Physical Resilience and Aging: What do we know?

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No conflicts of interest
Outline

- Define Physical Resilience
- Why does it matter?
- What does the research say?
- Take home messages
Physical resilience working definition:

The ability to optimize or recover function in disease, injury, or age-related physical decline

(Peters et al. 2019; Resnick et al. 2011; Whitson et al. 2016)
Existential questions......

➤ Who am I?

➤ Why am I here?
My PhD research (“Who am I?”)

Question: Can mobility rehabilitation be improved with knowledge of biology?

Aim: Examine clinical and physiological recovery of balance and mobility

→ Completed studies in inpatient rehabilitation, sub-acute, and chronic stroke
  • Involved brain imaging, neurophysiology (EEG, EMG, TMS), kinetics/kinematics (motion capture)
My PhD research ("Who am I?")

¬ Main statistical finding
  • On average, better motor function, some improved physiology – but not complete recovery or return to full life participation
Some individuals improve physiologically

(Peters et al. 2014 NNR)
Two patients – “same” stroke

Good outcome
- Lives at home
- Return to work and adaptive activities

Poor outcome
- Lives in long term care
- Long term disability and minimal social activities

What differentiates those who improve from those who do not?
My Burning Question.....

How is it that some older adults can bounce back after injury and others don’t?

Physical resilience
Physical resilience

The ability to optimize or recover function in disease, injury, or age-related physical decline

- Social, psychological, biological
- Combination of factors
(Colón-Emeric et al. 2019)
Physical resilience is multifaceted

- Biology
- Social factors
- Psychology
Biology

- Integrate molecular, cellular, and system-level processes

- Multiple contributors serve as redundancies (GOOD NEWS!)

- Biological **resilience responses** go from seconds (cellular) to months (e.g. recovery of muscle strength after injury)

(Hadley et al. 2017)
Biology

- 2 main stress response systems
  1) Endocrine (hormone): release cortisol
  2) Neural: sympathetic nervous system → release epinephrine/norepinephrine

- Stress systems *mediate stress response* (fight or flight)
  - Rapid energy mobilization to critical muscles and brain → *Get ready for action*

(Deuster 2013)
Biology - Reserve

- Difference between baseline and max capacity to respond
- Some stress increases reserve, too much stress depletes reserve
- At time of Stressor: Degree of reserve → influence response trajectory

(Hadley 2017)
Walking Speed

- Extremely frail
- Risk of death, hospitalization, & falls
- Functional impairments, severe walking disability
- Mortality, mobility, & ADL disability at 2 years
- Highly dependent
- Household walker
- Limited community ambulator
- Community ambulator
- Increased independence in self-care
- Able to do household activities
- Carry groceries & light yard work
- Extremely fit

Intervention to reduce falls, risk for LE limitation & death & hospitalization in 1 year, personal care
Cognitive decline in 5 years

Less likely to be hospitalized or have adverse event, independ in ADL

(Middleton et al. 2016)
Threshold for community walking

Walking speed

Stroke 6 months 12 months
Seals et al. 2016

**Great review article**

Figure 8. The influence of social demographic and psychological factors on physiological function with ageing

A, social influences and psycho-emotional traits may affect physiological function and disease risk with ageing by modulating the fundamental biological mechanisms of ageing. B, these factors may exert their effects in part by stimulating the central nervous system and thereby altering peripheral signalling that influences gene transcription and cellular function.
Psychology - Stress resilience trait

- **Hardiness**
  - Restructure stress to growth opportunities vs. allow it to become catastrophe
  - Characteristics:
    1. High in commitment
    2. High in challenge
    3. High in perceived control (i.e. internal locus of control)

(Maddi et al. 2005; Crust et al. 2005)
"I feel so lucky that I had a stroke....otherwise, I would never have learned how many people care for me...."

-- Stroke patient on the road to recovery
Social factors

- Liver transplant candidates (n=120; Swanson et al 2018)
- +ve relationship between physical function and resilience explained partly by higher levels of active coping and perceived social support
- Active ways patients/family approach medical issues impact ability to adapt and thrive
### Social support

(Koukouli et al. 2002)

#### Table 7: Amount of variance ($R^2$) in functioning explained by socio-demographic variables and physical health status variables (multiple regression analysis with sequential order of entered variables)

<table>
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<th>Models</th>
<th>SORM</th>
<th>SCR</th>
<th>SL</th>
<th>MSCR</th>
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<td>Socio-demographic</td>
<td>32.5***</td>
<td>37.1****</td>
<td>34.8***</td>
<td>15.1</td>
<td>21.7**</td>
</tr>
<tr>
<td>Sex / age</td>
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<td>9.4</td>
<td>11.1</td>
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<td>Education/employment</td>
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<td>5.1</td>
<td>5.4</td>
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<tr>
<td>Social support</td>
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<td>22.4</td>
<td>18.2</td>
<td>3.9</td>
<td>14.9</td>
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<tr>
<td>Physical health status</td>
<td>17.2*</td>
<td>26.8****</td>
<td>24.2***</td>
<td>17.5*</td>
<td>19.9*</td>
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<tr>
<td>Total $R^2$</td>
<td>49.7**</td>
<td>63.9***</td>
<td>59.0***</td>
<td>32.6*</td>
<td>41.6***</td>
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</tbody>
</table>

*** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$
Theory of social regulation of gene expression
1. Interpret life event (THREAT → STRESS)

2. Release adrenaline (FIGHT or FLIGHT)

3. Gene’s make proteins based on signal

4. Translation of social conditions to systemically distributed signaling molecules

5. Ultimately impact behaviour and health
Gene expression based on levels of social isolation

**Genes supporting early immune response—\textit{inflammation}—were selectively up-regulated in lonely older adults**

(Cole 2013; Cole et al 2007)
Biological mechanisms that determine the body’s dynamic capacity to respond

Outcomes
(Observations used to quantify response and recovery phenotypes)

Reserve
Psychology
Social Factors

(Colón-Emeric et al 2019)
Physical Health is more than biology

- Residents in a nursing home
  - Group 1: Arrange furniture, go where they wanted, spend time with whom they wanted, etc; *(given control + responsibility)*
  - Group 2: Told that staff *there to take care of and help them*
- Group 1 improved health; Group 2 a greater proportion had died
- **Personal control as we age**

(Mallers et al. 2013 *The Gerontologist*)
Physical fitness – A path to physical resilience?

- Regular physical activity induces +ve physiological, psychological, and social benefits
  - Protective for stressful events
  - Reduced risk of chronic disease

(Deuster 2013)
How to increase physical resilience in aging?

- Not a recipe……These are suggestions
- Maximize function NOW
  - Biology → Physical activity
    - With movement difficulty, see Physiotherapist
    - Questions re: type/intensity/dose for specific physiological functions like cognitive/motor/vascular etc.
  - Psychology
  - Social factors
- If/when pathology strikes → maximize YOUR physical resilience resources
Take home messages

- Physical resilience is complex
  - Intersections between biology, psychology, and social factors
  - Good news → can tap into redundancies or elements of strength to navigate stressors

- Future work to incorporate into rehabilitation
Acknowledgements

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