

# THE BONES WE BREAK



Science Fair 2024

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**GRADE 9 GATE**

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## 1.0 Objective

The objective of this study is to find out

- (1) Which bones do children fracture the most often?
  - (a) Neck and up
  - (b) Entire arm
  - (c) Entire Torso
  - (d) Entire leg
- (2) Do most bone fractures occur as a result of a fall?
- (3) What is our natural response to a fall?
- (4) Are children who play sports more susceptible to bone fractures than those who don't?
- (5) Test the validity of hypothesis

## 2.0 Hypothesis

**If** a child falls, **then** they are susceptible to a bone fracture in the upper limb **because** the natural reflex to a fall is often to extend the hand.

## 3.0 Method

### 3.1 Steps

- Completed a literature review to collect background information on:
  - What are the bones in the human body
  - Is a bone fracture different from a bone break?
  - What are the types of common youth bone fractures?
  - What is our natural response to a fall?

- collecting four data sets from reputable sources in the literature to test the hypothesis
- Two procedures were used to test the hypothesis:  
 Procedure 1: Conducting a study which collects data using a survey questionnaire.  
 Procedure 2: By analyzing four data sets from reputable sources
- **Procedure 1:** Conducting a study which collects data using a survey questionnaire.
  - (1) The survey questionnaire focused on the following:
    - Whether a bone fracture happened between 0- 18 years old
    - The location of the bone fracture
    - Reason for the bone fracture
    - How could have avoided the bone fracture

(2) Selection of a sample size.

The questionnaire is sent out to a group of volunteers through social media, text messages and emails. There was no age limit or country restrictions for who could fill out the survey. No personal information was collected from the individuals. Responses were collected over two weeks.

- (3) Information gathered through the responses to the survey questionnaire is converted into a data set.
  - (4) The data set from this study is reviewed and cleaned for quality control. The final data set included 303 entries.
  - (5) Data analysis using Microsoft Excel
  - (6) Derive conclusions
- **Procedure 2:** By analyzing four data sets from reputable sources
    - (1) Six data sets from reputable sources related to the topic are selected
    - (2) Select data that is applicable data for this study
    - (3) Analysis of the applicable data
  - Compared the conclusions from Procedure 1 with Procedure 2

### 3.1 My Questionnaire

## Science Fair 2024 - Bone Injuries and Causes in Youth

Hi! My name is Chenaya and I am a grade 9 student at Queen Elizabeth High School. I am doing a Calgary Youth Science Fair project about bone injuries and would really appreciate it if you could fill out this form.

Any questions in this form are only about bone breaks/fractures you received between the ages of 1-18 years.

Please fill the form out again if you have broken multiple bones :)

Thank you for supporting my science fair project!

Feel free to share this form with this link <https://forms.gle/hshYjja8DQYQJSC69>

*\* Indicates required question*

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1. Today's Date: \*

\_\_\_\_\_  
*Example: January 7, 2019*

2. Which city are you filling this form out from? \*

\_\_\_\_\_

3. If you've had a broken bone, at which age did your injury happen? \*

*Mark only one oval.*

- I have not broken/fractured a bone
- Under 1 years    *Skip to question 5*
- 1-4 years    *Skip to question 5*
- 5-9 years    *Skip to question 5*
- 10-14 years    *Skip to question 5*
- 15-18 years    *Skip to question 5*

4. If you HAVENT had a broken bone, which of the physical activities have you participated in?

Select all that apply

Check all that apply.

- Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc)
- Individual sports (ex. Swimming, Running, Tennis, Gymnastics, etc)
- Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)
- I HAVE NOT done any of these physical activities

5. If you HAVE broken a bone between the ages of 1-18 years, where did you break it?

If you have broken more than one bone, please fill out a separate form for each bone break you've had.

Mark only one oval.

- Ankle/Heel (Tarsals)
- Arm (Ulna/Radius/Humerus)
- Collarbone (Clavicle)
- Elbow
- Finger(s)/Hand (Metacarpals and Phalanges)
- Hip/Pelvis (Sacrum, Ilium)
- Knee (Patella)
- Leg (Tibia, Fibula, Femur)
- Nose (Nasal)
- Neck
- Ribs/Breastbone (Sternum)
- Shoulder (Scapula)
- Skull
- Spine
- Toe(s)/Foot (Metatarsals and Phalanges)
- Wrist (Carpals)
- Other: \_\_\_\_\_



6. If you HAVE broken a bone between the ages of 1-18 years, how did it happen?

Mark only one oval.

- Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc)
- Individual sports (ex. Swimming, Running, Tennis, Gymnastics, etc)
- Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)
- Day to Day Life (ex. Going up and down stairs, Moving things, etc)
- Accidents/Trauma (ex. Car accidents, Direct blow, etc)
- Other: \_\_\_\_\_

7. If you HAVE broken a bone between the ages of 1-18 years, what is the specific cause?

Mark only one oval.

- Fall (ex. Falling onto an outstretched hand resulting in a broken wrist)
- Any cause other than a fall (Direct blows, Accidents, Trauma)

8. Do you think your bone break could have been easily prevented? (Without completely stopping the activity that caused it)

Mark only one oval.

- Yes
- No

9. If yes to the previous question, how do you think your bone break could have been prevented?

Ex: Using the handrail when going down the stairs, wearing better protective gear, etc.

Max. 3000 characters

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10. Optional: Any other information you would wish to provide about your bone break.

Max. 5000 characters

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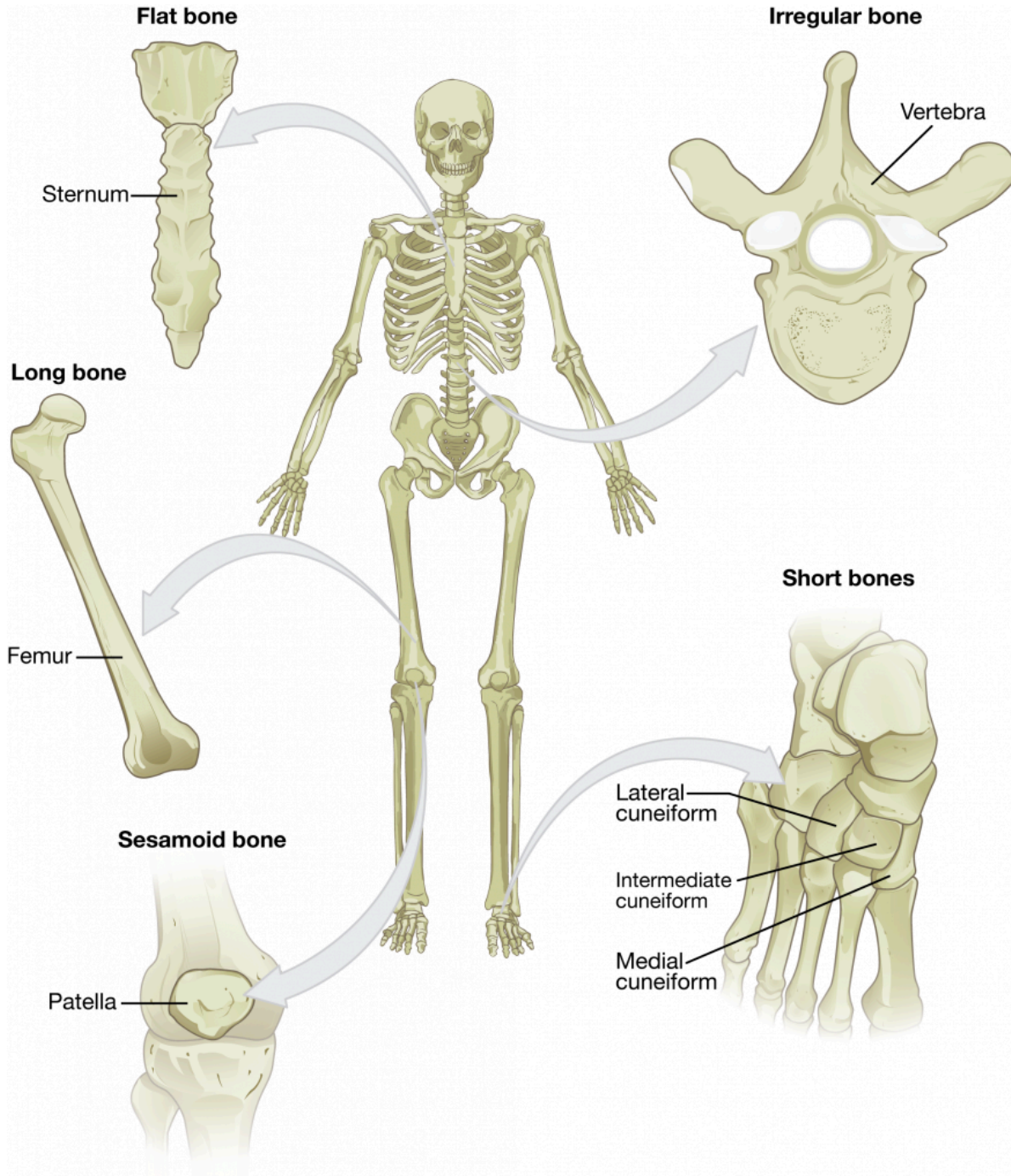
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Google Forms

## 4.0 Literature Review

### 4.1 What are the Bones in the Human Body



- A total of 206 bones in an adult. At birth, there are 300 bones.
- There are five types of bones:

### Flat Bones

- Protect internal organs like the brain, heart and pelvic organs
- Flat like a shield and sometimes have a curve
- Attachment for muscles
- The flat bones in your skull meet at joints called sutures, sutures can't move but they will fuse. They don't completely fuse until your growth is complete, typically around age 20. This allows your brain to grow and expand as an infant and child

### Long Bones

- Bones that are longer than they are wide like the femur and fingers
- Hard and dense bones that can support the body's weight and enable movement

### Short Bones

- Cube-shaped and contains spongy bones
- Found in the wrist and ankle
- Allow movement of the wrist and ankle
- Intended for strength, compactness, and motion

### Irregular Bones

- Bones like vertebrae, the middle part of the pelvis (sacrum), and certain bones in the jaw area
- Serves various purposes:
  - Protect nervous tissue (vertebrae)

### Sesamoid Bones (Reinforce tendons)

-ones embedded in tendons. These small, round bones are commonly found in the tendons of the hands, knees, and feet.

## **4.2 Is a Bone Fracture Different from a Bone Break?**

### Bone fracture vs. Bone break

Bone fractures and broken bones mean the same thing and they are used interchangeably. A fracture is simply the medical term for a broken bone

### Bone fracture vs. Bone Bruise

A bone bruise occurs when blood is trapped under the surface of the bone due to a forceful impact on the skin's surface and the bone does not crack. A bone fracture occurs when a force breaks or causes a crack in the bone, resulting in a more severe injury and longer healing time.

### Bone fractures vs. Sprains

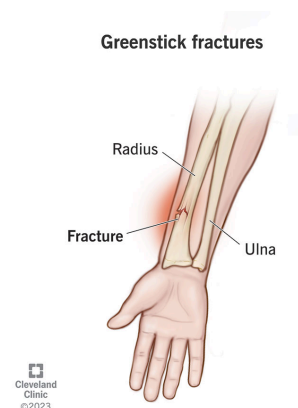
You can't sprain a bone. A sprain happens when one of your ligaments is stretched or torn. Ligaments are fibrous tissue that connects bone to bone.

## **4.3 The Main Types of Youth Bone Fractures:**

### **Fractures:**

#### Greenstick Fracture

- Most broken fractures in children are greenstick fractures, this is because children's bones are more flexible than adult bones
- Almost all greenstick fractures happen in children under 10 because kids have softer and less brittle bones than adults.
- Greenstick fractures bones that bend so much that they crack but they don't break all the way and they don't break into pieces
- They are called greenstick because when you try and break a greenstick (a branch that is still alive, it is still flexible) you won't be able to break it all the way through
- A greenstick fracture happens when there is enough energy to start a fracture but not enough energy to complete it
- Treated by immobilizing the fracture using a cast for about six weeks. If the crack is at a bad angle then surgery might be required
- Symptoms of greenstick fracture:
  - Pain
  - Bruising



- Tenderness
  - Swelling
  - Part of the body looks more bent or twisted than usual
- 
- Most common causes for greenstick fracture:
    - Fall (especially onto an outstretched hand)
    - Sports injuries
    - Car accidents
  - Who is most likely to get greenstick fracture:
    - As said before; children under the age of 10. Because they have more flexible bones that are softer and more pliable than adult bones and because children fall more
    - Children with vitamin D deficiency
  - Ways to prevent greenstick fractures:
    - Always wear a seatbelt
    - Wear proper protective equipment when doing sports (wrist guards)
    - Use proper tools (step stools to prevent falling)



- **Summary:**

**When there is enough energy to start a fracture but not enough energy to complete it. The bone bends until it cracks but doesn't break through, just like when you try a greenstick (tree branch that is still alive)**

### Buckle (Torus) Fracture

- Very common in children like the greenstick fracture
- Frequently happens around the wrist
- When one side of the bone is compressed, the other side bends/buckle
- Almost always affects children. They are incomplete fractures meaning the break won't go all the way through the bone
- They are compression fractures meaning they are caused by sudden pressure/force to the area (like a fall) that causes the bones to bulge out of place
- Like a soda can being crushed
- Commonly happens on the ulna and radius, but can also occur on longer bones like; the femur, tibia, fibula, humerus
- Most commonly occur when children fall onto outstretched hands and are treated with a split or cast, very very rare for them to be treated with surgery.
- They are more common in children than in adults for the same reasons why greenstick fractures are more common in children
- It doesn't happen on small bones like fingers or toes
- Very common: 1 in 4 children who break a bone receive buckle fracture and half of all wrist fractures are buckle fractures.
- Symptoms of buckle fractures:
  - Pain
  - Swelling
  - Tenderness
  - Bruising
  - Bump in body that is not usually there
- Causes:
  - When bones are compressed together with force
  - For example; when A child falls onto an outstretched hand
- Long bones may bend without breaking the cortex. Children's bones can be bent to 45 degrees before the cortex is disrupted and a greenstick or a complete fracture occurs. However if the bending force is released the bone may only partially return to its pre-bent position, resulting in plastic bowing.
- **Summary:**
- **They are compression fractures meaning they are caused by sudden pressure/force to the area (like a fall) that causes the bones to bulge out of place. Almost always**



**happens in children because their bones are softer and less brittle than adult bones.**

#### Hairline/Stress fracture

Small cracks in the bone typically are caused over time by overuse. Mostly occurs on weight-bearing bones like leg bones.



#### **4.4 What is our natural reflex to a fall?**

According to Orthopedic experts, our natural reflex to a fall can be explained using FOOSH. FOOSH is the shortened term for “fall on an outstretched hand.” It’s one of the most common injuries seen in the Emergency Department and can have a long-term effect on your fingers, hands, wrists, elbows or shoulders. The force of the impact between your hand and the surface you fall on is what creates FOOSH injuries. These can range from bruising to complete fractures.

Tumbles and falls can happen to anyone, at any age. From toddlers to the elderly, from those who are sedentary to professional athletes, our natural reflex to a fall is often to extend our hand.

[FOOSH Injuries: Breaking a Fall with Your Hand | Temple Health](#)

## **5.0 Analysis of Data Gathered from Literature**

### **5.1 Data set 1 (Italy Study)**

#### Overview

A study from Italy using data from the outpatient clinic of the Department of Orthopedics and Traumatology of Santobono-Pausilipon Children Hospital in Naples, Italy



RESEARCH ARTICLE

Open Access

## Pattern of fractures across pediatric age groups: analysis of individual and lifestyle factors

Giuliana Valerio<sup>1</sup>, Francesca Gallè<sup>1</sup>, Caterina Mancusi<sup>1</sup>, Valeria Di Onofrio<sup>1</sup>, Marianna Colapietro<sup>2</sup>, Pasquale Guida<sup>2</sup>, Giorgio Liguori<sup>1\*</sup>

**Data group:** Children from 2 to 14 years old

**Study period:** 1 January 2008 to 30 June 2008

**Number of participants:** 382

### Applicable Results

Fractures most frequently occurred in homes (41.6%), followed by playgrounds and footpaths (26.2%), sports facilities (18.3%), and educational facilities (13.9%), with gender differences existing only in adolescence.

The lifetime risk of sustaining a fracture in childhood is approximately 42%-64% in boys and 27%-40% in girls. (Average 43.25% between both genders)

### Results interpretation

Bone Fracture vs No bone fracture: 43.25% vs 56.75%

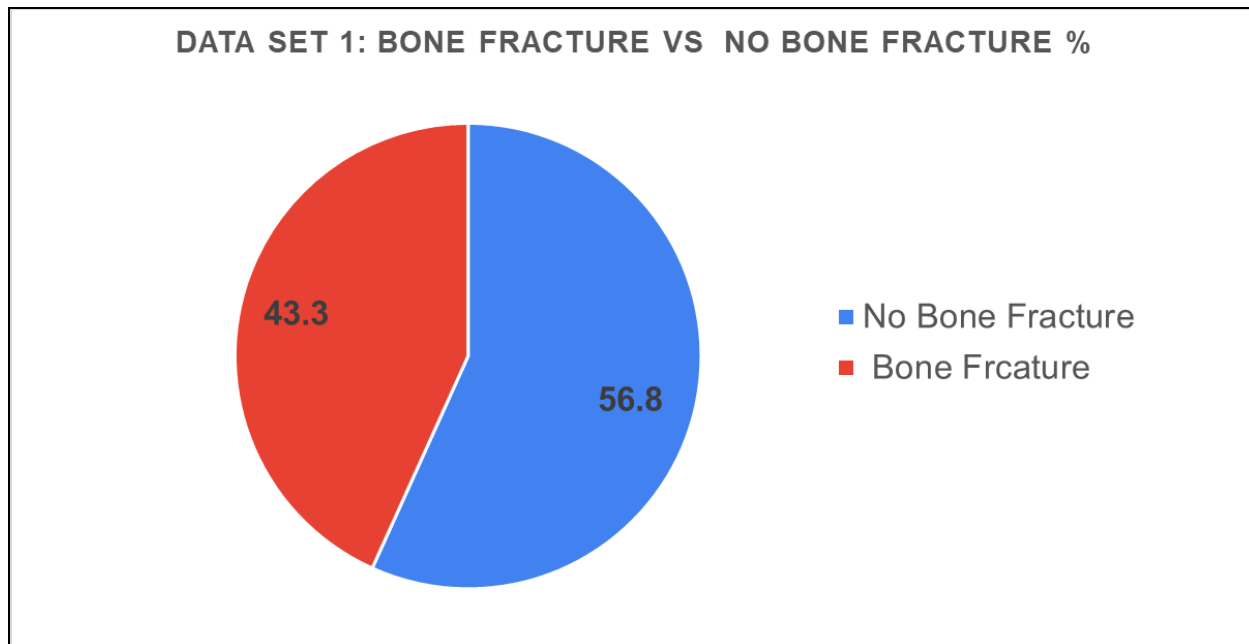
Home vs. playground vs. Sport facilities vs education facilities: 41.6% vs 26.2% vs 18.3% vs 13.9%

Bone broke during sport vs no sport= 41.6+13.9 vs 26.2+18.3

Assumption: Bone broke during sport including playground and sport facility data. Bone broke from no sports including Home and educational facilities.

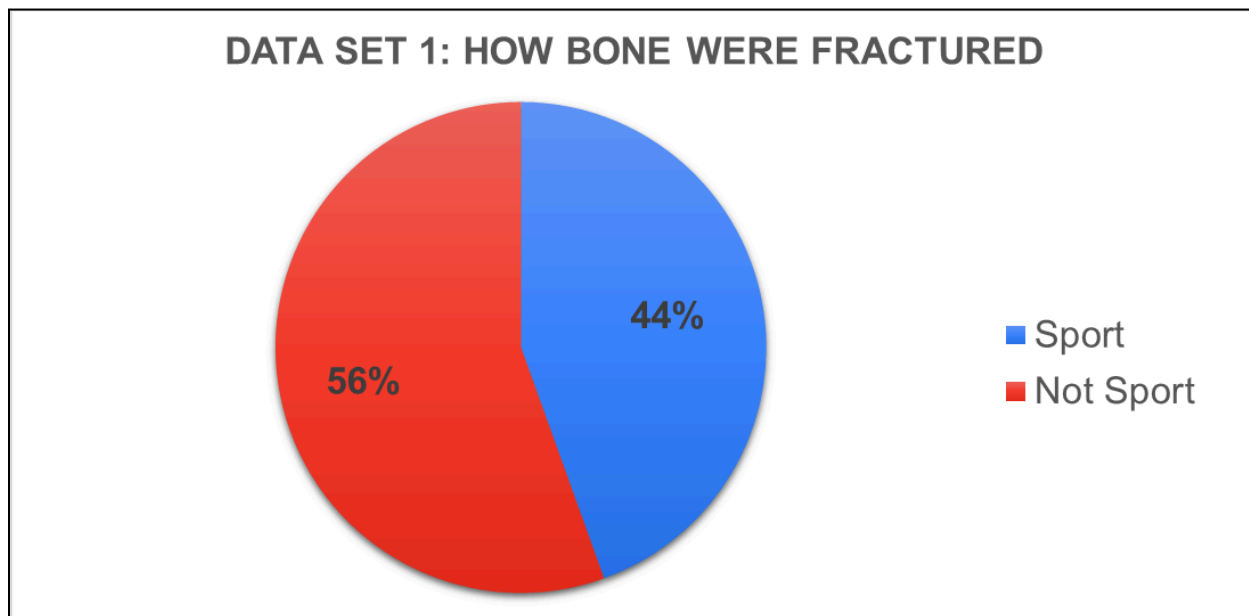
Excel Screenshot:

Bone Fracture	43.3
No Bone Fracture	56.8



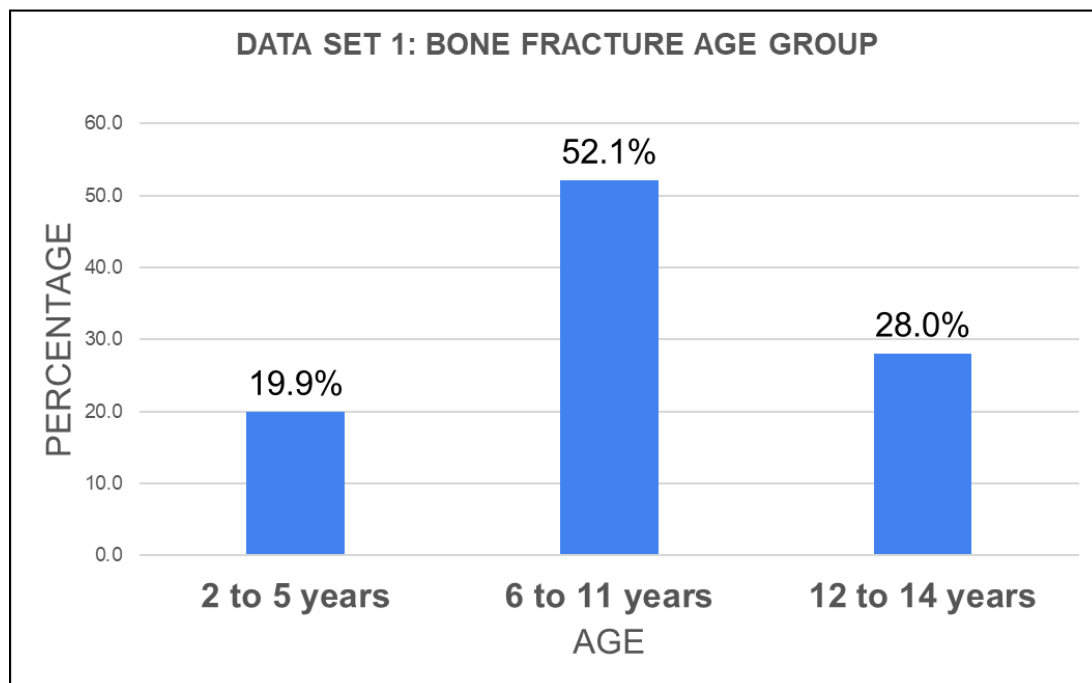
Excel Screenshot:

	%
Sport	44.5
Not during Sport	55.5



Excel Screenshot:

Age Range	#	%
2 to 5 years	76.0	19.9
6 to 11 years	199.0	52.1
12 to 14 years	107.0	28.0
TOTAL	382.0	



### **Anatomic sites of fractures**

The prevalence of fractures according to the anatomic site is shown in table 5. Except for two cases of clavicular fractures, the near totality of injuries involved the upper (84.1% cases) or lower limb (15.9%). The net prevalence of the upper limb over the lower limb was independent of age group. A slight gender discordance

## 5.2 Data set 2 (UK Study):

### Overview

A study from the United Kingdom (UK) using data from the General Practice Research Database.

JOURNAL OF BONE AND MINERAL RESEARCH  
 Volume 19, Number 12, 2004  
 Published online on September 20, 2004; doi: 10.1359/JBMR.040902  
 © 2004 American Society for Bone and Mineral Research

### Epidemiology of Childhood Fractures in Britain: A Study Using the General Practice Research Database

Cyrus Cooper,<sup>1</sup> Elaine M Dennison,<sup>1</sup> Herbert GM Leufkens,<sup>2</sup> Nicholas Bishop,<sup>3</sup> and Tjeerd P van Staa<sup>1,2,4</sup>

**Data group:** Children from 0 to 17 years old

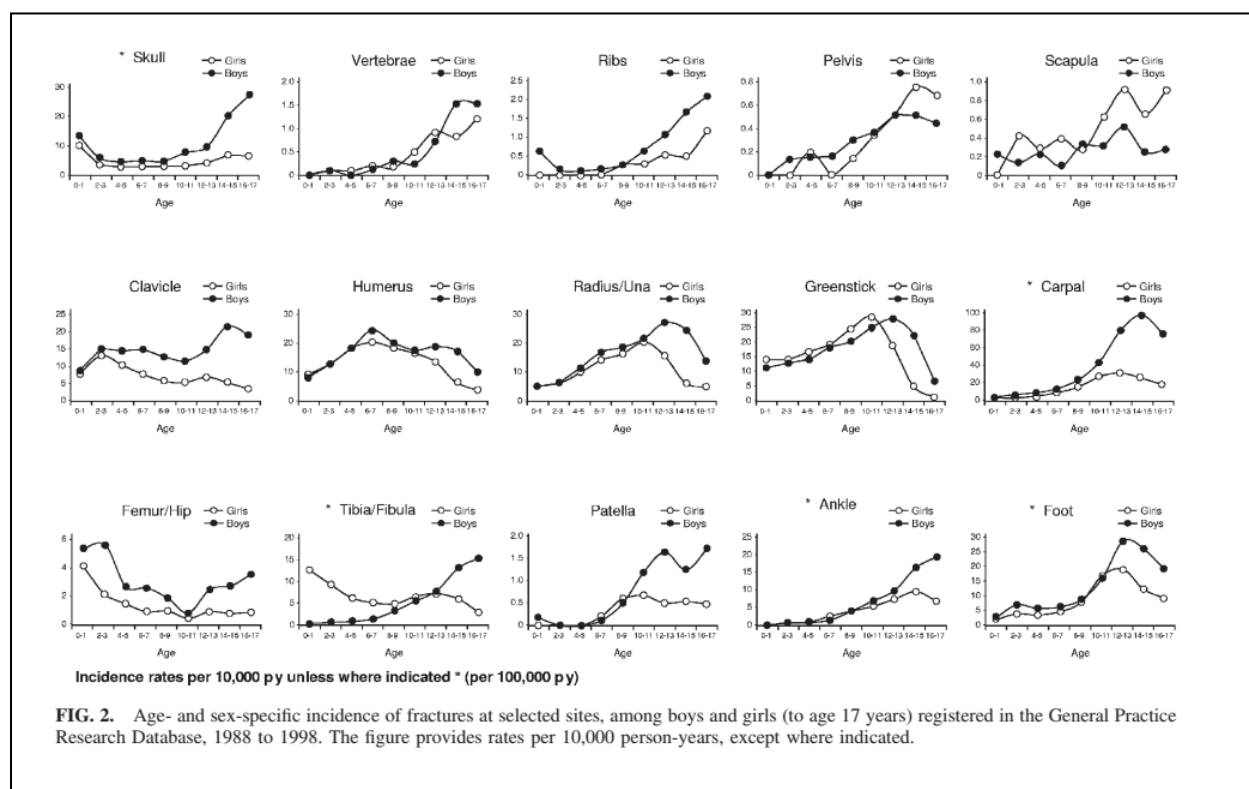
**Study period:** 1988 to 1998

**Number of participants:** 84129 (52,624 boys and 31,505 girls) from 7000000 data records from app residence

### Applicable Results

TABLE 1. DISTRIBUTION OF FRACTURES AND INCIDENCE RATES STANDARDIZED TO THE UK POPULATION

Fracture site	Boys		Girls		Both	
	No. of cases	Rate per 10,000 py	No. of cases	Rate per 10,000 py	No. of cases	Rate per 10,000 py
All	52,624	161.6	31,505	102.9	84,129	133.1
Radius/ulna	15,209	46.0	10,062	32.2	25,271	39.3
Carpal	12,152	36.7	4,702	15.0	16,854	26.1
Greenstick	6,627	17.3	4,805	15.5	10,462	16.4
Humerus	5,317	16.3	4,143	13.4	9,460	14.9
Clavicle	4,672	14.5	2,287	7.6	6,959	11.2
Foot	4,182	12.7	2,607	8.3	6,789	10.5
Tibia/Fibula	3,655	11.3	1,997	6.7	5,652	9.1
Skull	3,393	11.3	1,404	5.3	4,797	8.4
Ankle	1,690	5.1	1,043	3.3	2,733	4.2
Femur/hip	986	3.3	438	1.8	1,424	2.5
Patella	236	0.7	104	0.3	340	0.5
Ribs	233	0.8	106	0.4	339	0.6
Vertebral	159	0.5	134	0.4	293	0.5
Scapula	197	0.6	81	0.3	278	0.4
Pelvis	125	0.4	89	0.3	214	0.3



**Results:** A total of 52,624 boys and 31,505 girls sustained one or more fractures over the follow-up period, for a rate of 133.1/10,000 person-years. Fractures were more common in boys (161.6/10,000 person-years) than girls (102.9/10,000 person-years). The most common fracture in both sexes was that of the radius/ulna (30%). Fracture incidence was greater among boys than girls at all ages, with the peak incidence at 14 years of age among boys and 11 years of age among girls. Marked geographic variation was observed in standardized fracture incidence, with significantly ( $p < 0.01$ ) higher rates observed in Northern Ireland, Wales, and Scotland compared with southeast England.

**Conclusions:** Fractures are a common problem in childhood, with around one-third of boys and girls sustaining at least one fracture before 17 years of age. Rates are higher among boys than girls, and male incidence rates peak later than those among females. At their childhood peak, the incidence of fractures (boys, 3%; girls, 1.5%) is only surpassed at 85 years of age among women and never among men. The most common site affected in both genders is the radius/ulna. Studies to clarify the pathogenesis of these fractures, emphasizing bone fragility, are now required.

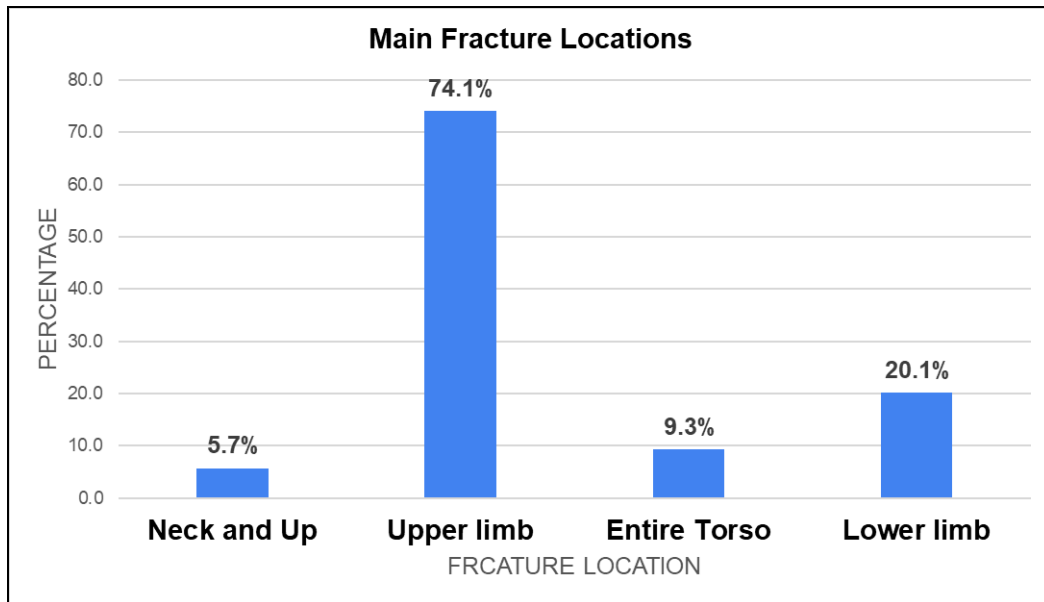
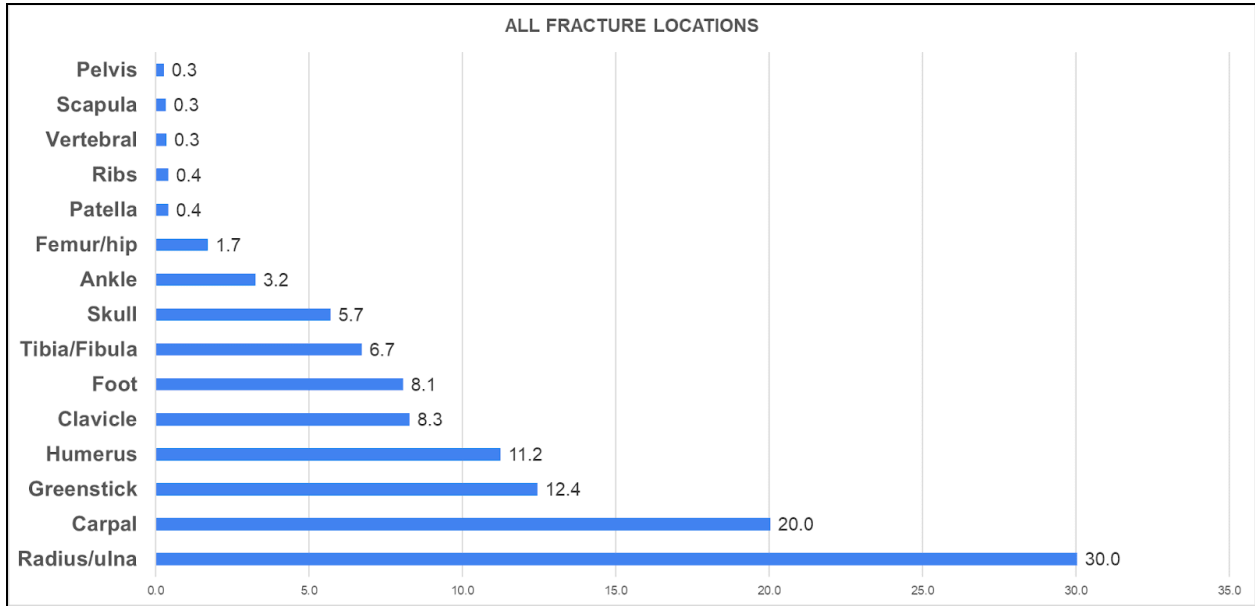
## Results interpretation

Excel Screenshot:

	Boys	52624	
	Girls	31505	
		84129	
	ALL	84129	%
	Radius/ulna	25271	30.0
	Carpal	16854	20.0
	Greenstick	10462	12.4
	Humerus	9460	11.2
	Clavicle	6959	8.3
	Foot	6789	8.1
	Tibia/Fibula	5652	6.7
	Skull	4797	5.7
	Ankle	2733	3.2
	Femur/hip	1424	1.7
	Patella	340	0.4
	Ribs	339	0.4
	Vertebral	293	0.3
	Scapula	278	0.3
	Pelvis	214	0.3

Excel Screenshot:

		%
	Neck and Up	5.7
	Upper limb	74.1
	Entire Torso	9.3
	Lower limb	20.1



**5.3 Data set 3 (US Study):**

Overview

The National Electronic Injury Surveillance System All Injury Program data 2005 through 2013 were accessed; 18 common sports and recreational activities in the United States were selected.

# The Demographics of Fractures and Dislocations Across the Entire United States due to Common Sports and Recreational Activities

Cory Meixner, MD,<sup>†</sup> and Randall T. Loder, MD\*<sup>‡</sup>

**Data group:** All ages including adults

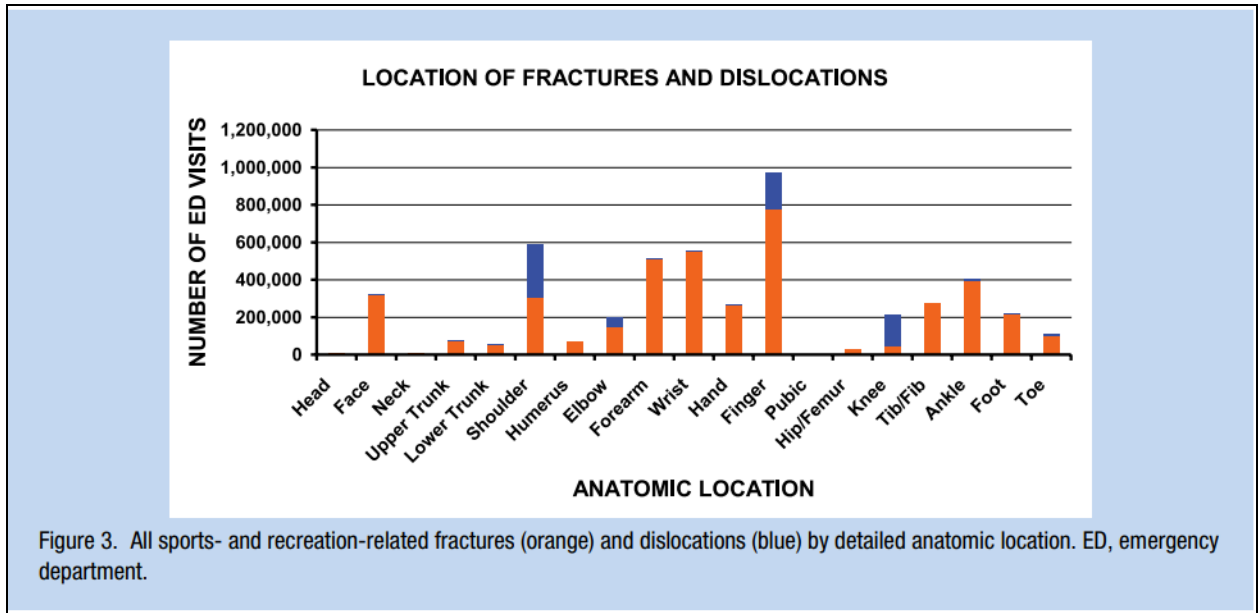
**Study period:** 2005-2013

**Number of participants:** 20,241,049 Emergency Department visits

## Applicable Results

Sports	Fractures		
	n	N	%N
Inline skating	1306	70,430	1.7
Ice skating	1063	48,013	1.2
Skateboard	5976	367,529	8.8
Toboggan/sled	1246	72,983	1.8
Gymnastics	3558	175,341	4.2
Basketball	16,244	799,328	19.2
Baseball	4937	279,664	6.7
Softball	2663	163,839	3.9
Ice hockey	1879	96,761	2.3
Football	19,491	935,183	22.5
Soccer	8811	440,426	10.6
Racquet sports	620	35,343	0.8
Volleyball	1223	75,467	1.8
Track/field	607	29,512	0.7
Combative	2956	171,927	4.1
Swimming	1596	94,049	2.3
Waterski/surf	426	35,813	0.9
Snow skiing	4038	268,156	6.4



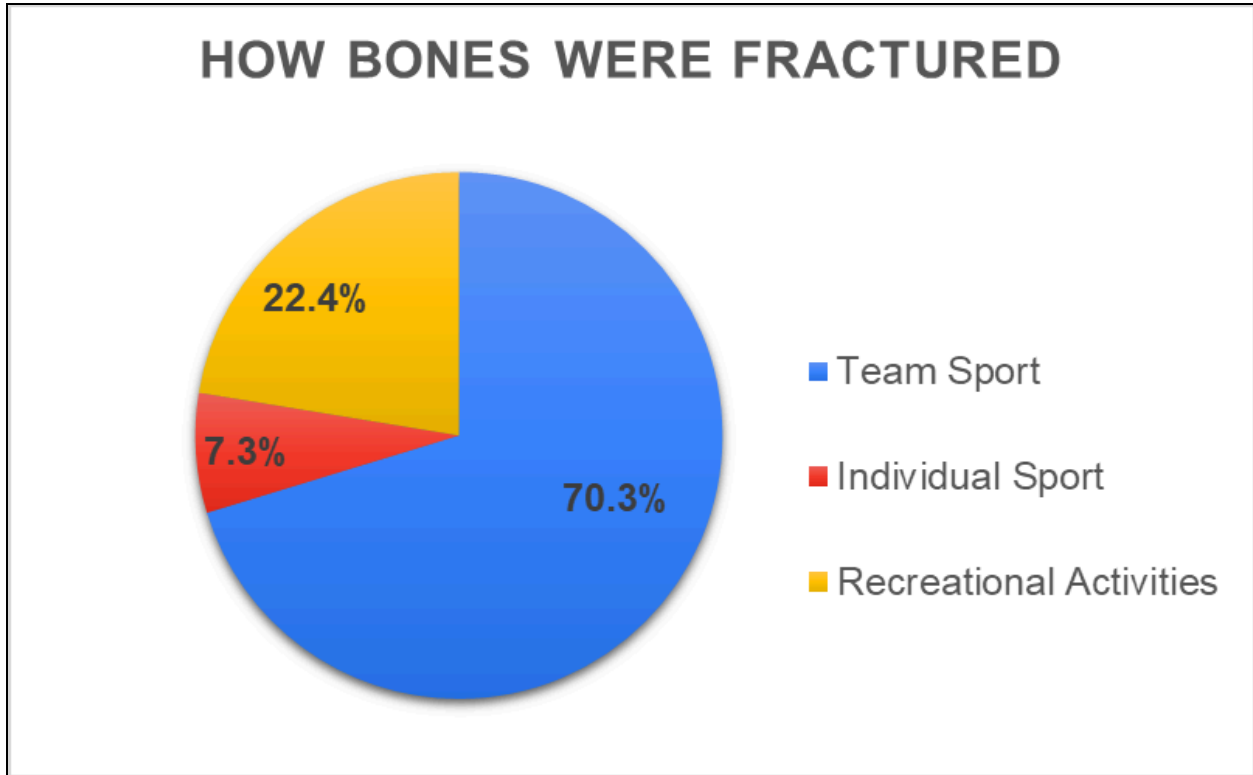


### Results interpretation

- The greatest burden of fractures from common sports and recreational activities involved football and basketball.
- The most common fracture was in the finger followed by the wrist and forearm.

Excel Screenshot:

Chart Area	Percentage of fracture	%
Team Sport		70.3
Individual Sport		7.3
Recreational Activities		22.4
		100



#### **5.4 Data set 4 (Switzerland Study):**

##### Overview

The National Electronic Injury Surveillance System All Injury Program data from 2005 through 2013 were accessed; 18 common sports and recreational activities in the United States were selected.

ORIGINAL ARTICLE

Endocrine Research

## Fractures during Childhood and Adolescence in Healthy Boys: Relation with Bone Mass, Microstructure, and Strength

T. Chevalley, J. P. Bonjour, B. van Rietbergen, S. Ferrari, and R. Rizzoli

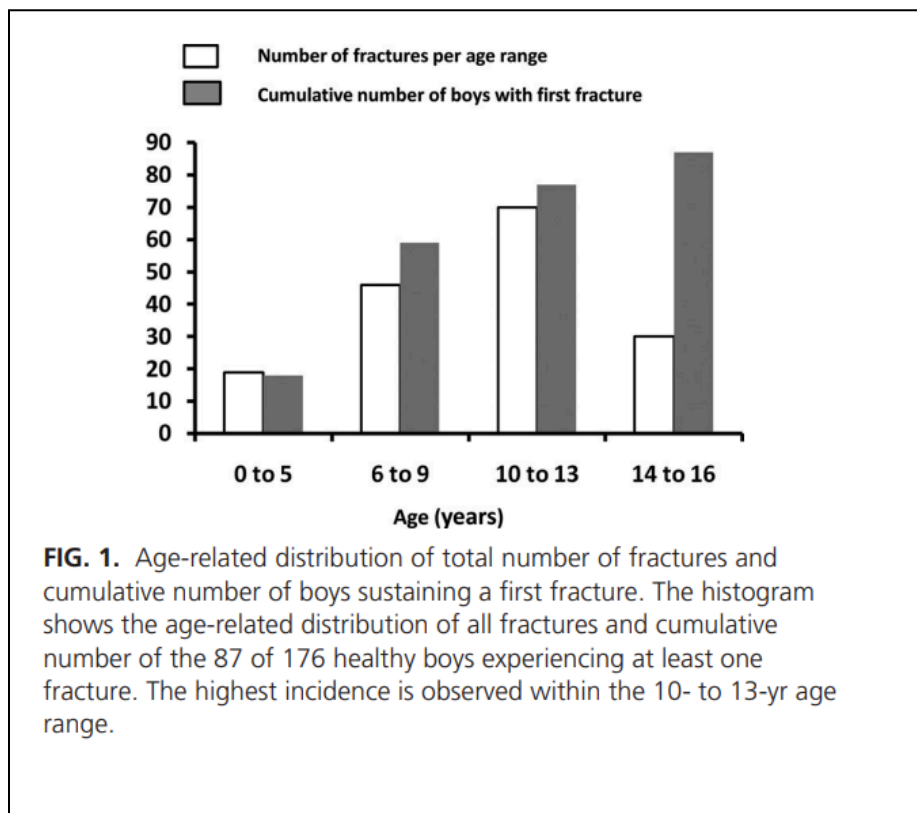
Division of Bone Diseases (T.C., J.P.B., S.F., R.R.), University Hospitals and Faculty of Medicine, CH-1211 Geneva 14, Switzerland; and Department of Biomedical Engineering (B.v.R.), Eindhoven University of Technology, 5612 AZ Eindhoven, The Netherlands

**Data group:** 7 to 15 years old

**Study period:** September 1999 to September 2000

**Number of participants:** 176 boys

### Applicable Results

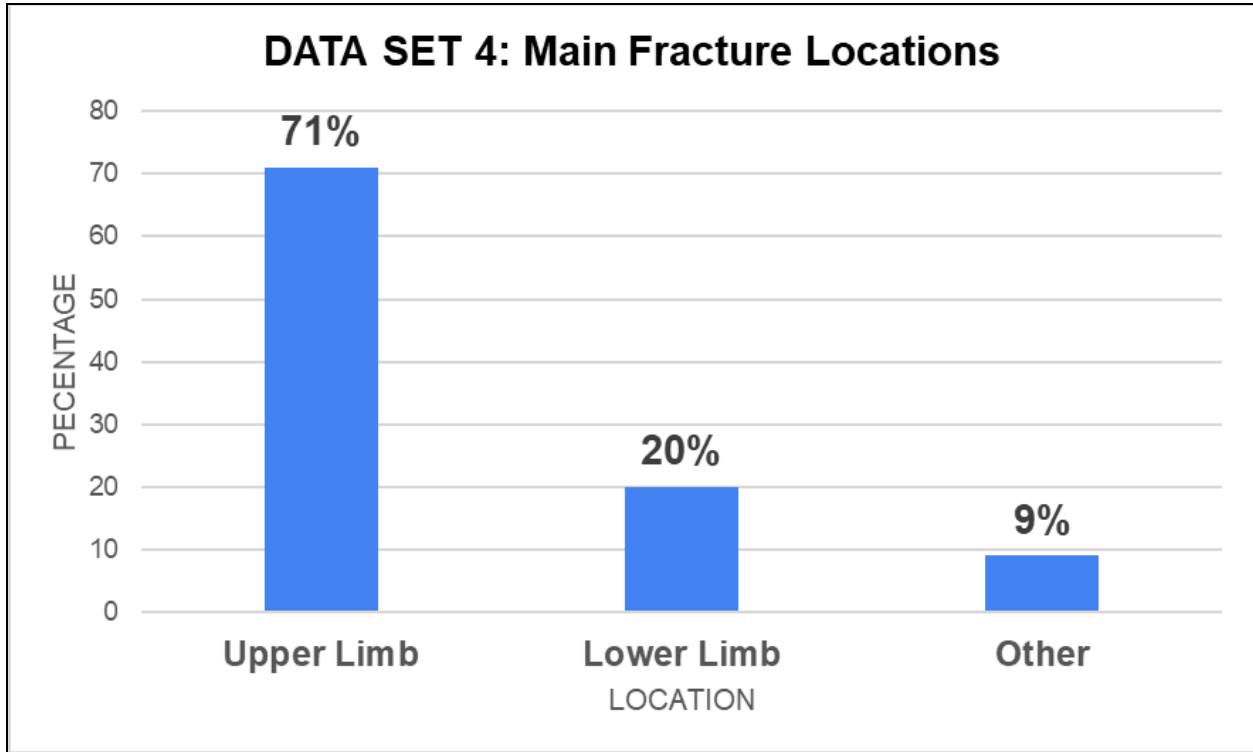


The total number of fracture was 156, occurring in 87 of the 176 boys followed up. Multiple fractures (two to five) were reported in 38 boys, accounting for two thirds of all fractures. Most common fractures were localized in forearm and wrist (39%), followed by hand/fingers (18%) and arm/shoulder (14%). Twenty percent of fractures occurred at the lower limb (including foot, ankle, tibia, and femur) and 8% at other sites. In boys having experienced more than one fracture, the upper limb was always affected. Peak fracture incidence occurred from 10–13 yr of age (Fig. 1).

## Results interpretation

Excel Screenshot:

	Forearm and Wrist	39%	
	Hand and Finger	18%	
	Arm and Sholder	14%	
	Entire leg	20%	
	Oher	8%	
	Upper Limb	71	
	Lower Limb	20	
	Other	9	



### **5.5 Data set 5 (Ireland Study):**

#### Overview

Collection of data of pediatric patients who presented with fractures to the orthopedic outpatient services of University Hospital Kerry, as well as patients admitted for inpatient treatment.

**Cureus** Open Access Original Article DOI: 10.7759/cureus.1624

**A Review of Epidemiological Distribution of Different Types of Fractures in Paediatric Age**

MN Baig<sup>1</sup>

1. Orthopaedics, Galway University Hospital

**Data group:** 0 to 18 years old

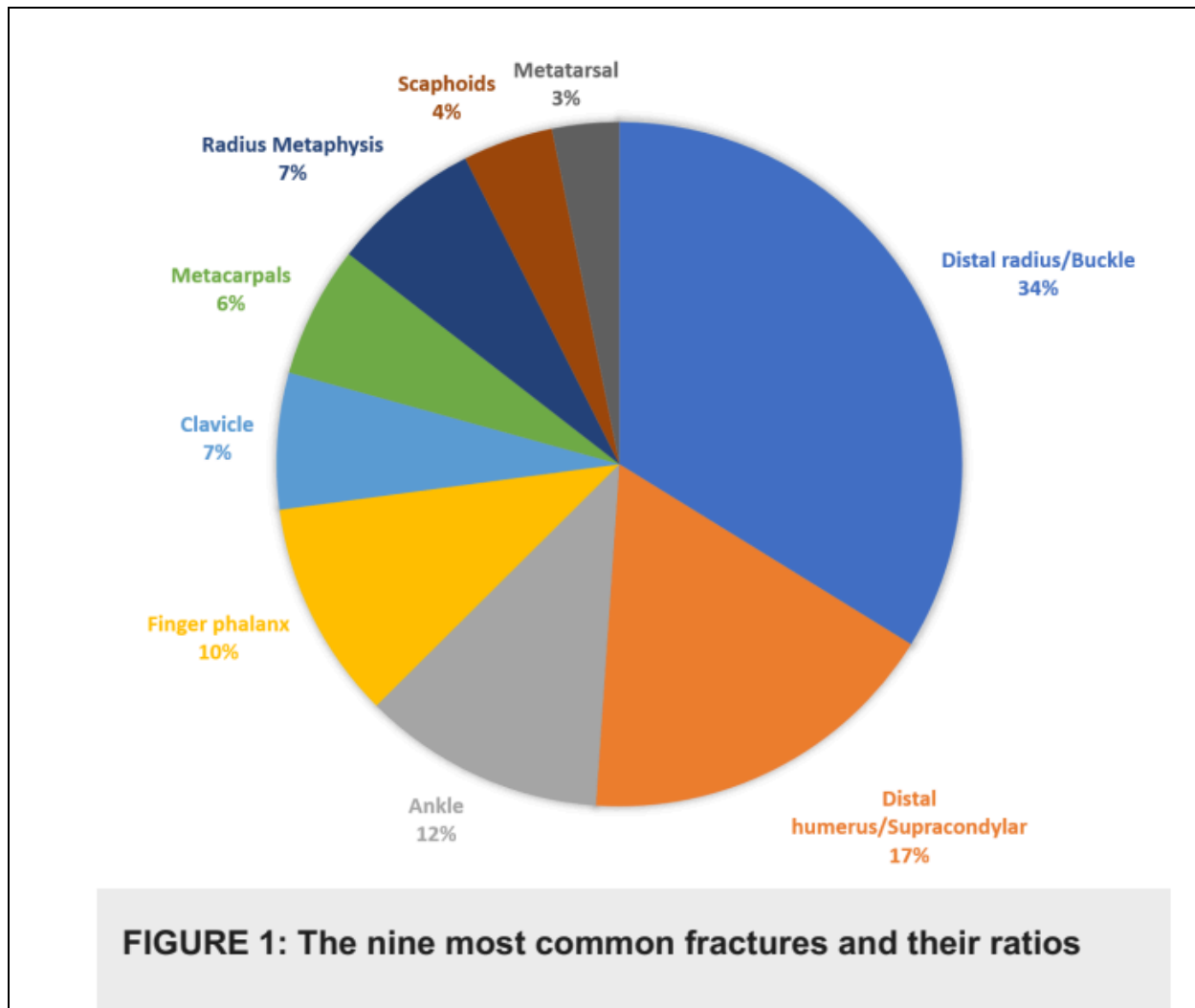
**Study period:** August 2015 to July 2016

**Number of participants:** 1022

## Applicable Results

Fracture	Frequency	Percent	Age (year)	Sex (Male:Female)
Clavicle	53	5.2	9.21	74:26
Proximal humerus	18	1.8	11.56	44:56
Distal humerus/Supracondylar	142	13.9	6.89	51:49
Radius/Ulna diaphysis	36	3.5	9.42	50:50
Radius metaphysis	58	5.7	8.41	41:59
Distal radius /Buckle	278	27.2	8.48	54:46
Scaphoids	35	3.4	13.37	40:60
Metacarpals	51	5.0	14.02	47:53
Phalanx fingers	85	8.3	12.85	39:61
Tibia diaphysis	13	1.3	8.00	46:54
Distal tibia	9	0.9	5.00	67:33
Femur diaphysis	19	1.9	14.42	42:58
Proximal tibia	25	2.4	8.56	88:12
Patella	7	0.7	13.29	29:71
Ankle	94	9.2	12.36	40:60
Toe phalanx	16	1.6	12.88	44:56
Metatarsals	26	2.5	11.23	54:46
Pubic rami	3	0.3	16.00	0:100
Olecranon	11	1.1	7.27	18:82
Hook of hamate	7	0.7	14.00	57:43
Ulnar styloid	18	1.8	12.00	100:0
Radial head	18	1.8	8.33	33:67

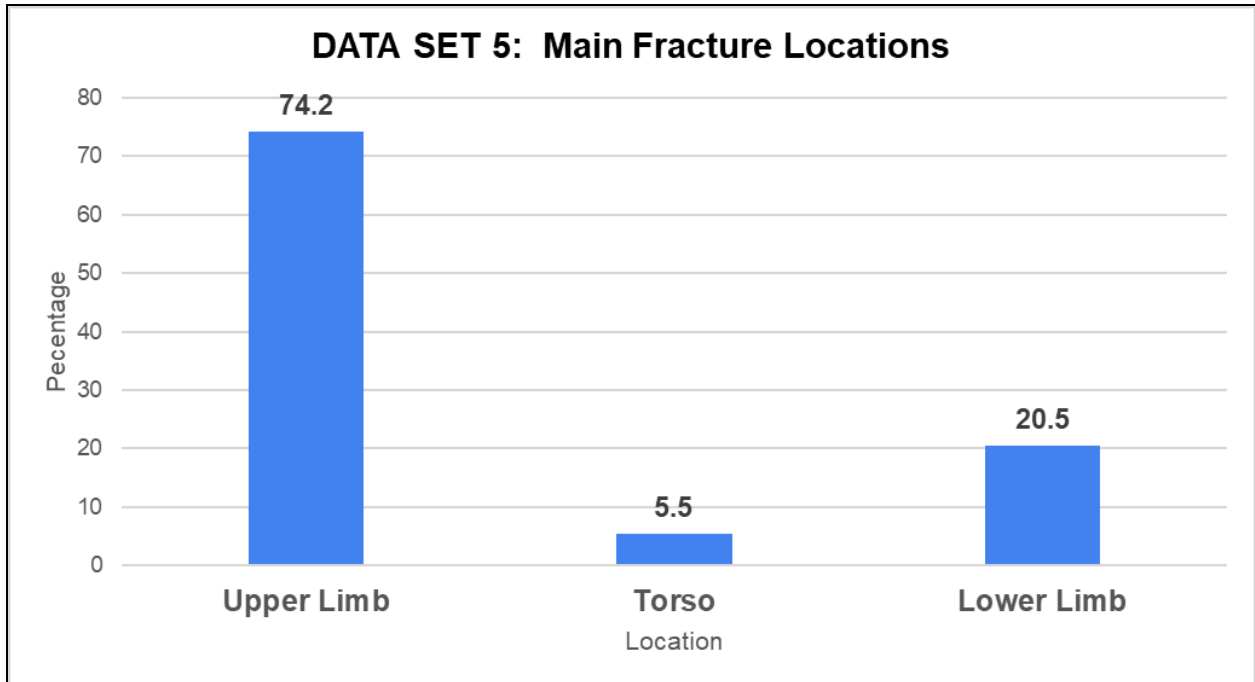
**TABLE 1: Common fractures and their epidemiological distribution according to age, sex, and frequency of different types of fractures**



## Results interpretation

Excel Screenshot:

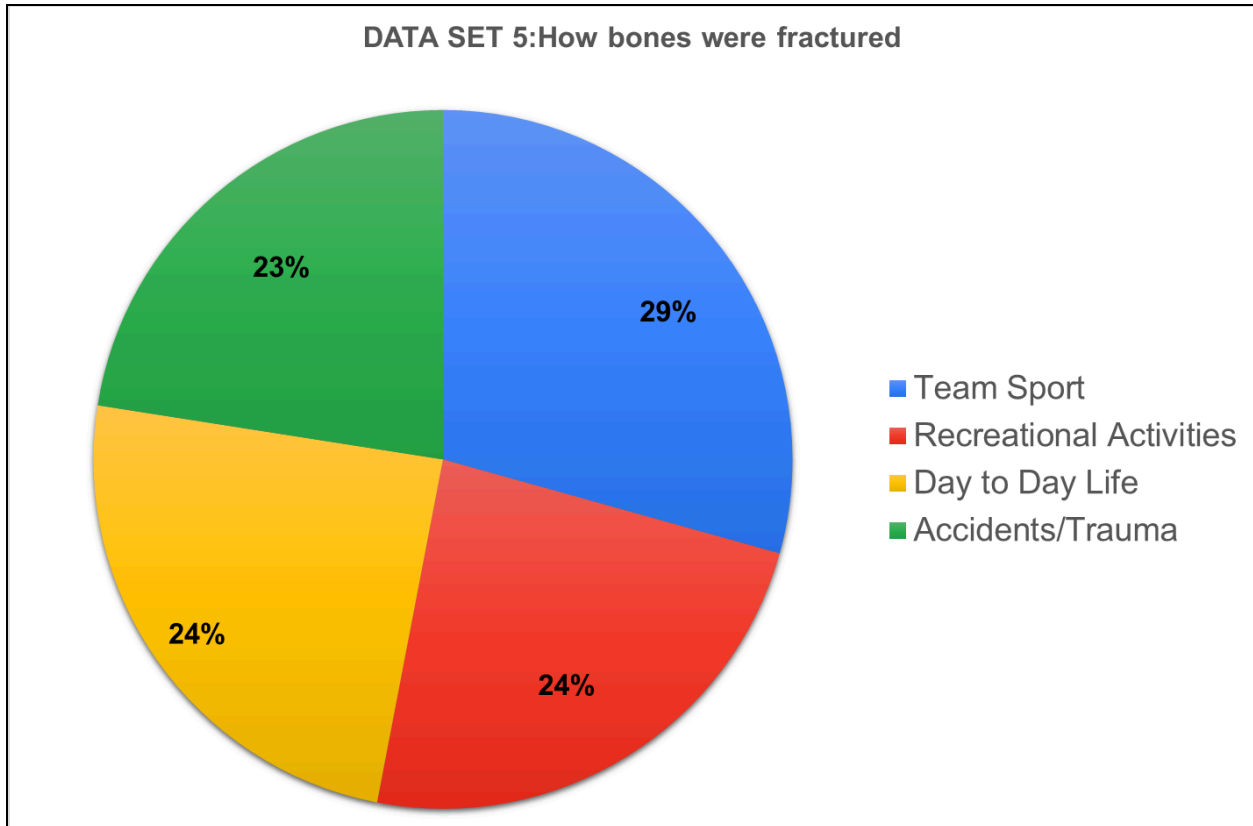
Location	%
Upper Limb	74.2
Torso	5.5
Lower Limb	20.5



Excel Screenshot:

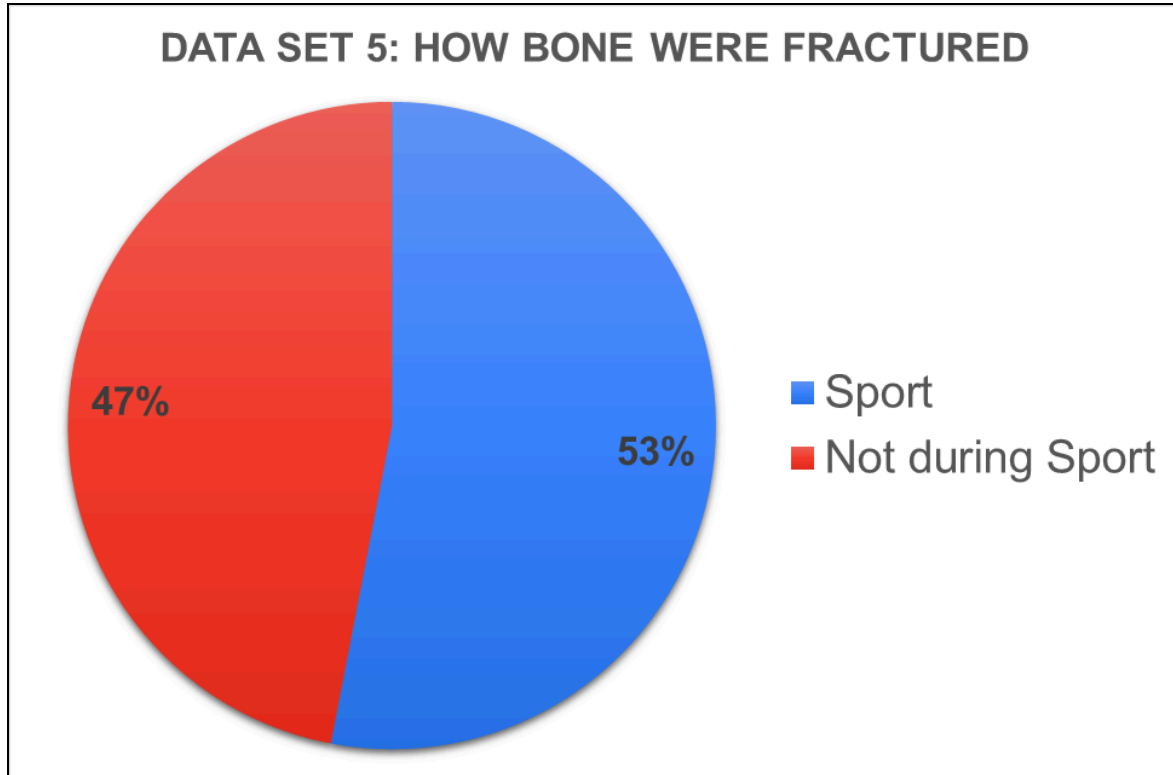
	MALE		FEMALE		TOTAL
Cause of fracture	Number of people	%	Number of people	%	%
Team Sport	62	32.0	59	26.6	29.3
Individual Sport	0	0.0	0		0.0
Recreational Activities	34	17.6	66	29.8	23.7
Day to Day Life	57.5	29.7	42.5	19.2	24.5
Accidents/Trauma	40	20.7	54	24.4	22.5
<b>TOTALS</b>	<b>193.5</b>	<b>100.0</b>	<b>221.5</b>	<b>100.0</b>	





Excel Screenshot:

Chart Area	53.0
Not during Sport	47.0



### 5.6 Data Set 6 (Canada Study)

#### Overview

Government of Canada's Open Government Data

Database:

Statistics Canada / Statistique Canada

[Home](#) > [Data](#)

**Archived Content**

Information identified as archived is provided for reference, research or recordkeeping purposes. It is not subject to the Government of Canada Web Standards and has not been altered or updated since it was archived. Please [contact us](#) to request a format other than those available.

**Archived - Health behaviour in school-aged children 2002, student response to question: What were the main results of the most serious injury?<sup>1, 2, 3</sup>**

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[Health behaviour in school-aged children 2002, student response to question: What were the main results of the most serious injury? \(statcan.gc.ca\)](#)

**Data group:** 11 to 15 years

**Study period:** 2002

**Number of participants:** Not known

## Applicable Results

Bone Injury: Bone was broken, dislocated or out of joint (includes broken and/or chipped teeth):

			Geography	Canada
			Result of injury	Bone was broken, dislocated or out of joint (includes broken and/or chipped teeth)
Sex	Age group	Student response	2002	
			Percent	
Males	11 years	Yes	25	
		No	75	
	13 years	Yes	28	
		No	72	
	15 years	Yes	38	
		No	62	
Females	11 years	Yes	22	
		No	78	
	13 years	Yes	23	
		No	77	
	15 years	Yes	22	
		No	78	

## Results interpretation

Excel Screenshot:

	Bone Fracture		26.3
	No bone fracture		73.7

# 6.0 Analysis of Data of My Research Questionnaire

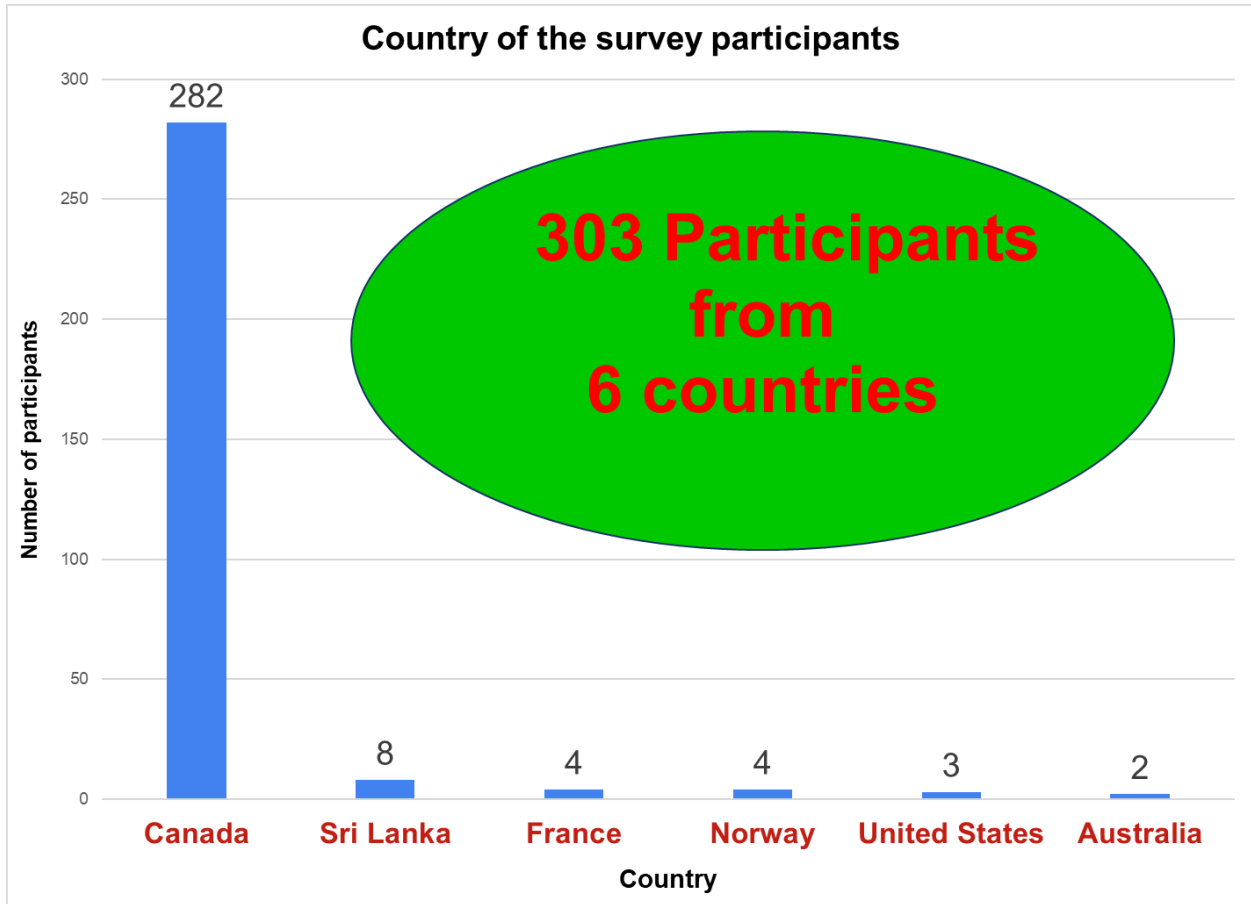
## 6.1: Data

This is a screenshot from showing the first several lines and the last several lines of the Excel spreadsheet of data gathered from my research questionnaire.

**PROCEDURE 1: SCREEN SHOTS OF THE DATA SET**

T	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Timestamp	Today's Date	Which country are you in?	Which city are you in?	If you've had a broken bone, at what age?	If you HAVEN'T had a broken bone, if you HAVE broken (if you HAVE broken, if you HAVE broken, if you HAVE broken, if you HAVE broken)	Do you think your bc if you to the previous spent?	Optional: Any other information you					
2	20170224 22:48:42	20170224	Canada	Calgary	Have not broken/fractured a bone	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)							
3	20170224 12:34:47	20170224	Canada	Calgary	Have not broken/fractured a bone	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)							
4	20170224 12:35:52	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Ankle/heel (Tarsals)	Yes		I could have been more cautious when I was going down the stairs. I could have used the handrail			
5	20170224 12:58:19	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Any cause other than (Toes)/Foot (Metatars)	Yes		Walking slower			
6	20170224 22:48:25	20170224	Canada	Calgary	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Accidents/Trauma (ex. Any cause other than (Toes)/Foot (Metatars)	No		A ball threw a ball on my face			
7	20170224 21:44:19	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Wrist (Carpals)	No		I fell on my wheel running backwards (S) I really hurt			
8	20170224 21:44:24	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
9	20170224 22:08:06	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
10	20170224 22:08:11	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
11	20170224 21:01:05	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
12	20170224 22:02:16	20170224	Canada	Deedman's Falls	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Any cause other than (Arm (Ulna/Radius/Hum)	No					
13	20170224 22:03:51	20170224	Canada	Calgary	1-4 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		Not trying to send down the stairs on a piece of wood			
14	20170224 22:05:07	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	No					
15	20170224 22:06:30	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
16	20170224 22:06:52	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Recreational activities (Any cause other than (Ankle/heel (Tarsals)	Yes		Being more careful on the stationary bike			
17	20170224 22:10:10	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
18	20170224 22:10:36	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
19	20170224 22:11:17	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
20	20170224 22:11:28	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
21	20170224 22:11:50	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Recreational activities (Fall (ex. Falling onto an Finger(s)/Hand (Metac)	No					
22	20170224 22:12:14	20170224	Canada	Calgary	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Accidents/Trauma (ex. Any cause other than (Finger(s)/Hand (Metac)	Yes		Been more careful shutting the door			
23	20170224 22:13:27	20170224	Canada	Calgary	Have not broken/fractured a bone	I HAVE NOT done any of these physical activities	Individual sports (ex. S Any cause other than (Toes)/Foot (Metatars)	Yes		Not overworking my foot			
24	20170224 22:14:49	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Any cause other than (Toes)/Foot (Metatars)	Yes					
25	20170224 22:15:12	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Any cause other than (Toes)/Foot (Metatars)	No					
26	20170224 22:15:59	20170224	Canada	Calgary	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		Ms Chemyon was handing my I was 5 I think, pink cast. Could NOT open beer of butter jens.			
27	20170224 22:17:36	20170224	Canada	Calgary	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		net jumping on the bed, and if you do put soft things around the bed in case you fall			
28	20170224 22:21:48	20170224	Canada	Calgary	1-4 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		I was on a seaxer I couldnt I was 4 and fell off a seaxer onto ice and broke my arm			
29	20170224 22:24:00	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
30	20170224 22:24:58	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
31	20170224 22:28:53	20170224	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
32	20170224 22:30:23	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
33	20170224 22:30:36	20170224	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		Not stupidly jumping off a spoon I jumped off the apron cone at hit hurt and I caught my foot and hand			
334	2040024 17:30:39	2040024	Canada	Calgary	15-10 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
335	2040024 17:54:18	2040024	Canada	Calgary	15-10 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
336	2040024 17:54:49	2040024	Canada	Calgary	15-10 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Any cause other than (Toes)/Foot (Metatars)	No					
337	2040024 17:56:55	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Any cause other than (Finger(s)/Hand (Metac)	No					
338	2040024 18:00:01	2040024	Canada	Calgary	Under 1 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Finger(s)/Hand (Metac)	No		Sluck my hand out when falling			
339	2040024 18:00:41	2040024	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)					
340	2040024 18:01:16	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Toes)/Foot (Metatars)	Yes		Thinking before doing something that I knew would injure me			
341	2040024 18:02:30	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Arm (Ulna/Radius/Hum)	Yes		Thinking before doing something that I knew would injure me			
342	2040024 18:03:19	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Finger(s)/Hand (Metac)	Yes		Thinking before doing something that I knew would injure me			
343	2040024 18:03:52	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Toes)/Foot (Metatars)	Yes		Thinking before doing something that I knew would injure me			
344	2040024 18:04:29	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Elbow)	Yes		Thinking before doing something that I knew would injure me			
345	2040024 18:05:01	2040024	Canada	Edmonton	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Individual sports (ex. S Fall (ex. Falling onto an Nose (Nasal)	Yes		Thinking before doing something that I knew would injure me			
346	2040024 18:05:45	2040024	Canada	Calgary	15-14 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Recreational activities (Fall (ex. Falling onto an Wrist (Carpals)	No					
347	2040024 18:06:40	2040024	Canada	Edmonton	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Ankle/heel (Tarsals)	No					
348	2040024 18:09:40	2040024	Australia	Melbourne	5-8 years	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)	Day to Day Life (ex. Or Fall (ex. Falling onto an Ankle/heel (Tarsals)	No					
349	2040024 18:12:38	2040024	Canada	Calgary	Have not broken/fractured a bone	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)						
350	2040024 18:20:41	2040024	Canada	Calgary	Have not broken/fractured a bone	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)							
351	2040024 18:05:04	2040024	Canada	Calgary	Have not broken/fractured a bone	Team sports (ex. Soccer, Hockey, Volleyball, Basketball, etc.)							
352	2040024 22:23:24	2040024	Canada	Calgary	Have not broken/fractured a bone	Individual sports (ex. Soccer, Running, Tennis, Gymnastics, etc.)	Recreational activities (ex. Trampoline, Bowling, Biking, Skateboarding, Rollerblading, etc.)						

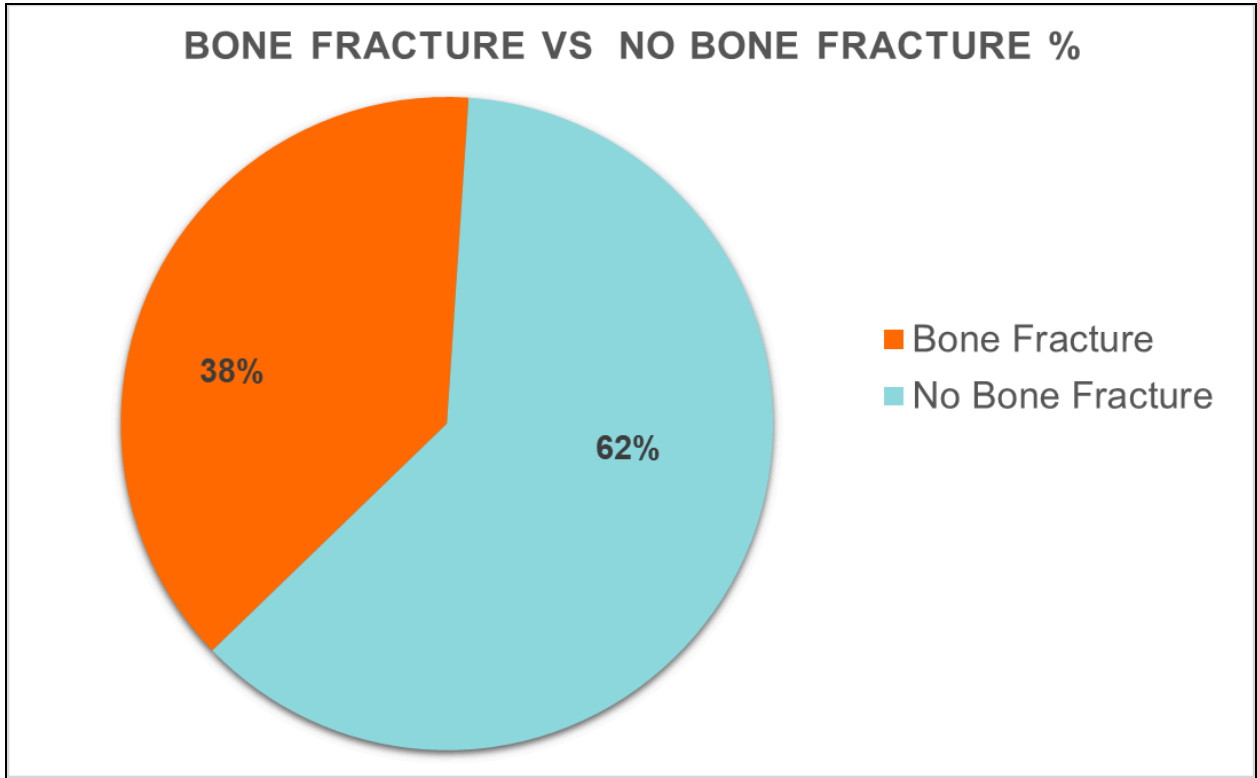
The graph below shows the breakdown of data.



## 6.2 Data Analysis

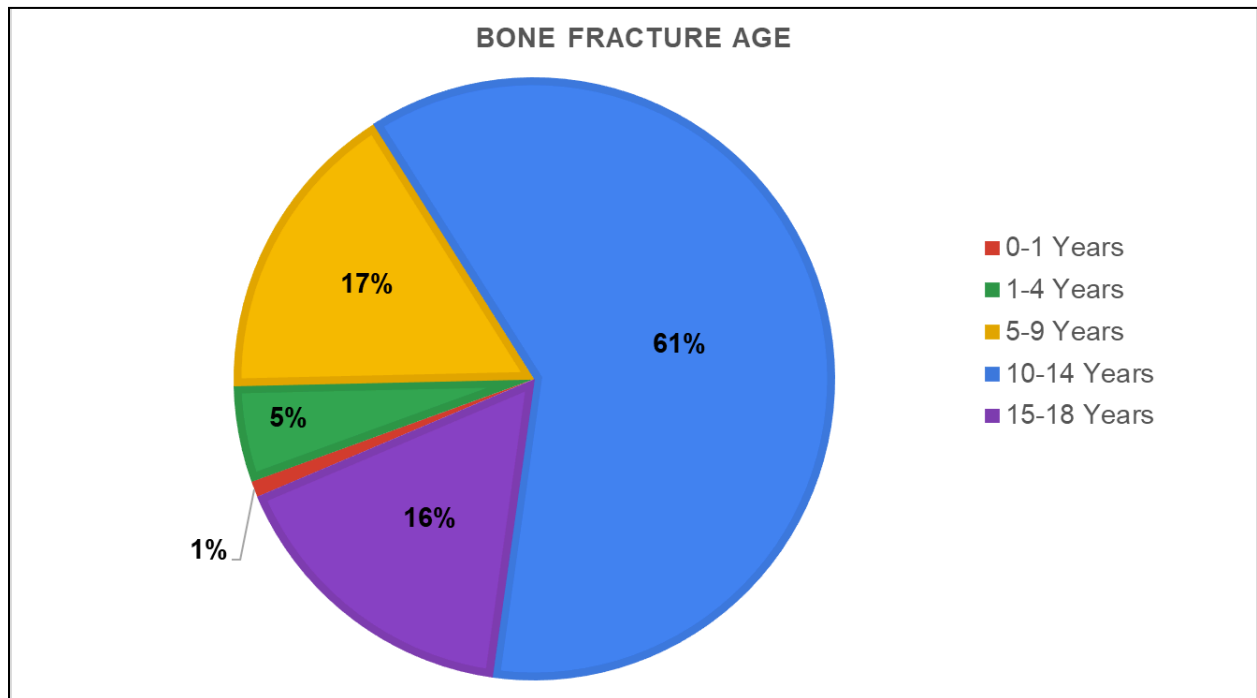
### Bone Fracture vs No Bone Fracture

				Percentage%	
Bone Fracture	116	38.3	Bone Fracture	38.3	
No Bone Fracture	187	61.7	No Bone Fracture	61.7	
	303				



## Age Group

Age	Number		
Not Fractured Bone	187	61.7	
0-1 Years	1	0.3	
1-4 Years	6	2.0	
5-9 Years	19	6.3	
10-14 Years	71	23.4	
15-18 Years	19	6.3	
	303		
Age Groups	Number with fractured bones	% with Fractured Bones	
0-1 Years	1	0.9	
1-4 Years	6	5.2	
5-9 Years	19	16.4	
10-14 Years	71	61.2	
15-18 Years	19	16.4	
	116		

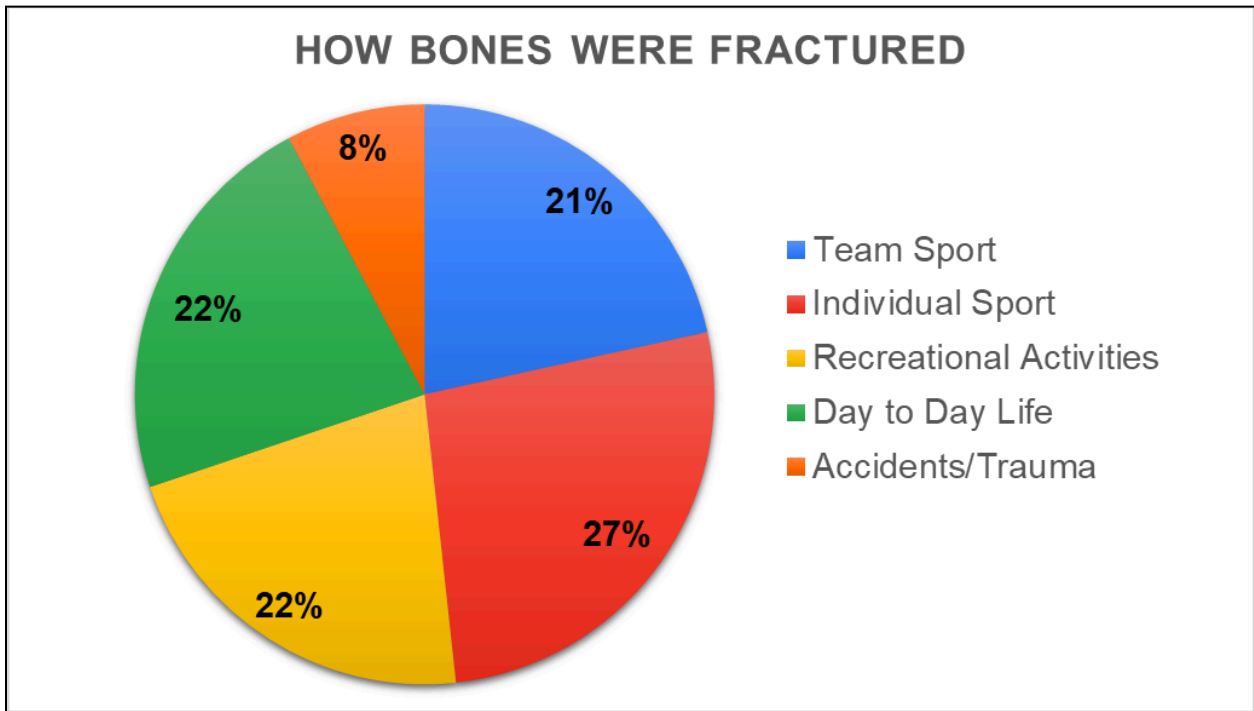


### Activities During Broken Bones

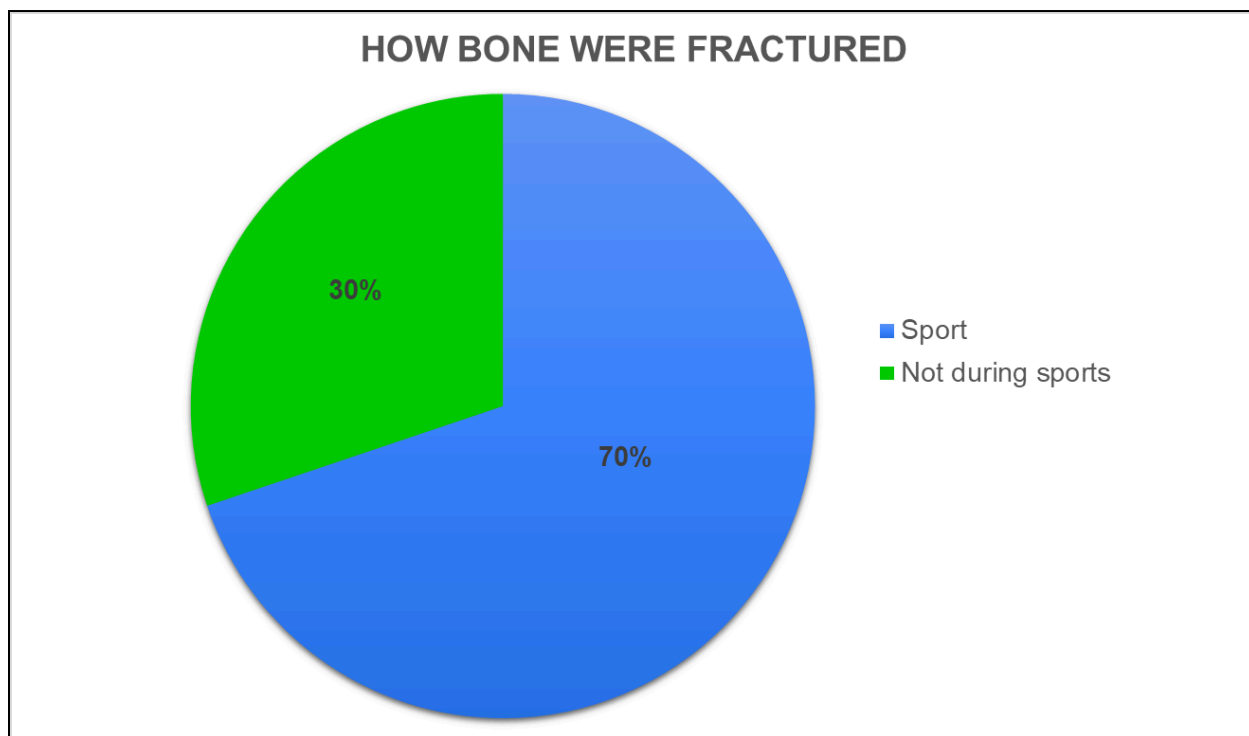
Cause of fracture	Number of people	%
Team Sport	25	21.6
Individual Sport	31	26.7
Recreational Activities	25	21.6
Day to Day Life	26	22.4
Accidents/Trauma	9	7.8
	116	

Cause of fracture	%
Team Sport	21.6
Individual Sport	26.7
Recreational Activities	21.6
Day to Day Life	22.4
Accidents/Trauma	7.8
	100.0

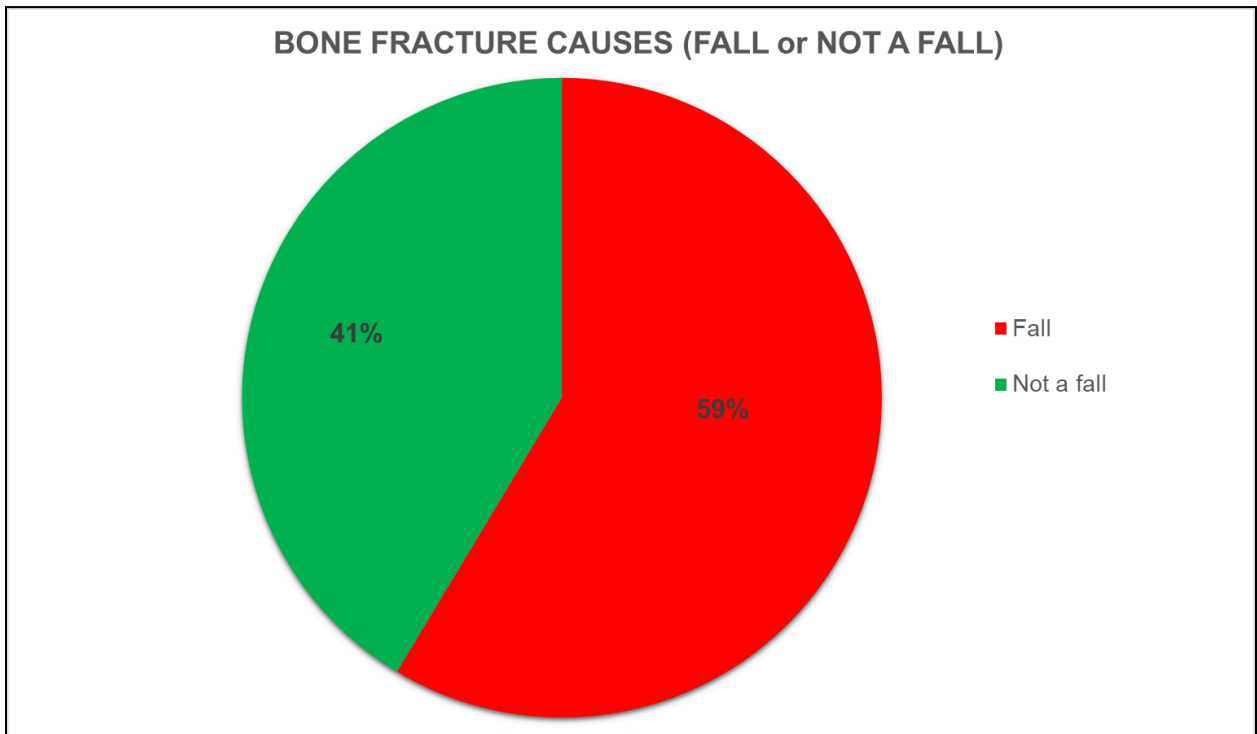






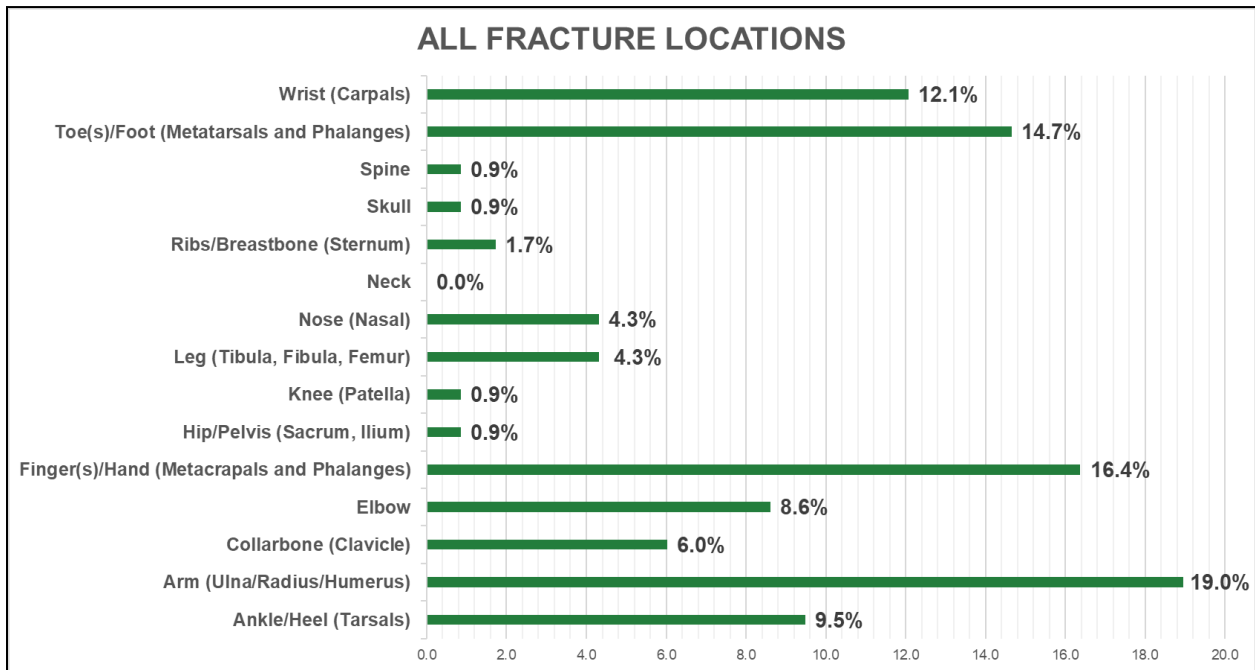
Fall or Not Fall

Cause				
Fall		68	58.6	
Not a fall		48	41.4	
		116		

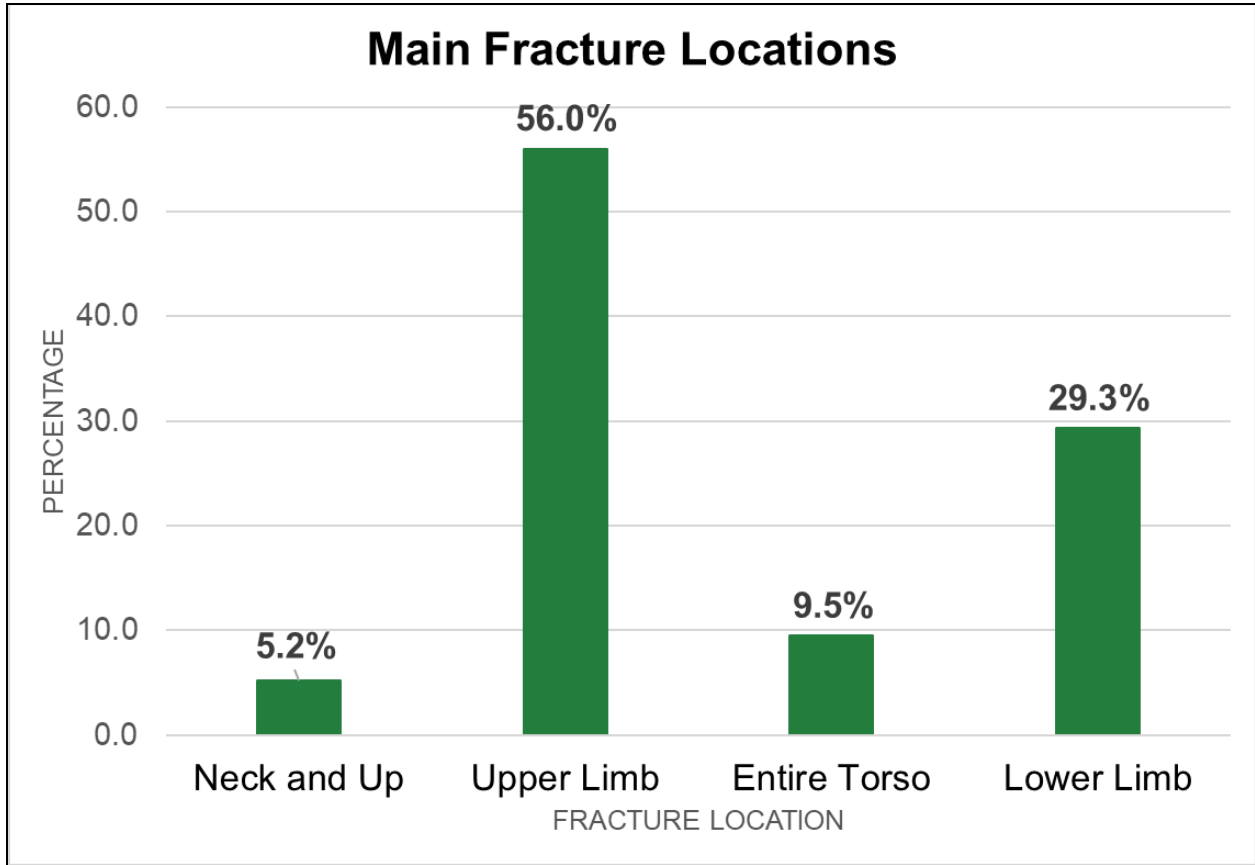


Injury Location

Fracture Location			Fracture Location	%
Ankle/Heel (Tarsals)	11	9.5	Ankle/Heel (Tarsals)	9.5
Arm (Ulna/Radius/Humerus)	22	19.0	Arm (Ulna/Radius/Humerus)	19.0
Collarbone (Clavicle)	7	6.0	Collarbone (Clavicle)	6.0
Elbow	10	8.6	Elbow	8.6
Finger(s)/Hand (Metacarpals and Phalanges)	19	16.4	Finger(s)/Hand (Metacarpals and Phalanges)	16.4
Hip/Pelvis (Sacrum, Ilium)	1	0.9	Hip/Pelvis (Sacrum, Ilium)	0.9
Knee (Patella)	1	0.9	Knee (Patella)	0.9
Leg (Tibula, Fibula, Femur)	5	4.3	Leg (Tibula, Fibula, Femur)	4.3
Nose (Nasal)	5	4.3	Nose (Nasal)	4.3
Neck	0	0.0	Neck	0.0
Ribs/Breastbone (Sternum)	2	1.7	Ribs/Breastbone (Sternum)	1.7
Skull	1	0.9	Skull	0.9
Spine	1	0.9	Spine	0.9
Toe(s)/Foot (Metatarsals and Phalanges)	17	14.7	Toe(s)/Foot (Metatarsals and Phalanges)	14.7
Wrist (Carpals)	14	12.1	Wrist (Carpals)	12.1
	116			

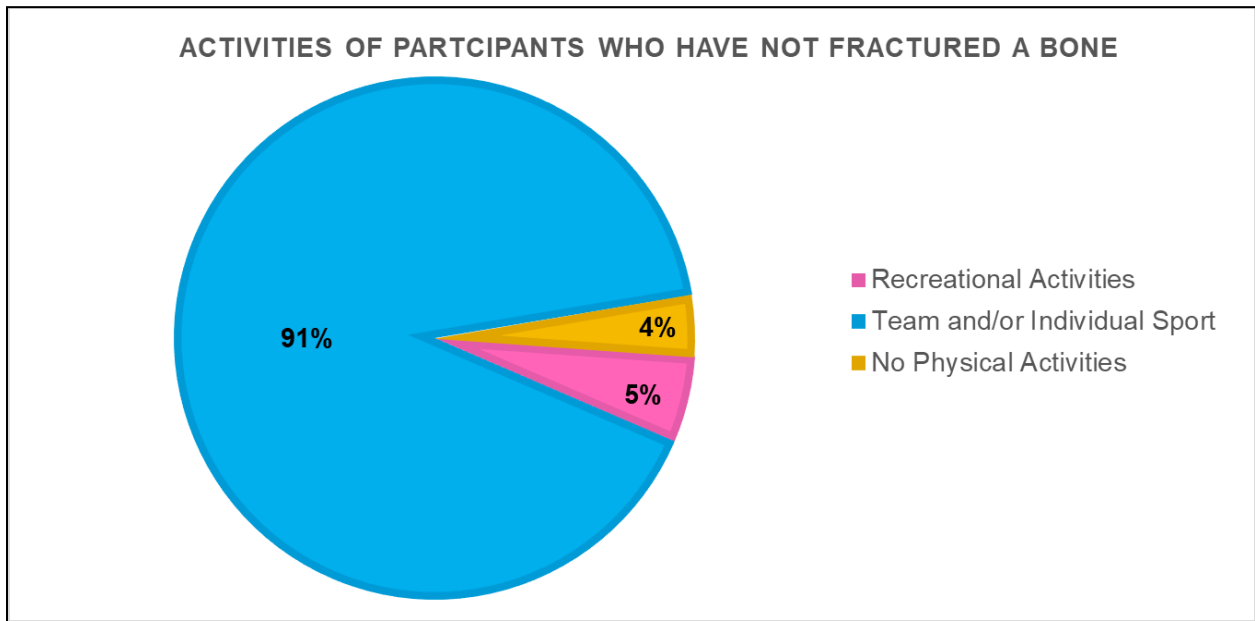


Fracture Location	%
Neck and Up	5.2
Upper Limb	56.0
Entire Torso	9.5
Lower Limb	29.3
	100.0



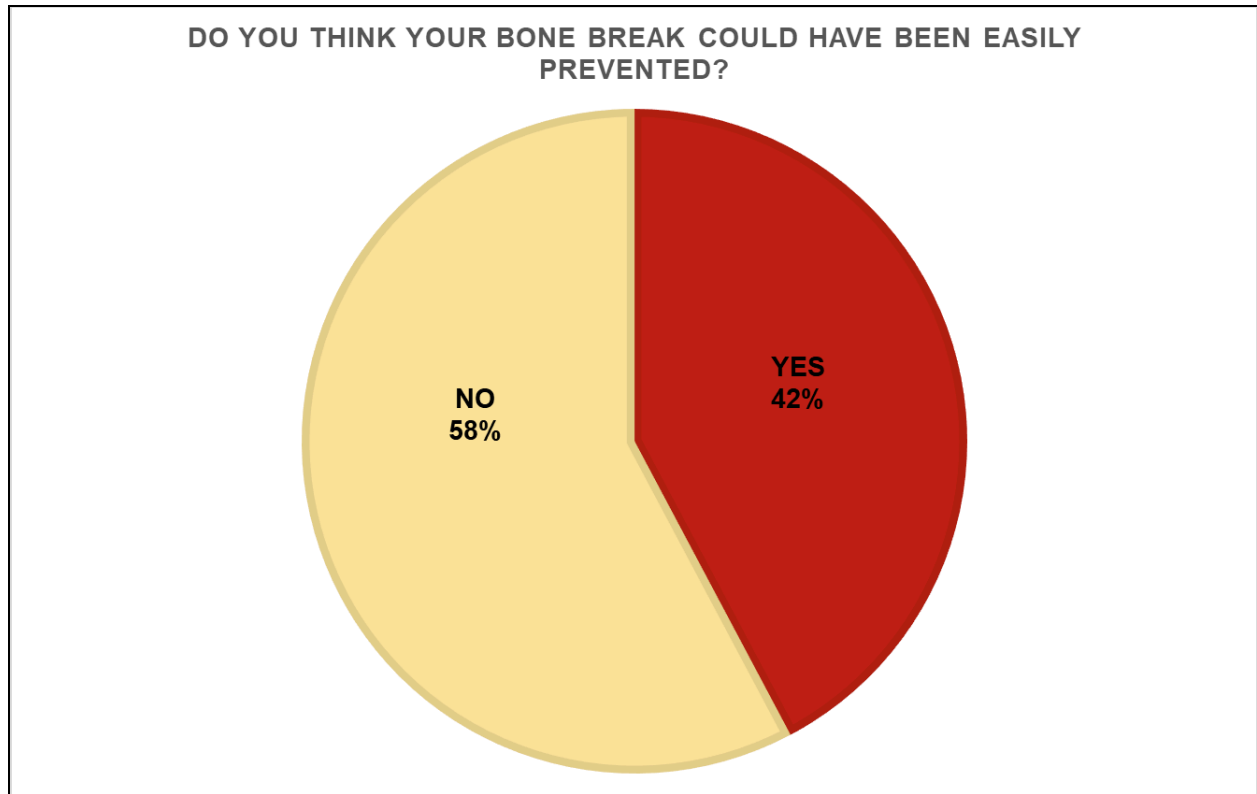
No Broken Bones

Type of Activity	Number of people	% of people
Recreational Activities	10	5.3
Team and/or Individual Sport	170	90.9
No Physical Activities	7	3.7
	187	



Opinion

Do you think your bone break could have been easily prevented?		%
Yes	49	42.2
No	67	57.8
	116	



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## 8.0 Time log

Dec 29	Research Project Ideas
Dec 31 to Jan 7	Research into the topic of bone injuries/ how children fall. Finalized Hypothesis
Jan 21- Jan 24	Design Research Questionnaire
Jan 27	Completed the literature review Selected Data Sets
Jan 29	Drafted the first email to Expert 1
Feb 10	Completed email to Expert 2
Feb 10	Finalized Research Questionnaire
Feb 17	Published the Research Questionnaire
Feb 24	Uploaded Basic Project Info and Ethics and Due Care information to CYSF Platform.
Feb 25	Closed off survey . Data Clean up
Feb 26-March 6	Research Questionnaire Data analysis  Comparison Research Questionnaire Data analysis with literature data sets Finalized conclusions and discussion
March 7- March 12	Finalized the trifold

## 9.0 Emails

***Following emails were sent to two experts in the field. No responses were received to date.***

Hi Dr. Weiss,



I hope this message finds you well. My name is Chenaya Senadheera and I am a Grade 9 Student from Calgary, Canada. Here in Calgary, students from grades 5-12 have the opportunity to create any science-related project for the Calgary Youth Science Fair (CYSF). Over 1,000 students compete for a spot to attend the Canada-Wide Science Fair

I am reaching out to you today because I would like expert guidance for my Calgary Youth Science Fair project this year. I am passionate about bone health and have always been interested in the science behind the causes of bone fractures and ways to prevent them. I was reading one of your articles about *The Most Common Fractures in Kids* and I found a lot of interesting information in it that would help me for my project this year.

Last year, I won a gold medal and two awards (The [Alberta Society of Gastroenterology Award](#) and The [University of Calgary Faculty of Arts Award](#)) for my science fair project, which focused on the effects of drinking milk on bone strength. This year, I am taking on an even bigger challenge by investigating which bones break the most in young people and how they break. I hypothesize that physical activity increases the likelihood of bone injury, especially wrist fractures because children try to catch themselves when they fall. My method is collecting data through publications and databases, I will also use data from a Google Form survey I have created. So far I have received 230 responses for my survey and the results I have found are similar to those in your article that I mentioned above. I find this super cool!

My ultimate goal is to raise awareness of the causes of bone fractures and provide tips on avoiding them. However, I need help finding adequate publications and databases about bone fractures in youth (ages 0-18) and their causes. I am hoping that you could give me some advice on my project and help me find more publications and data on bone fractures in youth.

Thank you for your time and consideration,  
Chenaya Senadheera

Hi Dr. Clark,

I hope this message finds you well. My name is Chenaya Senadheera and I am a Grade 9 Student from Queen Elizabeth High School. I am reaching out to you today because I would like expert guidance for my Calgary Youth Science Fair project this year. I am passionate about bone health and have always been interested in the science behind the causes of bone fractures and ways to prevent them. I was looking into some profiles about you, and I

learned that your work focuses on sports medicine and this is what my project revolves around.

Last year, I won a gold medal and two awards (The [Alberta Society of Gastroenterology Award](#) and The [University of Calgary Faculty of Arts Award](#)) for my science fair project, which focused on the effects of drinking milk on bone strength. This year, I am taking on an even bigger challenge by investigating which bones break the most in young people and how they break. I hypothesize that physical activity increases the likelihood of bone injury, especially wrist fractures because children try to catch themselves when they fall. My method is collecting data through publications and databases, I will also use data from a Google Form survey I have created. So far I have received 257 responses for my survey and I am aiming for 500 responses.

My ultimate goal is to raise awareness of the causes of bone fractures and provide tips on avoiding them. However, I am having trouble finding adequate publications and databases about bone fractures in youth (ages 0-18) and their causes. I am hoping that you could give me some advice on my project and help me find more publications and data on bone fractures in youth.

Thank you for your time and consideration,  
Chenaya Senadheera