Disclosure

• Sadly, I have no financial interests to disclose.
Learning Objectives

• Review the etiology and physiology of single functioning kidney.
• Discuss sports-related injury risks during contact/collision sports.
• Review evidence for sports-related kidney injury.
Single Functioning Kidney - Etiology

• Spectrum of Congenital Abnormalities of the Kidney and Urinary Tract (CAKUT):
  • Unilateral aplasia or agenesis.
  • Multicystic, dysplastic kidney (MCDK).
  • Genetic Syndromes, 3 pages of syndromes.

• Acquired etiologies:
  • Nephrectomy – Tumor, CAKUT
  • Trauma – Indirect focus of this talk
  • Renovascular disease
  • Philanthropic – Kidney donor, but not in pediatric age group.
Single Functioning Kidney- Epidemiology

- Routine fetal ultrasound screening has increased prenatal identification of patients with single kidney.
  - Renal agenesis/aplasia 1 in ~1300 births
  - MCDK 1:4300 births worldwide
  - **Cumulative incidence ~ 1:750-1:1500 births**.
    - * Future study from Utah Birth Defect Database
  - NKF uses 1:750 for all cause incidence.

https://www.kidney.org/atoz/content/onekidney
Congenital Single Kidney

• Pediatric nephrologists cannot give a talk without review of embryology.
  • Normal development-Starts at 5 weeks gestation

• Human kidney development complete at 34-36 weeks.

Congenital Single Kidney

- CAKUT leading to renal aplasia likely due to miscommunication at MM/UB level.

Congenital Single Kidney

- Individuals born with a solitary kidney have an increased risk of malformation in the remaining single kidney.
  - Vesicoureteral reflux
  - Hypodysplasia
  - Ureteral pelvic junction obstruction
  - Duplex collecting system
  - Megaureter without reflux
- Any patient with a prenatally identified single kidney needs post-natal imaging within 3-7 days of birth.
Single Functioning Kidney

• Children are born with reduced nephron number.
• Single kidney should increase in size as an adaptation to increased workload.
  • Compensatory hypertrophy.
• Higher risk of hypertension, proteinuria and CKD by 30 years of age.
  • Even higher if pt is obese.

• No specific policy/recommendations for health monitoring and maintenance for this population.
Single Kidney: Compensatory Hypertrophy
What About Single Kidney and Sports?

• Should a child or adolescent with a single kidney play sports?

• Which, if any, sports should be avoided?
How It Started…

• Teenage patient with a congenital single kidney, new to area, in our clinic.
• Healthy, no HTN, normal kidney function, expected compensatory hypertrophy with renal length >95% for patient height.
• Previously counseled to avoid contact sports, especially football.
• Took up competitive motocross racing instead.
• This got us thinking…….
The Questions

- At what point did motocross racing seem like a safe alternative to football?
- Are there recommendations for sports participation by children with a single kidney?
- What do physicians really do compared to the recommendations?
- What is the data on kidney injury in sports?
- How common are sports-related kidney injuries compared to other organs?
Are there recommendations for sports participation by children/adolescents with a single kidney?
## AAP List of Sports

<table>
<thead>
<tr>
<th>Contact or Collision</th>
<th>Limited Contact</th>
<th>Noncontact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>Baseball</td>
<td>Archery</td>
</tr>
<tr>
<td>Boxing*</td>
<td>Bicycling</td>
<td>Badminton</td>
</tr>
<tr>
<td>Diving</td>
<td>Cheerleading</td>
<td>Body building</td>
</tr>
<tr>
<td>Field hockey</td>
<td>Canoeing or kayaking (white water)</td>
<td>Bowling</td>
</tr>
<tr>
<td>Football Tackle</td>
<td>Fencing</td>
<td>Canoeing or kayaking (flat water)</td>
</tr>
<tr>
<td>Ice hockey†</td>
<td>Field events</td>
<td>Crew or rowing</td>
</tr>
<tr>
<td>Lacrosse</td>
<td>High jump</td>
<td>Curling</td>
</tr>
<tr>
<td>Martial arts</td>
<td>Pole vault</td>
<td>Dancing$</td>
</tr>
<tr>
<td>Rodeo</td>
<td>Floor hockey</td>
<td>Ballet</td>
</tr>
<tr>
<td>Rugby</td>
<td>Football</td>
<td>Modern</td>
</tr>
<tr>
<td>Ski jumping</td>
<td>Flag</td>
<td>Jazz</td>
</tr>
<tr>
<td>Soccer</td>
<td>Gymnastics</td>
<td>Field events</td>
</tr>
<tr>
<td>Team handball</td>
<td>Handball</td>
<td>Discus</td>
</tr>
<tr>
<td>Water polo</td>
<td>Horseback riding</td>
<td>Javelin</td>
</tr>
<tr>
<td>Wrestling</td>
<td>Racquetball</td>
<td>Shot put</td>
</tr>
<tr>
<td>Skating</td>
<td>Skating</td>
<td>Golf</td>
</tr>
<tr>
<td></td>
<td>Ice</td>
<td>Orienteering</td>
</tr>
<tr>
<td></td>
<td>In-line</td>
<td>Power lifting</td>
</tr>
<tr>
<td></td>
<td>Roller</td>
<td>Race walking</td>
</tr>
<tr>
<td></td>
<td>Skiing</td>
<td>Riflery</td>
</tr>
<tr>
<td></td>
<td>Cross-country</td>
<td>Rope jumping</td>
</tr>
<tr>
<td></td>
<td>Downhill</td>
<td>Running</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>Sailing</td>
</tr>
<tr>
<td></td>
<td>Skateboarding</td>
<td>Scuba diving</td>
</tr>
<tr>
<td></td>
<td>Snowboarding‡</td>
<td>Swimming</td>
</tr>
<tr>
<td></td>
<td>Softball</td>
<td>Table tennis</td>
</tr>
<tr>
<td></td>
<td>Squash</td>
<td>Tennis</td>
</tr>
<tr>
<td></td>
<td>Ultimate frisbee</td>
<td>Track</td>
</tr>
<tr>
<td></td>
<td>Volleyball</td>
<td>Weight lifting</td>
</tr>
<tr>
<td></td>
<td>Windsurfing or surfing</td>
<td></td>
</tr>
</tbody>
</table>
Yes: Current Recommendations

• AAP Committee on Sports Medicine and Fitness

• 1994-2008:
  • “Qualified Yes: Pending individual assessment” for contact/collision and limited contact sports.
  • No definition of what “individual assessment” included.

• Generally permissive recommendation.
Current Recommendations: AAP

• AAP Committee on Sports Medicine and Fitness

• 2008-Present: “Qualified yes” with individual assessment” maintained.

• Added:
  • Protective equipment may reduce risk of injury to the remaining kidney sufficiently to allow participation in most sports, providing such equipment remains in place during activity.
Current Recommendations: NKF

- NKF recommends that individuals with one kidney, including living donors, consider avoiding contact/collision sports.
  - Alonzo Mourning played in the NBA with a transplant.
  - Basketball is considered a contact/collision sport.

- An internet savvy parent or patient could easily get a conflicting message.
- No other guidelines regarding single kidney in sports.
What do physicians really do?
Opinion-Sports Medicine

• 1986, Physician and Sports Medicine.

• Recommended participation only for elite athletes with a single kidney.
  • Athletic scholarship
  • Professional contract
  • Olympic competition

• Otherwise, benefit of participation may not outweigh risks.
Survey-Sports Medicine


• 46% of respondents would discourage children with a single kidney from contact/collision sports participation.

• 58% would discourage contact/collision sports participation if the athlete were their own child.
Survey-Pediatric Urology

• 2002-Survey of AAP Section on Urology.

• 68% of respondents recommended against contact sports participation by patients with a single kidney.
Survey-Pediatric Nephrology

• Survey of members of the American Society of Pediatric Nephrology (ASPN).

• Recommendations regarding sports participation by children with a single, normal kidney.

• Which sports would be discouraged or permitted?

• Why?
ASPN Survey Results

• 62% of responding nephrologists would not allow contact/collision sports participation by an athlete with a single kidney.

• 85% Prohibited American football.
• 79% Prohibited Boxing*.
  • 21% allowed boxing. **Seriously, 21%!**
• 19% prohibited downhill skiing
• 5% prohibited cycling.

• Sequelae of loss of function and legal issues.
Survey - NFL Physicians and Athletic Trainers

- 2008 - 32 NFL teams, all responded.
  - Either team physicians or head trainers.
- 61% would allow a professional football player to compete with a solitary kidney.
- 51% would allow the same athlete to compete at the college level.
- 40% would allow football at the high school level.

Physician Practice Summary

• Since 1994, AAP generally permitting participation.

• 1996-2008, roughly 60% of sports medicine physicians, urologists, NFL team physicians and pediatric nephrologists counsel against participation in collision/contact sports for an athlete with a solitary kidney.

• Unless the athlete is really good.
What is the data on kidney injury in sports?
Kidney Injury Data: Some Perspective

• As of January 1, 2016, there are 108,709 people on the UNOS kidney transplant waiting list.
  • 22,818 Hypertensive Nephrosclerosis.
  • 31,382 Type II Diabetes.
  • 320 Lithium toxicity
  • 265 nephrolithiasis
  • 0 for trauma.
  • 1,522 diagnosis not specified
Kidney Injury Literature Review

- Search for articles addressing sports-related kidney injury.
  - No studies specifically addressing single kidney.

- 38 articles identified that addressed sports related kidney injury.
  - 22 injury database review articles.
  - 12 case reports.
  - 3 articles on physician opinion and practice patterns.
  - 1 AAP Guideline.
Kidney Injury Literature Review

- 22 injury database articles with kidney injury.

- 11 articles with detailed reporting.
  - One prospective paper.

- Motor vehicle accidents 3-10x more common etiology of kidney injury than sports.
  - Wear your seat belts!
Kidney Injury Literature Review

- 465 total sports-related kidney injuries.
- Most common sports causing kidney injury:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downhill Skiing</td>
<td>95</td>
</tr>
<tr>
<td>Cycling</td>
<td>91</td>
</tr>
<tr>
<td>Soccer</td>
<td>34</td>
</tr>
<tr>
<td>American Football</td>
<td>31</td>
</tr>
</tbody>
</table>

- Skiing and Cycling were 2/5 of the least restricted activity by pediatric nephrologists.
  - Cycling injuries not as part of getting hit by a car.
- 1 report of a patient with a single kidney suffering sports-related kidney contusion.
Incidence of Sports Related Kidney Injury

• One prospective paper calculated the incidence of sports related kidney injury.
• Trauma registry 1993-2000.

• Small population in a few counties of western New York state with ~ 290,260 children.

• 15 sports-related kidney injuries over 8 years, 1 nephrectomy.
Incidence of Sports Related Kidney Injury

• No surprise, 13/15 injuries were suffered by boys.
• 5/15 injuries due to football.
• 12/15 patients between 13 and 17 years old.

• Kidney injuries/million children/year:
  • 6.5 due to all causes
  • 2.2 due to football
  • 0.4 catastrophic injury with loss of function (skiing).
Kidney Injury in the NFL

A Strange Trend in Pro Football: Kidney Lacerations
In consecutive weeks, two star NFL players suffered serious kidney injuries.

Andrew Luck out 2-6 weeks with lacerated kidney
By Gregg Rosenthal
Around The NFL Editor
Published: Nov. 10, 2016 at 03:59 p.m. Updated: Nov. 10, 2016 at 06:20 p.m.

Andrew Luck's roller coaster season has taken a turn for the worse.
The Indianapolis Colts announced Tuesday that Luck will miss 2-6 weeks with a lacerated kidney and a partial tear of an abdominal muscle. The team says the injuries will not require surgery and a full recovery is expected.

ASN was going on in San Diego at that time.

Kidney Injury in the NFL

How common are sports-related kidney injuries compared to other organs?
Sports-Related Brain and Spine Injury Literature Search

• 1991-2000: 37 reported brain injury related deaths from high school football.
• Average incidence of 2.5 deaths/million players/year. (estimated 1.5 million players/year).

• 1993-2000: 48 cervical spine injuries from high school football with incomplete recovery.
• Average Incidence of 4.6/million players/year.

Concussions in the NFL: 2015

- Remember, there are 2 NFL players with kidney lacerations that did not require surgery in the same time frame.

Kidney vs Brain and Spinal Cord

<table>
<thead>
<tr>
<th>Organ</th>
<th>Incidence per million per year</th>
<th>Population</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney-all sports</td>
<td>0.4</td>
<td>All</td>
<td>1993-2000</td>
</tr>
<tr>
<td>Kidney-football Non-catastrophic</td>
<td>2.2</td>
<td>All</td>
<td>1993-2000</td>
</tr>
<tr>
<td>Brain Injury Fatality</td>
<td>2.4</td>
<td>HS football</td>
<td>1991-2000</td>
</tr>
<tr>
<td>Spinal Cord Injury</td>
<td>4.6</td>
<td>HS football</td>
<td>1993-2000</td>
</tr>
</tbody>
</table>

- Keep in mind, numbers in dark grey are for pediatric population in western New York State.
- Numbers in light grey are estimated 1.5 million HS football players annually.

Sports Related Kidney Injury

- Based on literature review, seems quite rare.
- Restriction of sports participation may not be warranted.
- Death from brain injury or permanent disability from cervical spine injury appear more common.
  - Very different populations, so definitive conclusions cannot be drawn.
- Need for prospective data.
National Athletics Trainer’s Association (NATA) Injury Surveillance Database

- Data collected by 246 NATA-certified athletic trainers at 240 schools on 10 varsity sports.

<table>
<thead>
<tr>
<th>Boys:</th>
<th>Girls:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>Field hockey</td>
</tr>
<tr>
<td>Wrestling</td>
<td>Softball</td>
</tr>
<tr>
<td>Baseball</td>
<td>Volleyball</td>
</tr>
<tr>
<td>Basketball</td>
<td>Basketball</td>
</tr>
<tr>
<td>Soccer</td>
<td>Soccer</td>
</tr>
</tbody>
</table>
NATA Database Advantages

• Nationwide sampling.
• Very large sample size.
• Included sports of interest, namely football.
• Standardized, detailed definitions and injury reporting.
  • Injury location, activity during injury and interventions.
• Exposure: Single game or practice session.
NATA Database Investigation

• Hypothesis:

• Incidence of catastrophic sports-related kidney injury is exceedingly rare and does not warrant limitation of participation by athletes with a single kidney.
NATA Database Investigation

• Objectives:
  • Investigate NATA database for sports-related kidney injury in the pediatric age group in order to:

1. Calculate the incidence of kidney injury by sport.

2. Determine the relative risk for kidney injury compared to other organs.

3. Extrapolate these data to athletes with a single kidney.
### NATA 1995-1997 Raw Numbers

<table>
<thead>
<tr>
<th>Athlete Exposures</th>
<th>All</th>
<th>Kidney</th>
<th>Head/Neck /Spine</th>
<th>MTBI</th>
<th>Knee</th>
<th>Eye</th>
<th>Testes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOYS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseball</td>
<td>311,295</td>
<td>861</td>
<td>1</td>
<td>16</td>
<td>15</td>
<td>90</td>
<td>16</td>
</tr>
<tr>
<td>Basketball</td>
<td>444,338</td>
<td>1933</td>
<td>1</td>
<td>64</td>
<td>51</td>
<td>215</td>
<td>22</td>
</tr>
<tr>
<td>Football</td>
<td>1,300,446</td>
<td>10557</td>
<td>12</td>
<td>1404</td>
<td>773</td>
<td>1594</td>
<td>26</td>
</tr>
<tr>
<td>Soccer</td>
<td>385,443</td>
<td>1765</td>
<td>1</td>
<td>72</td>
<td>69</td>
<td>267</td>
<td>11</td>
</tr>
<tr>
<td>Wrestling</td>
<td>522,608</td>
<td>2910</td>
<td>0</td>
<td>277</td>
<td>128</td>
<td>431</td>
<td>31</td>
</tr>
<tr>
<td><strong>GIRLS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basketball</td>
<td>394,143</td>
<td>1748</td>
<td>1</td>
<td>75</td>
<td>63</td>
<td>274</td>
<td>23</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>138,073</td>
<td>510</td>
<td>0</td>
<td>28</td>
<td>13</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>Softball</td>
<td>258,754</td>
<td>910</td>
<td>0</td>
<td>29</td>
<td>25</td>
<td>98</td>
<td>10</td>
</tr>
<tr>
<td>Soccer</td>
<td>335,512</td>
<td>1771</td>
<td>2</td>
<td>87</td>
<td>76</td>
<td>344</td>
<td>9</td>
</tr>
<tr>
<td>Volleyball</td>
<td>359,547</td>
<td>701</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>67</td>
<td>2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>4,450,159</td>
<td>23,666</td>
<td>18</td>
<td>2,069</td>
<td>1,219</td>
<td>3,450</td>
<td>148</td>
</tr>
</tbody>
</table>

MTBI: Mild Traumatic Brain Injury
NATA Reported Kidney Injuries

- 18 kidney injuries:
  - 3 lacerations
  - 15 contusions
- No kidney injuries required surgery or resulted in loss of function.
- No single kidneys identified during evaluation.
## Injury Case Rates (Incidence)

<table>
<thead>
<tr>
<th></th>
<th>BOYS</th>
<th>GIRLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Injury Case Rate (injuries/million exposures)</strong></td>
<td><strong>Kidney</strong></td>
<td><strong>Head/Neck/Spine</strong></td>
</tr>
<tr>
<td><strong>Baseball</strong></td>
<td>3.2</td>
<td>51.4</td>
</tr>
<tr>
<td><strong>Basketball</strong></td>
<td>2.3</td>
<td>144.0</td>
</tr>
<tr>
<td><strong>Football</strong></td>
<td>9.2</td>
<td>1079.6</td>
</tr>
<tr>
<td><strong>Soccer</strong></td>
<td>2.6</td>
<td>186.5</td>
</tr>
<tr>
<td><strong>Wrestling</strong></td>
<td>0</td>
<td>530.0</td>
</tr>
<tr>
<td><strong>Basketball</strong></td>
<td>2.5</td>
<td>190.5</td>
</tr>
<tr>
<td><strong>Field Hockey</strong></td>
<td>0</td>
<td>202.8</td>
</tr>
<tr>
<td><strong>Softball</strong></td>
<td>0</td>
<td>111.9</td>
</tr>
<tr>
<td><strong>Soccer</strong></td>
<td>5.9</td>
<td>259.3</td>
</tr>
<tr>
<td><strong>Volleyball</strong></td>
<td>0</td>
<td>47.3</td>
</tr>
</tbody>
</table>
Incidence Rate Ratio (IRR)

- IRR is a measure of relative risk allowing direct comparison of injury rates.

- IRR calculation:
  \[
  \frac{\text{Case rate organ}}{\text{case rate kidney}}
  \]
# Incidence Rate Ratio

<table>
<thead>
<tr>
<th></th>
<th>Kidney</th>
<th>Head/Neck/Spine</th>
<th>MTBI</th>
<th>Knee</th>
<th>Eye</th>
<th>Testes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOYS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseball</td>
<td>1.0</td>
<td>16.0</td>
<td>15.0</td>
<td>90.0</td>
<td>16.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Basketball</td>
<td>1.0</td>
<td>64.0</td>
<td>51.0</td>
<td>215.0</td>
<td>22.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Football</td>
<td>1.0</td>
<td>117.0</td>
<td>64.4</td>
<td>132.8</td>
<td>2.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Soccer</td>
<td>1.0</td>
<td>72.0</td>
<td>69.0</td>
<td>267.0</td>
<td>11.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Wrestling</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>GIRLS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basketball</td>
<td>1.0</td>
<td>75.0</td>
<td>63.0</td>
<td>274.0</td>
<td>23.0</td>
<td>N/A</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>N/A</td>
</tr>
<tr>
<td>Softball</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>N/A</td>
</tr>
<tr>
<td>Soccer</td>
<td>1.0</td>
<td>43.5</td>
<td>38.0</td>
<td>172.0</td>
<td>4.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Volleyball</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>N/A</td>
</tr>
</tbody>
</table>

IRR values reported in **BLACK BOLD** indicate significantly greater than 1.0 at the p <0.01 level
IRR calculation: (Case rate organ)/(case rate kidney)
Summary of NATA Database

- No catastrophic kidney injuries.

- Football caused majority of kidney injuries.

- Soccer leading cause of kidney injuries for girls.
  - Cheerleading likely causes most traumatic injuries in girls now.

- Kidney injury significantly less frequent than Head/neck/spine, MTBI and knee injuries for all sports studied.

http://nccsir.unc.edu/reports/
Conclusions - NATA Database

• First report of a large, prospective study of sports-related kidney injury in the adolescent age group.

• Kidney injury is exceedingly rare during high school sports participation.

• When it occurs, sports-related kidney injury is generally mild.
Other Databases: 1995-1997

- National Center for Catastrophic Sports Injury Research.
- Same time frame as NATA Data 1995-1997:
  - 15 deaths of high school football players directly attributable to football.
  - 24 deaths indirectly attributed to high school football.
    - Cardiomyopathy, hyponatremia
Updated Football Related Fatalities

- 2012-2014:
  - 13 fatalities directly related to participation in high school football.
  - Average 3.9 deaths/million players/year based on estimate of 1.1 million HS football players per year.
  - Participation in HS football is declining.
One Last Question

• What is the risk of kidney disease if patients with a single kidney opt to avoid sports and do nothing?

• I have been assured by many statisticians that my following slides could never make it to publication.

• However, I believe for clinicians, looking at risks of inactivity may be useful for counseling patients and families.
Extremely Suspicious Calculations

• Assumption 1: lack of exercise and sedentary lifestyle are significant modifiable risk factors for obesity.

• In 2010, 40-44% of American adults were obese with BMI >30.
  • This is 93-104 million people > 18 years based on 2010 census numbers of total US population of 234 million > 18 years old.

• Clearly, there is more to obesity than exercise, but bear with me.

http://www.niddk.nih.gov/health-information/health-statistics/Pages/overweight-obesity-statistics.aspx
http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf
Extremely Suspicious Calculations

• Assumption 2: Obesity is risk factor for Type II DM.
  • 80% of patients with Type II DM are obese.
  • In 2012, 29 million Americans had Type II DM.
  • So, in 2012, ~ 23 million obese American adults with Type II DM.

http://www.niddk.nih.gov/health-information/health-statistics/Pages/overweight-obesity-statistics.aspx
http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf
Extremely Suspicious Calculations

- Assumption 3: Type II DM is a significant risk factor for kidney failure.
- Kidney transplant waiting list:
  - 2012: 25,515 waiting for a transplant due to Type II DM.
  - 2012: 7,820 added to transplant waiting list due to Type II DM.
    - If 80% are obese, then ~ 20,400 people with obesity and Type II DM are awaiting kidney transplant.
    - ~ 6,300 added to transplant waiting list with obesity and Type II DM.

http://optn.transplant.hrsa.gov/latestData/rptData.asp
Extremely Suspicious Calculations

- So, ~20,400 patients with obesity and Type II DM awaiting kidney transplant and 6,300 new patients added to the list in 2012.
  - 234 million US adult population = 87/million people.
  - = 26.9 people/million/year added to list

- ~100 million obese population = 204/million.
  - 63 people/million/year added to list

- ~23 million obese population with Type 2 DM = 887/million people.
  - 274 people/million/year added to list.

http://optn.transplant.hrsa.gov/latestData/rptData.asp
### Apples and Oranges

<table>
<thead>
<tr>
<th>Condition</th>
<th>Incidence</th>
<th>Population</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney Injury</td>
<td>0.4/million/year</td>
<td>All</td>
<td>1993-2000</td>
</tr>
<tr>
<td>Brain Injury Fatality</td>
<td>2.4/million/year</td>
<td>HS Football</td>
<td>1991-2000</td>
</tr>
<tr>
<td>Spinal Cord Injury</td>
<td>0.7-5.3/million/year</td>
<td>HS Football</td>
<td>1993-2000</td>
</tr>
<tr>
<td>Awaiting kidney transplant</td>
<td>887/million</td>
<td>Obese US adults with Type II DM</td>
<td>2012</td>
</tr>
<tr>
<td>Added to transplant list 2012</td>
<td>274/million/year.</td>
<td>Obese US adults with Type II DM</td>
<td>2012</td>
</tr>
</tbody>
</table>

- Even if these calculations are wrong by 100x, physical activity is safer than sedentary lifestyle.
Extremely Suspicious Calculations

• The take home from this is to be careful when counseling a patient to avoid physical activity, even one considered to be dangerous.
Recommendations

• If you have a patient with a single kidney.
• Prenatally identified: Obtain renal US with 7 days or so.
  • Other imaging evaluating for reflux or obstruction depending on clinical and imaging findings.
• If older patient, confirm normal anatomic location and function of single kidney.
  • Single kidney should be slightly larger than a paired kidney.
  • This does not appear to increase sports injury risk.
Recommendations

• If you have a patient with a single kidney.
• Monitor athlete yearly for blood pressure and urinalysis to assess for development of proteinuria and risk of CKD.
• Bloodwork every 2-3 years to monitor kidney function.
Counseling

• Participation in sports and other physical activities have significant and enduring physical, social and mental health benefits.
• Risk of kidney injury during sports appears to be very low, but not zero.
• Consequences of catastrophic injury:
  • Sports-related single kidney injury:
    • Dialysis and transplantation
  • Sports related brain and spinal cord injury:
    • Possible death and paralysis.
• No exercise and sedentary lifestyle?
Counseling

• Activities with high velocities such as cycling, downhill skiing, and riding in a car appear to have a much higher risk of catastrophic renal injury than contact/collision sports.

• Wear seatbelts and helmets when cycling, skiing and snowboarding!

• Sedentary lifestyle, lack of exercise and obesity vs. sports participation.

• Bottom line: Participate in sport of choice without limitations. Except boxing. No boxing.
Relative Risk to Kidneys
THANK YOU

GO KIDNEYS!