NIH Toolbox

Assessment of Neurological and Behavioral Function

EMOTION Sensation Cognition MOTOR

Comparison of Somatosensory Functions in People with Diabetes and the General Population: NIH Toolbox Validation Project

Margo B. Holm, PhD, OTR/L, FAOTA, ABDA, University of Pittsburgh
Winifred Dunn, PhD, OTR/L, FAOTA, University of Kansas

This study is funded in whole or in part with Federal funds from the Blueprint for Neuroscience Research, National Institutes of Health under Contract No. HHS-N-260-2006-00007-C

BACKGROUND

Testing of Somatosensation for the NIH Toolbox

Purpose of the larger study: To validate a "toolbox" of measures that assess somatosensation, across the lifespan (ages 3-89)

Purpose of this study: To compare a cohort of older adult subjects with diabetes to a cohort of general population subjects (matched by age)

BACKGROUND

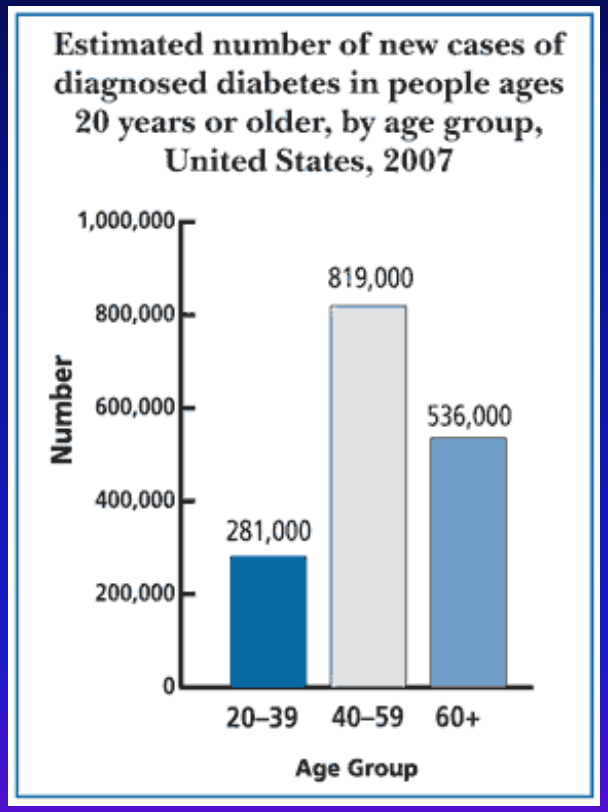
Diabetes: Prevalence

- **Prevalence of Diagnosed/Undiagnosed Diabetes in the United States, All Ages, 2007**
  - **23.6 million people—7.8 percent of the population—have diabetes.**
  - **Diagnosed:** 17.9 million people; **Undiagnosed:** 5.7 million people
    - **Age 20 years or older:** 23.5 million (10.7 %)
    - **Age 60 years or older:** 12.2 million (23.1%)

- **Data from the 2005 Indian Health Service (HIS) user population database indicate that**
  - **14.2 % of American Indians % Alaska Natives ages 20 years + receiving care from IHS had diabetes. After adjusting for population age differences,**
    - **16.5 percent of the total adult population served by IHS had diabetes**
      - **6 % among Alaska Native adults**
      - **29.3 % among American Indian adults in southern Arizona.**
- **After adjusting for population age differences, 2004 to 2006 national survey for ages 20 + indicate:**
  - **11.8 percent of non-Hispanic blacks had diagnosed diabetes.**
  - **10.4 percent of Hispanics,**
    - **Among Hispanics, rates were 8.2 percent for Cubans, 11.9 percent for Mexican Americans, and 12.6 percent for Puerto Ricans**
  - **7.5 percent of Asian Americans, and**
  - **6.6 percent of non-Hispanic whites,**
    - **http://www.diabetes.niddk.nih.gov/dm/pubs/statistics/#i_people**

BACKGROUND

Diabetes: Incidence



http://www.diabetes.niddk.nih.gov/dm/pubs/statistics/#i_people

BACKGROUND

Diabetic Somatic Neuropathies

- **Clinical classifications**
  - **Acute sensory and Chronic sensorimotor**
- **Stages of neuropathy**

•No neuropathy	•No symptoms or signs
•Chronic painful	•Burning, shooting, stabbing pains w/wo pins and needles; absent sensation to several modalities; reduced/absent reflexes
•Acute painful	•Above symptoms (severe)
•Painless with complete/ partial sensory loss	•Numbness, reduced/absent sensation, reduced thermal sensation, absent reflexes
•Late complications	Foot lesions and deformities; amputations

(Boulton et al., Diabetic somatic neuropathies, *Diabetic Care 27; 1458-1486, 2004)*

BACKGROUND

Diabetes and Neuropathy

- **Symptoms of sensory neuropathy affect**
  - **30% of persons with IDDM;**
  - **38% of persons in NIDDM; and**
  - **~ 10% of persons without diabetes** (Harris et al., *Diabetes Care 16: 1446-1452, 1993)*

- **Body Mass Index is associated with the incidence of neuropathy** (Tesfaye et al., New England Journal of Medicine 352: 342-350, 2005)

- **Compared to non-diabetic controls**
  - **subjects with diabetic neuropathy perform significantly worse on measures of walking speed, dynamic balance, and coordination** (Resnick et al., *Muscle Nerve 25: 43-50, 2002)*
  - **Women with diabetes, stratified by insulin use, are more likely to fall [OR 1.68 for NIDDM; OR 2.78 for NIDDM]** (Schwartz et al., *Diabetes Care 25: 1749-1754, 2002)*

- **Except for glycemic control, treatments for diabetic neuropathy are limited in their effectiveness** (Tesfaye et al., New England Journal of Medicine 352: 342-350 [p. 342], 2005)

BACKGROUND

Sensation

- Measures of mobility, strength, sensation and pain combined were robust predictors for identifying reduced activity and participation in persons with diabetes (Shaffer, S. Dissertation Abstract: 2007-99220-023)

- Older adults, compared to younger adults have significant plantar surface insensitivity, and advanced insensitivity in the seventh decade. Monofilaments may not be useful for detecting advanced sensitivity. (Perry, SD, *Somatosensory & Motor Research 20; 127-132, 2003)*

- Plantar tactile sensation, ankle flexibility, and toe plantarflexion strength were significant and independent predictors of balance and functional test performance in older adults. (Menz et al., *Journals of Gerontology, 60: 1546-1552, 2005).*

SUBJECT DEMOGRAPHICS

	Diabetes (n = 67)	General Population (n = 67)
Age in years, mean (SD)	75.9 (6.6)	75.5 (6.7)
% Female	61.2	55.2
% White	31.3	44.8
% ≥ HS Education	80.5	80.5
% income > $20,000/year	53.6	68.5

SELF-REPORTED HEALTH SPECIFICS

	Diabetes (n = 67)	General Population (n = 67)
% ≥ Good Health	68.6*	86.6
% Arthritis	58.2	52.6
% Neuropathy	28.4*	7.0
% Psoriasis, Eczema	7.5	10.5
% Hypertension	73.1	50.0
Weight in lbs., mean (SE)	203.6 (5.9)*	168.7 (6.5)

* $p < .05$

SENSATIONS THAT INTERFERED WITH EVERYDAY LIFE *LAST WEEK*

	Diabetes (n = 67)	General Population (n = 67)
% Prickling/ Stinging	10.4	5.3
% Burning	6.0	3.5
% Itching	10.4	7.0
% Aching	35.8	17.5

Toolbox measures

Wrist Position Sense clinical
Brief Kinesthesia Test
Stereognosis [3 ways]
Bottom of Foot Test
Self-Reported Pain Questionnaire

Toolbox measures

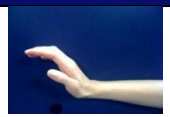
Testing Set-Up

Wrist Position Sense clinical
Stereognosis [3 ways]
Brief Kinesthesia Test

Bottom of Foot Test

Toolbox measures

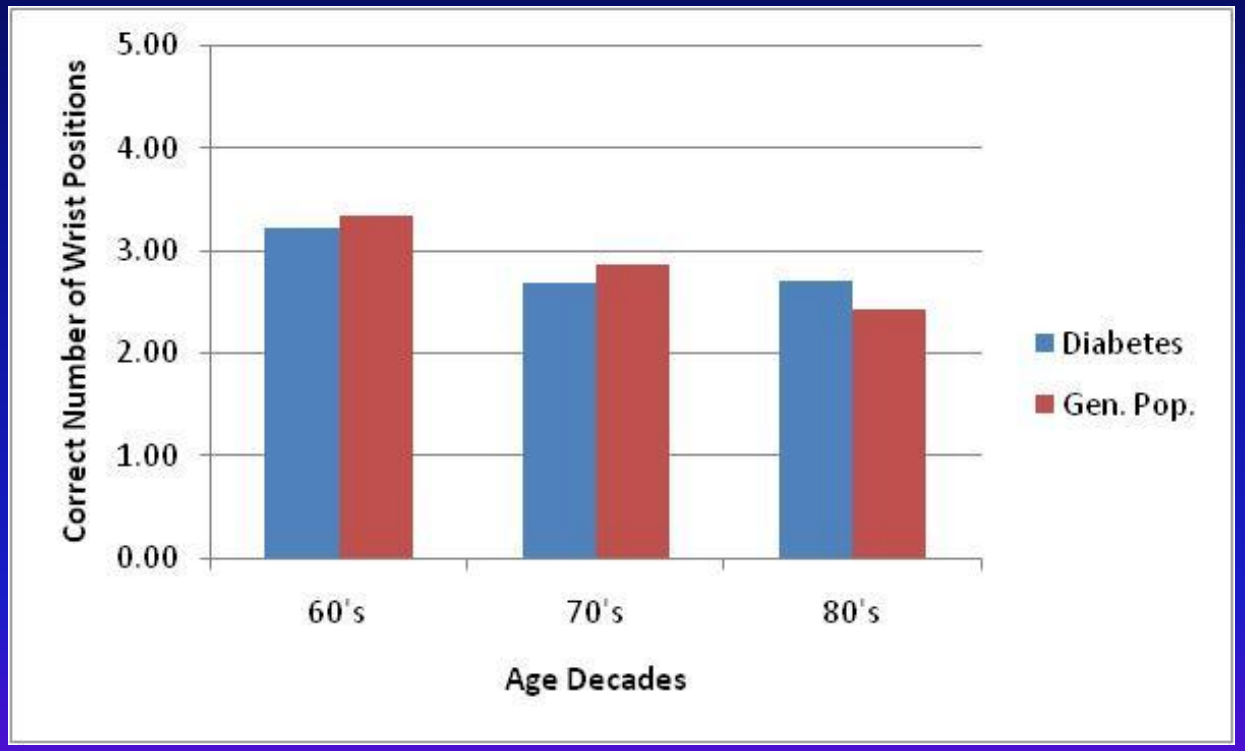
Wrist Position Sense Clinical

	Partial Extension "UP"	1	2	3	**4**	5
	Full Flexion "DOWN"	**1**	2	3	4	5
	Neutral "STRAIGHT"	1	2	**3**	4	5
	Full Extension "UP"	1	2	3	4	**5**
	Partial Flexion "DOWN"	1	**2**	3	4	5

*No significant difference between groups for accuracy of wrist positions

Toolbox measures

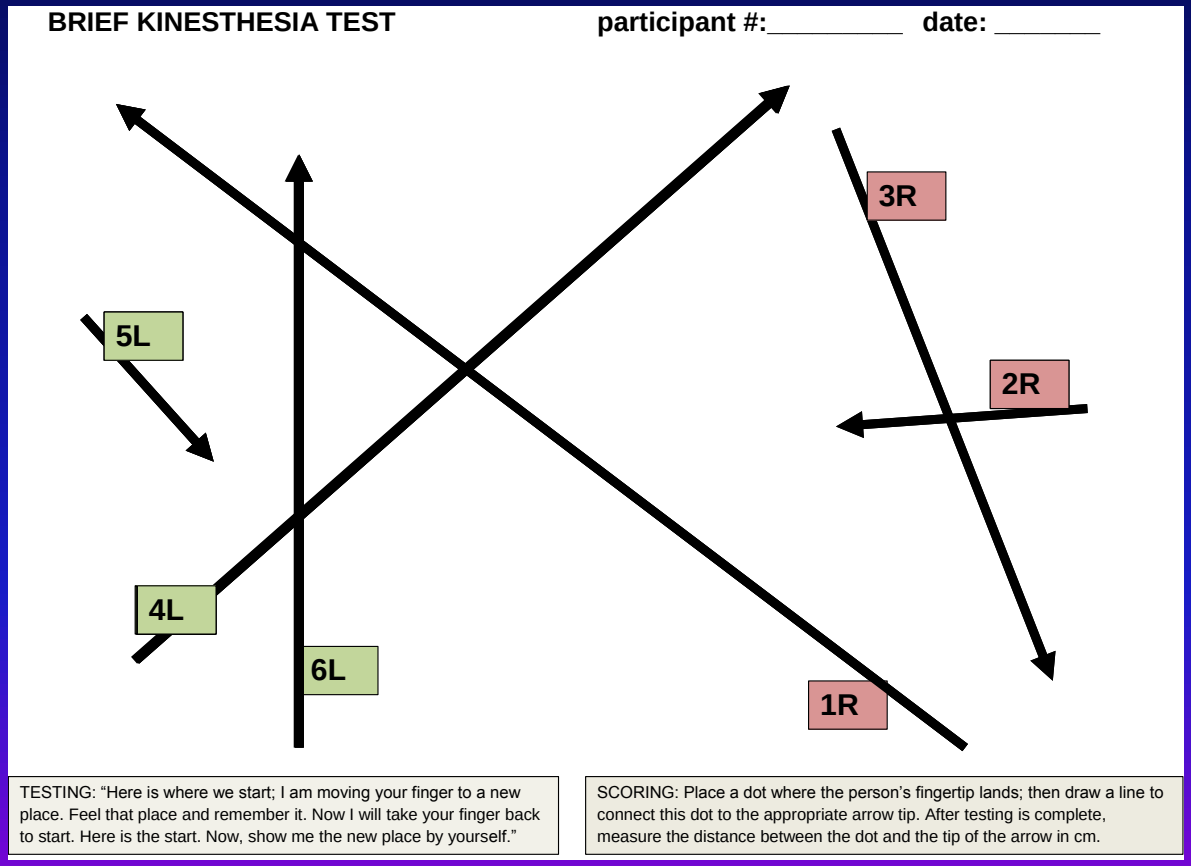
Wrist Position Sense Clinical



*No significant difference in wrist position accuracy between age decades

Toolbox measures

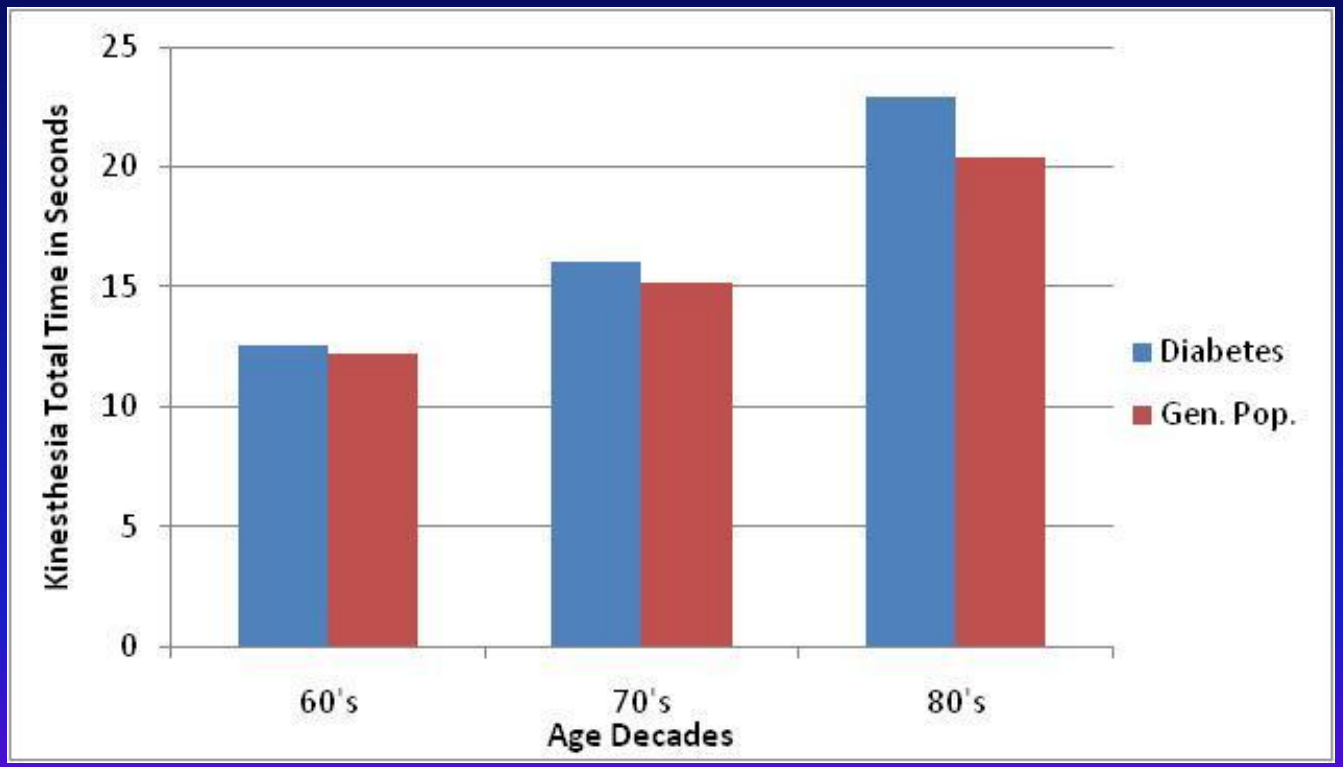
Brief Kinesthesia Test, by Groups



*No significant differences between the groups

Toolbox measures

Brief Kinesthesia Test, by Age Decades



60's and 70's = NS
60's and 80's = p <.001
70's and 80's = p <.001

Toolbox measures

Stereognosis [3 ways]

TOUCH INPUT and VISUAL OUTPUT

TOUCH INPUT and TOUCH OUTPUT

VISUAL INPUT and TOUCH OUTPUT

Toolbox measures

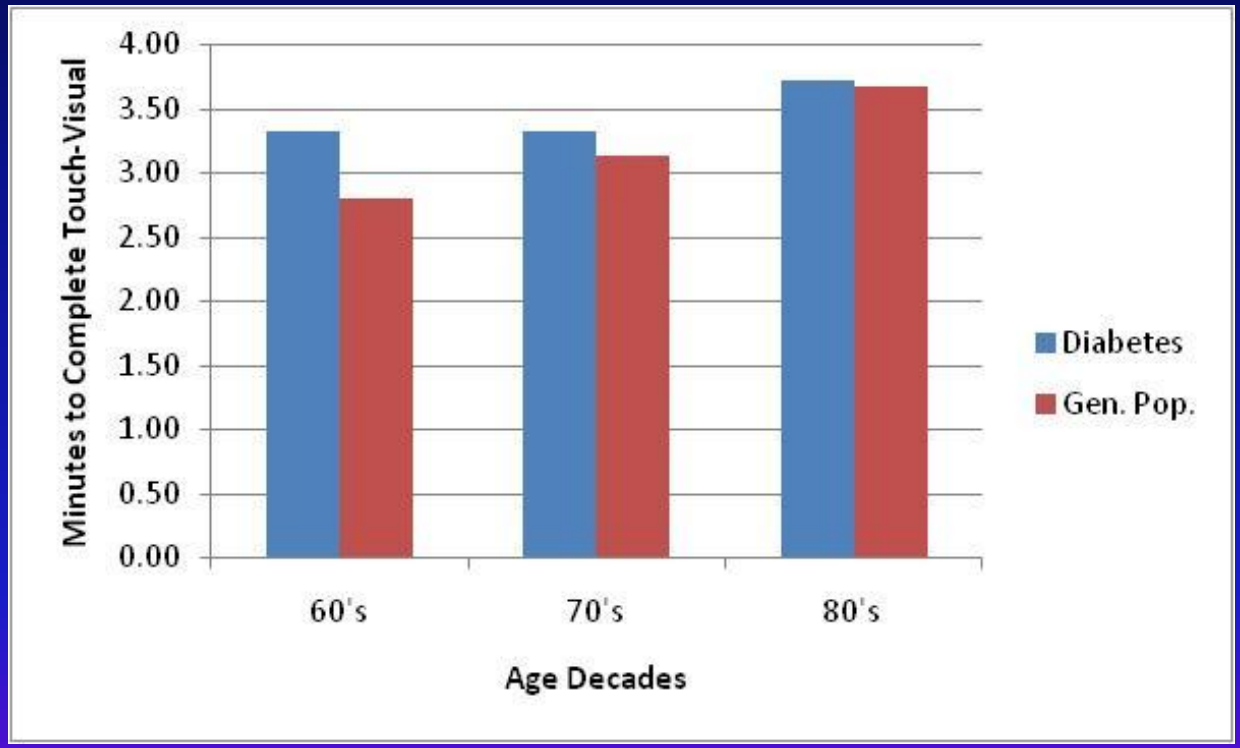
Stereognosis [TOUCH – VISUAL]

- **TOUCH INPUT**
- **VISUAL OUTPUT**

***No significant differences between the groups**

Toolbox measures

Stereognosis [Touch-Visual], by Age Decades

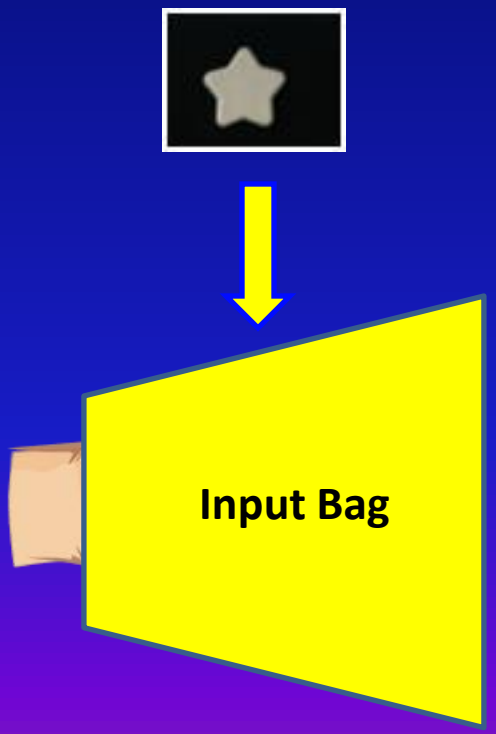


*No significant difference in touch – visual stereognosis between age decades

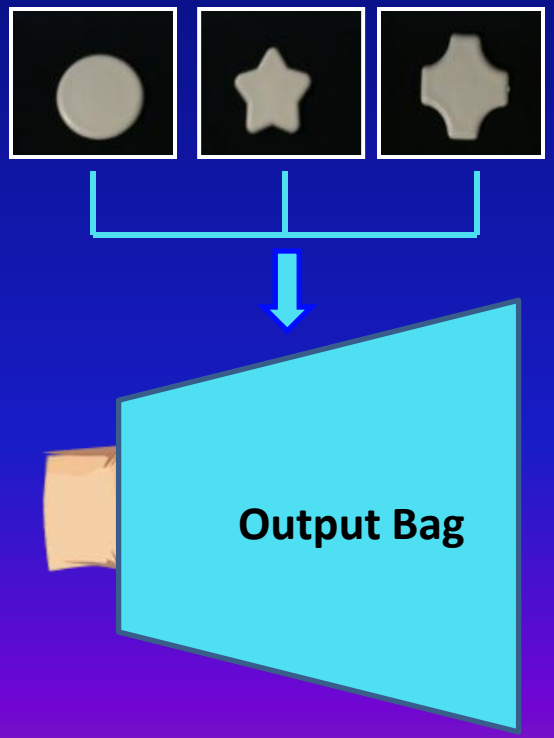
Toolbox measures

Stereognosis [TOUCH - TOUCH]

- TOUCH INPUT



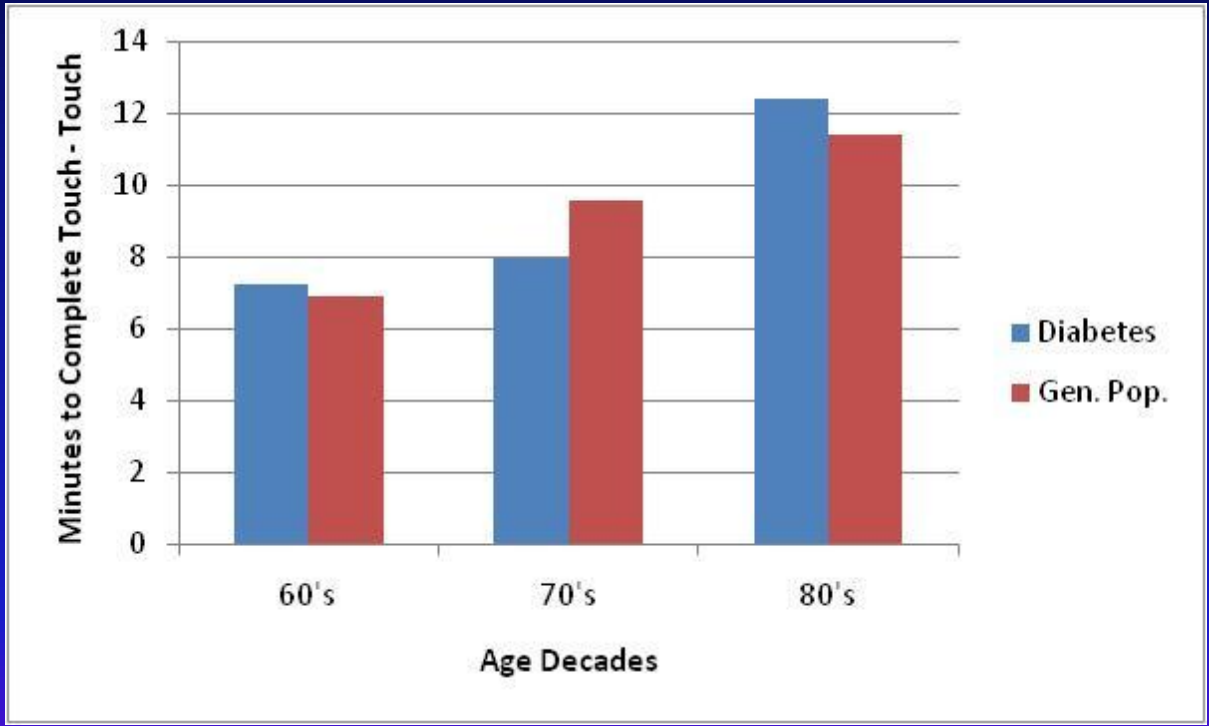
- TOUCH OUTPUT



*No significant differences between the groups

Toolbox measures

Stereognosis [Touch-Touch], by Age Decades



BY AGE DECADE

60's and 70's = NS

60's and 80's = p < .001

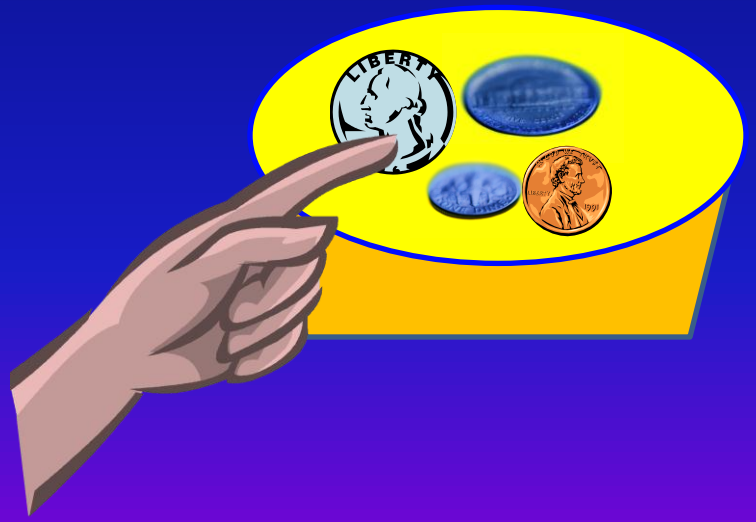
70's and 80's = NS

Toolbox measures

Stereognosis [VISUAL - TOUCH]

- VISUAL INPUT

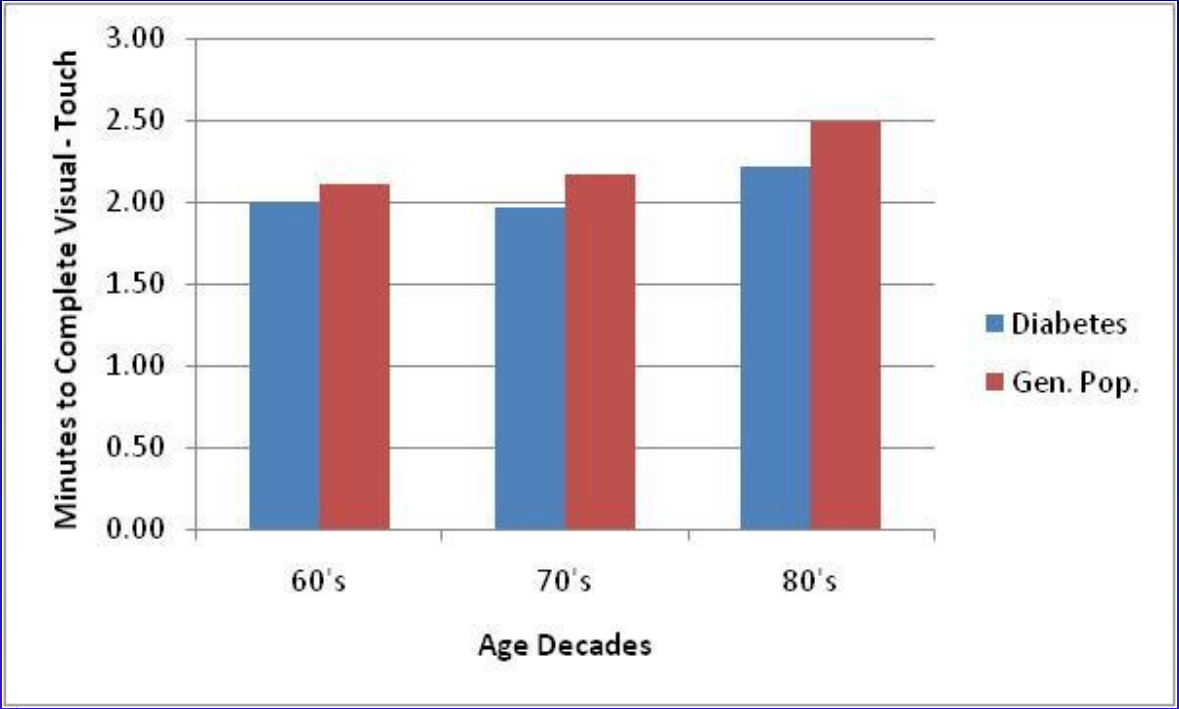
- TOUCH OUTPUT



*No significant differences between the groups

Toolbox measures

Stereognosis [Visual-Touch], by Age Decades



*No significant difference in visual - touch stereognosis between age decades

Toolbox measures

Bottom of Foot Test

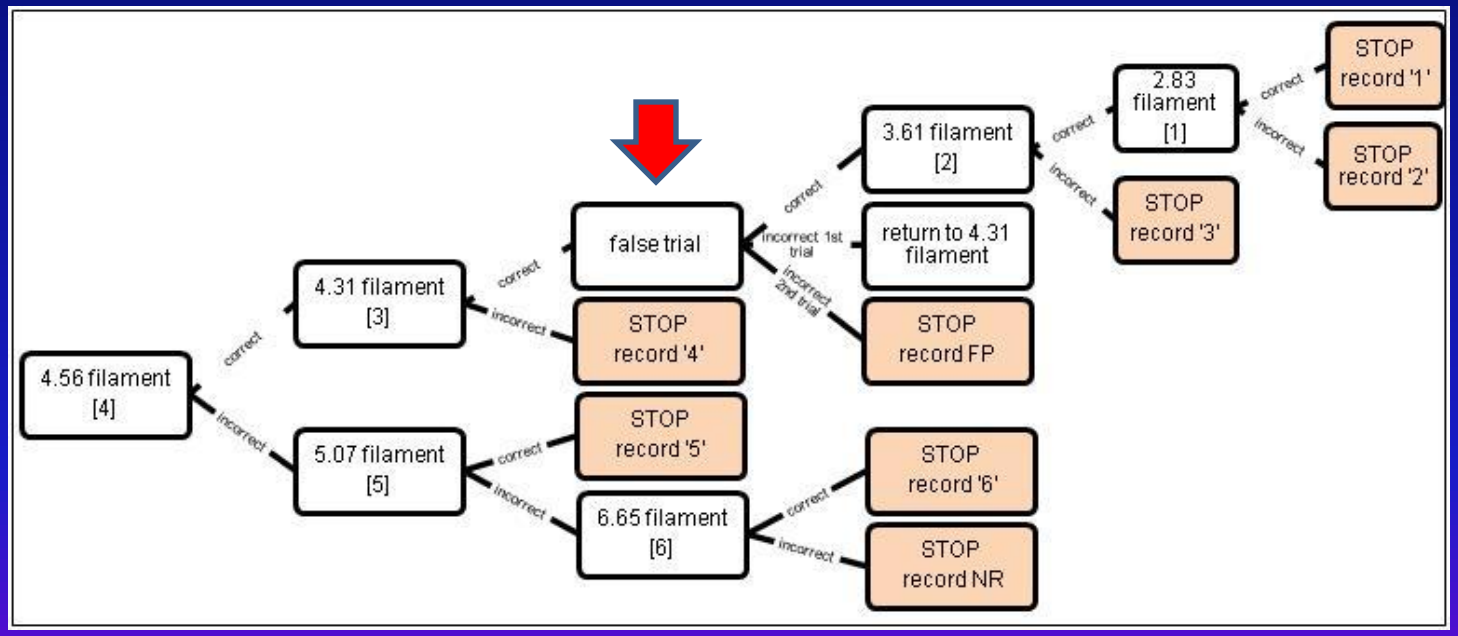
Big Toe

Little Toe

Arch

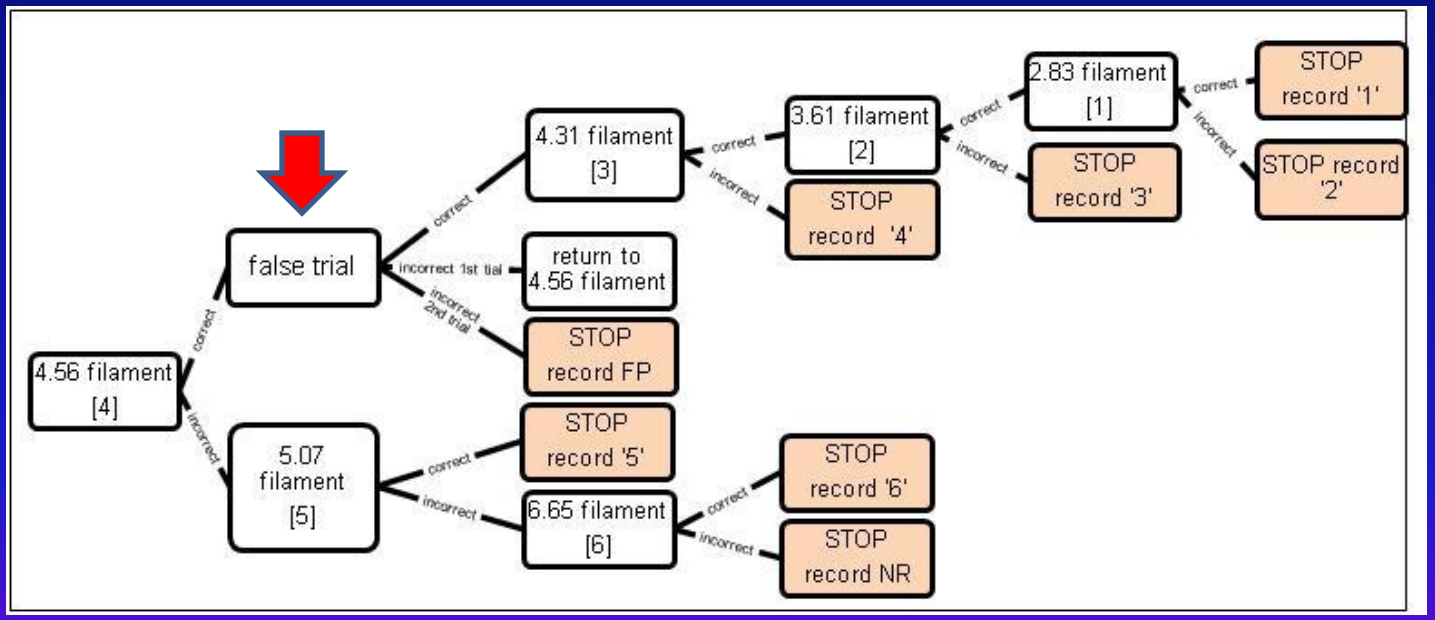
Toolbox measures

Bottom of Foot Test - Big Toe



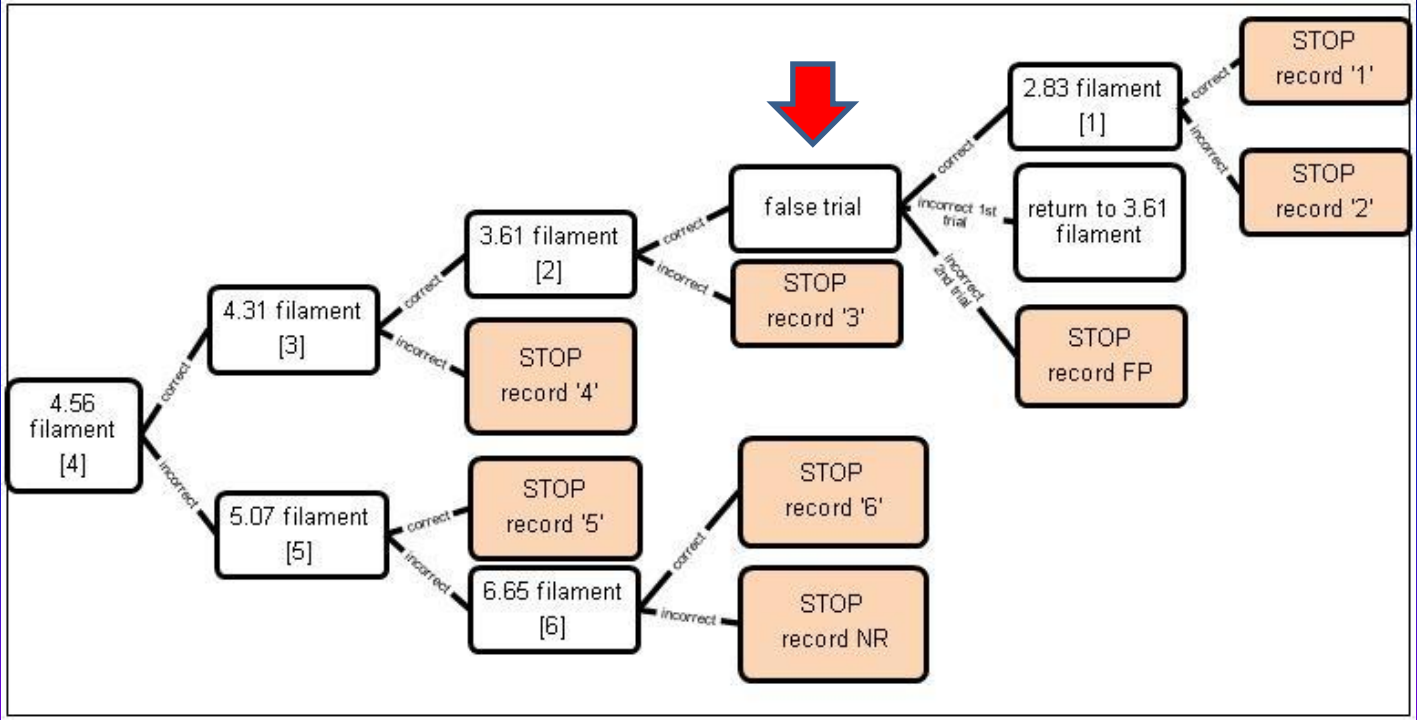
Toolbox measures

Bottom of Foot Test - Little Toe



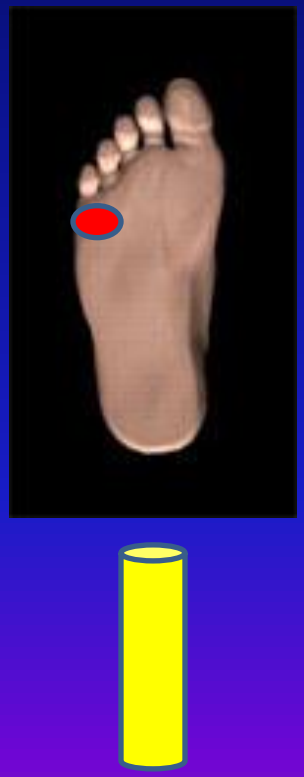
Toolbox measures

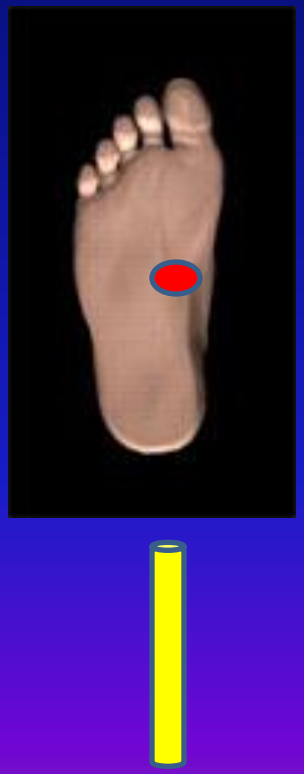
Bottom of Foot Test - Arch



Toolbox measures

Bottom of Foot Test





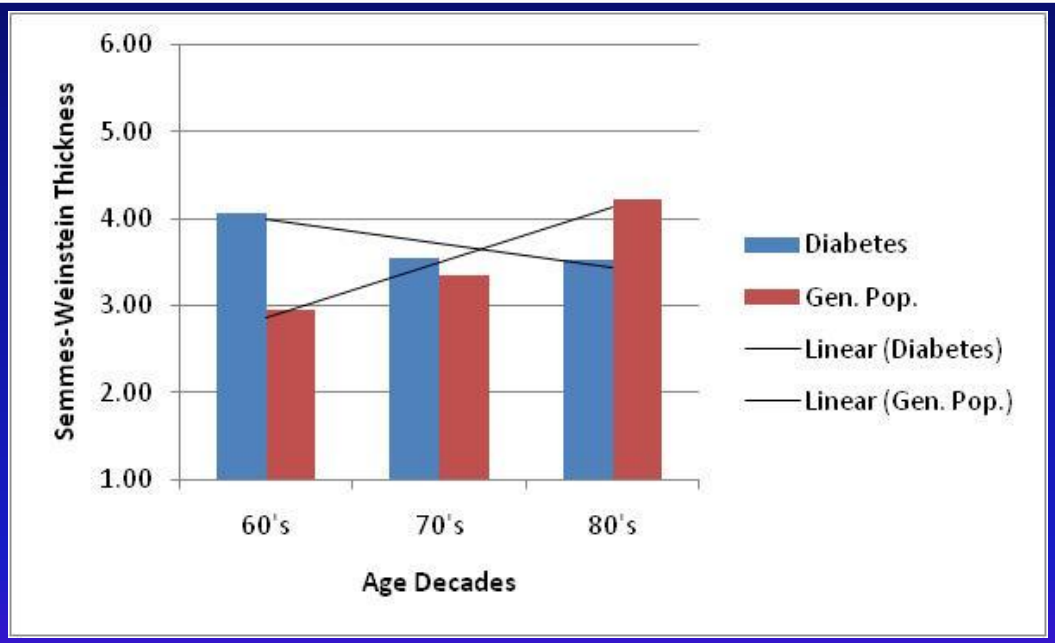
*No significant differences between the groups for any Semmes-Weinstein thickness

Toolbox measures

Mean Bottom of Foot Tests, by Group & Age

Thicker

Semmes-Weinstein
6 = 6.65
5 = 5.07
4 = 4.56
3 = 4.31
2 = 3.61
1 = 2.83



BY GROUP
60's = p < .02
70's = NS
80's = p < .05

BY AGE DECADE
60's and 70's = NS
60's and 80's = NS
70's and 80's = NS

Toolbox measures

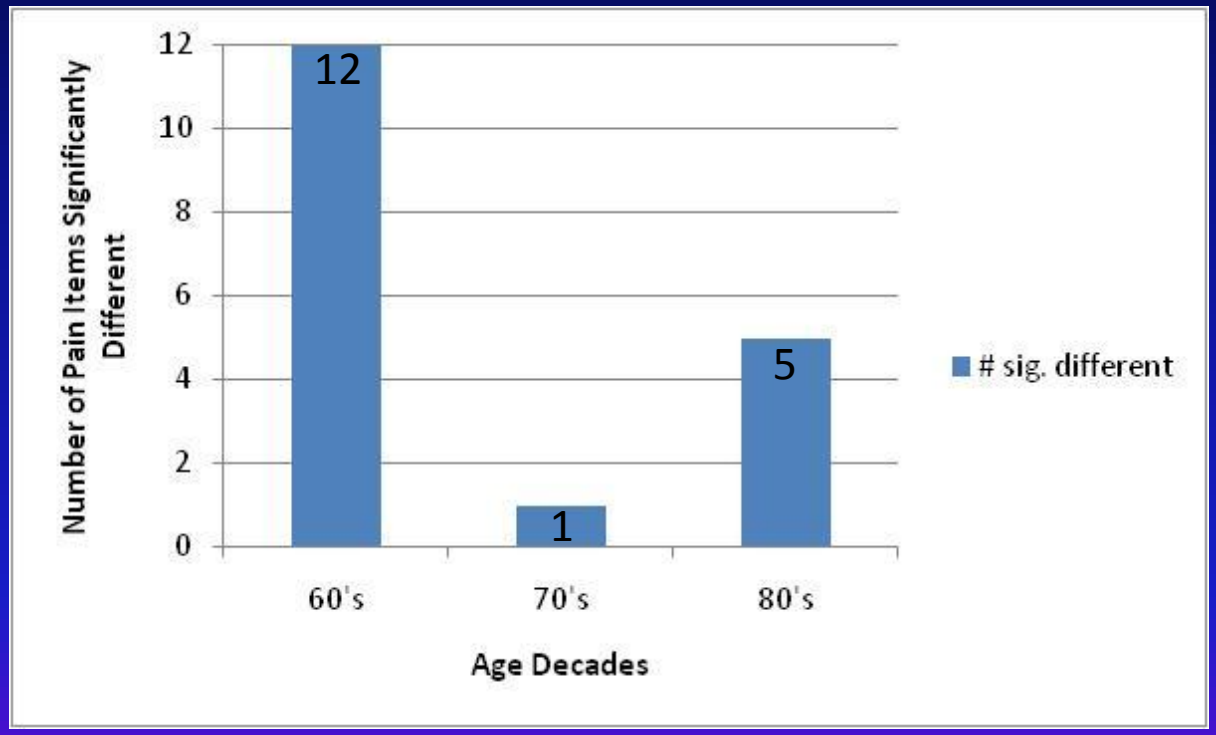
Self-Reported Pain

+ 11 questions on pain level and intensity

***No significant differences between the groups**

Toolbox measures

Self Reported Pain, by Age Decade



60's: Diabetic Group reported greater pain for all 12 items; all sig.
70's: Gen. Pop. Group reported greater pain for 11/12 items; 1 sig.
80's: Diabetic Group reported greater pain for all 12 items; 5 sig.

Toolbox measures

Wrist Position Sense clinical

Brief Kinesthesia Test

- Proprioception
  - Diabetic group of older adults was no different from the General Population group for matching "prepositioned" wrist angles accurately, and no difference by age decade
  - Diabetic group of older adults was no different from the General Population group when actively recreating proprioceptive "map" destinations. However, some age decade group differences were significant

Toolbox measures

Stereognosis [3 ways]

Bottom of Foot Test

- Tactile Sensation
  - Diabetic group of older adults was no different from the General Population group for matching Touch-Visual, Touch-Touch, or Visual-Touch measures accurately, but some age decade differences were significant when both hands were active.
  - Diabetic group of older adults was no different from the General Population group for plantar sensation. However, for the 60's and 80's there were within group differences …but no age decade differences were significant

Toolbox measures

Self-Reported Pain Questionnaire

- Pain sensation
  - Diabetic Group was no different from the General Population Group for reporting pain sensation. However, age decade differences were evident at each decade:
    - 60's: Diabetic Group experienced sig. greater pain
    - 70's: General Population group experienced greater pain
    - 80's: Diabetic Group experienced greater pain

Summary

- An age matched sample of older adult subjects with Diabetes and subjects from the General Population were compared on measures of sensation
- Although the Diabetic Group reported poorer health, obesity and neuropathy, no significant differences were found between the groups for any of the measures
- When age decade was considered, differences among 60, 70, and 80 year olds were found for the Brief Kinesthesia Test, Touch-Touch Stereognosis, the Bottom of Foot Test, and the Self-Reported Pain Questionnaire
- Somatosensation in the Diabetic population must be considered in relation to age for older adults

Toolbox measures

QUESTIONS?