

MULTICENTER OSTEOARTHRITIS STUDY

**144-MONTH HAND OSTEOARTHRITIS ASSESSMENT:
SCORING PROTOCOL AND DATASET DESCRIPTION (V7HANDOA)**

MARCH 2023

TABLE OF CONTENTS

1. Introduction.....	2
2. Hand Photo OA Scoring.....	2
2.1 Joint Scoring.....	2
2.2 Aggregated Scoring	4
3. Transfer of Photos and Scoring Database	5
4. SAS Dataset and Operations Manual	5
5. References	6
Appendix 1. Hand Photo Examples.....	7
Appendix 2. Description of Reliability Dataset and Results	10

1. Introduction

The Multicenter Osteoarthritis Study (MOST) is a longitudinal, prospective, observational study of knee osteoarthritis (OA) in older Americans with knee OA disease or at increased risk of developing it.

Hand photo exams for osteoarthritis scoring were acquired during clinic visits for the Existing Cohort (144-month follow-up visit) and the New Cohort (baseline visit). All participants undergo through an informed consent process prior to the clinic visit. Participants do not receive the results of the hand OA scores.

A digital still camera was used to capture a single photograph of the dorsum of both hands for hand osteoarthritis scoring. Hand photo exam procedures are described in MOST Hand Photo Examination Operations Manual. Staff were trained and certified before conducting this exam with MOST participants.

2. Hand Photo OA Scoring

Dr. Helgi Jónsson has developed a reproducible scoring system for hand osteoarthritis (HOA) from high quality hand photographs (see references: 1, 2 below). While looking at both hands, a bilateral composite grade for each joint row (DIP, PIP, MCP, CMC1) is recorded based on the presence of several findings indicating the presence of definite OA in a joint: hard tissue enlargement, visible soft tissue swelling, position, and deformity. See Figures 1-3 for examples of definite OA in DIP, PIP, MCP and CMC1 joints (which is a score of 2 or 3 in an individual joint category). Two aggregated scores are calculated from combining scores for each hand joint row.

IMPORTANT: The MCP row is scored for MOST, but it is NOT included in the calculation of aggregate scores.

Joint rows for HOA scoring

- DIP joint row: distal interphalangeal digits 2-5, and digit 1 (thumb) interphalangeal
- PIP joint row: proximal interphalangeal digits 2-5
- MCP joint row: metacarpal digits 1-5
- CMC1 joint: carpometacarpal digit 1 (thumb base)

2.1 Joint Scoring

For each participant, the distal interphalangeal (DIP), proximal interphalangeal (PIP), and thumb carpometacarpal (CMC1) joint rows for both hands together are each given a global row score of 0-3.

Scores go from 0-3 based roughly on the number of joints in both hands with definite OA, as defined in Figures 1-3.

0	no evidence of hand OA
1	possible hand OA
2	definite moderate hand OA
3	severe hand OA
7*	missing: not readable due to body habitus
9*	missing: not readable due to positioning or photo technical reasons

*Missing score values

The general rules for global row scores are as follows

Score = 1: For DIP, and PIP joint rows, if only one joint of the joint row has definite OA, the score for that joint row is 1.

Score = 1: For CMC1 joint row, if one or both joints have possible OA but there is no definite OA, the score for that joint row is 1.

Score = 2: For DIP, and PIP joint rows, if there is bilateral definite OA, with one or more joints on each hand having definite OA, the score for the joint row is 2.

Score = 2: For PIP joint rows, in addition to bilateral definite OA, if there are 2 or more joints on one hand with definite OA the score for the PIP joint row is 2.

Score = 2: For CMC1 joint row, if there is definite OA in one or both hand, the score for that joint row is 2.

Score = 3: For all joint rows, if score = 2 (above) AND there is one or more severely affected joints (Fig. 2-4, grade 3), the score for the joint row is 3.

Additional scoring rules and considerations

DIP Joints

For the DIP joints, definite OA in a joint generally requires both deformity and hard tissue enlargement (see figure 2, grade 2-3); deformity in a single DIP joint does not count as definite OA in that joint.

Following the clinical ACR criteria, the greatest weight in the global score for a row is given to the DIP2-3 bilaterally, PIP2-3 bilaterally and MCP2-3 bilaterally. The 5th finger is weighted less in creating the global score for the joint row than OA findings in the row for the other fingers. The 5th finger is problematic with flexion contractures and familial deformities common.

For example, if there is definite DIP5 OA in one of both hands and no definite OA elsewhere in the DIP row or in rest of the hand, the DIP row score is 0. However, if there is bilateral definite DIP5 OA and no definite OA elsewhere in the DIP row, but there is definite OA in other rows, then the DIP row can be scored as 1 or 2 depending on how typical the DIP5 findings are of OA.

PIP Joints

The PIP joints are more robust, but the same rules as DIP joints apply for definite, but isolated, PIP5 OA.

IP Joints

The digit 1 (thumb interphalangeal) IP joints are not scored separately but are taken into account in the DIP row score. The status of the thumb IP joint is somewhat similar to that of DIP5.

For example:

- If there is no definite DIP2-4 OA in either hand, but there is unilateral or bilateral definite IP OA, the DIP row score is still 0. However, if there are other clues (such as possible OA in other DIP 2-4 joints, or the IP findings are very typical of OA, or there is definite OA in other joint rows) it could sway the DIP row score from 0 to 1.
- If there is no definite DIP2-4 OA in either hand, but there is bilateral severe IP OA, the DIP row score = 1
- If there is unilateral definite DIP2-4 OA, and there is definite IP OA in one or both hands this could sway the DIP row score from a 1 to 2.

CMC1 Joints

Thumb CMC1 joints are scored based on enlargement of the joint and abnormal positioning (see figure 4). Abnormal positioning reflects palmar migration of the base of the first metacarpal bone and is reflected on photography by a number of factors, including disappearance of the normal configuration of the CMC1 joint, medial rotation of the thumb showing increased folding of the skin over the first metacarpal joint (MCP1) and sometimes hyperextension of that joint. The severity of both enlargement and abnormal position will be considered in the CMC1 row the score.

Severe OA/Deformity

When a joint row has definite OA (row score = 2) and severe deformity (>30° or grade 3 in figures 2-4) in any joint in a row, the recorded score is raised from 2 to 3. For example, if a row has definite OA (row score=2) a severely deformed joint would increase the row score to 3. However, if a row has possible OA (row score=1) a severely deformed joint would NOT increase the row score to 2.

Reading atlas

Reference photographs (Figure 1-3 and Reference 2) will be used as an assistive tool in the reading of all photographs. See Appendix A for details.

Reliability readings

The 48 random hand photos have been re-read 2 times by the same reader to evaluate short-term and long-term intra-reader reliability. See Appendix B for details.

2.2 Aggregated Scoring

“HJSCORE” (Dr Helgi Jónsson SCORE): data range 0-9

HJSCORE is a global hand OA score calculated for each participant from the aggregate (summation) of the joint row scores (range 0-9):

- DIP score (0-3)
- PIP score (0-3)
- CMC1 score (0-3)

If any of the DIP, PIP, or CMC1 scores is missing (or unscorable – special value 7 or 9) in the database the HJSCORE calculation will show as missing (the reader was allowed to manually insert value if calculation was missing).

“HOASCORE” (hand OA score): data range 0-4

HOASCORE is a global hand OA score calculated as an aggregated score taken from previous three joint row scores truncated at 4 (4 will be the highest possible HOASCORE+).

If the sum of any non-missing DIP, PIP, or CMC1 scores is ≥ 4 then the HOASCORE will be 4. If that sum is less than 4, the HOASCORE+ calculation will show as sum of the three joint row scores.

If any of the DIP, PIP, MCP or CMC1 scores is missing in the database the, the HOASCORE is missing (reader can manually insert value if calculation is missing).

3. Transfer of Photos and Scoring Database

For the reading project, the MOST Coordinating Center at UCSF securely transferred the hand photos and scoresheets to the reader electronically. The MOST hand photos were sent in batches of 50 photos per batch. The scoring results were similarly securely transferred to the MOST Coordinating Center electronically. Note: hand photos are not available for public release.

Table – Summary of hand photo exam status

	Original cohort		New cohort		Total	
	N	col%	N	col%	N	col%
Total CV	1309	100.0%	1525	100.0%	2,834	100.0%
Hand Photo status						
1:Photo stored	1279	97.7%	1509	99.0%	2,788	98.3%
3:Attempted, not stored	7	0.6%	4	0.3%	11	0.3%
5:Not done, no consent	1	0.1%	9	0.6%	10	0.3%
6:Not done, equipment failure	0	0.0%	0	0.0%	0	0.0%
7:Not done, refused	3	0.2%	0	0.0%	3	0.1%
8:Not done, reason unknown	19	1.5%	3	0.2%	22	0.7%

4. SAS Dataset and Operations Manual

V7HANDOA (N=2789; one observation per participant)

Distributions (*Distributions_V7HANDOA.pdf*)

Variable Guide (*VariableGuide_V7HANDOA.pdf*)

Table – Variable name and label

Variable	Label
DIP	Distal interphalangeal joint row score
PIP	Proximal interphalangeal joint row score
MCP	Metacarpal joint row score
CMC1	Thumb carpometacarpal joint row score
HJSCORE	Reader (Dr Helgi Jonsson) score
HOAScore	Hand osteoarthritis score

Operations Manual available at

https://agingresearchbiobank.nia.nih.gov/studies/most/documents/?f=Manual_of_Procedures

5. References

1. Marshall M, Jonsson H, Helgadottir GP, Nicholls E, van der Windt D, Myers H, Dziedzic K. Reliability of Assessing Hand Osteoarthritis on Digital Photographs and Associations With Radiographic and Clinical Findings. *Arthritis Care Res (Hoboken)*. 2014 Jun;66(6):828-36. doi: 10.1002/acr.22225. PMID: 26259552.
2. Jonsson H, Helgadottir GP, Aspelund T, Sverrisdottir JE, Eiriksdottir G, Sigurdsson S, Eliasson GJ, Jonsson A, Ingvarsson T, Harris TB, Launer L, Gudnason V. The use of digital photographs for the diagnosis of hand osteoarthritis: the AGES-Reykjavik study. *BMC Musculoskelet Disord*. 2012 Feb 16;13:20. doi: 10.1186/1471-2474-13-20. PMID: 22340303

Appendix 1. Hand Photo Examples

Figure 1: Figure 1 from Reference 2 (2012) - DIPs.

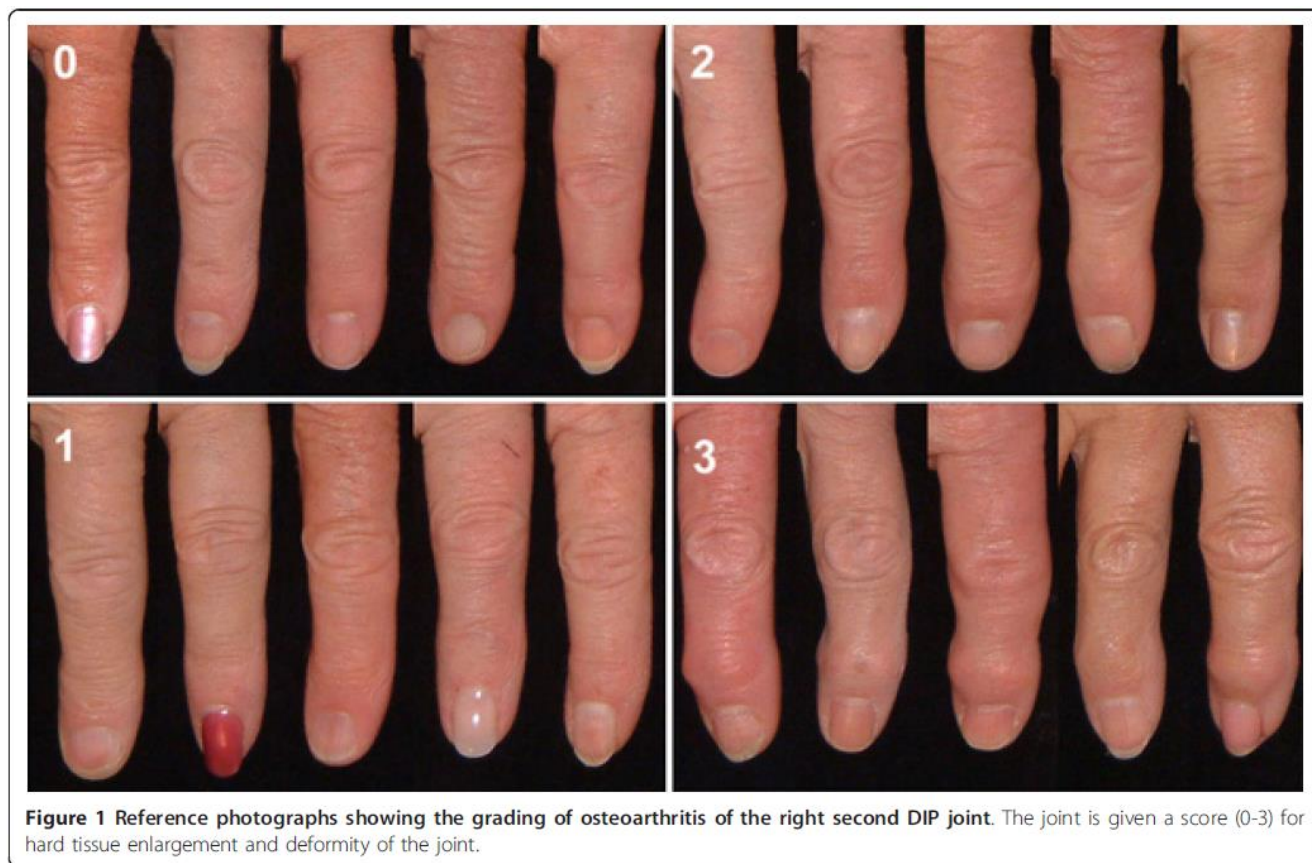


Figure 2: Figure 2 from Reference 2 (2012) - PIPs.

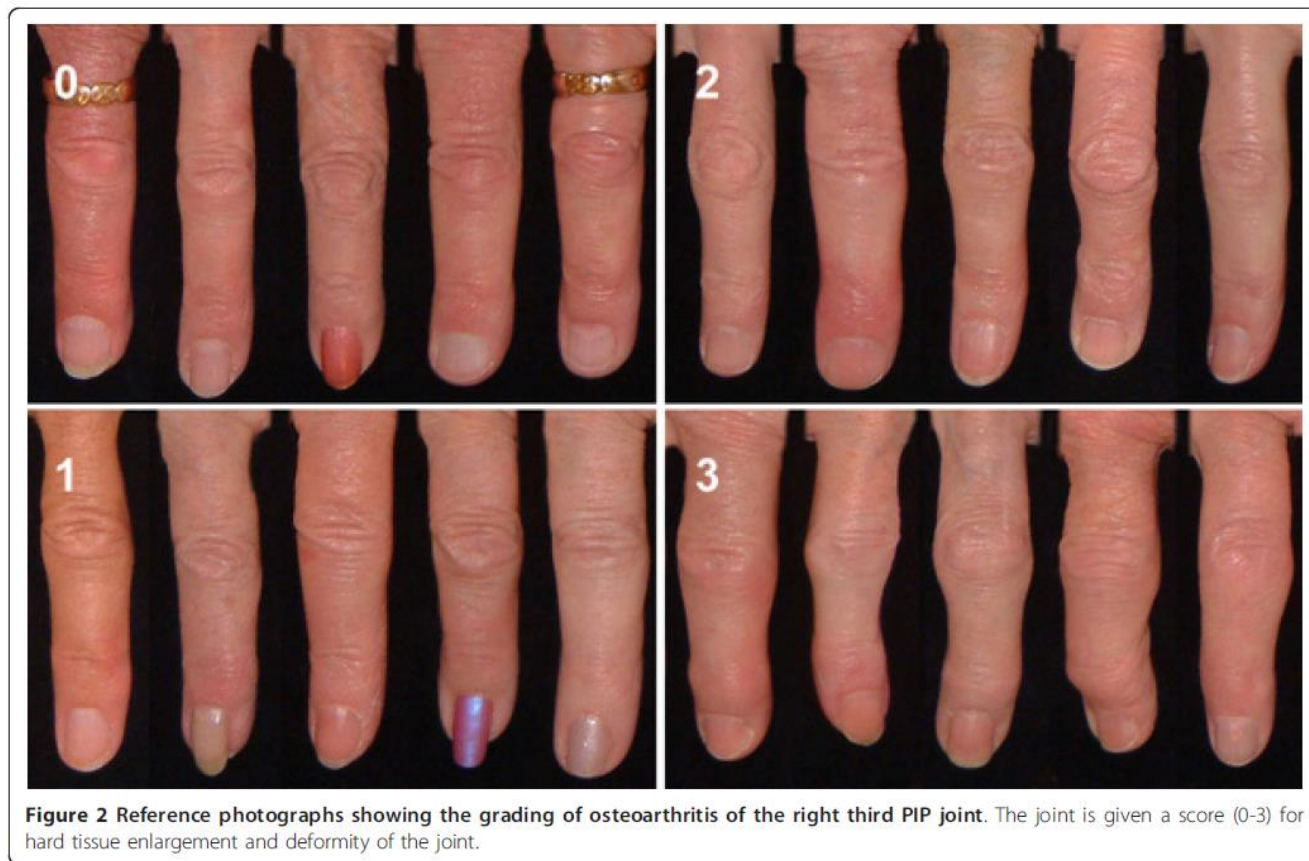


Figure 3: Figure 3 from Reference 2 (2012) – CMC1.

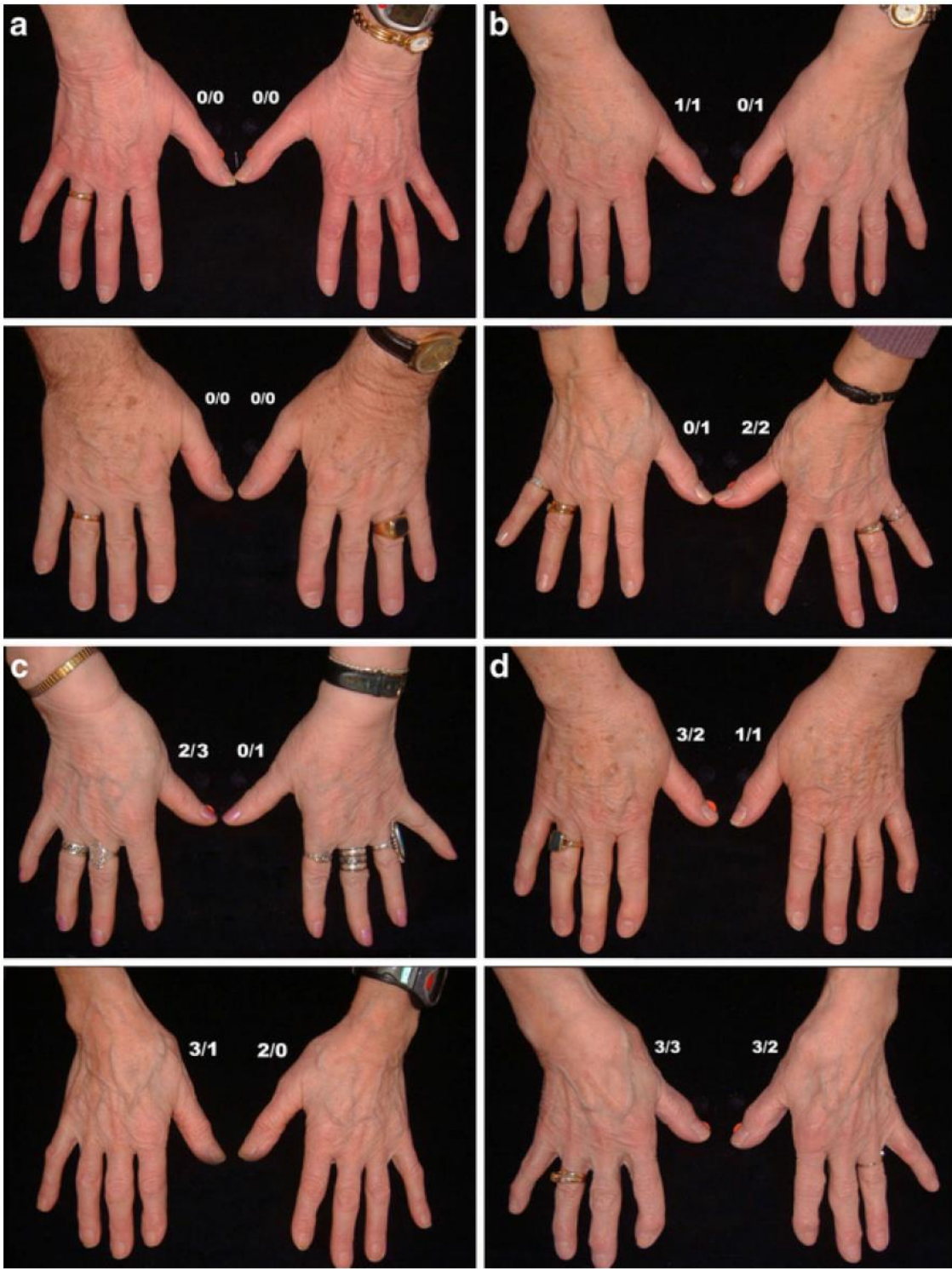


Figure 3 Reference photographs showing the grading of osteoarthritis of the CMC1 joints. The number on the left is the score for enlargement of the joint (0-3) and the number on the right represents position/subluxation of the thumb (0-3). a) Healthy CMC1 joints. b, c, d) Increasing osteoarthritis of the CMC1 joints.

Appendix 2. Description of Reliability Dataset and Results

A sample of 48 participants originally read by Dr. Helgi Jónsson during the period 12/5/2017 – 1/6/2018 were selected for examining intra-reader reliability. These were selected to be 12 men and 12 women from each clinic. The sample was weighted with approximately equal numbers of DIP=0, DIP=1, DIP=2 and DIP=3 scores, which also provided a good range of PIP and CMC1 assessment scores. Reader was unaware of the selection and photos were mixed within different batches.

For intra-reader reliability, comparing readings from (1) and (2) gives reliability over a short term, and comparing (1) and (3) over a longer period. The majority of the main readings (80%, 2225/2789) were done during the period 12/5/2017 and 2/14/2018, with the remainder done in the following months until the final readings were done on 10/2/2018.

As shown in table 1, Dr Helgi Jónsson's results had good agreements in both the short term and longer term, with weighted kappas above 0.8 for almost all features.

Table 1. Weighted kappa and 95% Confidence Intervals for intra-reader reliability readings of features of hand OA from hand photographs.

	Reading #1 vs Reading #2	Reading #1 vs Reading #3
DIP	0.90 [0.82 - 0.98]	0.80 [0.70 - 0.90]
PIP	0.88 [0.80 - 0.96]	0.87 [0.79 - 0.95]
CMC1	0.75 [0.62 - 0.88]	0.83 [0.71 - 0.94]
HOAScore	0.83 [0.75 - 0.91]	0.83 [0.75 - 0.91]
HJScore	0.86 [0.80 - 0.92]	0.82 [0.77 - 0.88]
	N=48	N=47 (1 unscorable)

There was no evidence of any drift between the 1st set of readings and the 2nd set from February 2018, but there was slight underscoring of DIP and PIP in the readings done in the 3rd set of readings done in August 2018, as shown in the tables 2-3.

Table 2. Short Term Intra-Reader Reliability Cross Tabs

DIP Score

DIP_num1	DIP_num2				
Frequency	0	1	2	3	Total
0	9	0	0	0	9
1	2	6	2	0	10
2	0	2	12	0	14
3	0	0	0	15	15
Total	11	8	14	15	48

PIP Score

PIP_num1	PIP_num2				
Frequency	0	1	2	3	Total
0	26	1	0	0	27
1	1	4	1	0	6
2	0	1	4	0	5
3	0	0	3	7	10
Total	27	6	8	7	48

CMC1 Score

CMC1_num1	CMC1_num2					
Frequency	0	1	2	3	Total	
0	25	4	0	0	29	
1	4	3	2	0	9	
2	0	0	2	3	5	
3	0	0	0	5	5	
Total	29	7	4	8	48	

HOA Score

HOAscore_num1	HOAscore_num2					
Frequency	0	1	2	3	4	Total
0	6	2	0	0	0	8
1	3	4	1	1	0	9
2	0	3	4	1	0	8
3	0	0	1	4	0	5
4	0	0	0	1	17	18
Total	9	9	6	7	17	48

HJSCORE

HJscore_num1	HJscore_num2										
Frequency	0	1	2	3	4	5	6	7	8	9	Total
0	6	2	0	0	0	0	0	0	0	0	8
1	3	4	1	1	0	0	0	0	0	0	9
2	0	3	4	1	0	0	0	0	0	0	8
3	0	0	1	4	0	0	0	0	0	0	5
4	0	0	0	1	1	0	0	0	0	0	2
5	0	0	0	0	0	0	0	1	0	0	1
6	0	0	0	0	1	0	4	0	0	0	5
7	0	0	0	0	0	0	0	2	2	0	4
8	0	0	0	0	0	0	0	0	1	1	2
9	0	0	0	0	0	0	0	0	1	3	4
Total	9	9	6	7	2	0	4	3	4	4	48

Table 3. Long Term Intra-Reader Reliability Cross Tabs

DIP Score

DIP_num1	DIP_num3				
Frequency	0	1	2	3	Total
0	9	0	0	0	9
1	4	6	0	0	10
2	0	5	7	2	14
3	0	0	1	13	14
Total	13	11	8	15	47
Frequency Missing = 1					

PIP Score

PIP_num1	PIP_num3				
Frequency	0	1	2	3	Total
0	27	0	0	0	27
1	1	4	1	0	6
2	0	1	4	0	5
3	0	0	4	5	9
Total	28	5	9	5	47
Frequency Missing = 1					

CMC1 Score

CMC1_num1	CMC1_num3				
Frequency	0	1	2	3	Total
0	26	3	0	0	29
1	2	5	2	0	9
2	0	0	4	1	5
3	0	0	0	4	4
Total	28	8	6	5	47
Frequency Missing = 1					

HOA Score

HOAscore_num1	HOAscore_num3					
Frequency	0	1	2	3	4	Total
0	6	2	0	0	0	8
1	3	6	0	0	0	9
2	1	4	2	1	0	8
3	0	0	1	4	0	5
4	0	0	0	1	16	17
Total	10	12	3	6	16	47
Frequency Missing = 1						

HJScore

HJscore_num1	HJscore_num3										
Frequency	0	1	2	3	4	5	6	7	8	9	Total
0	6	2	0	0	0	0	0	0	0	0	8
1	3	6	0	0	0	0	0	0	0	0	9
2	1	4	2	1	0	0	0	0	0	0	8
3	0	0	1	4	0	0	0	0	0	0	5
4	0	0	0	1	0	0	1	0	0	0	2
5	0	0	0	0	1	0	0	0	0	0	1
6	0	0	0	0	0	2	1	2	0	0	5
7	0	0	0	0	0	0	2	1	1	0	4
8	0	0	0	0	0	0	0	0	1	1	2
9	0	0	0	0	0	0	0	0	2	1	3
Total	10	12	3	6	1	2	4	3	4	2	47
Frequency Missing = 1											