336.721	208.175	29.440

* $p < .0001$

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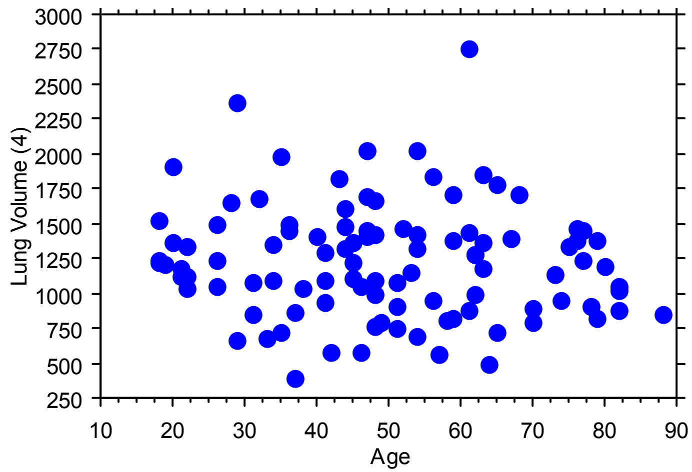
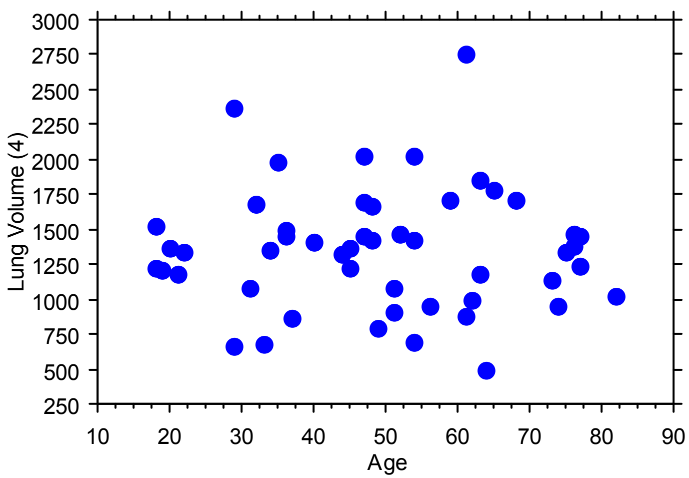
Lung Volume vs. Age

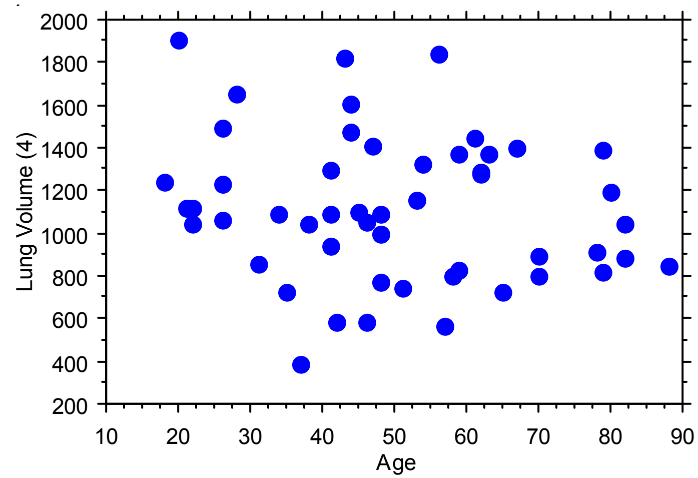
102 Michigan CIREN Cases (Adult 18+) with Chest CTs



Male



Female



	Count	Mean	Variance	Std. Dev.	Std. Err
F	51	1112.297	115674.589	340.110	47.625
M	50	1354.722	191905.751	438.070	61.953

* p =.002

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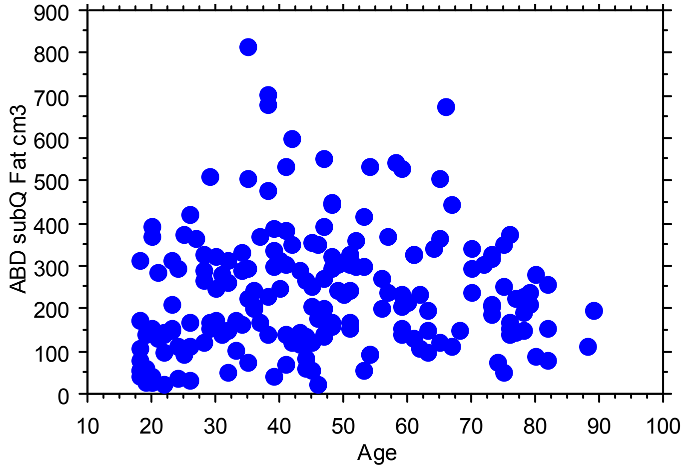
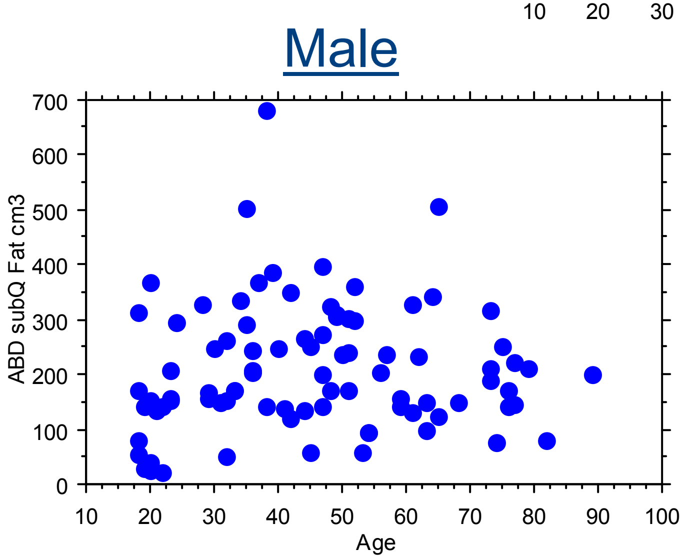
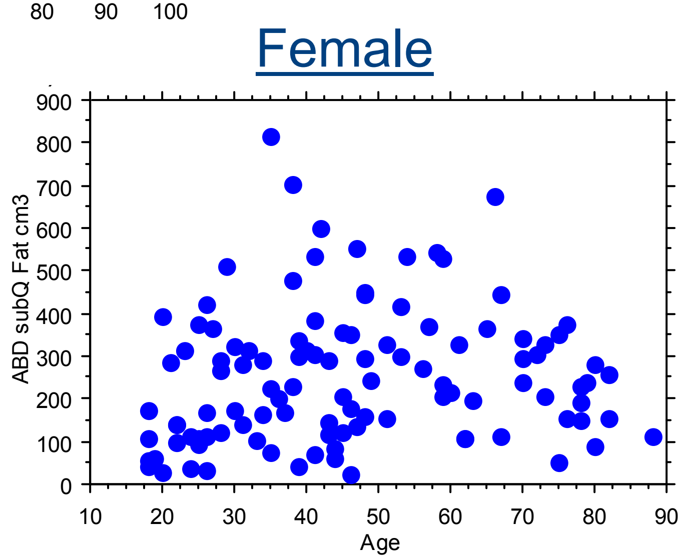
Abdominal SubQ Fat vs. Age

197 Michigan CIREN Cases (Adult 18+) with Abd CTs







	Count	Mean	Variance	Std. Dev.	Std. Err
F	108	254.210	25645.393	160.142	15.410
M	89	207.241	13518.650	116.270	12.325

* p =.02

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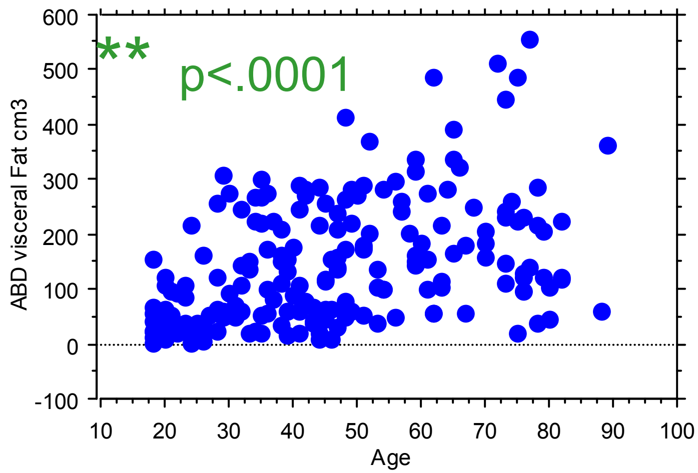
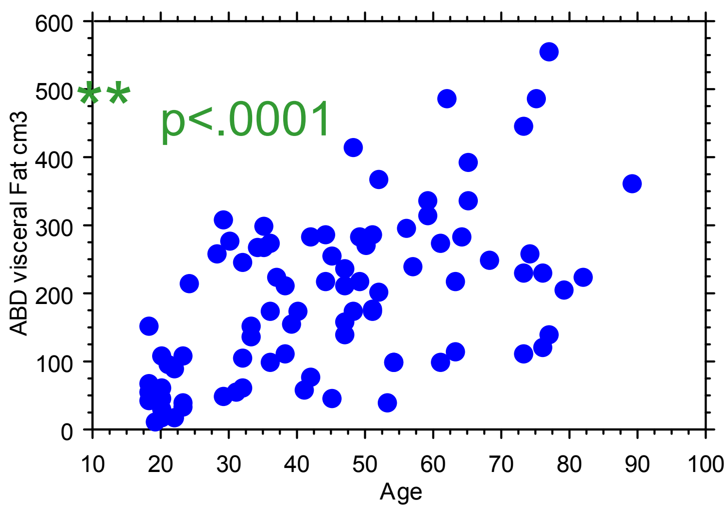
Abdominal Visceral Fat vs. Age

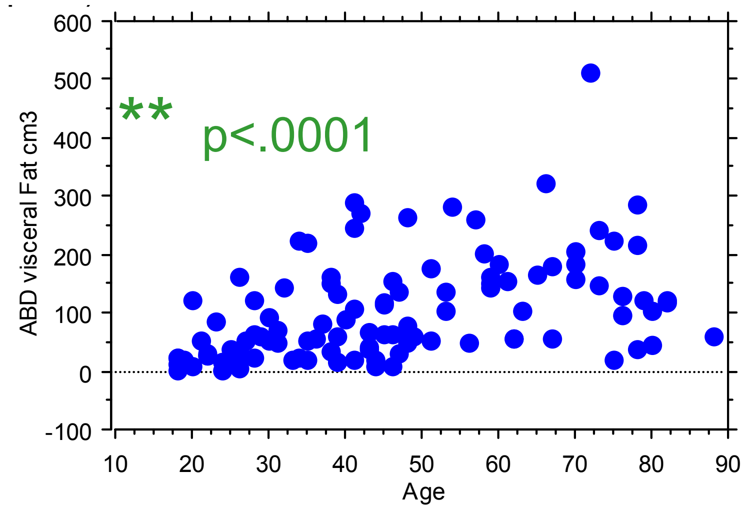
197 Michigan CIREN Cases (Adult 18+) with Abd CTs



Male



Female



	Count	Mean	Variance	Std. Dev.	Std. Err
F	108	104.131	7858.504	88.648	8.530
M	89	191.313	14683.349	121.175	12.845

* p <.0001

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Summary

With increasing age:

- **Rib angles become more horizontal in males**
- **Bone loses density in both males and females**
- **Chest Fat gain is greater in males**
- **Chest Muscle loss is greater in females**
- **Visceral Fat increases in both males and females**

** Males significantly differed from females in **all** components measured ***except*** bone density

Injury Tolerance

Do changes in body composition and geometry with aging result in altered injury tolerance?

CAVEAT: CIREN cases are biased towards subjects who sustained significant injuries.

Age vs. Injury Severity

298 Michigan CIREN Cases (Adult 18+)

Male

	Correlation	Count	Z-Value	P-Value
Age, ISS	.098	130	1.103	.2700
Age, MAIS 4T	.222	130	2.550	.0108
Age, MAIS 5A	-.008	130	-.092	.9267

Female

	Correlation	Count	Z-Value	P-Value
Age, ISS	.113	168	1.459	.1447
Age, MAIS 4T	.221	168	2.891	.0038
Age, MAIS 5A	-.034	168	-.440	.6598
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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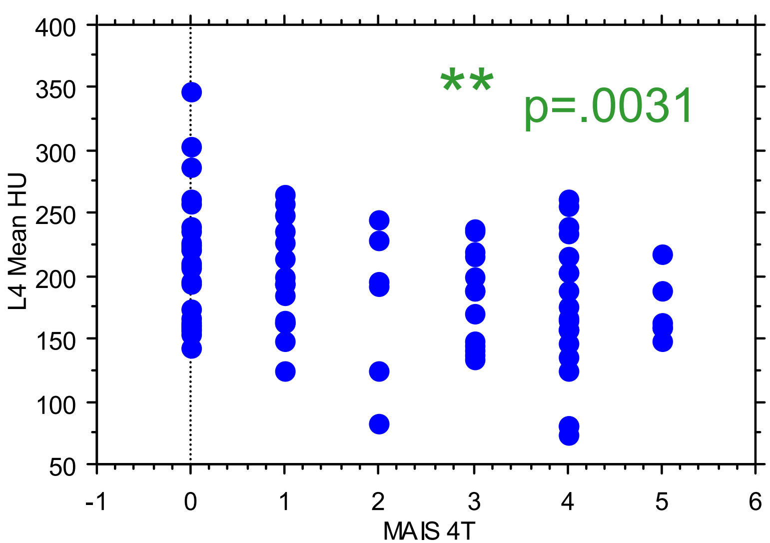
Bone Density vs. Chest Injury

197 Michigan CIREN Cases (Adult 18+)

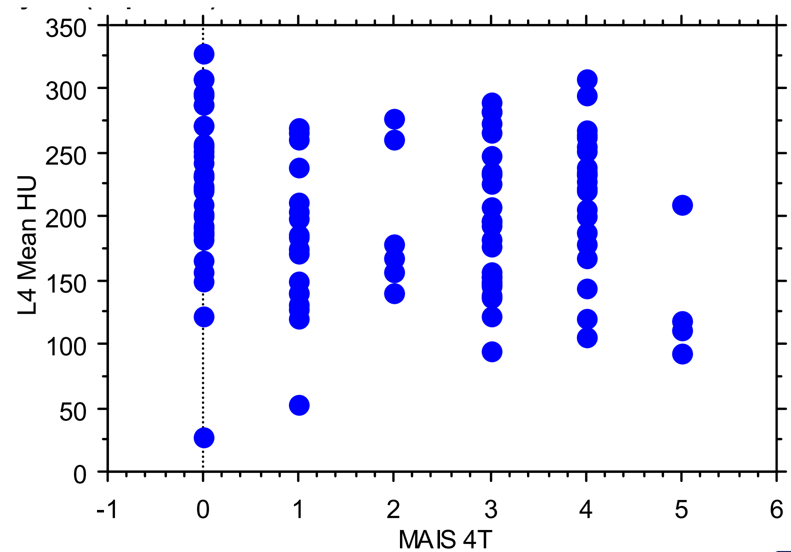
Male

	Correlation	Count	Z-Value	P-Value
L4 Mean HU, ISS	-.081	87	-.740	.4592
L4 Mean HU, MAIS 4T	-.312	87	-2.960	.0031
L4 Mean HU, MAIS 5A	.037	87	.336	.7371
L4 Mean HU, Total rib fx count	-.298	87	-2.813	.0049
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Female

	Correlation	Count	Z-Value	P-Value
L4 Mean HU, ISS	-.078	110	-.804	.4217
L4 Mean HU, MAIS 4T	-.139	110	-1.443	.1492
L4 Mean HU, MAIS 5A	.101	110	1.052	.2930
L4 Mean HU, Total rib fx count	-.269	110	-2.853	.0043
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Bone Density vs. MAIS 4T

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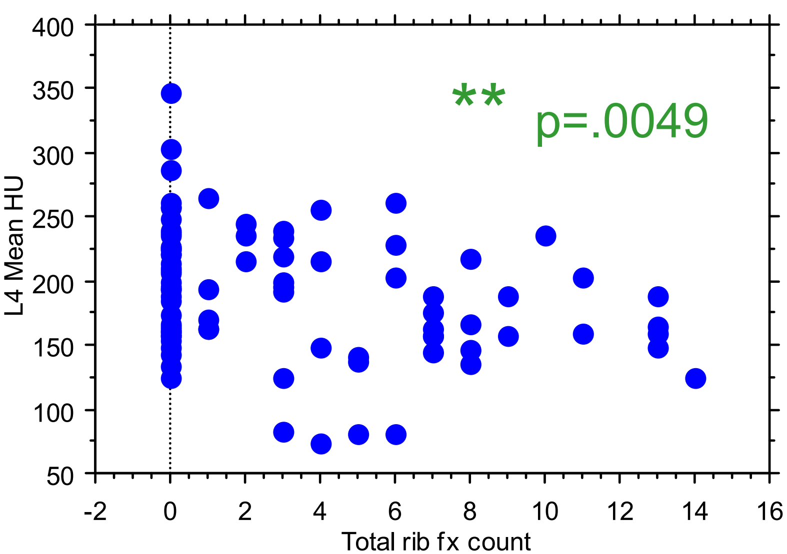
Bone Density vs. Chest Injury

197 Michigan CIREN Cases (Adult 18+) with Abd CT

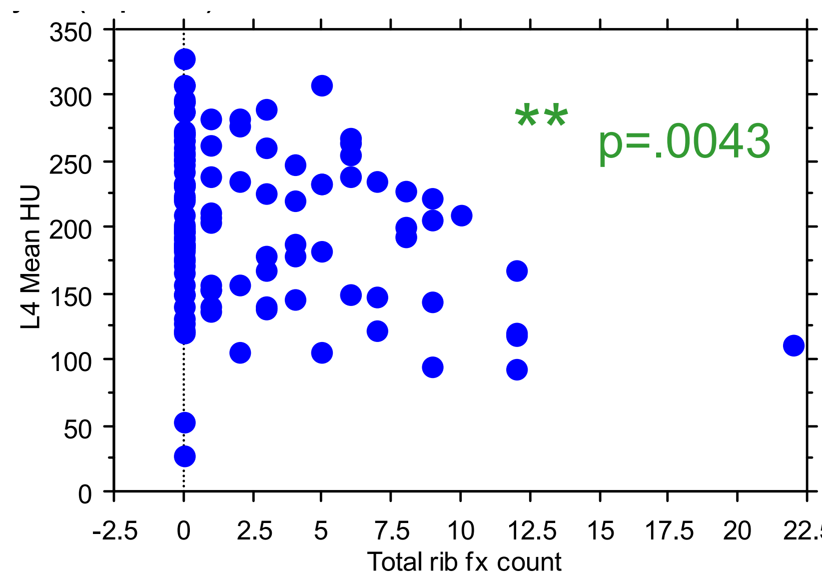
Male

	Correlation	Count	Z-Value	P-Value
L4 Mean HU, ISS	-.081	87	-.740	.4592
L4 Mean HU, MAIS 4T	-.312	87	-2.960	.0031
L4 Mean HU, MAIS 5A	.037	87	.336	.7371
L4 Mean HU, Total rib fx count	-.298	87	-2.813	.0049



Female

	Correlation	Count	Z-Value	P-Value
L4 Mean HU, ISS	-.078	110	-.804	.4217
L4 Mean HU, MAIS 4T	-.139	110	-1.443	.1492
L4 Mean HU, MAIS 5A	.101	110	1.052	.2930
L4 Mean HU, Total rib fx count	-.269	110	-2.853	.0043



Bone Density vs. Total Ribs Fractured

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Chest Fat Volume vs. Injury Severity

102 Michigan CIREN Cases (Adult 18+) with Chest CTs

Male

	Correlation	Count	Z-Value	P-Value
Fat Vol (4), ISS	-.068	50	-.469	.6392
Fat Vol (4), MAIS 4T	-.005	50	-.033	.9741
Fat Vol (4), MAIS 5A	.228	50	1.593	.1112

Female

	Correlation	Count	Z-Value	P-Value
Fat Vol (4), ISS	-.297	52	-2.146	.0319
Fat Vol (4), MAIS 4T	-.345	52	-2.516	.0119
Fat Vol (4), MAIS 5A	-.035	52	-.247	.8047


0-380 ms:912-1431
ransverse
IABLEmm)
5.6 TRAUMA CHES
Inferior

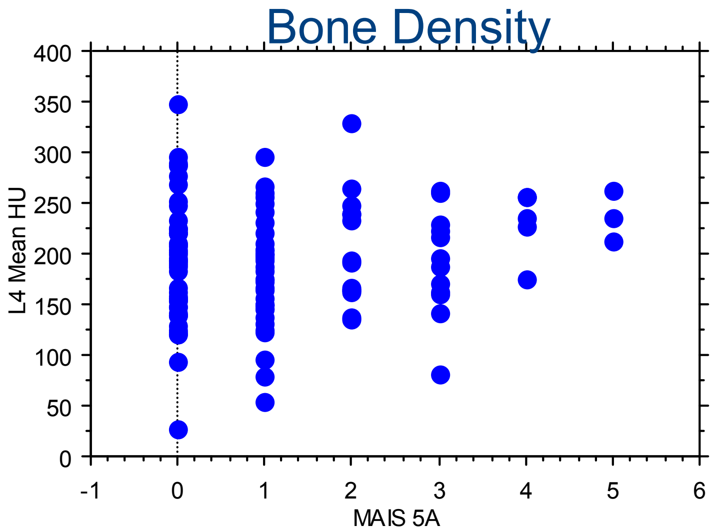
SQ

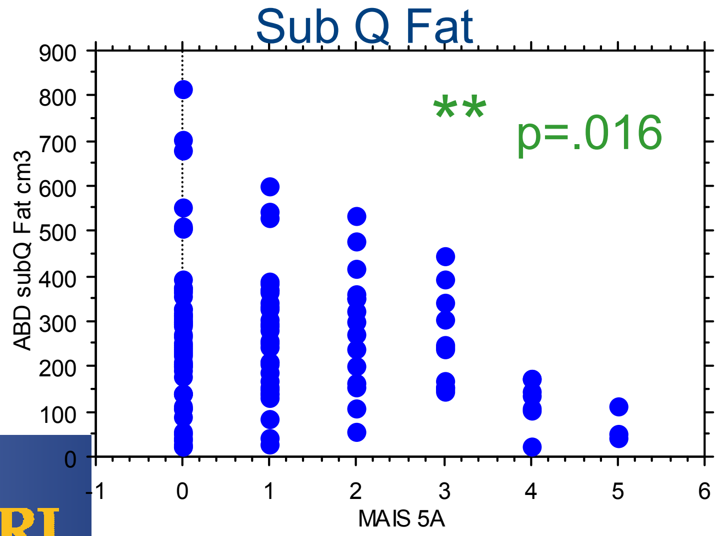
Visceral

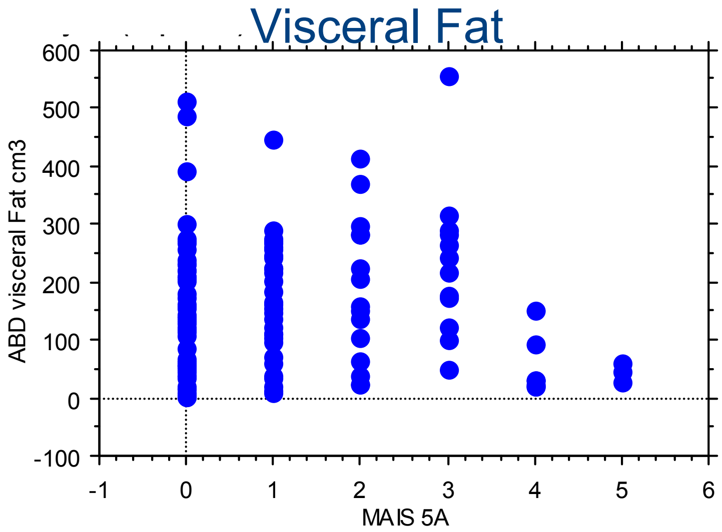

agittal MPR
ERIVED\SECONDARY COMPRESSED
12x512
Superior
nterior
Posteri
200 mm
/:500 L:50
VP:120 mA:240-260 ms:1431
12x512x104 Transverse
.86x0.86xVARIABLEmm)
6.2 ABDOMEN/PELVIS (ER)
Inferior
Plug-n-View

Abdominal Injuries - Frontal Crashes

	Correlation	Count	Z-Value	P-Value
MAIS 5A, Age	-.119	190	-1.634	.1022
MAIS 5A, L4 Mean HU	.139	122	1.527	.1268
MAIS 5A, ABD subQ Fat cm3	-.215	124	-2.404	.0162
MAIS 5A, ABD visceral Fat cm3	-.016	124	-.181	.8566
MAIS 5A, Fat Vol (4)	-.040	53	-.286	.7749
MAIS 5A, Muscle Vol (4)	.013	53	.095	.9242
MAIS 5A, Bone Vol (4)	-.068	53	-.479	.6320
MAIS 5A, Lung Volume (4)	-.058	53	-.410	.6818
MAIS 5A, Total Volume (4)	-.062	53	-.442	.6588







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Chest Component Volumes vs. Injury Severity

Fisher's R to Z
Hypothesized Correlation = 0

	Correlation	Count	Z-Value	P-Value
MAIS 4T, L4 Mean HU	-.208	197	-2.937	.0033
MAIS 4T, Fat Vol (4)	-.187	102	-1.881	.0599
MAIS 4T, Muscle Vol (4)	-.238	102	-2.417	.0156
MAIS 4T, Bone Vol (4)	-.148	102	-1.485	.1377
MAIS 4T, Lung Volume (4)	-.344	101	-3.549	.0004
MAIS 4T, Total Volume (4)	-.307	102	-3.156	.0016
MAIS 4T, R6	-.206	120	-2.262	.0237
MAIS 4T, R7	-.194	129	-2.211	.0270
MAIS 4T, R8	-.195	142	-2.329	.0199
MAIS 4T, R9	-.166	153	-2.056	.0398
MAIS 4T, ABD subQ Fat cm3	-.117	197	-1.633	.1025
MAIS 4T, ABD visceral Fat cm3	.102	197	1.429	.1531

Chest Component Volumes vs. Injury Severity Male

Fisher's R to Z
Hypothesized Correlation = 0
Inclusion criteria: Male from CIREN Adult 18+ Combined Chest Query.xls (imported).svd

	Correlation	Count	Z-Value	P-Value	
MAIS 4T, L4 Mean HU	-.312	87	-2.960	.0031	* M
MAIS 4T, Fat Vol (4)	-.005	50	-.033	.9741	* F
MAIS 4T, Muscle Vol (4)	-.290	50	-2.046	.0408	* M
MAIS 4T, Bone Vol (4)	-.138	50	-.949	.3425	
MAIS 4T, Lung Volume (4)	-.540	50	-4.146	<.0001	* M
MAIS 4T, Total Volume (4)	-.206	50	-1.435	.1513	* F
MAIS 4T, R6	.055	56	.401	.6881	* F
MAIS 4T, R7	.053	61	.403	.6870	* F
MAIS 4T, R8	.041	62	.313	.7545	* F
MAIS 4T, R9	.018	66	.145	.8847	* F
MAIS 4T, ABD subQ Fat cm3	-.098	89	-.911	.3625	
MAIS 4T, ABD visceral Fat cm3	.212	89	1.994	.0461	* M

Chest Component Volumes vs. Injury Severity Female

Fisher's R to Z
Hypothesized Correlation = 0
Inclusion criteria: Female from CIREN Adult 18+ Combined Chest Query.xls (imported).svd

	Correlation	Count	Z-Value	P-Value	
MAIS 4T, L4 Mean HU	-.139	110	-1.443	.1492	* M
MAIS 4T, Fat Vol (4)	-.345	52	-2.516	.0119	* F
MAIS 4T, Muscle Vol (4)	-.242	52	-1.726	.0843	* M
MAIS 4T, Bone Vol (4)	-.180	52	-1.274	.2027	
MAIS 4T, Lung Volume (4)	-.086	51	-.598	.5500	* M
MAIS 4T, Total Volume (4)	-.414	52	-3.080	.0021	* F
MAIS 4T, R6	-.433	64	-3.621	.0003	* F
MAIS 4T, R7	-.399	68	-3.406	.0007	* F
MAIS 4T, R8	-.374	80	-3.450	.0006	* F
MAIS 4T, R9	-.297	87	-2.803	.0051	* F
MAIS 4T, ABD subQ Fat cm3	-.140	108	-1.440	.1498	
MAIS 4T, ABD visceral Fat cm3	.018	108	.184	.8537	* M

Data Overload??

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Summary I

With increasing age:

- **Rib angles become more horizontal in males**
- **Bone loses density in both males and females**
- **Chest Fat gain is greater in males**
- **Chest Muscle loss is greater in females**
- **Visceral Fat increases in both males and females**

** Males significantly differed from females in **all** components measured *except* bone density

Summary II

- **There appear to be trends toward altered injury tolerance with differences in body composition.**

- **CAVEAT: CIREN cases are biased towards subjects who sustained significant injuries.**

Conclusion

- There are large changes in body geometry and composition with aging. These changes differ by gender.
- These changes are associated with differences in observed injury severity.
  - Caveat: selected study population
- Much more joint medical, crash and CT analysis needs to be done on subjects who were not significantly injured in crashes similar to those in CIREN.
- Optimal control populations for CT-based body component analysis need to be identified and analyzed.

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- CT Analysis
  - Craig Poster, Chris Brede, David Lange, Aaron Lange, Jennifer Cannon.

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- Research Scholarship: AAAM

- CIREN: NHTSA

- The views expressed are those of the authors only.