Frailty and its relevance in caring for acutely ill older adults

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Disclosures

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All the supporting frailty index material is freely available, including as open access.

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Outline (1): What is frailty?

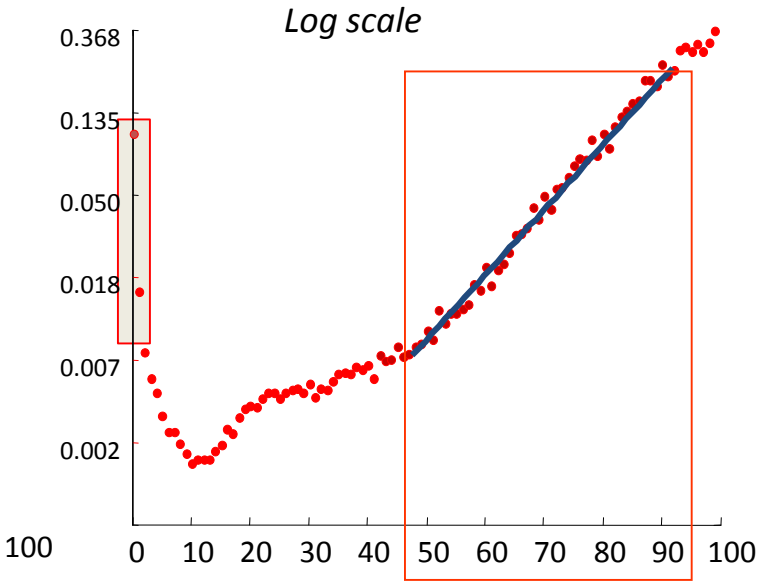
- Frailty reflects multiply determined risk, *greater than for others of the same age*.
- It can be viewed as a *state* or as a *syndrome*.
- In population, clinical and basic science studies all instruments measure frailty by the number of *health deficits*.

Outline (2): Why does frailty matter?

- *Health deficits* arise across the life course, as cellular/molecular damage goes unremoved or unrepaired. (This is also the basis of ageing.)
- Frail older adults challenge health care in their complexity, which we must embrace.
- Much of what we must learn, and of what we must do, can sound, to our peril, to be simple.

The older people get the more likely they are to die (on average)

$$\mu = R \cdot \exp(\alpha \cdot t)$$



Age (years)

The rate of mortality as a function of chronological age (Canadian data, cohort 1900-1901).

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People age at different rates.

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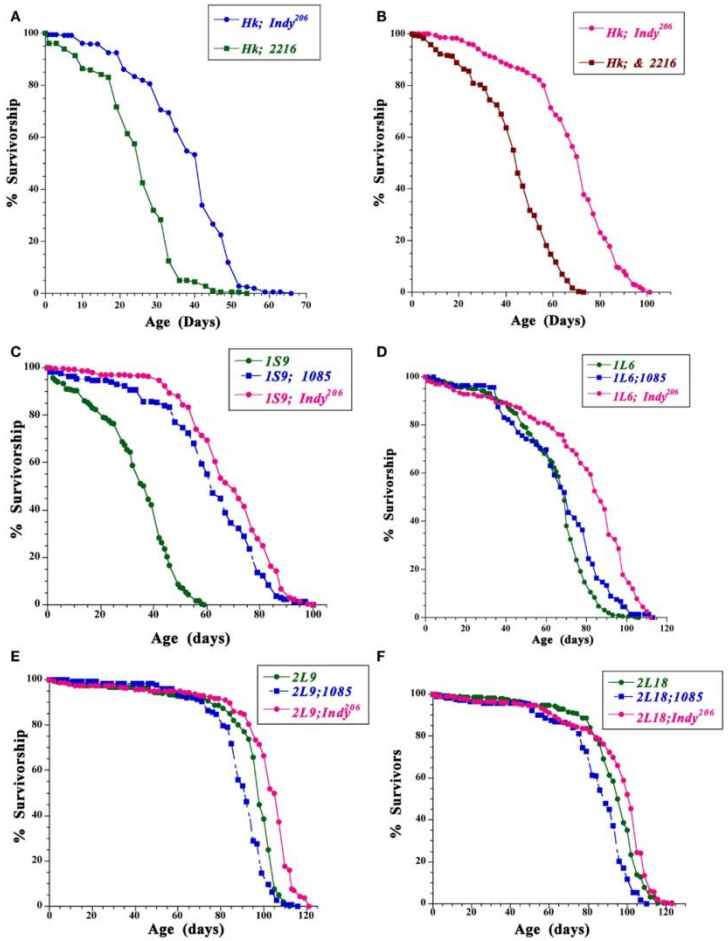
Organisms die at varying rates: survival of longevity mutations in *drosophila*



Rogina B, Helfand SL. *Front Genet* 2013; http://dx.doi.org/10.3389/fgene.2013.00047

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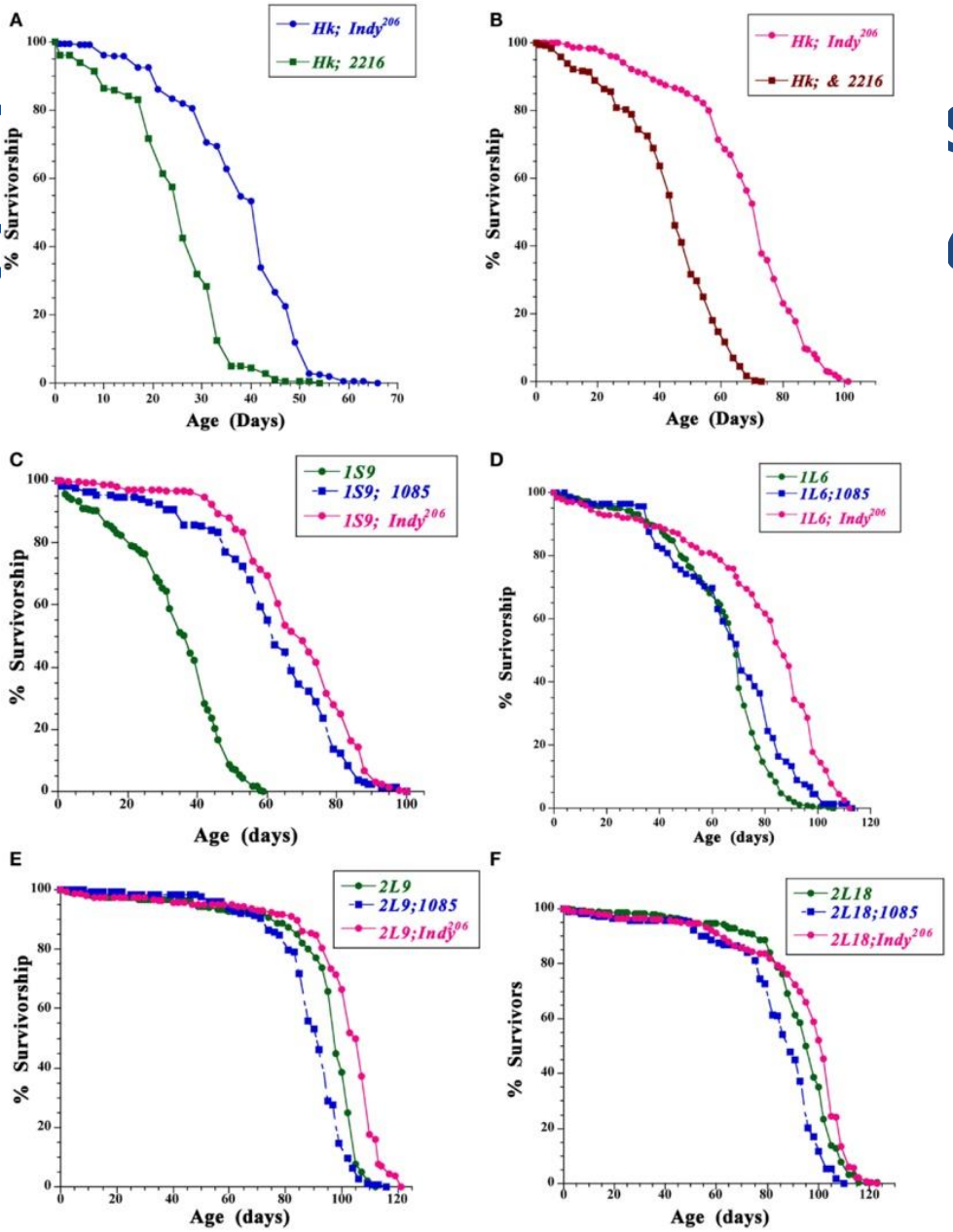
Organisr long survival of *ophila*



Rogina B, Helfand SL. *Front Genet* 2013; http://dx.doi.org/10.3389/fgene.2013.00047

Bansal A, Zhu LJ, Yen K, et al., **Uncoupling lifespan and healthspan in C elegans longevity mutants.** *Proc Natl Acad Sci USA*. 2015;112(3):E277-86

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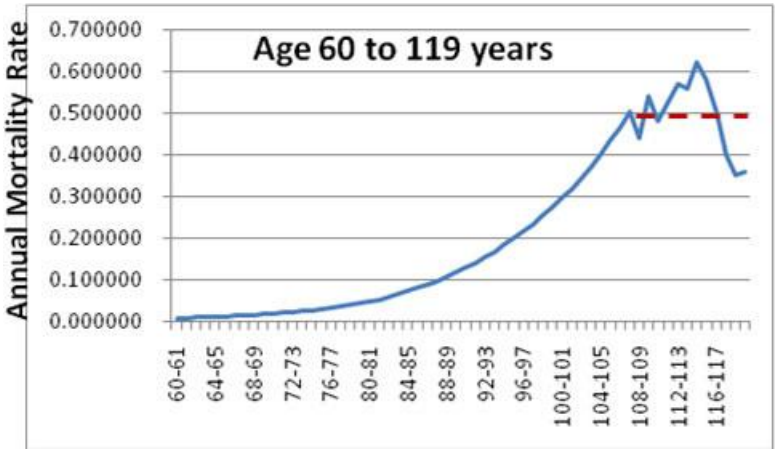
“Statistical frailty”

Age vs. ageing

Vaupel J, Manton K, Stollard E. The impact of heterogeneity in individual frailty on the dynamics of mortality. *Demography* 1979; 16:439-54



Missoy & Vaupel. *Society for Industrial & Applied Mathematics Review* 2015;57:61-70.

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Operationalizing frailty

Variables are *highly specified*: prototype is the frailty phenotype

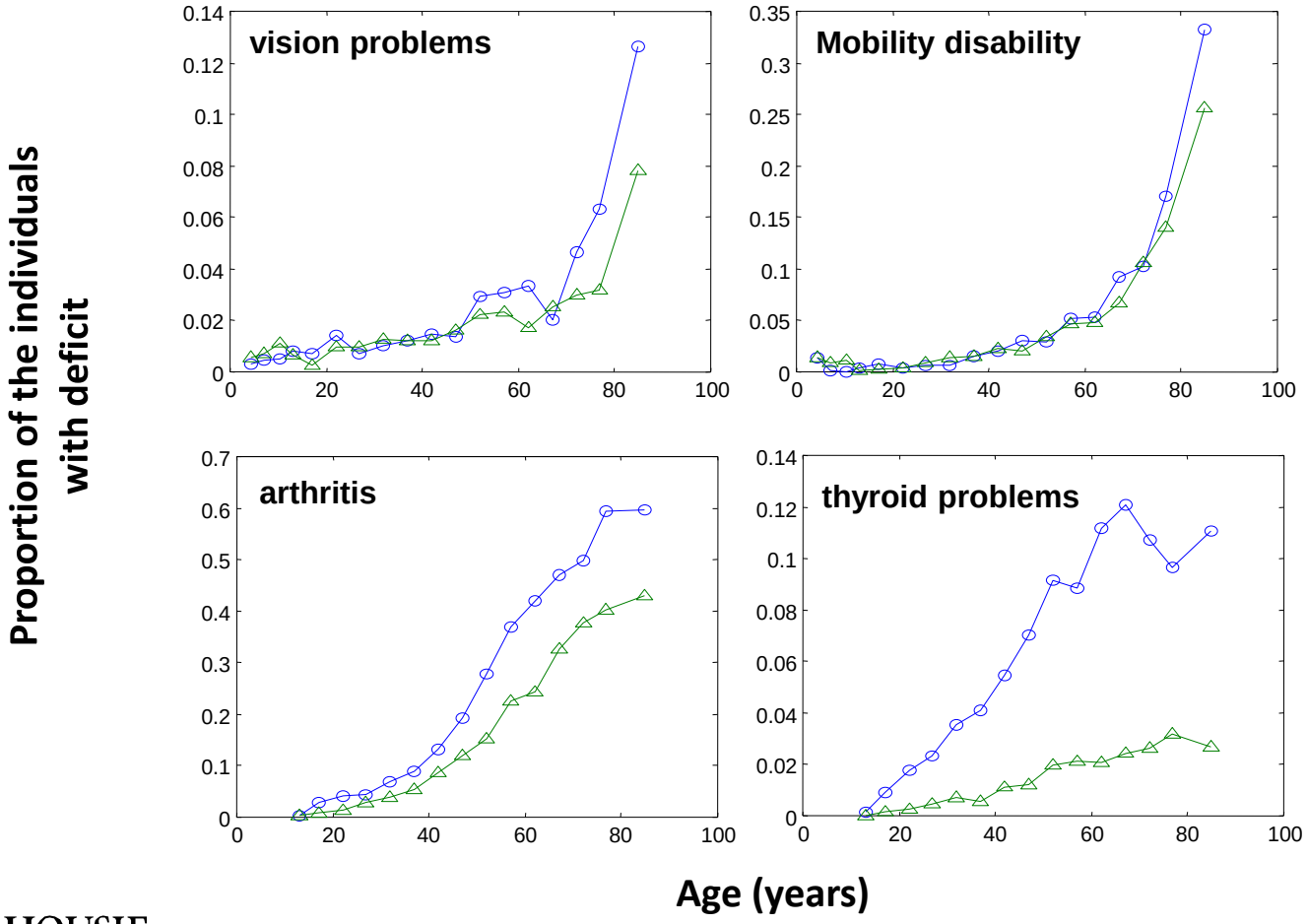
- Slow mobility
- Weakness
- Weight loss
- Decreased activities
- Exhaustion
  - Fried et al.,. 2001;56 *J Gerontol A Biol Sci Med Sci* (3):M146-56.

Variables are *hardly specified*: prototype is the Frailty Index

- Count health deficits (30-100)
  - age associated but does not saturate;
  - associated with adverse outcome
  - <5% missing data
- Divide by the number of deficits considered.
  - Mitnitski et al., *ScientificWorldJ* 2001;1:323-326.
  - Searle et al., *BMC Geriatr* 2008;8:24.

The older people get, the more likely they are to accumulate health deficits

(Canadian National Population Health Survey, n= 66,580)



Rockwood & Mitnitski *Rev Clin Gerontol* 2007;18:1-12.

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Deficit accumulation can be estimated with the frailty index

Frailty Index = $\frac{\text{Number of deficits an individual has}}{\text{Total number of deficits measured}}$

e.g. in a dataset with 50 health deficits measured, a person with 10 things wrong (10 deficits) has a frailty index of 10/50 = 0.20.

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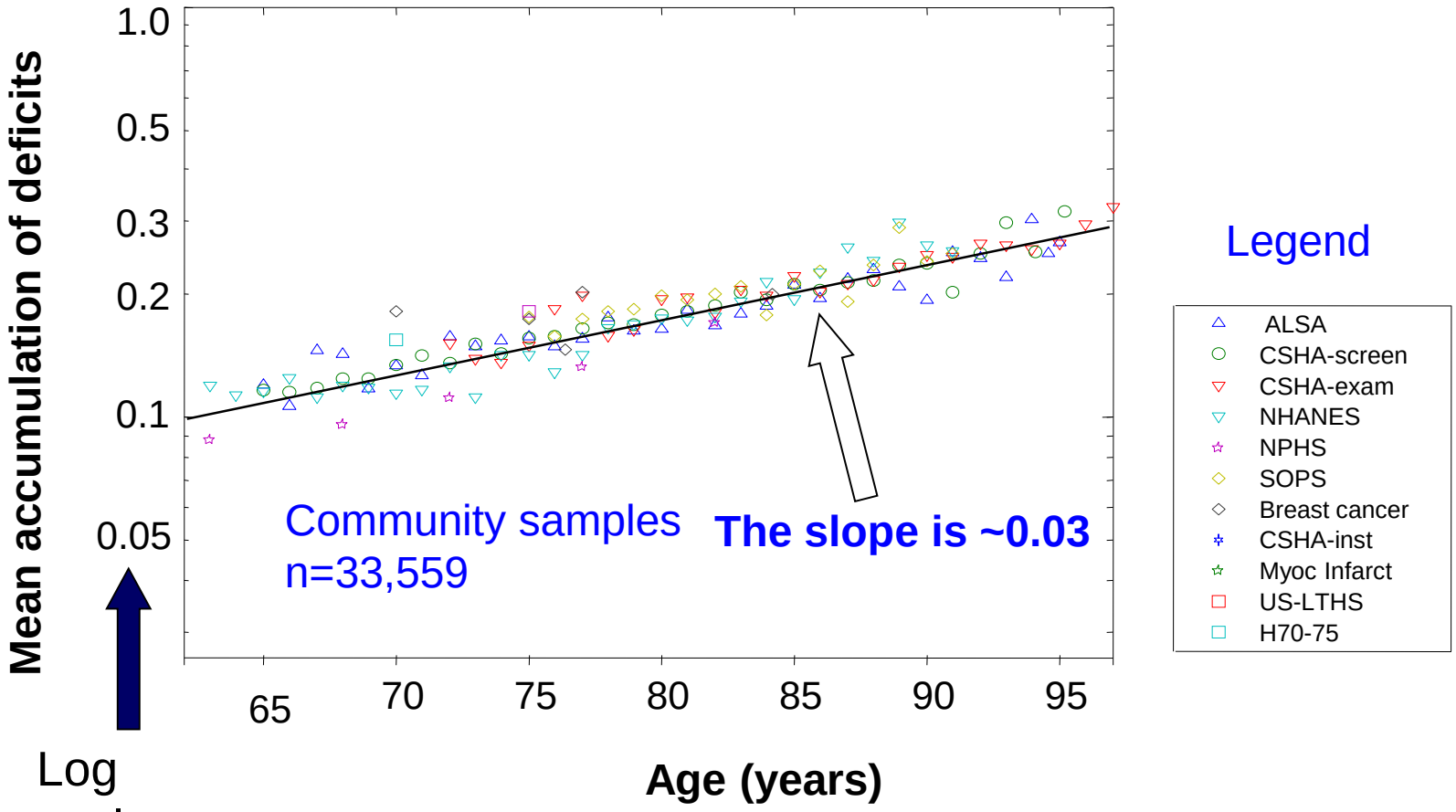
Deficits accumulate characteristically in old age



Mitnitski, *et al*., *J Am Geriatr Soc*, 2005;53:2184-9

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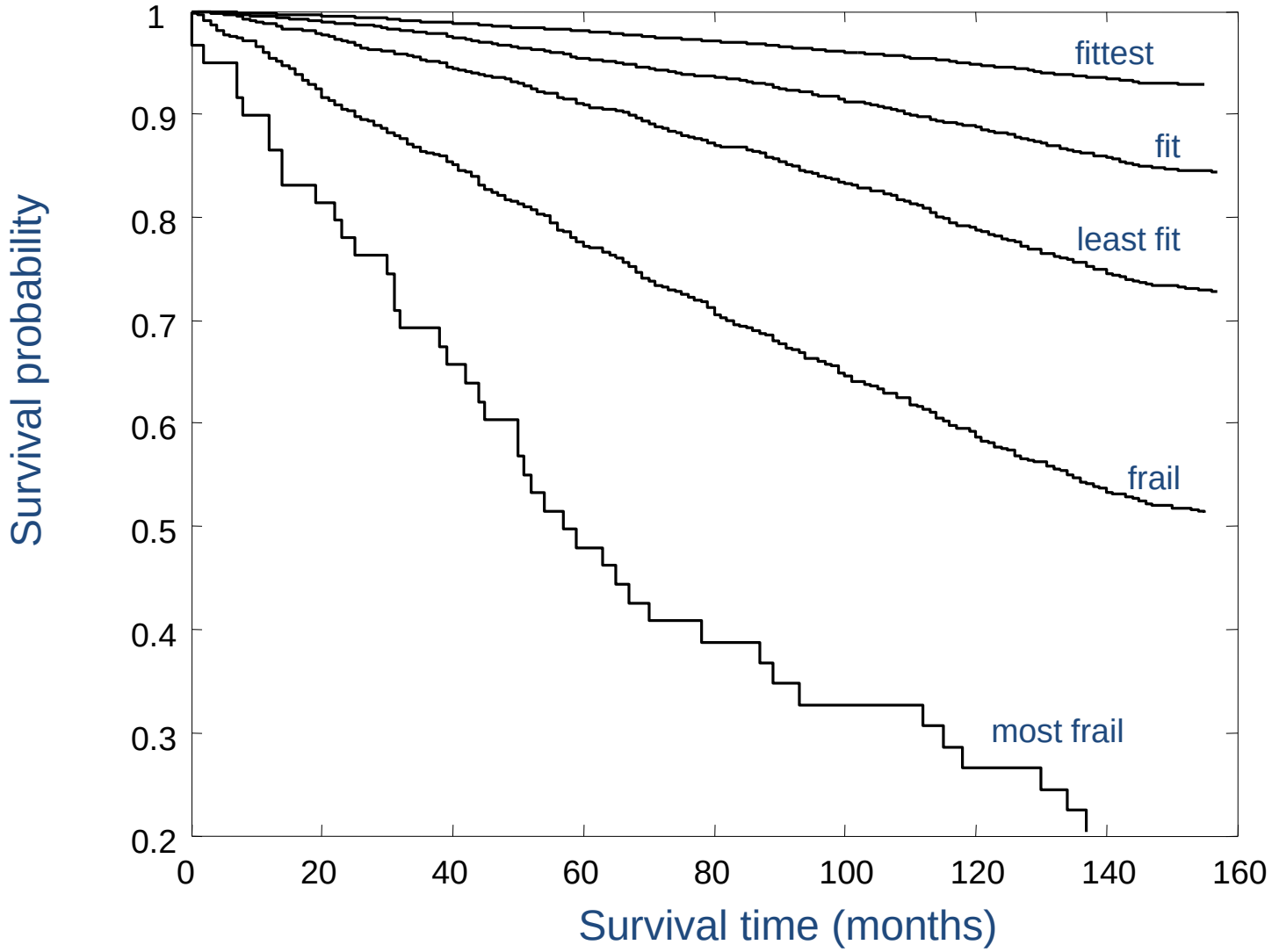
The more health deficits, the shorter the survival



Rockwood et al., *CMAJ* 2011; 183(8):E487-958

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What is frailty?
What we have said so far.

- Frailty = increased risk *for that age*.
- Risk varies because people accumulate health deficits at different rates.
- People of the same age have different numbers of things wrong. This is the basis of frailty.
- Does it matter which things wrong people have?

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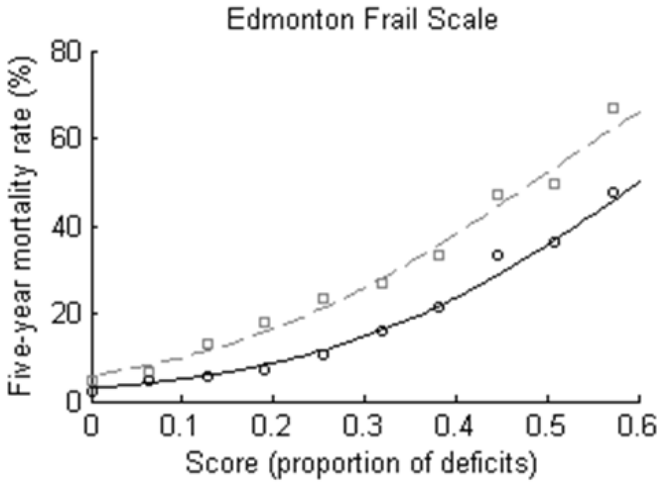
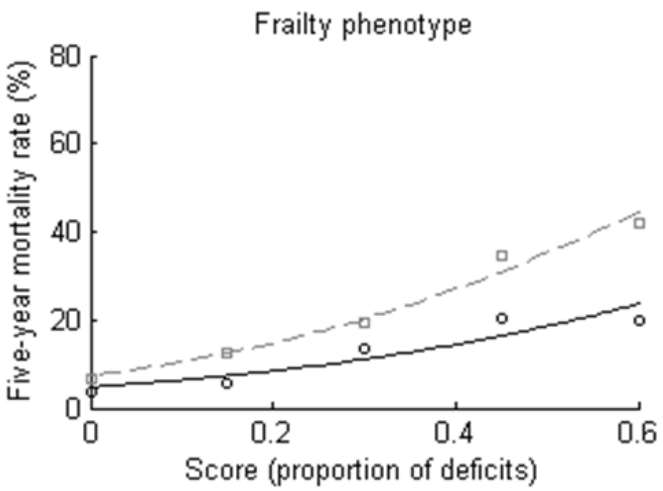
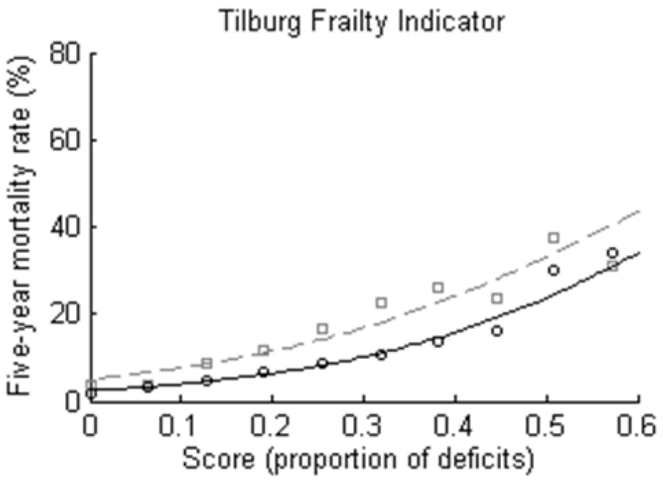
Increase in 5-year mortality

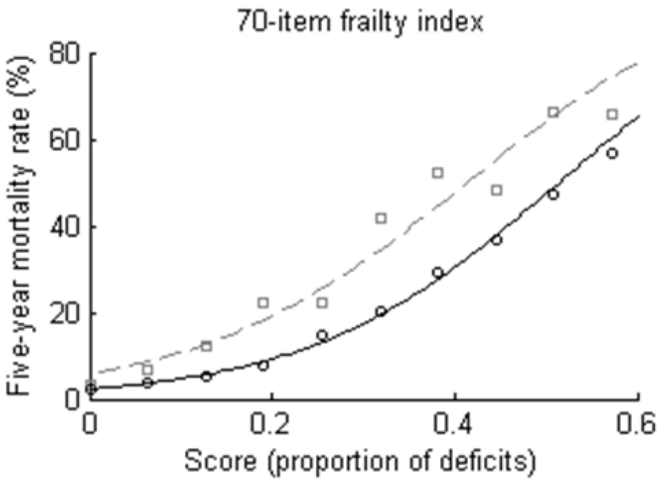




Women

Men





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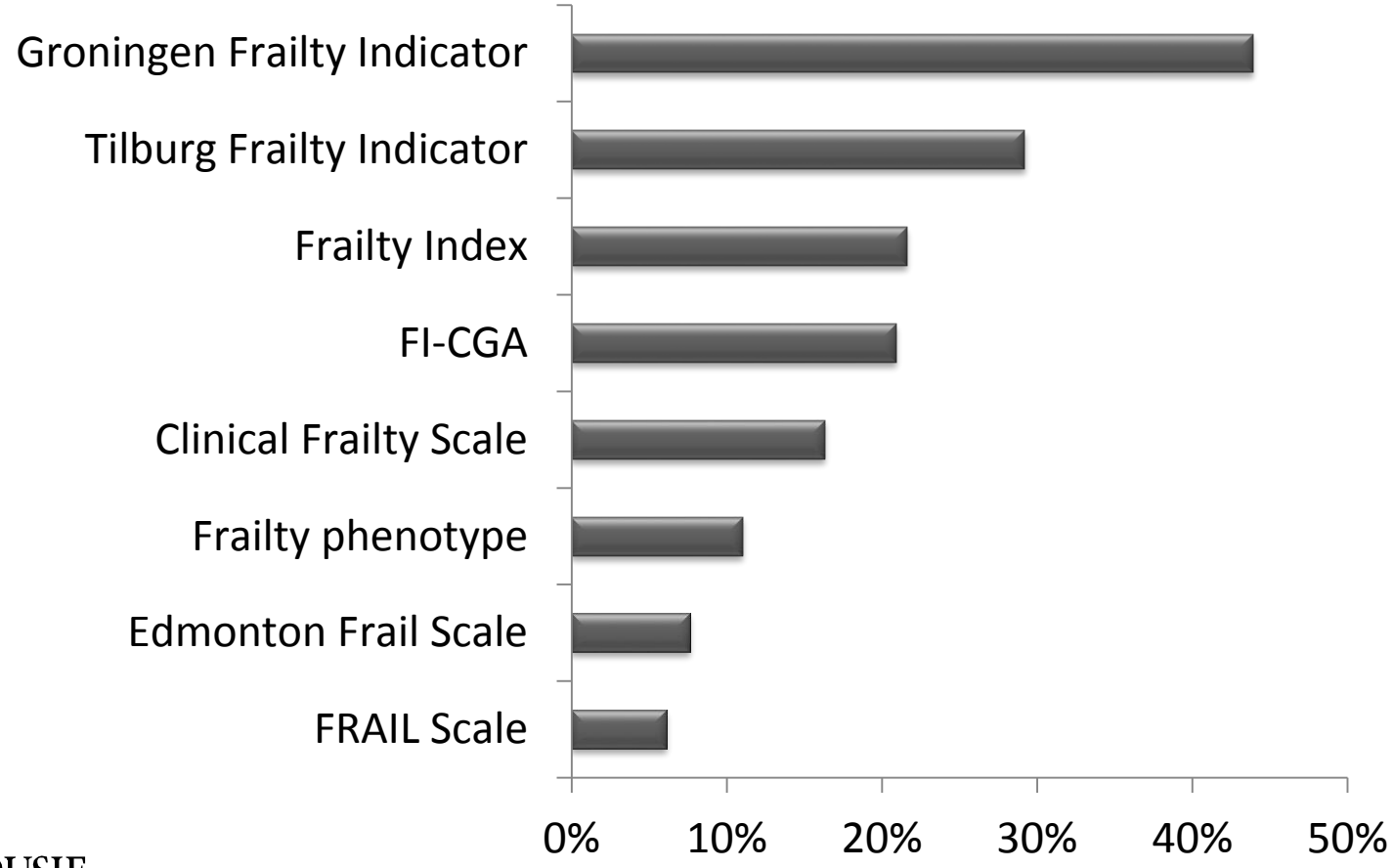
Theou et al, J Am Geriatr Soc, 2014;62(5):901-906.

Frailty prevalence varies: effect of cut-points



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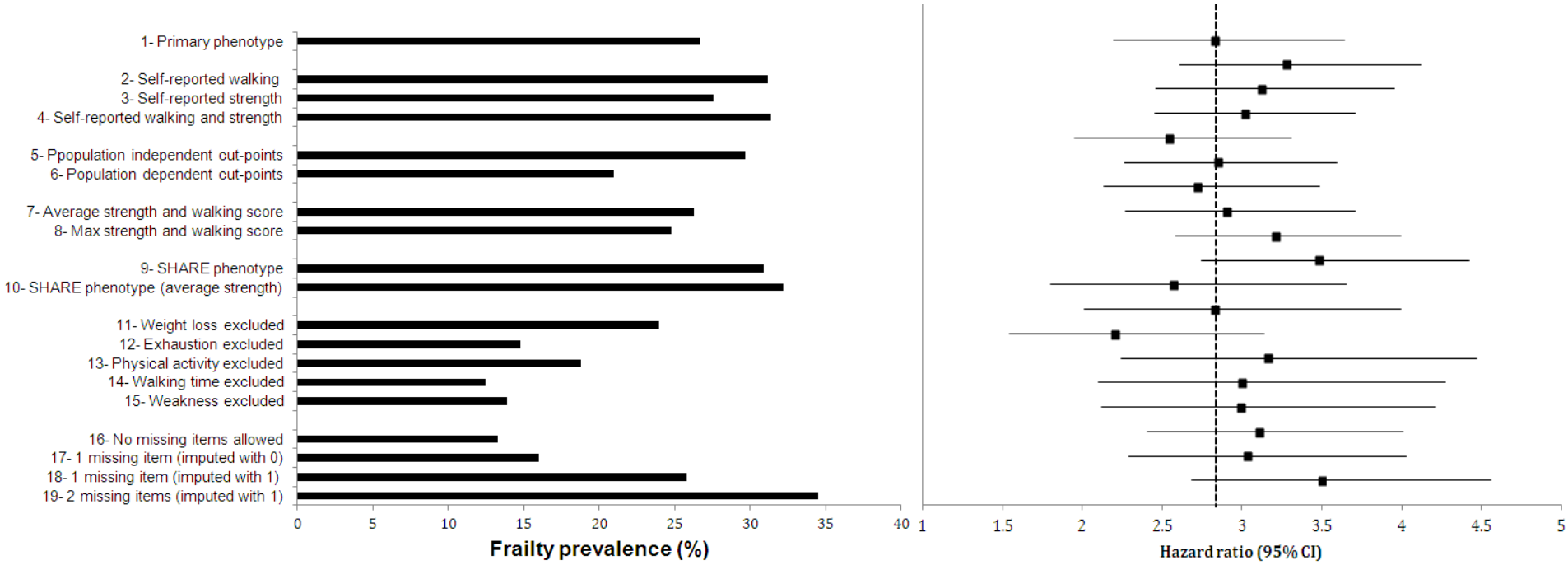
Theou et al, J Am Geriatr Soc, 2013;61(9):1537-51.

Modifications of the Frailty Phenotype Criteria

- Systematic Review: 264 included studies
- 24 studies assessed the criteria as proposed in the original frailty phenotype study



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Theou et al., *Ageing Research Reviews* 2015;21 (5):78-94.

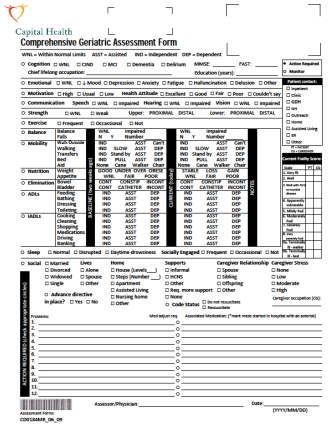
Frailty measurement in acutely ill older adults

Screening

- Rapid
- Easy to use
- Valid
- Reliable
- More sensitive than specific

Definitive evaluation

- Feasible
- Easy for routine use
- Valid
- Reliable
- Needs high specificity


Capital Health
Comprehensive Geriatric Assessment Form

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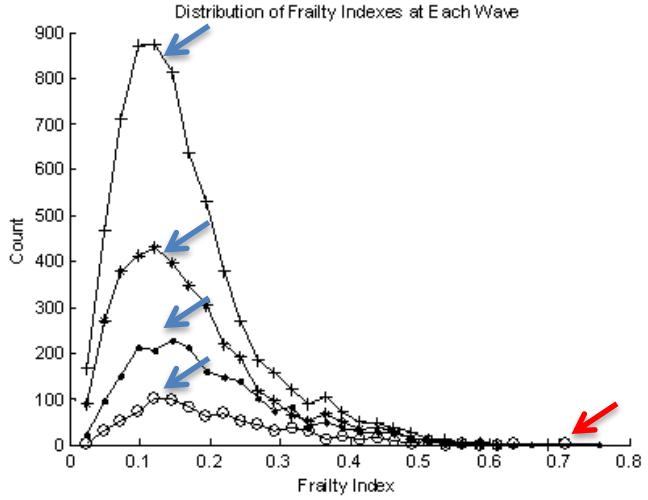
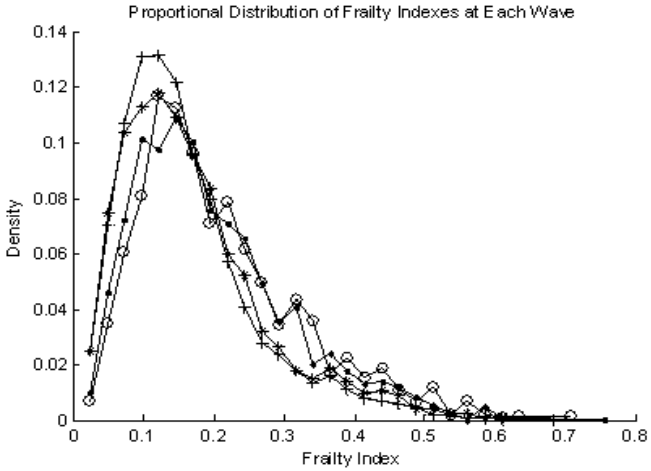
Distribution of the Frailty Index

4 waves of the Chinese Longitudinal Health and Longevity Study;

6664 people ages 80-99





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Bennett et al., *Age Ageing* 2013;42(3):372-7.

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Outline (2): Why does frailty matter?

- Health deficits arise across the life course, as cellular/molecular damage goes unremoved or unrepaired. (This is also the basis of ageing.)

López-Otín C, Blasco MA, Partridge L, et al. **The hallmarks of aging**. *Cell*. 2013;153(6):1194-217.4

Fontana L, et al. **Medical research: treat ageing**. *Nature* 2014;511:405-7.

Howlett SE, Rockwood K. **Ageing: develop models of frailty**. *Nature*. 2014;512:253.

Mitnitski A, Rockwood K. **The rate of ageing**. *Biogeront-ology*. 2015 May 14. [Epub]

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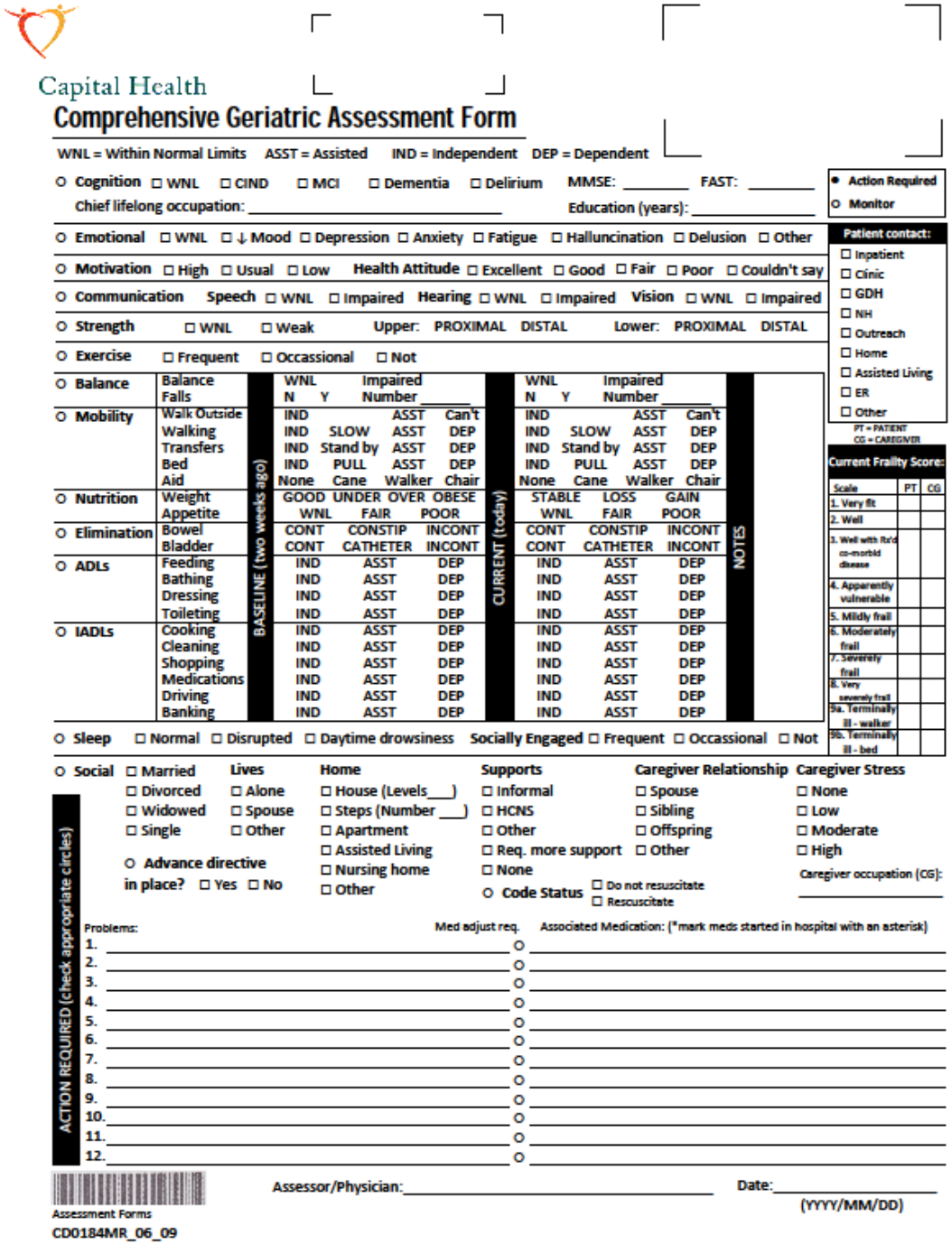
2013 153, 1194-1217DOI: (10.1016/j.cell.2013.05.039)

Cell PRESS

Outline (2): Why does frailty matter?

- Frail older adults challenge health care in their complexity, which we must embrace.
- Much of what we must learn, and what we must do, sounds, at our peril, to be simple.

Comprehensive Geriatric Assessment Form



Capital Health

Comprehensive Geriatric Assessment Form

WNL = Within Normal Limits ASST = Assisted IND = Independent DEP = Dependent

○ Cognition ☐ WNL ☐ CIND ☐ MCI ☐ Dementia ☐ Delirium MMSE: _____ FAST: _____
Chief lifelong occupation: _____ Education (years): _____

○ Emotional ☐ WNL ☐ ↓ Mood ☐ Depression ☐ Anxiety ☐ Fatigue ☐ Hallucination ☐ Delusion ☐ Other

○ Motivation ☐ High ☐ Usual ☐ Low Health Attitude ☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Couldn't say

○ Communication Speech ☐ WNL ☐ Impaired Hearing ☐ WNL ☐ Impaired Vision ☐ WNL ☐ Impaired

○ Strength ☐ WNL ☐ Weak Upper: PROXIMAL DISTAL Lower: PROXIMAL DISTAL

○ Exercise ☐ Frequent ☐ Occassional ☐ Not

		BASELINE (two weeks ago)	CURRENT (today)	NOTES
○ Balance	Balance	WNL N Y	WNL N Y	
	Falls	Impaired Number _____	Impaired Number _____	
○ Mobility	Walk Outside	IND ASST Can't	IND ASST Can't	
	Walking	IND SLOW ASST DEP	IND SLOW ASST DEP	
	Transfers	IND Stand by ASST DEP	IND Stand by ASST DEP	
	Bed	IND PULL ASST DEP	IND PULL ASST DEP	
	Aid	None Cane Walker Chair	None Cane Walker Chair	
○ Nutrition	Weight	GOOD UNDER OVER OBESE	STABLE LOSS GAIN	
	Appetite	WNL FAIR POOR	WNL FAIR POOR	
○ Elimination	Bowel	CONT CONSTIP INCONT	CONT CONSTIP INCONT	
	Bladder	CONT CATHETER INCONT	CONT CATHETER INCONT	
○ ADLs	Feeding	IND ASST DEP	IND ASST DEP	
	Bathing	IND ASST DEP	IND ASST DEP	
	Dressing	IND ASST DEP	IND ASST DEP	
	Toileting	IND ASST DEP	IND ASST DEP	
○ IADLs	Cooking	IND ASST DEP	IND ASST DEP	
	Cleaning	IND ASST DEP	IND ASST DEP	
	Shopping	IND ASST DEP	IND ASST DEP	
	Medications	IND ASST DEP	IND ASST DEP	
	Driving	IND ASST DEP	IND ASST DEP	
	Banking	IND ASST DEP	IND ASST DEP	

○ Sleep ☐ Normal ☐ Disrupted ☐ Daytime drowsiness Socially Engaged ☐ Frequent ☐ Occassional ☐ Not

○ Social ☐ Married ☐ Divorced ☐ Widowed ☐ Single
Lives ☐ Alone ☐ Spouse ☐ Other
Home ☐ House (Levels___) ☐ Steps (Number ___) ☐ Apartment ☐ Assisted Living ☐ Nursing home ☐ Other
Supports ☐ Informal ☐ HCNS ☐ Other ☐ Req. more support ☐ None
Caregiver Relationship ☐ Spouse ☐ Sibling ☐ Offspring ☐ Other
Caregiver Stress ☐ None ☐ Low ☐ Moderate ☐ High
○ Advance directive in place? ☐ Yes ☐ No
○ Code Status ☐ Do not resuscitate ☐ Rescuscitate
Caregiver occupation (CG): _____

ACTION REQUIRED (check appropriate circles)

Problems:	Med adjust req.	Associated Medication: (*mark meds started in hospital with an asterisk)
1.	○	
2.	○	
3.	○	
4.	○	
5.	○	
6.	○	
7.	○	
8.	○	
9.	○	
10.	○	
11.	○	
12.	○	

Assessor/Physician: _____ Date: _____ (YYYY/MM/DD)

Assessment Forms
CD0184MR_06_09

○ Action Required
○ Monitor

Patient contact:
☐ Inpatient
☐ Clinic
☐ GDH
☐ NH
☐ Outreach
☐ Home
☐ Assisted Living
☐ ER
☐ Other

PT = PATIENT
CG = CAREGIVER

Current Frailty Score:

Scale	PT	CG
1. Very fit		
2. Well		
3. Well with Rx'd co-morbid disease		
4. Apparently vulnerable		
5. Mildly frail		
6. Moderately frail		
7. Severely frail		
8. Very severely frail		
9a. Terminally ill - walker		
9b. Terminally ill - bed		

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Comprehensive Geriatric Assessment

WNL = Within Normal Limits ASST = Assisted IND = Independent DEP = Dependent

- Cognition [X] WNL [ ] CIND [ ] MCI [ ] Dementia [ ] Delirium MMSE: NL FAST: 3
  Chief lifelong occupation: Office Manager Education (years): 16
- Emotional [X] WNL [ ] ↓Mood [ ] Depression [ ] Anxiety [ ] Fatigue [ ] Hallucination [ ] Delusion [ ] Other
- Motivation [ ] High [X] Usual [ ] Low Health Attitude [ ] Excellent [ ] Good [ ] Fair [ ] Poor [X] Couldn't say
- Communication Speech [X] WNL [ ] Impaired Hearing [X] WNL [ ] Impaired Vision [X] WNL [ ] Impaired
- Strength [ ] WNL [X] Weak Upper: PROXIMAL DISTAL Lower: PROXIMAL DISTAL
- Exercise [ ] Frequent [ ] Occassional [X] Not
- Balance WNL (Impaired) WNL (Impaired)

Action Required / Monitor

Patient contact: [ ] Inpatient [ ] Clinic [ ] GDH [ ] NH [ ] Outreach [X] Home [ ] Assisted Living

		BASELINE (two weeks ago)				CURRENT (today)			
	Bed / Aid	IND	PULL	ASST	DEP	IND	PULL	ASST	DEP
		None	Cane	Walker	Chair	None	Cane	Walker	Chair
O Nutrition	Weight	GOOD	UNDER	OVER	OBESE	STABLE	LOSS	GAIN	
	Appetite	WNL	FAIR	POOR		WNL	FAIR	POOR	
O Elimination	Bowel	CONT	CONSTIP	INCONT		CONT	CONSTIP	INCONT	
	Bladder	CONT	CATHETER	INCONT		CONT	CATHETER	INCONT	
O ADLs	Feeding	IND	ASST	DEP		IND	ASST	DEP	
	Bathing	IND	ASST	DEP		IND	ASST	DEP	
	Dressing	IND	ASST	DEP		IND	ASST	DEP	
	Toileting	IND	ASST	DEP		IND	ASST	DEP	
O IADLs	Cooking	IND	ASST	DEP		IND	ASST	DEP	

ACTION REQUIRED (check appropriate)

Problems:	Med adjust req.	Associated Medication: (*mark meds started in hospital with an asterisk)
1. Weak and dizzy - falls	O	
2. COPD	O	Advir/Ventolin +/- Prednisone
3. Osteoarthritis	O	Tylenol PRN (no NSAIDs)
4. Osteoporosis	O	-
5. Mild CRF	O	Ramipril 5 mg/day
6. Disordered sleep	O	Trazadone 50 mg PO qhs
7. Hypertension	O	Amlodipin 5 mg
8. GERD	O	Omeprazol 20 mg/day
9. Large lung mass (XR NYD)	O	
10. Anemia hgb 85(N) indices	O	
11. Hyponatremia Nat = 128	O	
12. Hypoalbuminemia (22)	O	
13. Hypoxemia (Sa 02 92% RA)		

Assessor/Physician: _____ Date: 2012/01/01 (YYYY/MM/DD)

Assessment Forms
CD0184MR_06_09

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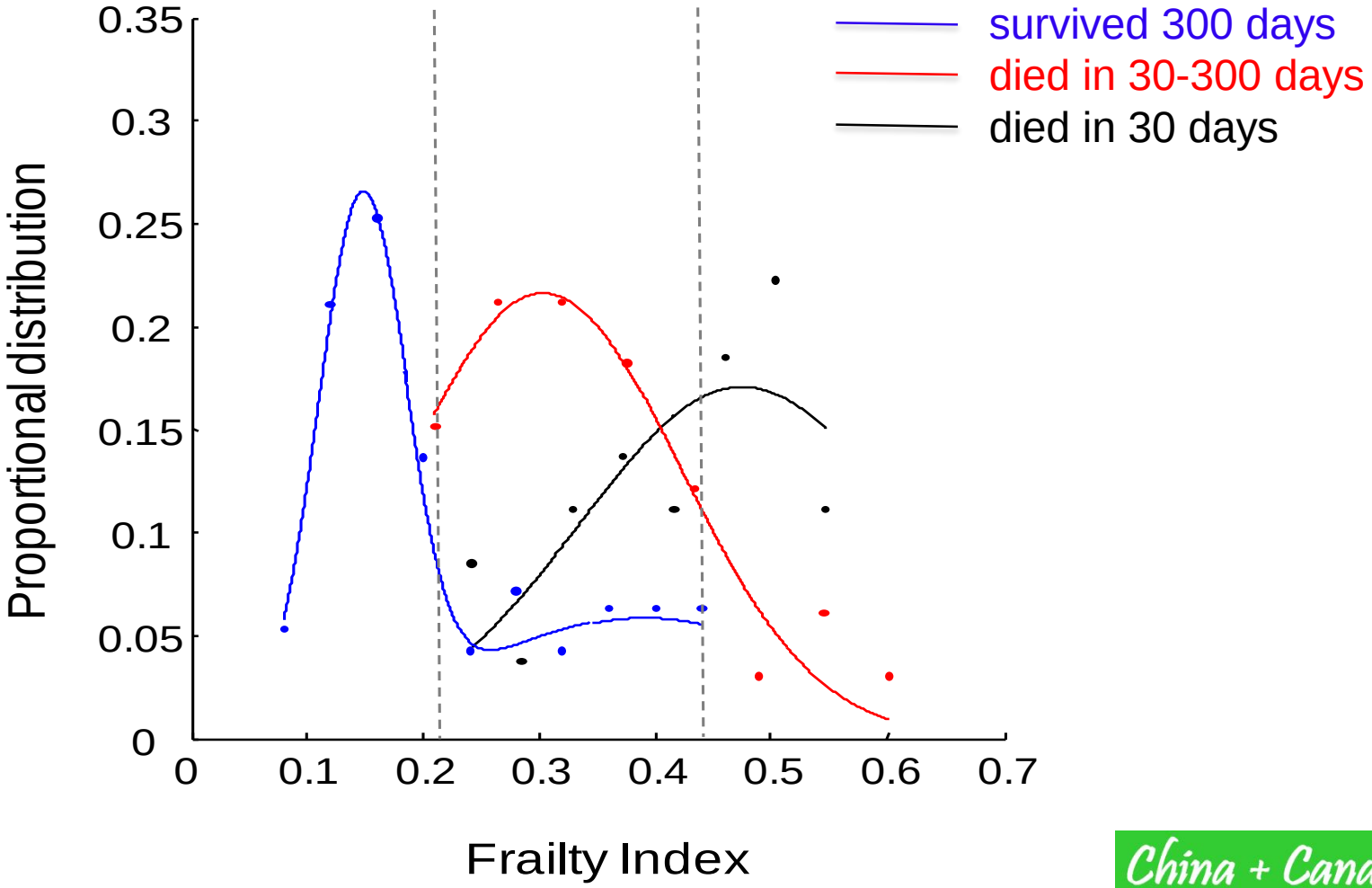
Guangzhou Specialized Geriatric ICU FI Distribution



Zeng et al., *J Gerontol Biol Sci Med Sci*. 2015; Sept 22 E-pub.

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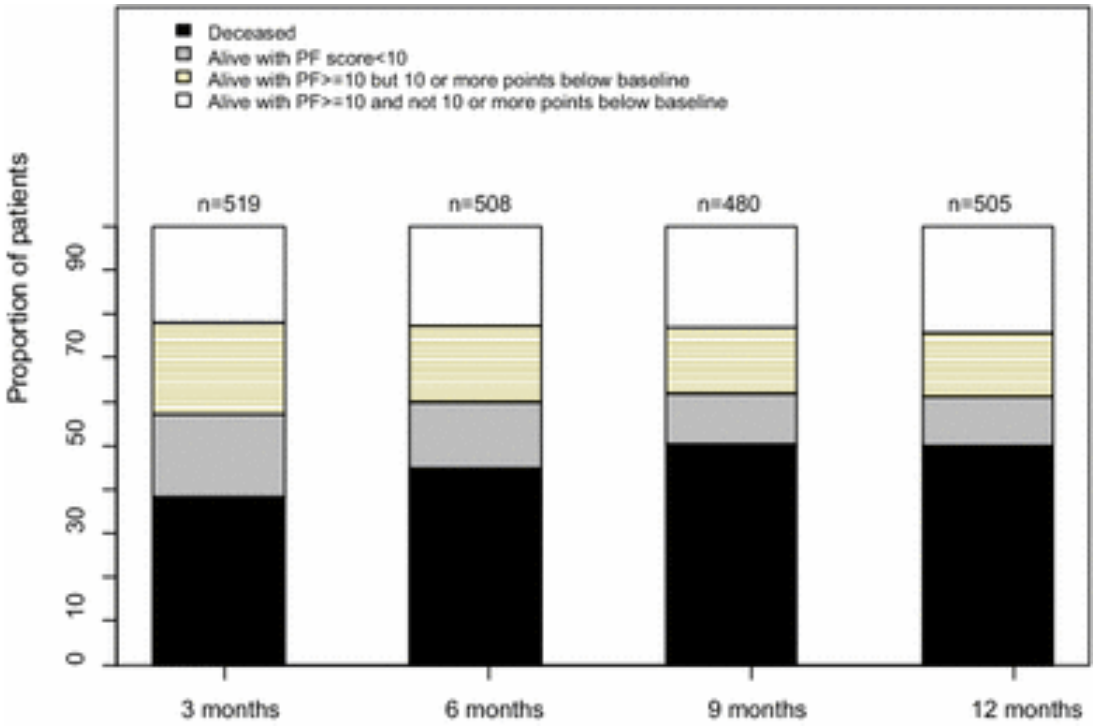
Outcomes of Intensive Care of People aged 80+ years



Primary ICU diagnosis
Co-morbidity
Baseline physical functioning
Frailty Index

AUC=0.79

Heyland et al. *Intensive Care Med* 2015;2015;41:1911-1920.

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Reasons to collect data on frailty in routine care

Areas in which frail people do better

- Hypertension treatment Warwick et al. *BMC Med* 2015;13:78
- Testostrerone therapy Kenny *J Am Geriatr Soc* 2010;58(6):1134-43
- Comprehensive Geriatric Assessment Ellis *BMJ* 2011;343:d6553

Areas in which frail people do less well.

- Trauma surgery Joseph et al. *JAMA Surgery* 2014
- Acute myocardial infarction Ekerstad *Circulation* 2011

Is this a signal to improve care overall?

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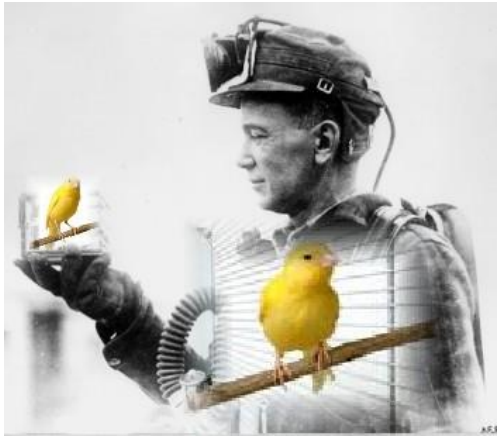
"The modern general hospital is complex, expensive and has proved harmful to many people, and so simpler, cheaper and safer care alternatives have been sought, particularly for older people who are now the predominant users of hospital care."



Young J, Gladman JR, Forsyth DR, Holditch C. **The second national audit of intermediate care**. *Age Ageing*. 2015;44:182-4.

Andrew MK, Rockwood K. **Making our health and care systems fit for an ageing population: considerations for Canada**. *Can Geriatr J*. 2014;17(4):133-5.

Oliver D. **Re: making health and care systems fit.. Why we wrote it, who we wrote it for, and how relevant it might be to Canada**. *Can Geriatr J*. 2014;17(4):136-9

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FI-LAB

Table 1 Clinical and laboratory data used to construct the FI-LAB

Variable[a]	Low cut-off	High cut-off
Albumin (g/L)	32	45
AST (SGOT; IU/L)	8	33
BP, supine systolic (mmHg)	90	140
BP, supine diastolic (mmHg)		
Calcium (mM)		
Creatinine (μM)		
Folate (nM)		
Folate, RBC (nM)		
Glucose, fasting (mM)		
Hemoglobin (g/L)[b]		
Mean corpuscular volume (fL)		
Phosphatase, alkaline (IU/L)		
Phosphorus, inorganic (mM)		
Potassium (mM)		
Protein, total (g/L)		
Sodium (mM)	136	142
TSH (μIU/L)	0.5	5
Thyroxine (T4; nM)	71	161
T4, Free (pM)	12	30
Urea (mM)	2.9	8.2
VDRL	0	0
Vitamin B12 (pg/L)	118	701
White blood cells (number/L)	1.8×10^9	7.8×10^9

Variable[a]	Low cut-off	High cut-off
Potassium (mM)	3.8	5
Protein, total (g/L)	60	78
Sodium (mM)	136	142

Howlett et al., *BMC Medicine 12*: 171, 2014.

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Clinical *vs*. subclinical deficit accumulation

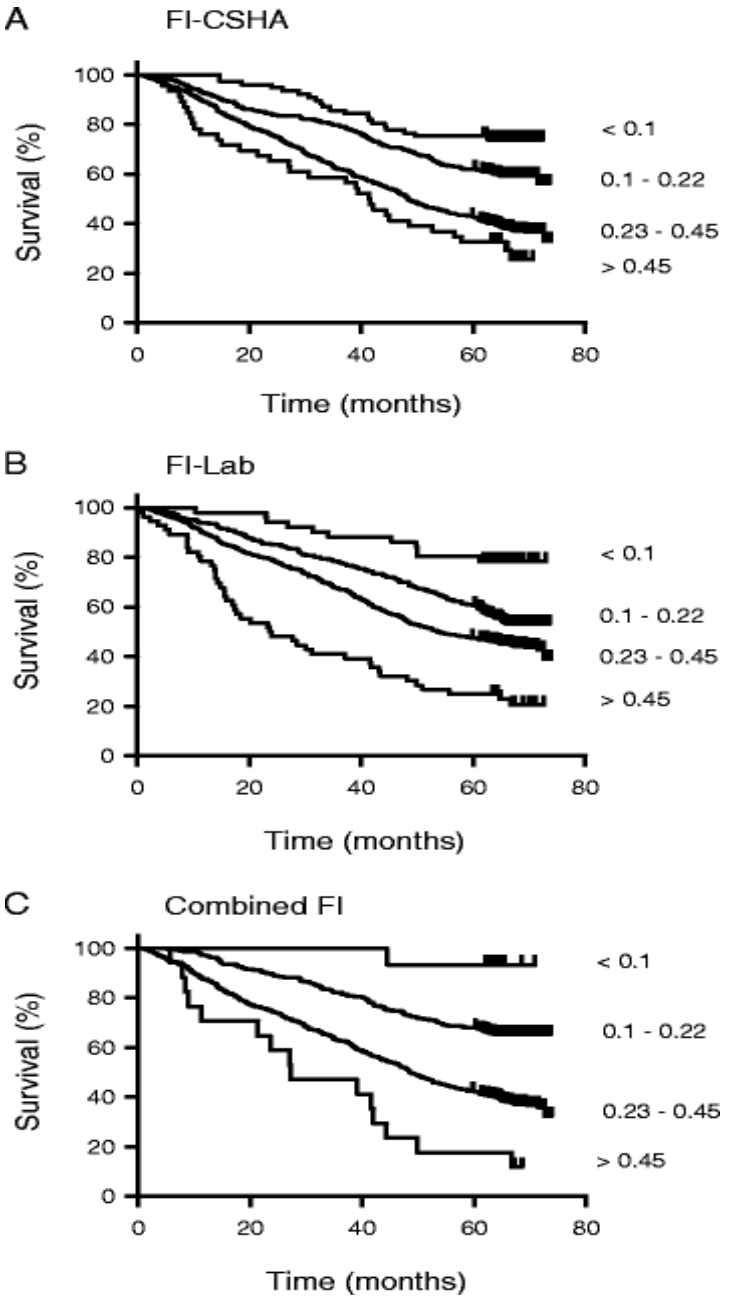
A: Clinical frailty index

B: FI-LAB

C: Combined frailty index

N=1008; Canadian Study of Health & Aging, 1st Clinical exam participants.

Howlett et al., *BMC Medicine* 2014;12:171 see also Rockwood et al. *J Am Med Dir Assoc* 2015 May 5 E-pub



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- Frailty reflects multiply determined risk, *greater than for others of the same age*.
- It can be viewed as a *state* or as a *syndrome*.
- In population, clinical and basic science studies all instruments measure frailty by the number of *health deficits*.

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- *Health deficits* arise across the life course, as cellular/molecular damage goes unremoved or unrepaired. (This is also the basis of ageing.)
- Frail older adults challenge health care in their complexity, which we must embrace.
- Much of what we must learn, and of what we must do, can sound, to our peril, to be simple.

Measuring deficit accumulation across the life course:

The frailty index quantifies age-related health deficit accumulation.

Its characteristic behaviour suggests specific ageing mechanisms, now being studied by our group.

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Geriatric Giants

immobility

instability

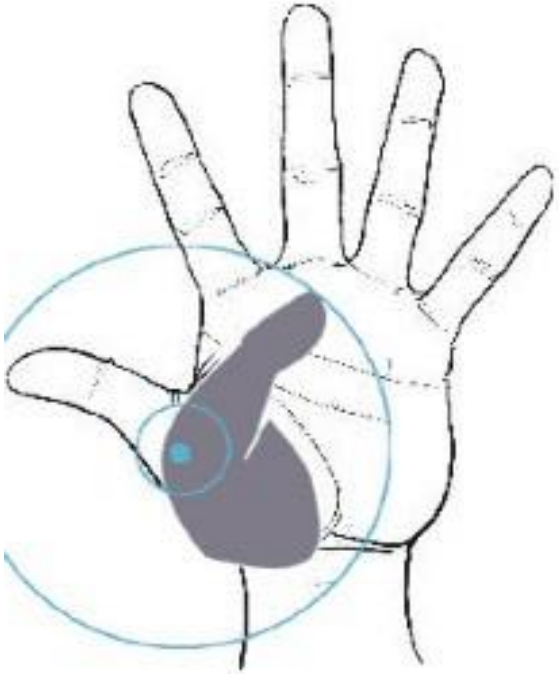
incontinence

impaired intellect/memory

impaired independence

"sensitive but non-specific signs of illness in older adults"

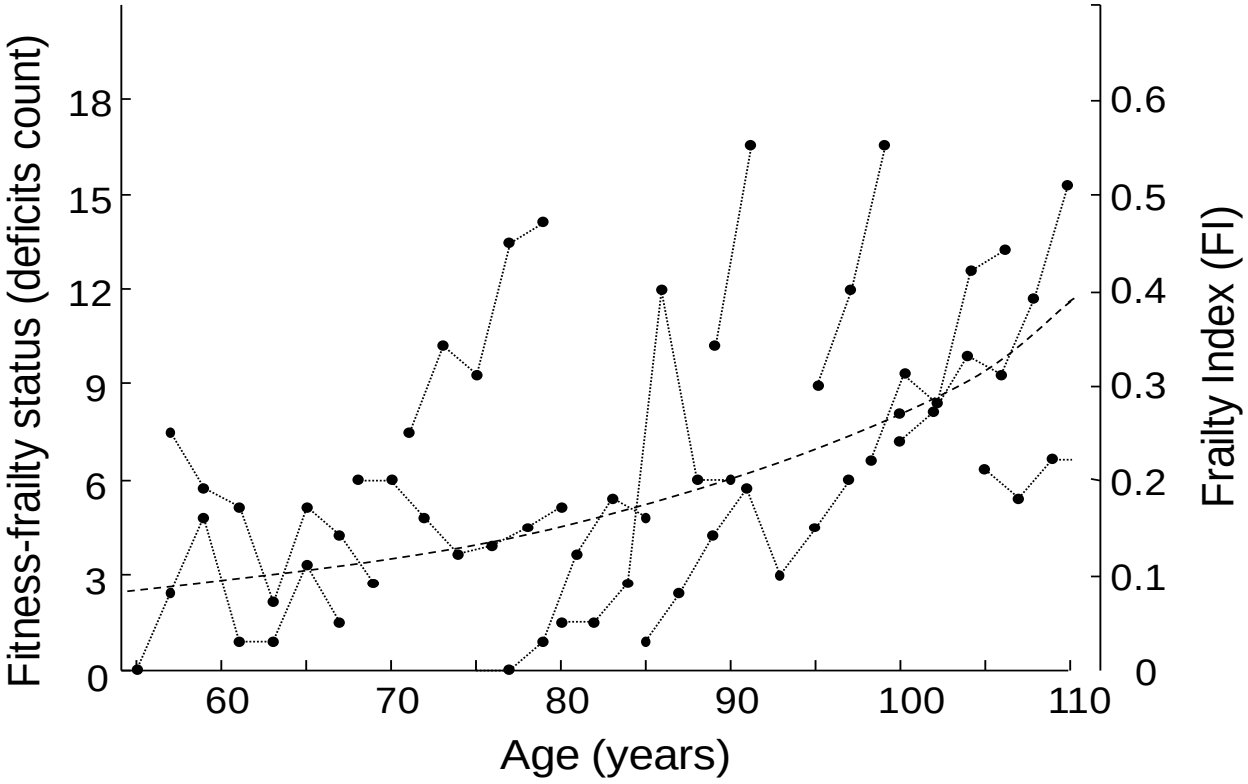
Isaacs B. *The Challenge of Geriatric Medicine*. OUP 1980



The "Geriatric Giants" in a new light

- The items that integrate resiliency to determine overall health status (mobility, function, cognition, social engagement) are not seen as falling within the remit of a history and physical examination.

Individuals show many trajectories in accumulation health deficits



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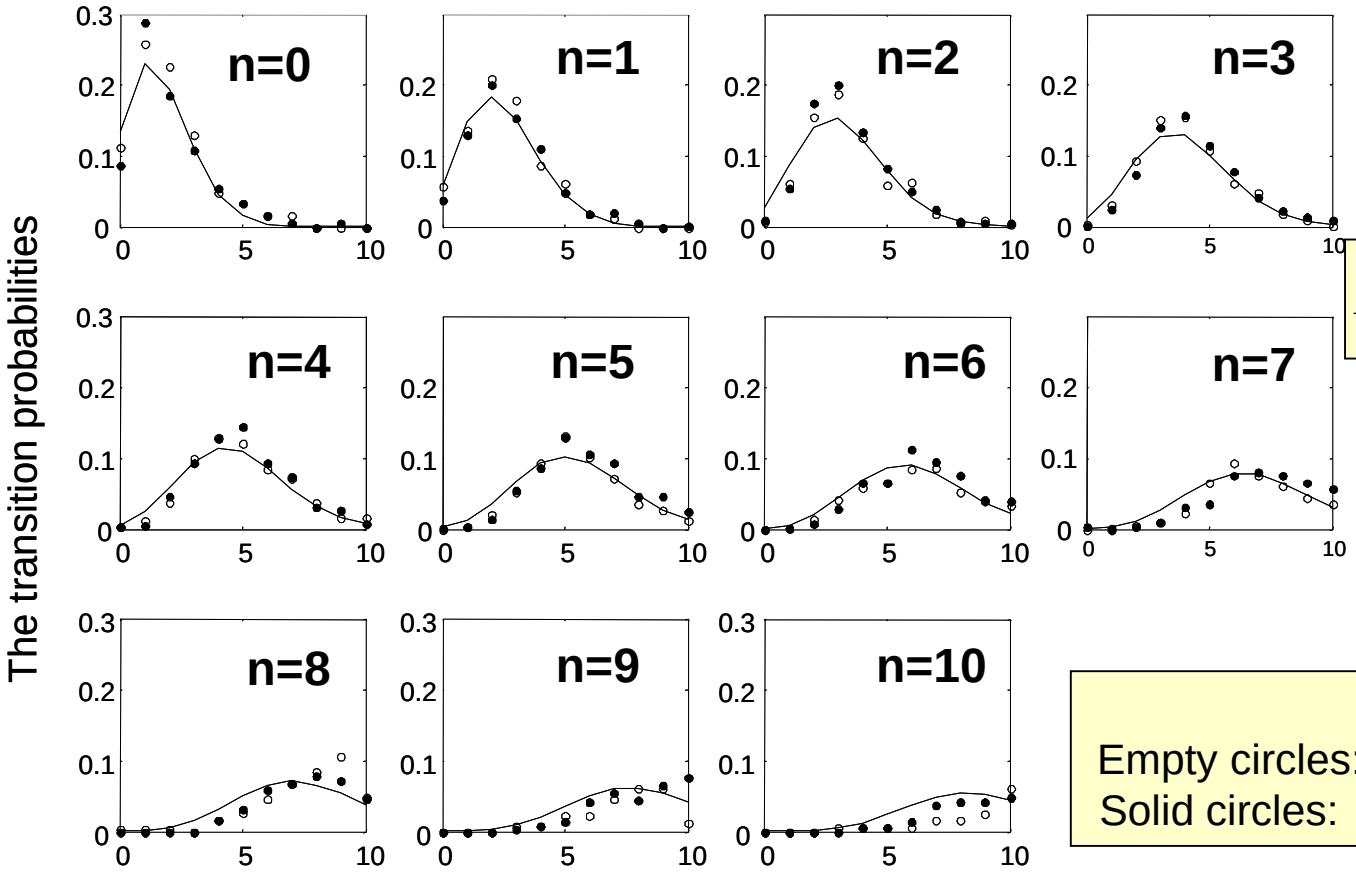
Mitnitski et al., Exp Gerontol 2012;(12):893-899.

5-year transitions between different states of health (empty circles), replicated 5 years later (solid circles)*



The model

$$P_{nk} = \frac{\rho(n)^k}{k!} e^{\rho(n)} (1 - P_{nd})$$

Goodness of fit
r = 0.99

Legend:
Empty circles: CSHA-1 → CSHA-2
Solid circles: CSHA-2 → CSHA-3

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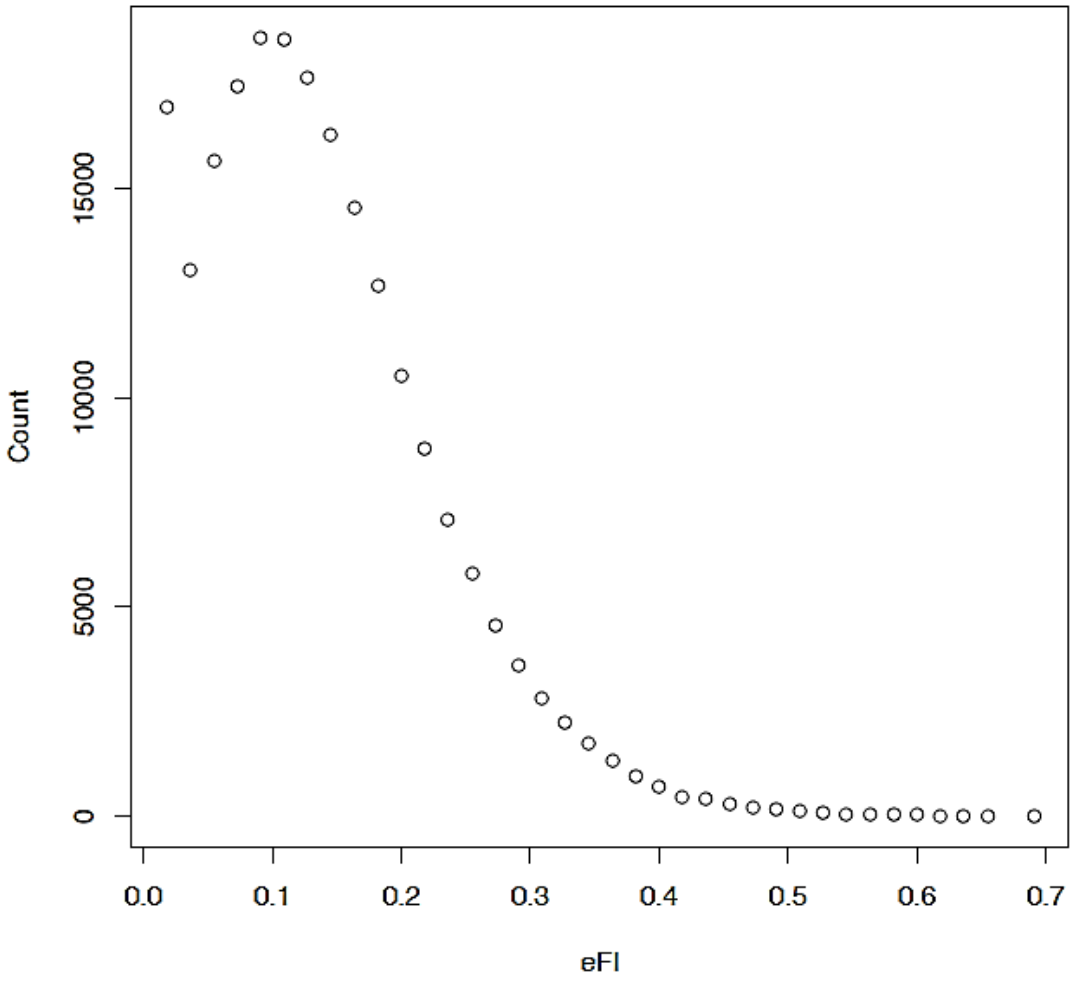
*Mitnitski, Bao, Rockwood., *Mech Ageing Dev* 2006, 127;490-493

eFI Distribution (UK) from routinely collected GP data.



Courtesy of Prof. John Young, Leeds

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