OAI Data:
- Access to Clinical Data & Images
- Image Derived Biomarkers

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University of California at San Francisco
Outline

- **Getting OAI Data**
  - downloadable data & documentation
  - x-ray and MRI images

- **Exploring data & documentation**
  - summary documents
  - “Search & Browse”, Variable Guides, Data Explorer
  - selecting subjects and linking to images (and vice versa)

- **CIA – Centrally read Image Assessments**
  - types of assessments (readings_measurements)
  - projects for which there are data
  - structure of released image assessment data

- **Summary**
Online access to OAI data

- OAI Online (www.oai.ucsf.edu)

- Website contains overview documents
  - register to get downloadable data

- Downloadable data:
  - questionnaire, clinical exam, and demographic data
  - image meta-data (who has what images available and when)
  - image derived biomarkers
  - related documentation and tools for exploring data
Obtaining OAI Images

- requesting images:
  - e-mail electronic request form to OAllmageHelp@psg.ucsf.edu
  - images sent on external USB hard drive

- online image access (upcoming):
  - through NBIA (National Biomedical Imaging Archive)

- further details about available images at:
  http://www.oai.ucsf.edu/datarelease/DataImaging.asp
OAI Annual Knee Imaging

- All participants, baseline, 12mo, 24mo, 36mo, 48mo
- Knee Radiographs:
  - Bilateral Fixed Flexion: baseline and then annually
- Knee MRI (3T Siemens Trio, or TIM Trio):
  - baseline and then annually
  - R knee: long protocol, L knee: shorter protocol

<table>
<thead>
<tr>
<th>Pulse Sequence</th>
<th>Right Knee (mins)</th>
<th>Left Knee (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localizer (3 plane)</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>SAG 3D DESS WE (with Cor &amp; Axial MPRs)</td>
<td>10.6</td>
<td>10.6</td>
</tr>
<tr>
<td>COR IW 2D TSE</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>SAG IW 2D TSE (with fat suppression)</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>COR T1W 3D FLASH WE</td>
<td>8.6</td>
<td>--</td>
</tr>
<tr>
<td>SAG 2D muti-echo (T2 MAP)</td>
<td>10.6</td>
<td>--</td>
</tr>
<tr>
<td>TOTAL</td>
<td>38.4</td>
<td>19.2</td>
</tr>
</tbody>
</table>
OAI Additional Imaging

- Additional Knee Radiographs:
  - Fluoro-guided L and R knee: Enrollment and annually*
  - Lateral L & R knee: enrollment and 36-month (controls)

- Additional Knee MRI visits:
  - Interim 18-month visit in 287 (unilateral MRI)
  - Interim 30-month visit in ~500 ppts (unilateral MRI)
  - Also with clinical outcomes and biospecimen collection

- Pelvis and Hand Radiographs:
  - Enrollment visit and 48-month visit

- Bilateral Full-Limb Radiograph:
  - 12-month, 24-month or 36-month visit

- Thigh MRI:
  - Enrollment, 24-month and 48-month

* Fluoro in subset of progression subcohort only
OAI Imaging Details

- Imaging Schedule:
  - visits and examination schedules:
    http://www.oai.ucsf.edu/datarelease/DataImaging.asp

- Operations Manuals:
  - detailed information on how the images were acquired
    http://www.oai.ucsf.edu/datarelease/DataImaging.asp

- DICOM Image Release Notes:
  - image releases have a set of notes on the hard drive
  - includes types of images, pulse sequence parameters
  - they are also downloadable at:
    http://www.oai.ucsf.edu/datarelease/DataImaging.asp

- Images identified uniquely by a 12 digit “barcode”: 
  - “01660xxxxxxx” uniquely identifies an x-ray image
  - “01661yyyyyyy” uniquely identifies images from an MR sequence
How to find data

- 1000+ variables collected per participant at enrollment
  - 100s more per follow-up visit
  - growing number of image readings/measurements

- “About OAI”: General Information
  - study design documents, visit and exam schedule

- “Data and Documentation”: Interactive Exploration
  - “Search and Browse”
  - “Data Explorer”
Interactive “Search and Browse”

- powerful tool on OAI Online to become familiar with data
- search any variable
  - or by category of variable
- longitudinal display
  - which visits variable collected at
- access data collection form
  - know the exact questions asked, or measurement taken
- look at frequencies
- review notes about variables
- see SAS code for calculated variables
- show a trivial example now
  - further examples later for image derived biomarkers
Search keyword and/or category

Keyword or phrase: buttocks

Browse/Limit Category:
- (No Category)
- Anthropometry
- Back pain
- Biospecimens collection

Visit:
- P02 Initial Eligibility Intvw
- P01 Screening
- V00 Enrollment
- V01 12 month Annual
### Search Results

#### Back pain

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<thead>
<tr>
<th>Label</th>
<th>Root</th>
<th>P02</th>
<th>P01</th>
<th>V00</th>
<th>V01</th>
<th>V02</th>
<th>V03</th>
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<tbody>
<tr>
<td>Any back pain, past 30 days</td>
<td>BP30</td>
<td></td>
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<td></td>
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<tr>
<td>How often bothered by back pain, past 30 days</td>
<td>BP300FT</td>
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<td></td>
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<tr>
<td>When had back pain how bad was it on average, past 30 days</td>
<td>BPBAD</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Back pain location, upper back</td>
<td>BPUB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain location, middle back</td>
<td>BPMB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain location, lower back</td>
<td>BPLB</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain location, buttocks</td>
<td>BPB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain location, don't know</td>
<td>BPDK</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Limit activities due to back pain, past 30 days (calc)</td>
<td>BPACTCV</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total days in bed and/or limited activity due to back pain, past 30 days (calc)</td>
<td>BPTOT</td>
<td></td>
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</tr>
<tr>
<td>How many days stay in bed due to back pain, past 30 days (calc)</td>
<td>BPBEDCV</td>
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<td></td>
<td></td>
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<tr>
<td>How many days limit activities due to back pain, past 30 days (calc)</td>
<td>BPDAYCV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Add Checked Items to Cart*
Annotated Data Collection Form

BACK PAIN and FUNCTION

The next questions are about back pain.

43 During the **past 30 days**, have you had any back pain?  BP30
   1 O Yes  0 O No  O D O Don't know  O R O Refused

a. How often were you bothered by back pain in the **past 30 days**?  BP30OFT
   (Examiner Note: Read response options. OPTIONAL - Show Card #3.)
   O All of the time  O Most of the time  O Some of the time  O Rarely  O D O Don't know
   3 2 1 0 .D

b. When you had back pain, how bad was it on average?  BPBAD
   (Examiner Note: Read response options.)
   1 O Mild  2 O Moderate  3 O Severe  O D O Don't know

c. In what part or parts of your back is the pain usually located?
   (Examiner Note: REQUIRED - Show Card #4. Mark all that apply.)

   10 Upper Back  BPUB
   10 Middle Back  BPMB
   10 Lower Back  BPLB

   1 O Buttocks  BPB
   O D O Don't know  BPDK

d. During the **past 30 days**, have you limited your activities because of back pain?

   BPACT  1 O Yes  0 O No  O D O Don't know  O R (Refused)

i. How many days did you stay in bed because of your back? If you are unsure, please make your best guess.
   BPBED  [ ] days  O D O Don't know  BPBEDCV

ii. How many days did you limit your activities because of your back? Do not include days you stayed in bed. If you are unsure, please make your best guess.
   BPDAY  [ ] days  O D O Don't know  BPDAYCV
Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Screening</th>
<th>12 month Annual</th>
<th>24 month Annual</th>
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<tbody>
<tr>
<td>SAS Format Name</td>
<td>YNDC</td>
<td>YNDC</td>
<td>YNDC</td>
</tr>
<tr>
<td>Yes</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>315</td>
<td>100</td>
<td>170</td>
</tr>
<tr>
<td>Missing Form/Incomplete Workbook</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>A Not Expected</td>
<td>4481</td>
<td>2355</td>
<td>2278</td>
</tr>
<tr>
<td>Missing</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Related Labels:
- Any back pain, past 30 days
  - How often bothered by back pain, past 30 days
  - When had back pain, how bad was it on average, past 30 days
- Back pain location, upper back
- Back pain location, middle back
- Back pain location, lower back
- Back pain location, buttocks

Osteoarthritis Initiative
Variable Guides

- Offline access to documentation of variables
  - under “Clinical Tab” of “Data and Documentation”

- Download PDF files
  - search for items of interest:

```
P01BPB
Label:   SV:Q43c Back pain location, buttocks
Data Collection Form:  Screening Visit Workbook Page 21
SAS Dataset:  JointSx00
Release Comments:  None

<table>
<thead>
<tr>
<th>Category</th>
<th>SubCategory</th>
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<tbody>
<tr>
<td>Back pain</td>
<td>Back pain</td>
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</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>N</th>
<th>%</th>
<th>Cumulative N</th>
<th>Cumulative %</th>
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</thead>
<tbody>
<tr>
<td>1: Yes</td>
<td>315</td>
<td>6.57</td>
<td>315</td>
<td>6.57</td>
</tr>
<tr>
<td>A: Not Expected</td>
<td>4,481</td>
<td>93.43</td>
<td>4,796</td>
<td>100.00</td>
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</table>
```

- Will show further examples for Image Biomarkers
Data Explorer

- Another powerful tool available on OAI Online to become familiar with data

- Generate descriptive statistics:
  - frequency distributions
  - cross tabulations

- Useful for exploring suitable selection criteria:
  - how many participants/knees might be available for your study design?
  - relax or make strict your inclusion/exclusion criteria and interactively see changes in numbers
Baseline:
- Knee pain status (KSX) vs. Radiographic OA (XRKOAA)
- Only in elderly people who aren’t overweight
### Data Explorer Cross Tabulation

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<thead>
<tr>
<th></th>
<th>P01KSX</th>
<th>P01XRKO A</th>
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<tr>
<td></td>
<td>0:</td>
<td>1:</td>
</tr>
<tr>
<td></td>
<td>Neither</td>
<td>Right knee only</td>
</tr>
<tr>
<td>M: Missing</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.17</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>33.33</td>
<td>0.00</td>
</tr>
<tr>
<td>0: No pain either knee</td>
<td>77</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>13.18</td>
<td>1.71</td>
</tr>
<tr>
<td></td>
<td>62.10</td>
<td>8.06</td>
</tr>
<tr>
<td></td>
<td>26.66</td>
<td>13.70</td>
</tr>
<tr>
<td>1: Infreq pain 1 knee, no pain other knee</td>
<td>52</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>8.90</td>
<td>2.74</td>
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<td></td>
<td>42.62</td>
<td>13.11</td>
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<td></td>
<td>17.87</td>
<td>21.92</td>
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<tr>
<td>2: Infreq pain both knees</td>
<td>68</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>11.64</td>
<td>2.05</td>
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<tr>
<td></td>
<td>54.40</td>
<td>9.60</td>
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<tr>
<td></td>
<td>23.37</td>
<td>16.44</td>
</tr>
<tr>
<td>3: Freq pain 1 knee, no pain other knee</td>
<td>36</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>6.16</td>
<td>2.23</td>
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<td></td>
<td>50.70</td>
<td>18.31</td>
</tr>
<tr>
<td></td>
<td>12.37</td>
<td>17.81</td>
</tr>
<tr>
<td>4: Freq pain 1 knee, infreq pain other knee</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>4.11</td>
<td>1.88</td>
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<td></td>
<td>43.64</td>
<td>20.00</td>
</tr>
<tr>
<td></td>
<td>8.25</td>
<td>15.07</td>
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<td>5: Freq pain both knees</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>5.65</td>
<td>1.88</td>
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<td></td>
<td>39.29</td>
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<td>Total</td>
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<td>73</td>
</tr>
<tr>
<td></td>
<td>49.83</td>
<td>12.50</td>
</tr>
</tbody>
</table>
Beyond Data Explorer

- to find IDs of matching participants:
  - *need to use downloadable data*

- to find if they have specific x-rays at two visits:
  - *use imaging meta-data VxxEXAMTP and VxxXRBARCD*
  - 498/584 = 85% have baseline (V00) and 24m (V03) knee x-rays

<table>
<thead>
<tr>
<th>ID</th>
<th>P01KSX</th>
<th>P01XRKOAK</th>
<th>V00AGE</th>
<th>P01BMI</th>
<th>V00XRBARCD</th>
<th>V00EXAMTP</th>
<th>V03XRBARCD</th>
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<td>Bilateral PA Fixed Flexion Knee</td>
<td>016601920604</td>
<td>Bilateral PA Fixed Flexion Knee</td>
</tr>
</tbody>
</table>

- can also then use CIA datasets to look for those with existing image readings/measurements
Image Assessment Data

CIA Centrally Read Image Assessments:

- Semi-quantitative (SQ) readings of knee x-rays
  - OARSI JSN, Kellgren & Lawrence grades – longitudinal
  - osteophytes, attrition, cysts – cross-sectional (BL)

- Joint Space Width (JSW) measurements
  - minimum JSW in medial compartment - longitudinal
  - JSW at 7 locations across medial compartment - longitudinal

- Quantitative Cartilage Morphology
  - volume/thickness, etc – longitudinal

Ancillary Study

- Knee Alignment
  - HKA (Hip Knee Ankle angle) – cross-sectional
OAI Sponsored CIA in Progression Subcohort

1050 “Core” progression subcohort participants:
- K&L Grades, OARSI JSN Grades
- JSW measurements
- baseline, 12m and 24m visits (36m in some)

~600 Participants (Index Knees)*:
- more extensive baseline x-ray readings osteophytes, attrition, sclerosis, etc
- longitudinal quantitative cartilage morphology bl, 12m and 24m visits (36m in some?)

Knee Alignment (cross-sectional) in almost all

* Index Knee = frequent knee pain at baseline, + K&L 2-3 + JSW > 1mm
An additional 110 similar participants have equivalent data from BL and 12m
CIA Datasets and Documentation

Datasets identified by:

- Type of analysis
  - `kxr_sq` SQ readings from knee x-ray
  - `kxr_jsw` JSW measurements from knee x-ray
  - `kmri_qcart` Quant cartilage from knee MRI
  - `flxr_kneealign` alignment from full limb x-ray

- “Vendor” performing the analysis
  - `BU` Boston University (David Felson)
  - `Duryea` Jeff Duryea, Boston
  - `Eckstein` Felix Eckstein (Chondrometrics/Paracelcus)
  - `VS` Virtualscopics
  - `Cooke` Derek Cooke, Ontario, Canada

- Visit from which the measurements were obtained
  - Example: kxr_sq_bu00
CIA Projects

- For specific reading type/vendor combination data can be from more than one reading projects:
  - each project is given a unique identifying number

- **Example: kmri_qcart_ecksteinXX datasets:**
  - cartilage morphology measurements from one vendor
  - contain data from Projects “04”, “07”, “08”, “09”

- Projects from the same vendor have similarities to their measurements/readings:
  - but differ by participant/knee selection criteria
  - can also differ by image types/visits analyzed

- Documentation available for similarities/differences

  [http://www.oai.ucsf.edu/datarelease/ImageAssessments.asp](http://www.oai.ucsf.edu/datarelease/ImageAssessments.asp)
CIA Core Sample X-ray Readings

- Project “06” - Bilateral Fixed Flexion Knee Radiographs
  - *longitudinal SQ readings (1050 participants)*:
    - K&L grades, medial and lateral OARSI JSN grades
      - baseline, 12m, and 24m visit
  - *baseline SQ readings (~600 participants with Index Knees)*:
    - osteophytes, attrition, cysts, sclerosis, etc..

- Project “05” - Bilateral Fixed Flexion Knee Radiographs
  - *longitudinal JSW measurements (1050 participants)*:
    - minimum medial compartment JSW,
    - fixed locations (N=7) across medial compartment
      lateral compartment JSW to follow
    - baseline, 12m and 24m visits
CIA - MR Readings in Core Index Knees

- Project “09” - Knee MRI (Sagittal 3D DESS WE)
  - unilateral in “index knee”
  - baseline, 12m and 24m visits
  - whole tibia plateau (medial and lateral)
    - and also each subdivided into 7 locations
  - weight bearing (central) femur (medial and lateral)
    - and also each subdivided into 3 locations
  - ~110 knees, and eventually ~600 knees
Chondrometrics Reading Projects

- All part of Felix Eckstein's Consortium

- Project “04” – Knee MRI (Coronal FLASH)
  - unilateral (right knee) quantitative cartilage measurements
  - from baseline and 12m
  - 160 progression subcohort participants

- Project “07” – Knee MRI (Coronal FLASH)
  - unilateral (right knee) quantitative cartilage measurements
  - from baseline and 12m
  - 131 mainly progression subcohort participants

- Project “08” – Knee MRI (to compare DESS with Project “04”)
  - overlap with knees from project “04”
  - from baseline and 12m

  - presents results of Project “04”
Other Released Reading Projects

- **Project “01” - Bilateral Fixed Flexion Knee Radiographs**
  - SQ x-ray readings (bilateral) from baseline and 12m
  - similar reading protocols to Project “06”
    - but more comprehensive IRFs scored longitudinally
  - 160 progression subcohort participants

- **Project “02” - Joint Space Width (JSW) measurements**
  - JSW (bilateral) from baseline and 12m
  - similar reading protocols to Project “05”
  - 160 progression subcohort participants

- **Project “03” - Knee MRI (Sag 3D DESS)**
  - unilateral quantitative cartilage and other measurements
  - from baseline and 12m SAG DESS
  - performed by VirtualScopics
  - 160 progression subcohort participants

  - presents results from Projects “01” and “03”
Ancillary Study (Knee Alignment)

- Project “60” - HKA Angle
- Alignment from progression subcohort
  - Derek Cooke (Ontario)
  - David Felson (Boston)
- Full Limb Radiograph
  - cross-sectional varus/valgus malalignment
  - acquired at one visit
- Progression subcohort:
  - usually 12m or 24m
- Datasets:
  - flxr_kneealign_cookeXX
  - XX is visit
    (01=12m, 03=24m, etc)
Search & Browse for HKA

- http://www.oai.ucsf.edu/datarelease/ldd.asp

Click on label to get statistics and link to download
Variable Guide

- large PDF files
- search to find variables of interest

V01HKANGLE

Label: FU kXR reading (DC): limb alignment (mechanical axis) HKA (hip-knee-ankle) angle from full limb x-ray [degrees]

Data Collection Form: f1XR knee align, single timepoint (Cooke)

SAS Dataset: f1XR_KneeAlign_Cooke01

Release Comments: None

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<th>SubCategory</th>
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<td>Knee Alignment (Cooke)</td>
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<table>
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<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std Dev</th>
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<td>261</td>
<td>12.60</td>
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<td>3.96</td>
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</tbody>
</table>
Dataset Structure

- simplest example is HKA (flxr_kneealign_cooke01):

<table>
<thead>
<tr>
<th>ID</th>
<th>SIDE</th>
<th>VERSION</th>
<th>V01BRCDDDC</th>
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<td>9040390</td>
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<td>2</td>
<td>1.2</td>
<td>016601215206</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

- all measurements from READPRJ “60”
- each limb has a separate record (row)
- each person can have multiple records
- “barcode” tells you which image was analyzed
- get further documentation when you download data
Image Assessment Documentation

- more details in documents on download page: http://www.oai.ucsf.edu/datarelease/ImageAssessments.asp

- specific to each vendor
- details of methods
- descriptions of technique
  - differences between projects
- references to publications

eg: for HKA
- how defined and measured
- -ve = varus
- +ve = valgus

Figure 1. Common frontal plane lower limb alignment patterns. A. Varus alignment: knee center is lateral to the LBA (HKA is negative). B. Neutral alignment: knee center is located on the LBA (HKA = 0°). Femoral and tibial mechanical axes are colinear. C. Valgus alignment: knee center is medial to the LBA (HKA is positive). LBA: load-bearing axis; HKA: hip-knee-ankle angle; FM: femoral mechanical axis; TM: tibial mechanical axis. (From reference 1).
Fixed Flexion Knee Radiographs
Central SQ Reading of Knee X-rays

- **Reading Protocol**
  - *readers blinded to chronological order*
  - *each film read by 2 readers*
  - *discrepancies adjudicated*
    - OA (K-L ≥ 2) vs. noOA (K-L < 2)
    - JSN change
    - consensus of 3 readers

- **Experienced team of knee OA readers**
  - *musculoskeletal radiologist, 2 rheumatologists*
  - *Framingham, MOST, BOKS, BOA*
SQ Knee Reading Data

- Kellgren & Lawrence Grades (longitudinal)
- OARSI JSN Grades (longitudinal)
- other IRFs (eg: osteophytes, sclerosis, etc)
  - cross sectional only in subset for Project “06”

- Datasets
  - $kxr_{sq\_bu00}$, $kxr_{sq\_bu01}$, $krx_{sq\_bu03}$
- Contain data from more than one project
  - Project “01” and Project “06” have a slight overlap
- For each project, usually two records per person
  - for right and left knees
Search & Browse “Joint Space Narrowing”

Summary of Results:
14 Record(s)

<table>
<thead>
<tr>
<th>Category</th>
<th>SubCategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Assessments: X-ray</td>
<td>Knee x-ray SG read (BU)</td>
</tr>
<tr>
<td>Joint Imaging</td>
<td>Fixed-flexion knee x-ray</td>
</tr>
<tr>
<td>Knee pain/OA status</td>
<td>Knee pain/OA status</td>
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</tbody>
</table>

**Image Assessments: X-ray** (See All Labels in Category)

<table>
<thead>
<tr>
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<th>Root</th>
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<th>P01</th>
<th>V00</th>
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<th>V02</th>
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<tr>
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<tr>
<td>lateral compartment</td>
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<tr>
<td>BLU F U XKR reading (BU): joint space narrowing (OARSI grades 0-3)</td>
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</table>
Longitudinal JSN – one record per knee

- **kxr_sq_bu00:**

<table>
<thead>
<tr>
<th>ID</th>
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<th>V00XRJSM</th>
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<tr>
<td>9000798</td>
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<td>06</td>
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- **kxr_sq_bu01:**

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<td>9000798</td>
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</table>

- **kxr_sq_bu03:**

<table>
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<tr>
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<td>9000798</td>
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<td>06</td>
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</tbody>
</table>

- **merged by ID, SIDE, READPRJ:**

<table>
<thead>
<tr>
<th>ID</th>
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<th>READPRJ</th>
<th>V00XRJSM</th>
<th>V00XRJSL</th>
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<td>0</td>
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<tr>
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<td>06</td>
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<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Multiple records per knee: for some participants (e.g., 9003406) there will be data in the “00” and “01” data from both Project “06” and “01”.

Potential problem: need to avoid matching 24-month data from kxr_sq_bu03 (project “06”) with baseline and 12-m data from Project “01”.
Longitudinal JSN - 2+ records per knee

- **kxr_sq_bu00**
  
<table>
<thead>
<tr>
<th>ID</th>
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<th>READPRJ</th>
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<tbody>
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<td>9000798</td>
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- **kxr_sq_bu01**
  
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<tr>
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- **kxr_sq_bu03**
  
<table>
<thead>
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<td>9000798</td>
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<td>06</td>
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</tbody>
</table>

Do not need to calculate changes

Have repeated measures
- by participant
- by knee
- by time

Powerful way to utilize 3+ time points

“Long” format:

<table>
<thead>
<tr>
<th>ID</th>
<th>SIDE</th>
<th>VISIT</th>
<th>READPRJ</th>
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<td>2</td>
<td>03</td>
<td>06</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
JSW Measurements

- Performed by Jeff Duryea’s group (Boston)
- Datasets:
  - `kxr_qjsw_duryea00, kxr_qjsw_duryea01, kxr_qjsw_duryea03`
- “Search and Browse” for “JSW”:

<table>
<thead>
<tr>
<th>Label</th>
<th>Root</th>
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<th>P01</th>
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<th>V04</th>
<th>V05</th>
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<td>PRJ02JD</td>
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<tr>
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<tr>
<td>BL/FU kXR reading (JD): barcode of image analyzed</td>
<td>BRCODJD</td>
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<tr>
<td>BL/FU kXR reading (JD): x-ray beam angle from Synatex phantom [degrees]</td>
<td>BXBANG</td>
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<tr>
<td>BL/FU kXR reading (JD): width of tibial condyle used to define x=1.0 [mm]</td>
<td>CFWDT1H</td>
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<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.150 [mm]</td>
<td>JSW150</td>
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<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.175 [mm]</td>
<td>JSW175</td>
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</tr>
<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.200 [mm]</td>
<td>JSW200</td>
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<td></td>
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</tr>
<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.225 [mm]</td>
<td>JSW225</td>
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<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.250 [mm]</td>
<td>JSW250</td>
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<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.275 [mm]</td>
<td>JSW275</td>
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<tr>
<td>BL/FU kXR reading (JD): medial JSW at x=0.300 [mm]</td>
<td>JSW300</td>
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<td></td>
</tr>
<tr>
<td>BL/FU kXR reading (JD): medial minimum JSW [mm]</td>
<td>MCMJSW</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

multiple measurements per knee
Joint Space Width Measurements

- measured by Jeff Duryea’s Group in Boston

- **minJSW (medial)** and **JSW(x)** at fixed locations:
  - medial compartment JSW: From \( x = 0.15 - 0.30 \)
  - lateral compartment JSW: From \( x = 0.70 - 0.90 \)

- **Longitudinal data issues similar to SQ Readings**
  - also have repeated measurement by location
Quantitative Cartilage Morphology

- **Chondrometrics Consortium**
  - Felix Eckstein’s team, OAI and Pharma Partners

- **data for 320 knees already released to public**
  - via OAI Online [http://www.oai.ucsf.edu](http://www.oai.ucsf.edu)
  - Projects “04”, “07” and “08”

- **data for 600 more knees will be released**
  - initial 107 knees released soon
  - additional data twice per year

- **almost all will have x-ray readings/measurements & other core assessments**
  - usually from Projects “05”, “06”
Quantitative Cartilage Measurements

- datasets: kmri_qcart_eckstein00, …01, …03
- 92 measurements per knee per visit
- measurements include:
  - VC, tAB, VCTAB, ThCtAB, dAB%
- at multiple cartilage plates:
  - cMF, cLF, MT, LT
- and their subregions:
  - eg: cMF → (ecMF, ccMF, icMF)
- one record per knee, per project:
  - multiple projects, some with overlap
Cartilage Plates & Subregions

- Each measurement at each location has unique variable name:
  - can use “standard nomenclature” to find
- Online and downloadable documentation defines:
  - which knees and image types were measured
Quantitative Cartilage MRI Nomenclature

- measurement type & anatomical location standardized:
  - further information in downloadable documentation and also:

- examples are:
  - MT.VC = volume of cartilage on medial tibial plateau
  - eMT.ThCtAB.aME = mean thickness of cartilage averaged over the whole of the external medial tibial plateau subregion

- can use nomenclature to find variables in datasets:
  - from online “Search & Browse”
  - from downloadable Variable Guides

- can use variable names to find similar measurements
Exploring Cartilage Measurements

- **Search & Browse** “MT.ThCtAB“:

<table>
<thead>
<tr>
<th>Label</th>
<th>Root</th>
<th>P02</th>
<th>P01</th>
<th>V00</th>
<th>V01</th>
<th>V02</th>
<th>V03</th>
<th>V04</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLFU kMRI reading (FE): mean cartilage thickness - medial tibia (MT.ThCtAB (mm))</td>
<td>WMTMTH</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
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<td>✔️</td>
</tr>
<tr>
<td>BLFU kMRI reading (FE): SD of cartilage thickness - medial tibia (MT.ThCtAB (mm))</td>
<td>WMTCTS</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>BLFU kMRI reading (FE): CV of cartilage thickness - medial tibia (MT.ThCtAB (%)</td>
<td>WMTACV</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
</tr>
<tr>
<td>BLFU kMRI reading (FE): minimum cartilage thickness - medial tibia (center) (MT.ThCtAB (mm))</td>
<td>CMTWAT</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
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<tr>
<td>BLFU kMRI reading (FE): mean cartilage thickness - medial tibia (center) (MT.ThCtAB (mm))</td>
<td>CMTMTH</td>
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<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>BLFU kMRI reading (FE): mean cartilage thickness - medial tibia (external) (MT.ThCtAB (mm))</td>
<td>EMTMTH</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>BLFU kMRI reading (FE): mean cartilage thickness - medial tibia (internal) (MT.ThCtAB (mm))</td>
<td>IMTMTH</td>
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<td>✔️</td>
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<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

- similarly search for “.ThCtAB” for all mean thickness variables

- **NB**: all .ThCtAB variable names end “MTH”
  - *this holds for all measurement types:*
    - eg: VCN is “volume of cartilage (normalized)”
      = .VCtAB in standard nomenclature
Combining Data from a Single “Vendor”

- Care is needed when merging data from different reading projects
- Longitudinal data from within one reading project can be used “as is”
  - with correct merging by ID, SIDE, READPRJ
- Pairing Baseline data from one reading project with follow-up data from another project is possible
  - but statistically more complex
- Cross-Sectionally, combining data from two+ reading projects is possible
  - but users are requested to read ALL the relevant documentation to check that reading methods are similar
Simple Examples for a single “Vendor”

- JSW measurements at BL and 12m were performed in a similar manner for Projects “05” and “02”:
  - stratifying or selecting participants based on their baseline JSW could feasibly use data from both projects
  - defining “progressors” by their change in JSW could also feasibly combine data from both
  - care would be needed due to overlap between the knees in each project

- Similar analogy between SQ readings from Projects “06” and “01”
Simple Examples for a single “Vendor”

- Cartilage Thickness Measurements are available at BL and 12m for projects “04”, “07”, “08” and “09”:
  - documentation shows that the techniques were similar
  - **BUT** MR images used came from a variety of different pulse sequences
  - estimating statistics for a group of knees may be affected by systematic differences between the values from different MR image types
  - more care is needed combining this type of data
Strategies for pooling longitudinal qCart data

- Data from different MR sequences or vendors
- For examining change in qCart measurement
  - there are methods to pool data

- Without cross-calibration data
  - use statistical model to adjust
  - indicator variable for sequence/vendor plus interactions with main predictors

- With cross-calibration data
  - convert all values to standard vendor or standard sequence
  - more rigorous version: use multiple imputation to account for random error in conversions
Merging Different Types of Data

- Demographic or Clinical Data with Image Assessments:
  - simply match relevant image assessment data with clinical data by the variable ID (uniquely identifies a participant)
  - use visit code (V00, V01, V03, etc) to match by visit.
  - one dataset (AllClinicalXX) per visit (XX) contains almost all clinical data - excludes medication inventory and image meta-data, and CIA data
  - need to do this to get AGE, GENDER, BMI, RACE, etc
Merging Different Types of Data

- Image Meta-Data and Image Assessments:
  - useful if you want to use existing image assessments to select participants/knees for new image-based analyses

Example:
- calculate medial tibia (MT) baseline T2 measurements:
  - in knees which had no denuded areas of bone on MT at BL
  - but developed a denuded area on MT by 24m follow-up
  - how do we find which T2 multi-echo images are available?
Incident Denuded Area on Medial Tibia

- merged kmri_qcart_ecsktein00 and 03 data:

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- find 7 unique matching knees

- merge with L or R “SAG T2 MAP” records from dataset MRI00:

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- find 5 matching sets of images in which to measure T2
Example “T2 Map” Image Found
Summary

- **OAI clinical, questionnaire, images and image-derived biomarker data available to all**
  - access through OAI Online
  - upcoming online access to images via NBIA

- **OAI will be releasing limb alignment measurements in progression subcohort, and later in incidence subcohort**

- **OAI will be releasing SQ knee x-ray readings + JSW on 1000+ progression subcohort participants (bl, 12m, 24m)**

- **OAI will be releasing cartilage volume/thickness measurements from 600+ knees (bl, 12m, 24m)**

- **SQ knee XR + JSW and qCart will be in “core” group of progression subcohort**
Summary

- Use OAI Online to explore and download data
  - *data are complex, but documentation is vast*
- **CIA** x-ray data (knee SQ readings and JSW) in 1050 core progression subcohort participants complete
  - will be used to update released image assessment datasets
- Index Knees from those Core participants will be getting **Cartilage Morphology Measurements**
  - *new readings will be added regularly as they are completed*
- Ancillary Study and other collected data can potentially be added into existing or newly created datasets
Summary

- Can use image-derived biomarkers merged with relevant demographic clinical data for your own analyses of OA:
  - but be careful with data from multiple projects/vendors
- Can use image-derived biomarkers to select new images types for further analysis/measurements:
  - can use downloadable data to select images
- Many other assessments being done by others:
  - some already released, more to be released
- Encourage people release data through OAI Online:
  - once you have published – it could be useful to others
- Feedback from everyone would be helpful:
  - OAIOnlineFeedback@psg.ucsf.edu