

NIH Toolbox



Technical Manual

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NIH Toolbox Technical Manual

Domain:

MOTOR

Subdomain:

STRENGTH

Measure:

NIH Toolbox Grip Strength Test

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This Technical Manual contains the following informational sections:

Section 1: Introduction to NIH Toolbox

Section 2: Validation

Section 3: Norming

**Section 4: NIH Toolbox and the National Children's
Study (NCS)**

Section 5: Domain Definition

Section 6: Subdomain Definition

Section 7: Measure Description

**Section 8: Post-Validation/Post-Norming Changes to
the Measure**

Section 9: The Measure's Scoring Model

Section 10: Measure Norms

Section 1: Introduction to NIH Toolbox

NIH Toolbox is a multidimensional set of brief measures assessing cognitive, emotional, motor, and sensory function from ages 3-85. This suite of on-line and royalty-free measures can be administered to study participants 3 to 85 years of age in two hours or less, across diverse study designs and settings.

What is the NIH Toolbox?

The NIH Toolbox provides a standard set of royalty-free, brief, and comprehensive assessment tools that can be used by researchers and clinicians in a variety of settings, with a particular emphasis on measuring outcomes in longitudinal epidemiologic studies and prevention or intervention trials across the lifespan (ages 3-85). The battery ensures that assessment methods and results can be used for comparisons across existing and future studies and provides a “common currency” for the study of neurological research that promotes economies of scale and enhanced efficiency in measurement. The NIH Toolbox can be used to monitor neurological and behavioral function over time and measure key constructs across developmental stages. This facilitates the study of functional changes across the lifespan, including evaluating intervention and treatment effectiveness.

The NIH Toolbox Batteries

The basic NIH Toolbox can be administered within two hours and divides tests into four domain batteries: Cognition, Emotion, Motor, and Sensation. In addition, within some domains, there are supplemental measures that are available to be administered.

Selection of the NIH Toolbox Domains and Subdomains

Four domains were selected for the NIH Toolbox: Cognition, Emotion, Motor, and Sensation. Subdomain selection was based upon literature reviews, expert interviews, and multiple formal Requests for Information (RFI) of NIH-funded researchers. Initial literature and database reviews and an RFI identified the subdomains for inclusion in the NIH Toolbox, existing measures relevant to the project goals, and criteria for instrument selection. NIH Project Team members, external content experts, and contract scientists met at a follow-up consensus meeting to discuss potential subdomains along with the criteria affecting instrument selection, creation, and norming. Additional expert interviews were undertaken to gather more detailed information from clinical and scientific experts to help further refine the list of possible subdomains. A second consensus group meeting was held and results directed the decision for the final NIH Toolbox to assess four core domain areas (cognitive, emotional, motor, and sensory health and function).

Selection of Measures for the NIH Toolbox

More than 1,400 existing measures were identified and evaluated for potential inclusion in the NIH Toolbox. The selection criteria included a measure's applicability across the life span,

psychometric soundness, brevity, ease of use, applicability in diverse settings and with different groups, and lack of intellectual property constraints. There was also a preference for instruments that were already validated and normed for use with individuals between 3 and 85 years old. Results of the instrument selection process yielded draft development plans established for the NIH Toolbox measures.

Early Childhood Use

NIH Toolbox measure development focused special attention on assessing young children, to ensure that all tests given are developmentally appropriate for ages 3-7. A special team of early childhood assessment consultants was engaged to provide testing guidelines for the very young, to offer input on measure development, and to review all NIH Toolbox measures to ensure they fit the needs of young children. Advanced statistical methods were used to emphasize continuity of measurement, allowing Toolbox users to confidently conduct longitudinal measurement from age 3 through the life span while assessing the same domain constructs.

Section 2: Validation

Validation studies were conducted for all NIH Toolbox Motor domain measures, to assure that these important tools for research met rigorous psychometric standards. Studies were

conducted across the entire age range and were statistically compared against “gold standard” measures wherever available.

For specifics regarding Motor domain measure validation, see: Reuben et al., Motor Assessment Using the NIH Toolbox, *Neurology*, in press; Rine et al., Vestibular Function Assessment Using the NIH Toolbox, *Neurology*, in press. These manuscripts describe measure development studies undertaken (e.g., expert panels for content development and validation; cognitive interviews; small and large-scale pilot testing) and psychometric characteristics (e.g., internal consistency and test-retest reliability; convergent and divergent validity).

Section 3: Norming

NIH Toolbox conducted a large national standardization study in both English and Spanish languages to allow for normative comparisons on each assessment. A sample of 4,859 participants, ages 3-85 – representative of the U.S. population based on gender, ethnicity, race, and socioeconomic status – was administered all of the NIH Toolbox measures at sites around the country (n = 2,917 English-speaking children, ages 3-17; n = 496 Spanish-speaking children, ages 3-7; n = 1,038 English-speaking adults, ages 18-85; n = 408 Spanish-speaking adults, ages 18-85). NIH Toolbox normative scores are now available for each year of age from 3 through 17, as well as for age ranges 18-29, 30-39, 40-49, 50-59, 60-69, and 70-85, allowing for targeted and accurate comparisons to the U.S. population.

Specifics regarding NIH Toolbox norming sampling methods (e.g., stratification by age, gender, and language preference; sampling a minimum of 25-100 individuals per targeted demographic and language subgroup) and norming analytic methods (e.g., post-stratification adjustment using iterative proportional fitting, i.e., “raking”) can be found in the following publication: Beaumont et al., Norming Plans for the NIH Toolbox, *Neurology*, in press.

Section 4: NIH Toolbox and the National Children’s Study (NCS)

In collaboration with NIH Toolbox scientists, NCS investigators selected measures from PROMIS and NIH Toolbox for a Maternal Health Profile, the Maternal Self-Reported Health Battery. This profile assesses Physical Health (Physical function, Fatigue, Sleep disturbance, Sleep-related impairment), Mental Health (Anger, Anxiety, Depression, Positive affect, Perceived stress, Self-efficacy), and Social Health (Social support and companionship, Social isolation). The Maternal Self-Reported Health Battery was field tested in fall 2011, using an online sample of 1000 women (200 pre-conception, 150 pregnant women (50 per trimester), and 650 mothers with a child between 0-36 months of age). In addition, NIH Toolbox norming was jointly sponsored by the NCS and included: 3,413 children in single-year age bands (from 3-17 years); 1,446 adults in seven age bands, including the mothers of children also being tested; and 105 pregnant

women. The NIH Toolbox sampling plan matched distributions of race/ethnicity and level of education for each age band.

Section 5: Domain Definition

Domain: MOTOR

Motor function involves complex physiological processes and requires the integration of multiple systems, including neuromuscular, musculoskeletal, cardiopulmonary, and neural motor and sensory-perceptual systems. Motor functional status is indicative of current physical health status, burden of disease, and long-term health outcomes, and is integrally related to daily functioning and quality of life. Given its importance to overall neurological health and function, motor function was identified as a key domain for inclusion in the NIH Toolbox. The Motor domain includes measures of:

DEXTERITY

Measured by:

NIH Toolbox 9-Hole Pegboard Dexterity Test

STRENGTH

Measured by:

NIH Toolbox Grip Strength Test

BALANCE

Measured by:

NIH Toolbox Standing Balance Test

LOCOMOTION

Measured by:

NIH Toolbox 4-Meter Walk Gait Speed Test

ENDURANCE

Measured by:

NIH Toolbox 2-Minute Walk Endurance Test

MOTOR Batteries

The NIH Toolbox Motor Battery for ages 7-85 includes all five core measures described above.

For ages 3-6, the NIH Toolbox Early Childhood Motor Battery includes four core tests, while excluding the 4-Meter Walk Gait Speed Test. There are individual scores provided for each measure, as described below, but there are no composite scores provided for the Motor Battery.

Section 6: Subdomain Definition

Subdomain: STRENGTH

Strength refers to the capacity of a muscle to produce the tension necessary for maintaining posture, initiating movement, or controlling movement during conditions of load on the musculoskeletal system. More simply, muscle strength is the magnitude of force generated by an isolated muscle or a muscle group. This battery assesses only upper extremity strength. In NIH Toolbox, Strength is measured by:

NIH Toolbox Grip Strength Test

Section 7: Measure Description

MOTOR Core Measure

The NIH Toolbox Grip Strength Test is adapted from the grip strength testing protocol of the American Society of Hand Therapy. Participants are seated in a chair with their feet touching the ground. With the elbow bent to 90 degrees and the arm against the trunk, wrist at neutral, participants squeeze the Jamar Plus Digital dynamometer as hard as they can for a count of three. The dynamometer provides a digital reading of force in pounds. A practice trial at less than full force and one test trial are completed with each hand. The test takes approximately

three minutes to administer and is recommended for ages 3-85. Dominant vs. Non-Dominant Hand (i.e., “handedness”) is assessed at the outset of Toolbox testing.

Section 8: Post-Validation/Post-Norming Changes to the Measure

No notable Post-Validation/Post-Norming changes were made to the measure subsequent to those changes previously reported on during the measure’s development and validation phases (Reuben et al., Motor Assessment Using the NIH Toolbox, *Neurology*, in press).

Section 9: The Measure’s Scoring Model

Measurement theory applied for scoring:

Classical Test Theory (CTT)

CTT scoring approach employed:

Count (the number of pounds of force generated using the (a) dominant hand, (b) non-dominant hand

Measure length:

Fixed

Response data:

Continuous

Scores computed/available*:

Computed Score-Dominant Hand

Age-Adjusted Scale Score (dominant hand; mean=100, standard deviation=15)

Fully Adjusted Scale Score (dominant hand; mean=100, standard deviation=15)

Unadjusted Scale Score (dominant hand; mean=100, standard deviation=15)

National Percentile Rank (corresponds to the Age-Adjusted Scale Score)

Computed Score-Non-Dominant Hand

*Details on these scores and their interpretations are available in the NIH Toolbox Scoring and Interpretation Guide.

Section 10: Measure Norms

The following Tables and Figure present NIH Toolbox normative data associated with this measure:

- Table 1.** Measure Raw/Computed Score, Unadjusted Scale Score, and Fully Adjusted Scale Score Summary (N, Mean, Standard Deviation) by Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)
- Table 2.** Measure Raw/Computed Score Statistics (N, Mean, Standard Deviation, Minimum/Maximum Observed, 25th/50th/75th Percentile) per Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)
- Figure 1.** Measure Mean Unadjusted Scale Scores across All Age Groups (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85)

Table 1. NIH Toolbox Grip Strength Test by Age Group	Grip Strength Test (pounds)			Grip Strength Unadjusted Scale Score			Grip Strength Fully Adjusted Scale Score		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age Group									
3	184	9.36	2.46	184	74.23	3.68	168	97.25	7.30
4	229	12.24	2.98	229	78.08	3.54	214	96.96	7.01
5	208	16.88	3.16	208	82.86	2.60	187	97.07	7.95
6	212	21.56	3.62	212	86.08	2.63	193	97.23	7.74
7	241	25.44	3.67	241	88.44	2.41	222	97.07	8.14
8	201	28.86	4.31	201	90.42	2.30	197	97.47	8.16
9	209	34.72	4.86	209	93.39	2.43	199	97.34	7.41
10	223	38.46	5.04	223	95.10	2.77	212	97.23	7.98
11	215	45.34	6.00	215	98.52	2.84	205	96.93	8.85
12	210	51.83	6.91	210	101.58	3.27	202	97.14	9.16
13	214	61.54	8.59	214	106.17	4.00	206	97.23	8.82
14	229	67.99	9.77	229	108.96	5.06	221	97.53	8.08
15	213	74.17	11.65	213	111.82	5.10	207	97.56	8.74
16	208	78.79	12.82	208	113.82	5.52	198	97.63	8.19
17	216	84.32	14.35	216	116.07	6.12	208	97.73	8.99
18 - 29	253	84.90	50.90	253	116.28	21.86	244	97.67	28.97
30 - 39	296	79.57	40.50	296	114.07	17.45	282	97.56	23.06
40 - 49	234	83.90	47.33	234	115.92	20.20	222	97.80	28.29
50 - 59	182	79.61	48.50	182	113.95	21.06	168	97.68	28.30
60 - 69	158	69.78	41.31	158	109.66	18.39	148	97.51	22.76
70 - 85	236	59.65	27.45	236	105.16	12.83	207	97.69	16.61
All	4571	70.97	31.00	4571	109.85	14.29	4310	97.58	15.24

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 3		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	50	44	94	47	43	90	97	87	184
	Mean	10.45	9.14	9.95	7.41	7.54	7.46	9.72	8.78	9.36
	Standard Deviation	3.49	1.68	2.81	1.29	2.34	1.86	2.76	2.05	2.46
	Minimum Observed	3.50	4.40	3.50	1.50	1.00	1.00	1.50	1.00	1.00
	25th Percentile	6.60	7.00	6.80	5.40	4.30	5.00	6.00	6.80	6.10
	50th Percentile (Median)	10.70	9.00	9.30	7.00	6.50	7.00	8.60	8.70	8.70
	75th Percentile	13.50	10.60	12.70	8.70	9.10	9.10	12.80	10.10	12.20
	Maximum Observed	23.80	15.00	23.80	14.40	51.10	51.10	23.80	51.10	51.10

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 4		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	62	62	124	48	57	105	110	119	229
	Mean	13.41	11.23	12.52	11.93	9.78	10.98	13.15	10.94	12.24
	Standard Deviation	3.43	2.61	3.11	3.92	1.15	2.79	3.65	2.05	2.98
	Minimum Observed	0.20	3.10	0.20	2.30	1.30	1.30	0.20	1.30	0.20
	25th Percentile	9.80	7.90	9.10	7.60	7.80	7.60	9.60	7.80	8.90
	50th Percentile (Median)	13.00	11.50	12.00	10.50	9.30	9.80	12.40	10.50	11.60
	75th Percentile	16.60	14.20	15.90	13.60	12.20	12.90	16.50	13.90	15.60
	Maximum Observed	26.60	20.80	26.60	80.00	18.50	80.00	80.00	20.80	80.00

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 5		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	61	62	123	40	45	85	101	107	208
	Mean	17.59	17.09	17.39	14.15	14.67	14.38	17.03	16.65	16.88
	Standard Deviation	4.15	3.37	3.77	2.18	1.25	1.74	3.58	2.72	3.16
	Minimum Observed	6.50	8.60	6.50	4.70	5.70	4.70	4.70	5.70	4.70
	25th Percentile	13.90	12.20	13.20	10.00	12.40	10.70	13.10	12.40	13.10
	50th Percentile (Median)	16.90	17.60	17.10	13.30	14.80	13.90	16.80	16.30	16.80
	75th Percentile	20.20	20.90	20.40	18.70	17.10	17.50	20.10	20.00	20.10
	Maximum Observed	35.60	31.70	35.60	25.90	25.30	25.90	35.60	31.70	35.60

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 6		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	59	59	118	42	52	94	101	111	212
	Mean	23.03	21.74	22.51	18.71	16.40	17.68	22.23	20.60	21.56
	Standard Deviation	4.76	3.78	4.30	1.99	1.94	1.99	3.98	3.23	3.62
	Minimum Observed	8.50	4.50	4.50	5.80	6.80	5.80	5.80	4.50	4.50
	25th Percentile	17.00	18.30	17.70	16.00	11.90	15.20	16.40	16.50	16.40
	50th Percentile (Median)	24.20	21.30	23.00	17.60	16.10	17.10	23.20	20.70	21.80
	75th Percentile	28.10	25.30	26.70	22.70	20.60	21.50	27.00	24.60	25.50
	Maximum Observed	41.00	37.60	41.00	30.30	30.90	30.90	41.00	37.60	41.00

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 7		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	79	75	154	44	43	87	123	118	241
	Mean	25.18	27.49	26.05	22.62	20.67	21.86	24.82	26.48	25.44
	Standard Deviation	4.32	3.46	3.97	3.08	2.53	2.82	3.94	3.33	3.67
	Minimum Observed	5.30	16.10	5.30	6.20	4.10	4.10	5.30	4.10	4.10
	25th Percentile	21.80	22.30	21.80	15.30	16.10	16.10	21.30	21.40	21.40
	50th Percentile (Median)	25.10	26.20	25.40	23.00	21.00	22.80	25.10	25.80	25.10
	75th Percentile	28.50	32.90	30.30	28.90	26.10	28.10	28.50	32.60	30.00
	Maximum Observed	42.30	43.60	43.60	44.20	39.20	44.20	44.20	43.60	44.20

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 8		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	105	96	201	0	0	0	105	96	201
	Mean	29.46	27.92	28.86				29.46	27.92	28.86
	Standard Deviation	4.79	3.69	4.31				4.79	3.69	4.31
	Minimum Observed	9.90	15.20	9.90				9.90	15.20	9.90
	25th Percentile	24.10	22.50	23.30				24.10	22.50	23.30
	50th Percentile (Median)	29.20	27.60	28.80				29.20	27.60	28.80
	75th Percentile	35.20	32.50	33.50				35.20	32.50	33.50
	Maximum Observed	48.00	46.40	48.00				48.00	46.40	48.00

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 9		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	106	103	209	0	0	0	106	103	209
	Mean	36.14	32.47	34.72				36.14	32.47	34.72
	Standard Deviation	5.41	4.00	4.86				5.41	4.00	4.86
	Minimum Observed	16.40	9.60	9.60				16.40	9.60	9.60
	25th Percentile	30.20	26.70	28.40				30.20	26.70	28.40
	50th Percentile (Median)	35.40	32.80	34.30				35.40	32.80	34.30
	75th Percentile	43.10	37.10	41.00				43.10	37.10	41.00
	Maximum Observed	59.60	58.10	59.60				59.60	58.10	59.60

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 10		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	112	111	223	0	0	0	112	111	223
	Mean	39.15	37.38	38.46				39.15	37.38	38.46
	Standard Deviation	5.67	4.29	5.04				5.67	4.29	5.04
	Minimum Observed	3.20	8.70	3.20				3.20	8.70	3.20
	25th Percentile	34.50	31.50	33.30				34.50	31.50	33.30
	50th Percentile (Median)	39.00	36.60	38.40				39.00	36.60	38.40
	75th Percentile	43.90	43.00	43.60				43.90	43.00	43.60
	Maximum Observed	63.20	57.50	63.20				63.20	57.50	63.20

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 11		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	108	107	215	0	0	0	108	107	215
	Mean	45.65	44.89	45.34				45.65	44.89	45.34
	Standard Deviation	6.75	5.17	6.00				6.75	5.17	6.00
	Minimum Observed	23.30	15.70	15.70				23.30	15.70	15.70
	25th Percentile	38.70	39.20	38.70				38.70	39.20	38.70
	50th Percentile (Median)	44.10	44.10	44.10				44.10	44.10	44.10
	75th Percentile	51.60	50.00	50.90				51.60	50.00	50.90
	Maximum Observed	107.90	80.10	107.90				107.90	80.10	107.90

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 12		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	98	112	210	0	0	0	98	112	210
	Mean	52.39	51.09	51.83				52.39	51.09	51.83
	Standard Deviation	8.43	5.24	6.91				8.43	5.24	6.91
	Minimum Observed	12.90	23.70	12.90				12.90	23.70	12.90
	25th Percentile	42.60	44.80	43.40				42.60	44.80	43.40
	50th Percentile (Median)	51.50	51.40	51.50				51.50	51.40	51.50
	75th Percentile	60.40	58.60	59.80				60.40	58.60	59.80
	Maximum Observed	109.10	79.90	109.10				109.10	79.90	109.10

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 13		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	115	99	214	0	0	0	115	99	214
	Mean	64.60	55.64	61.54				64.60	55.64	61.54
	Standard Deviation	10.15	5.35	8.59				10.15	5.35	8.59
	Minimum Observed	25.30	31.00	25.30				25.30	31.00	25.30
	25th Percentile	50.30	49.20	49.50				50.30	49.20	49.50
	50th Percentile (Median)	63.80	55.80	59.40				63.80	55.80	59.40
	75th Percentile	77.00	63.00	70.90				77.00	63.00	70.90
	Maximum Observed	107.30	89.10	107.30				107.30	89.10	107.30

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 14		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	109	120	229	0	0	0	109	120	229
	Mean	74.27	59.21	67.99				74.27	59.21	67.99
	Standard Deviation	11.12	6.33	9.77				11.12	6.33	9.77
	Minimum Observed	0.10	25.00	0.10				0.10	25.00	0.10
	25th Percentile	63.40	49.90	54.90				63.40	49.90	54.90
	50th Percentile (Median)	73.30	58.90	67.20				73.30	58.90	67.20
	75th Percentile	86.60	69.40	80.10				86.60	69.40	80.10
	Maximum Observed	113.50	94.20	113.50				113.50	94.20	113.50

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 15		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	105	108	213	0	0	0	105	108	213
	Mean	83.32	61.71	74.17				83.32	61.71	74.17
	Standard Deviation	12.78	6.03	11.65				12.78	6.03	11.65
	Minimum Observed	26.00	23.30	23.30				26.00	23.30	23.30
	25th Percentile	66.70	55.30	59.30				66.70	55.30	59.30
	50th Percentile (Median)	84.30	61.20	70.50				84.30	61.20	70.50
	75th Percentile	93.50	69.40	86.20				93.50	69.40	86.20
	Maximum Observed	132.80	94.70	132.80				132.80	94.70	132.80

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 16		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	101	107	208	0	0	0	101	107	208
	Mean	91.05	62.10	78.79				91.05	62.10	78.79
	Standard Deviation	12.35	6.54	12.82				12.35	6.54	12.82
	Minimum Observed	41.50	25.50	25.50				41.50	25.50	25.50
	25th Percentile	77.40	55.10	63.20				77.40	55.10	63.20
	50th Percentile (Median)	87.60	62.30	76.20				87.60	62.30	76.20
	75th Percentile	104.90	69.50	89.80				104.90	69.50	89.80
	Maximum Observed	140.60	90.70	140.60				140.60	90.70	140.60

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 17		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	107	109	216	0	0	0	107	109	216
	Mean	97.57	62.45	84.32				97.57	62.45	84.32
	Standard Deviation	13.72	6.22	14.35				13.72	6.22	14.35
	Minimum Observed	27.80	34.00	27.80				27.80	34.00	27.80
	25th Percentile	85.30	54.70	64.10				85.30	54.70	64.10
	50th Percentile (Median)	98.00	62.90	84.20				98.00	62.90	84.20
	75th Percentile	110.10	71.10	101.90				110.10	71.10	101.90
	Maximum Observed	145.70	100.70	145.70				145.70	100.70	145.70

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 18-29		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	56	103	159	22	72	94	78	175	253
	Mean	109.88	67.39	87.51	92.35	58.88	69.77	108.02	65.85	84.90
	Standard Deviation	55.05	29.78	59.73	24.70	14.96	24.89	49.67	25.26	50.90
	Minimum Observed	58.60	27.80	27.80	53.30	21.00	21.00	53.30	21.00	21.00
	25th Percentile	95.90	55.60	64.40	79.10	48.60	56.80	95.00	55.00	63.00
	50th Percentile (Median)	108.90	65.60	85.40	91.20	61.90	65.20	108.60	65.10	80.10
	75th Percentile	125.60	77.40	108.60	110.10	66.90	82.80	121.80	75.80	106.80
	Maximum Observed	168.60	106.80	168.60	130.90	92.30	130.90	168.60	106.80	168.60

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 30-39		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	53	148	201	21	74	95	74	222	296
	Mean	111.25	65.19	80.98	89.99	60.05	69.47	108.83	64.54	79.57
	Standard Deviation	43.25	22.05	46.63	29.26	10.45	20.66	41.25	19.11	40.50
	Minimum Observed	46.20	34.20	34.20	25.10	25.00	25.00	25.10	25.00	25.00
	25th Percentile	93.30	54.10	63.30	70.80	52.70	54.90	89.20	53.90	61.50
	50th Percentile (Median)	112.40	68.20	74.50	92.90	61.80	66.90	112.00	67.00	73.00
	75th Percentile	126.40	74.70	95.40	113.00	69.10	76.70	124.80	74.00	93.30
	Maximum Observed	153.30	95.40	153.30	126.40	87.50	126.40	153.30	95.40	153.30

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 40-49		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	60	106	166	27	41	68	87	147	234
	Mean	108.56	66.29	85.15	85.46	61.48	73.47	105.81	65.82	83.90
	Standard Deviation	51.95	24.35	53.98	24.44	13.05	22.03	47.18	21.87	47.33
	Minimum Observed	48.60	24.00	24.00	39.80	26.20	26.20	39.80	24.00	24.00
	25th Percentile	88.00	58.30	65.70	74.90	53.00	58.60	87.20	57.10	64.70
	50th Percentile (Median)	108.50	66.60	79.00	89.10	60.10	72.20	105.30	66.60	78.30
	75th Percentile	124.80	76.00	103.30	98.00	71.80	89.10	123.70	75.90	99.10
	Maximum Observed	160.70	99.60	160.70	123.90	84.90	123.90	160.70	99.60	160.70

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 50-59		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	54	77	131	25	26	51	79	103	182
	Mean	97.56	61.25	80.98	79.01	50.52	67.73	95.45	60.27	79.61
	Standard Deviation	49.24	25.13	53.02	37.16	12.28	31.58	47.22	23.12	48.50
	Minimum Observed	51.30	32.80	32.80	6.90	23.20	6.90	6.90	23.20	6.90
	25th Percentile	85.00	51.20	61.80	71.50	42.10	47.80	79.00	50.60	60.80
	50th Percentile (Median)	97.60	61.80	76.90	79.80	51.00	65.30	97.00	60.80	75.60
	75th Percentile	115.90	69.00	100.80	99.70	60.40	89.30	114.00	67.30	98.70
	Maximum Observed	138.20	102.50	138.20	135.70	71.60	135.70	138.20	102.50	138.20

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 60-69		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	46	70	116	18	24	42	64	94	158
	Mean	89.01	53.34	71.31	62.72	41.88	53.20	86.64	52.44	69.78
	Standard Deviation	37.88	20.74	44.86	29.75	15.11	24.48	38.45	19.98	41.31
	Minimum Observed	52.50	32.90	32.90	30.30	10.00	10.00	30.30	10.00	10.00
	25th Percentile	76.60	45.00	52.40	41.20	31.10	36.40	74.40	45.00	50.10
	50th Percentile (Median)	91.10	52.40	68.20	52.70	42.30	49.00	90.20	51.60	66.60
	75th Percentile	100.70	61.80	92.90	73.90	52.10	67.30	100.70	61.60	91.10
	Maximum Observed	124.80	75.90	124.80	118.80	77.30	118.80	124.80	77.30	124.80

Table 2. NIH Toolbox Grip Strength Test (pounds) – Age 70-85		English			Spanish			Total		All
		Males	Females	Total	Males	Females	Total	Males	Females	
	N	94	101	195	21	20	41	115	121	236
	Mean	71.20	45.50	60.44	48.46	37.73	44.15	70.07	45.14	59.65
	Standard Deviation	31.58	12.86	29.24	15.77	8.18	12.98	30.06	12.32	27.45
	Minimum Observed	19.80	26.30	19.80	8.90	4.70	4.70	8.90	4.70	4.70
	25th Percentile	61.40	37.30	42.90	30.10	30.90	30.90	60.10	37.00	42.40
	50th Percentile (Median)	73.10	44.20	57.60	47.20	40.10	42.00	73.00	44.10	56.40
	75th Percentile	84.20	51.70	76.60	64.70	48.10	56.00	84.20	51.60	76.00
	Maximum Observed	136.00	82.80	136.00	80.20	53.80	80.20	136.00	82.80	136.00

Table 2. NIH Toolbox Grip Strength Test (pounds) – NCS Sample of Mothers		English	Spanish	All
	N	73	34	107
	Mean	68.99	61.08	66.48
	Standard Deviation	14.96	11.89	14.48
	Minimum Observed	33.80	31.10	31.10
	25th Percentile	59.20	53.90	57.00
	50th Percentile (Median)	70.00	62.60	67.60
	75th Percentile	79.60	69.00	76.00
	Maximum Observed	99.60	84.20	99.60

Table 2. NIH Toolbox Grip Strength Test (pounds) – NCS Sample of Pregnant Women		English	Spanish	All
	N	81	44	125
	Mean	64.40	57.56	61.99
	Standard Deviation	15.96	16.01	16.25
	Minimum Observed	28.40	21.00	21.00
	25th Percentile	53.30	48.05	51.20
	50th Percentile (Median)	66.80	60.80	63.80
	75th Percentile	74.60	67.05	72.60
	Maximum Observed	99.10	92.30	99.10

Figure 1
Least Squares Means

