Associations among age-related rates of change in physical function:

A coordinated analysis

(author list not ordered)

Scott M. Hofer

Annie G. Robitaille

Cassandra L. Brown

Graciela Muniz

Andrey V. Koval

Andrea M. Piccinin

University of Victoria

Sean Clouston

Stony Brook School of Medicine

Andrea Zammit

Albert Einstein College of Medicine

Philipp Handschuh

Ulm University

Chenkai Wu

Oregon State University

Valerie Jarry

Université de Sherbrooke

Deborah Finkel

Indiana University Southeast

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Abstract

Declines in physical function are a well-documented feature of later life that can lead to mobility limitations, falls and death. Evidence from longitudinal studies suggests that… (mention rates of change for individual functions?) Xue et al., 2010). Cross-sectional evidence, while confounded with generational differences, suggests …(mention range of age diffs?) (xxx Laukkanen, Heikkinen, Kauppinen, 1995; .

Associations among the changes in different physical functions may exist, and may stem from common indexing of general functional decline or from a xxx’ing and possibly reciprocal cascade of decline in which one leads to another. For example, general XXX (atrophy and disuse) associated with biopsychosocial aspects of the aging process may result in general loss of physical function. alternatively, or concurrently, loss in one function may lead to loss in another, such as declining pulmonary function may limit walking speed, which may in turn contribute to loss of pulmonary and cardiac fitness.

Based on the cross-sectional evidence, it seems that upper body strength (e.g., grip strength), lower body strength (e.g., walking speed), and pulmonary function are associated (Cook et al., 1995; Hirsch et al., 1997; Pegorari, Ruas & Patrizzi, 2013). In particular, walking speed and pulmonary function may have a functional association (need to identify and summarize what is out there; [there is a 2013 paper on Nigerian amateur boxers…!]), although grip strength cut points have also been developed to predict risk of mobility limitation (Sallinen et al, 2010). Cross-sectional data and analysis, however, represent expected differences among individuals of different ages at a particular point in time.

Given the risk that these cross-sectional findings may be driven by generational changes (Schaie…) or mean trends (Hofer, Berg & Era, 2003), it is important to validate them, where possible, in longitudinal data. This will address the question of whether it is likely that particular individuals who experience decline in a particular physical function are likely to more or less concurrently experience decline in other physical functions.

The current research simultaneously evaluates cross-sectional, longitudinal, and patterning of associations in the same individuals, and repeats these evaluations in eight-nine longitudinal datasets.

…Timed-up-and-go, which involves both upper and lower body strength, would be expected to correlate more highly with Grip than would walking speed alone, due to the construct overlap.

Methods

Samples.

(couple of sentences and a reference for each study, then point to table for characteristics to compare)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Baseline age range | Number of occasions | Inter-occasion intervals (year) | Sampling | ? |
| Einstein Aging Study |  | 7 | 1 |  |  |
| English Longitudinal Study of Aging |  | 3 |  |  |  |
| Health and Retirement Study |  | 3 (2004,06,10) | 2,4 |  |  |
| ILSE |  | 3 |  |  |  |
| Longitudinal Aging Study Amsterdam |  | 4-5 |  |  |  |
| Memory and Aging Project |  | 5 | 1 |  |  |
| Nutrition and Aging |  |  |  |  |  |
| Octogenarian Twins | 80-9x | 5 | 2 |  |  |
|  |  |  |  |  |  |
| Swedish \_\_ Twin Study of Aging |  |  |  |  |  |

Measures.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Upper body (Grip) strength | Pulmonary function | Lower body strength |
| Einstein Aging Study | Maximum of three dominant hand trials, grip dynamometer | Maximum of three trials, grip dynamometer | Walk 12 ft at usual pace on GAITRite walkway; two trials; average cm/s |
| English Longitudinal Study of Aging | Three trials at waves 2,4,6. | Maximum of three trials, Vitalograph Micro Spirometer (l in first s (FEV1); waves 2,4,6 | Walk 8 ft at usual pace; Average of two trials;  Walking aids permitted; Waves 1-6; (m/s) |
| Health and Retirement Study | Two trials for each hand, Smedley spring-type hand dynamometer (kg) | Average Maximum expiration speed of three trials of Mini-Wright peak flow meter, taken 30s apart. | Walk 98.5in (~2.5m), turn and return; Average of up to two trials |
| ILSE | Vigorimeter (largest bulb), 3 trials each hand (+2 practice) | -- | *Timed Up-and-Go*: Stand from chair, walk 3m, return and sit down (s) |
| Longitudinal Aging Study Amsterdam | Average of larger of two trials, each hand, Takei strain-gauged dynamometer adjusted to each hand. | Maximum expiration speed of three trials of Mini-Wright peak flow meter. | Walk 3m, turn and return as quickly as possible (s) |
| Memory and Aging Project | Average of two trials each per hand (lbs) | Average of two spirometer trials (l/s) | Time to walk 8m (m/s) |
| Nutrition and Aging | Average of best of three maximal contractions for each hand, Martin Vigorimeter (KPa) | --- | *Timed Up-and-Go*: Stand from chair, walk 3m, return and sit down (s)  *Gait speed*: faster of two usual pace trials, 4m (s) |
| Octogenarian Twins | Maximum force, three trials per hand, Martin Vigorimeter (lbs/in2) | Maximum of three spirometer trials repeated twice (15 mins apart) (l/s) | Normal gait 3m, turn and return |
| Swedish Adoption Twin Study of Aging |  |  |  |

Statistical analysis.

We fit Bivariate Latent Growth models separately for men and women, specifying linear growth and time since first measurement as the chronological metric, allowing time to vary by individual. Mplus version(s) xxx-xxx were used (Muthen, xxxx)

Results

*Sex differences.* On average, men had higher scores than women on all physical functions. (compare variability – in EAS men more variable except for gait)

*Age differences.* On average, all of the physical functions showed significant differences across baseline age (LASA; check the rest!!).

*Age changes.* On average, all of the physical functions showed significant declines over time (check, and describe magnitude relative to the cross-sectional differences – and comment). For most of the studies, sexes and variable combinations

*Other Covariates*.

*Cross-sectional associations.* Correlations among baseline performance (intercepts) on the physical measures were statistically significant for all variable pairs and both sexes in the ELSA, MAP, and NuAge studies. None of the correlations were significant for EAS or ILSE (Grip Strength and Timed-up-and-go only). HRS and LASA had significant correlations between PEF and walking for both sexes and between PEF and Grip (women only in HRS). Similarly, PEF and Grip were correlated only for women in OCTO-Twin. (SATSA?)

*Longitudinal associations*.

Table x-A. Correlations among Random Effects for Grip Strength and Walking Speed\*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Female | | | Male | | |
|  | Intercepts | Slopes | Residuals | Intercepts | Slopes | Residuals |
| Einstein |  |  |  |  |  |  |
| English | 0.39\* | 0.74 | 0.01 | 0.28\* | 0.43 | 0.01 |
| HRS | 0.20 | 0.12 | 0.02 | 0.16 | 0.07 | 0.05 |
| ILSE | -0.01 | 0.49 | 0.11 | 0.50 | 0.83 | -0.14 |
| LASA | -0.28 | -0.50 | 0.01 | -0.45 | -0.32 | -0.04 |
| MAP | 0.30\* | -0.47 | -0.01 | 0.27\* | 0.35 | 0.002 |
| NuAge | -0.18\*/-0.27\* | -0.10/-0.26 | -0.04/-0.01 | -0.20\*/-0.25\* | -0.25/-0.24\* | -0.05\*/-0.04 |
| Octo-Twin | -- | -- | -- | -- | -- | -- |
|  |  |  |  |  |  |  |

\* Timed-up-and-go in ILSE and NuAge.

Note: Controlling for Baseline Age, education, height, smoking, cardiovascular illness, and diabetes.

Table x-B. Correlations among Intercepts for physical function variables

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | F |  |  | M |  |
|  | Grip strength-Walking speed | Grip-strength—Pulmonary | Pulmonary- Walking Speed | Grip strength-Walking speed | Grip-strength—Pulmonary | Pulmonary- Walking Speed |
| Einstein |  |  |  |  |  |  |
| English | 0.39\* | 0.21\* | 0.18\* | 0.28\* | 0.18\* | 0.22\* |
| HRS | 0.20 | 0.29\* | 0.28\* | 0.16 | 0.11 | 0.30\* |
| ILSE | /-0.01 | -- | -- | / 0.50 |  |  |
| LASA | 0.28 | 0.30\* | -0.29\* | -0.45 | 0.23\* | -0.29\* |
| MAP | 0.30\* | 0.12\* | 0.24\* | 0.27\* | 0.29\* | 0.22\* |
| NuAge | -0.18\*/-0.27\* | -- | -- | -0.20\*/-0.25\* | -- | -- |
| Octo-Twin | -- | 0.37\* | -- | -- | 0.15 | -- |
|  |  |  |  |  |  |  |

Table x-C. Correlations among Intercepts for physical function variables

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Grip strength-Walking speed | | Grip-strength—Pulmonary | | Pulmonary- Walking Speed | |
|  | F | M | F | M | F | M |
| Einstein |  |  |  |  |  |  |
| ELSA | 0.39\* | 0.28\* | 0.21\* | 0.18\* | 0.18\* | 0.22\* |
| HRS | 0.20 | 0.16 | 0.29\* | 0.11 | 0.28\* | 0.30\* |
| ILSE | -0.01 | 0.50 | -- |  | -- |  |
| LASA | 0.28 | -0.45 | 0.30\* | 0.23\* | -0.29\* | -0.29\* |
| MAP | 0.30\* | 0.27\* | 0.12\* | 0.29\* | 0.24\* | 0.22\* |
| NuAge | -0.18\*/-0.27\* | -0.20\*/-0.25\* | -- | -- | -- | -- |
| Octo-Twin | -- | -- | 0.37\* | 0.15 | -- | -- |
|  |  |  |  |  |  |  |

Time-patterned fluctuations.

Discussion

Grip strength in particular has been shown to have high test-retest stability (Wolinsky et al., 2005).

References

(possibly see also Buchman et al, 2008, Physical frailty in older persons is associated with Alzheimer disease pathology)

Table 1. Descriptive statistics for the xxx studies

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | Study | | | | |  | |
| Variable | |  | EAS  (n = 2254) | Year 3  (n = 2545) | Year 6  (n = 2076) | LASA  (n = 3107) | Year 12  (n = 1257) | | Year 15  (n = 985) |
|  | |  | M (SD) | M (SD) | M (SD) | M (SD) | M (SD) | | M (SD) |
| Demographic | | |  |  |  |  |  | |  |
| Age, years | | | 78.3 (5.4) |  |  | 70.8 |  | |  |
| Education, years | | | 13.0 (3.7) |  |  | 8.76(3.32) |  | |  |
| Height, cm | | | 163.9 (9.9) |  |  | 171.10(8.7) |  | |  |
| Smoking history(%) | | | 1125 (53.4) |  |  | 25.5% |  | |  |
| Cardiovascular disease(%) | | | 364 (16.8) |  |  | 29% |  | |  |
| Diabetes (%) | | | 365 (16.8) |  |  | 7.9% |  | |  |
| Physical |  | |  |  |  |  |  | |  |
| Pulmonary: | Peak expiratory flow | | 319.3 (120.7) |  |  | 403.07(130.1) |  | |  |
| Muscle: | Grip Strength | | 20.6 (8.0) |  |  | -- |  | |  |
| Gait: | Walking Speed | |  |  |  | 8.62(5.93) |  | |  |
| Study Characteristics | | |  |  |  |  |  | |  |
| Retention from previous wave (%) | | | NA |  |  | 100.0 |  | |  |
| Representative sample | | | Yes |  |  | Yes |  | |  |
| Oldest Birth Cohort (year) | | | 1898 |  |  | 1908 |  | |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | Year of Assessment | | | | |
| Variable | |  | Baseline  (n = 2254) | Year 2  (n = 1355) | Year 4  (n = 729) | Year 6  (n = 441) | Year 8  (n = 242) |
|  | |  | M (SD) | M (SD) | M (SD) | M (SD) | M (SD) |
| Demographic | | |  |  |  |  |  |
| Age, years | | | 78.3 (5.4) | 79.5 (5.5) | 81.4 (5.2) | 82.8 (5.1) | 84.0 (4.5) |
| Education, years | | | 13.0 (3.7) | 13.5 (3.6) | 13.8 (3.5) | 14.1 (3.5) | 14.1 (3.6) |
| Height, cm | | | 163.9 (9.9) | 163.1 (10.2) | 163.4 (9.9) | 163.8 (10.3) | 162.4 (9.8) |
| Smoking historya (%) | | | 1125 (53.4) | 684 (53.3) | 371 (54.1) | 216 (50.9) | 98 (46.7) |
| Cardiovascular diseasea,b (%) | | | 364 (16.8) | 229 (17.2) | 130 (17.9) | 95 (22.1) | 51 (24.1) |
| Diabetesa (%) | | | 365 (16.8) | 218 (16.4) | 132 (18.2) | 87 (20.3) | 41 (19.3) |
| Physical |  | |  |  |  |  |  |
| Pulmonary: | Peak flow, L/min | | 319.3 (120.7) | 306.3 (112.3) | 301.2 (122.2) | 285.1 (114.6) | 270.3 (121.5) |
| Muscle: | Grip strength, kg | | 20.6 (8.0) | 19.9 (7.9) | 18.8 (8.9) | 18.2 (8.3) | 16.7 (9.1) |
| Cognitive |  | |  |  |  |  |  |
| Global: | MMSE | | 25.7 (2.4) | 25.9 (2.3) | 26.2 (2.3) | 26.4 (1.9) | 26.5 (1.6) |
| Memory: | Logical Memory | | 18.7 (7.2) | 19.8 (7.6) | 20.7 (7.7) | 21.1 (7.5) | 20.8 (8.2) |
| Working M: | Digit Span (total) | | 13.3 (3.7) | 13.6 (3.7) | 14.5 (3.6) | 14.9 (3.6) | 15.1 (3.3) |
| Knowledge: | Vocabulary | | 44.7 (14.1) | 45.7 (13.1) | 45.2 (13.1) | 44.3 (12.9) | 44.0 (12.8) |
| Reasoning: | Block Design | | 19.6 (9.5) | 20.5 (9.6) | 23.4 (9.9) | 24.5 (9.1) | 25.2 (8.7) |
| Speed: | Digit Symbol Coding | | 37.2 (14.8) | 39.2 (14.6) | 42.7 (14.4) | 43.9 (14.7) | 44.1 (12.9) |
| Visuospatial: | Figure Copy Recall | | 10.5 (3.8) | 10.8 (4.1) | 11.4 (4.1) | 11.1 (4.4) | 10.5 (4.6) |
| Executive: | Trail Making Test B | | 157.0 (77.3) | 148.6 (74.7) | 145.3 (72.7) | 149.1 (76.1) | 148.2 (74.) |
| Fluency: | Category | | 35.0 (9.7) | 35.6 (10.1) | 36.2 (10.3) | 35.8 (10.3) | 36.0 (10.9) |
|  | FAS | | 32.7 (13.3) | 34.1 (13.3) | 36.1 (13.6) | 38.0 (13.6) | 38.2 (13.3) |
|  | Boston Naming Task | | 11.2 (2.9) | 11.3 (2.8) | 11.5 (2.9) | 11.6 (2.8) | 11.9 (2.7) |
| Study Characteristics | | |  |  |  |  |  |
| Retention from previous wave (%) | | | NA | 60.2 | 53.8 | 60.5 | 54.9 |
| Representative sample | | | Yes | Yes | Yes | Yes | Yes |
| Oldest Birth Cohort (year) | | | 1898 | 1899 | 1903 | 1908 | 1911 |

a.Dichotomous variable (0=no; 1=yes). b = Cardiovascular disease = History of myocardial infarction or angina or ever had heart failure.

**SLOPE-SLOPE Correlations**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | FEMALE | |  |  |  |  |  |  | MALE |  |  |  |  |
|  | FEV-GAIT | | FEV-GRIP | | GAIT-GRIP | | TUG-Grip | | FEV-GAIT | | FEV-GRIP | | GAIT-GRIP | | GRIP-TUG | |
|  | r | se | r | se | r | se |  |  | r | se | r | se | r | se |  |  |
| EAS | -0.444 | 0.76 | -0.152 | 0.875 | 0.412 | 0.484 |  |  | -0.487 | 1.779 | 0.032 | 2.346 | 0.42 | 2.312 |  |  |
| ELSA | 0.358 | 0.609 | 0.335 | 0.547 | 0.742 | 0.431 |  |  | 0.261 | 0.303 | 0.336 | 0.29 | 0.426 | 0.299 |  |  |
| HRS | 0.578 | 1.189 | -0.523 | 1.109 | 0.12 | 0.987 |  |  | 0.816 | 0.311 | -0.262 | 0.913 | 0.07 | 0.667 |  |  |
| ILSE |  |  |  |  |  |  | 0.488 | 1.13 |  |  |  |  |  |  | 0.828 | 6.663 |
| LASA | -0.316 | 0.197 | 0.096 | 1.283 | -0.532 | 3.202 |  |  | -0.513 | 0.099 | 0.565 | 0.097 | -0.321 | 0.319 |  |  |
| MAP | -0.028 | 0.386 | 0.016 | 0.362 | -0.471 | 0.306 |  |  | -0.475 | 0.59 | -0.027 | 0.393 | 0.345 | 0.327 |  |  |
| NuAge |  |  |  |  | -0.104 | 0.116 | -0.26 | 0.17 |  |  |  |  | -0.245 | 0.283 | -0.238 | 0.119 |
| OCTO | -0.583 | 0.909 | 0.344 | 0.374 | -0.043 | 0.24 |  |  | -0.792 | 0.169 | 0.101 | 0.604 | -0.7 | 0.51 |  |  |
| SATSA |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |