



## Examination of Post-hospital Residential Brain Injury Rehabilitation Outcomes Across the Age Spectrum

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# Aging and Brain Injury

## Objectives:

Review and understand aging process for those injured and within normal develop.

Impact – How does the brain adapt?

Role of Exercise and Activity

Aging Study outcomes – Does Age matter when it comes to rehabilitation outcomes?

# Aging Today

## Ageism and Stereotypes

Cultural context influences how people experience growing old.

Examples include the following:

In the United States, ageism—negative stereotypes of older adults —is common.

In Asian nations, older people are honored—*filial piety*. Youth are considered immature and unknowledgeable.

## **Youth and Moderate to Severe TBI %**

# Children and Adolescents

## Child and Adolescent outcomes in TBI in the US

The earlier the injury, the greater the life-time disability.

### Research from Mary Free Bed Rehabilitation Hospital

Michigan, 2010 data presented to NAN International Conference

Noted that those injured pre-teen years were never likely to work or have ability to graduate high school.

Noted that those injured from 11-15 had a limited ability to work in their lifetime, likely at a less competitive level, but would graduate with a high school degree (with assist)

Noted that those injury 16-18 were likely to work with assist at a semi-competitive level or higher, likely to graduate high school with or without assist.

## **Adults and Moderate to Severe TBI %**

# Quick Statistics

## TBI and Adults for Moderate to Severe Injury

Horn & Lewis, 2014

Research review and analysis using 1040 individuals from a total sample of Moderate to Severe TBI only

Analysis – Multiple Analysis of Variance (significant results at  $p < .01$ )

Results/Findings: the sample demonstrated almost equal distribution of age ranges from 18-65+ averaging 75 individuals per group (ages 18-24, 25-34, 35-44, 45-54, 55-64, and 65+)

The sample demonstrated significant reduction of disability with a comprehensive rehabilitation program noting changes from admission to discharge (average length of stay 5 months for the total sample). However, age did not significantly impact whether disability was reduced or not. The youngest group had the best level of adjustment.

# Age and Moderate to Severe TBI %

## Aging in TBI in the US

<18 years: 9.6%

18-24 years: 17.3%

25-34 years: 17.8%

35-44 years: 16.3%

45-54 years: 20.9%

55-64 years: 14.9%

65+ years: 3.3%

Working group was 25-64 year olds.

Total sample: 707 cases selected from a sample of 1040 cases

# Normal Aging Health Concerns

# Health and Disease (CDC)

## Chronic health problems, most common:

**Conditions contributing to Cardiovascular disease:** high blood pressure (40%); smoking (13%); poor diet (13%); insufficient physical activity (11%); and abnormal blood glucose levels (8%).

- **Hypertension:** 33% of the US population; 44% prevalence with AA
- **Arthritis:** 9% of adults have been diagnosed; another 22% self-report
- **Sensory impairments:** reduced vision, reduced sensation - neuropathy
- **Type 2 Diabetes:** 8% of the population diagnosed; estimated another 8% of the population is undiagnosed; 38% considered pre-diabetic
- **Obesity:** increased in 20 years – 35% of adults are obese and is related to heart disease, stroke, and diabetes.
- **Atherosclerosis** (related to excess fats in diets); 13% of the population has high cholesterol levels
- *Misuse of medications leads to drug interactions or changes in metabolism.*
- **Smoking:** 20% of men, 15% of women smoke; 40% of the population remains at risk for second hand smoke

# Health and Disease w/TBI

- *The rate of developing co-existing conditions following TBI is not necessarily any more or less than without TBI.*
- However, what is beginning to be clear is when a person sustains a TBI, then they will have greater difficulty with self-management and medical management. This difficulty with management of health is more or less depending upon severity; the greater the injury severity, then greater assistance will be needed for better health management.
- Research: the combination of TBI and diabetes resulted in a life span reduction of 25 years as compared to those with TBI without Diabetes.

# Health and Disease w/TBI

## According to the CDC – 2014

- Death rates peak in TBI from 0-44 years of age, and 75+ years of age.
- TBI is the leading cause of death and disability in the United States.

### Other stats:

Motor Vehicle Collision – 34% (most often 15-24 year olds)

Falls – 17% (most often 75+ years old)

Firearms – 35% (most often with minorities; younger)

**Normal Aging decline...**

# Mental Processing Changes in Advanced Age

In neuropsychology, significant age related change in healthy normal cognitive functions is thought to begin at 50.... But why???

## SMALL VESSEL ISCHEMIC DISEASE

Understanding various aspects of processing

Processing speed declines; slower on memory tasks; problem solving takes longer

Memory affected by aging

sensory memory declines

speed of working memory decreases

may take longer to organize, rehearse, and encode information

long-term memory may decline

But, overall, age-related declines in memory are gradual and non-consequential, unless disease processes (like Alzheimer's disease) are involved.

# Cognitive Decline

## *Dementia*

- chronic confusion, forgetfulness, and accompanying personality change
- serious and life-altering

## General causes of cognitive decline

- poor general health, non-stimulating environment, taking many prescription drugs

## Specific causes of cognitive decline

- strokes
- atherosclerosis
- Alzheimer's disease

# Adulthood and Aging

## The Shrinking, Slowing Brain

Brain loss: 5-10% of weight in ages 20 to 90

Death of brain cells

Shrinkage of prefrontal cortex

General slowing of function in brain and spinal cord begins in middle adulthood and accelerates in late adulthood

Reductions in neurotransmitters

# Sleep concerns

Many adults don't get enough sleep

Middle age may bring sleep problems

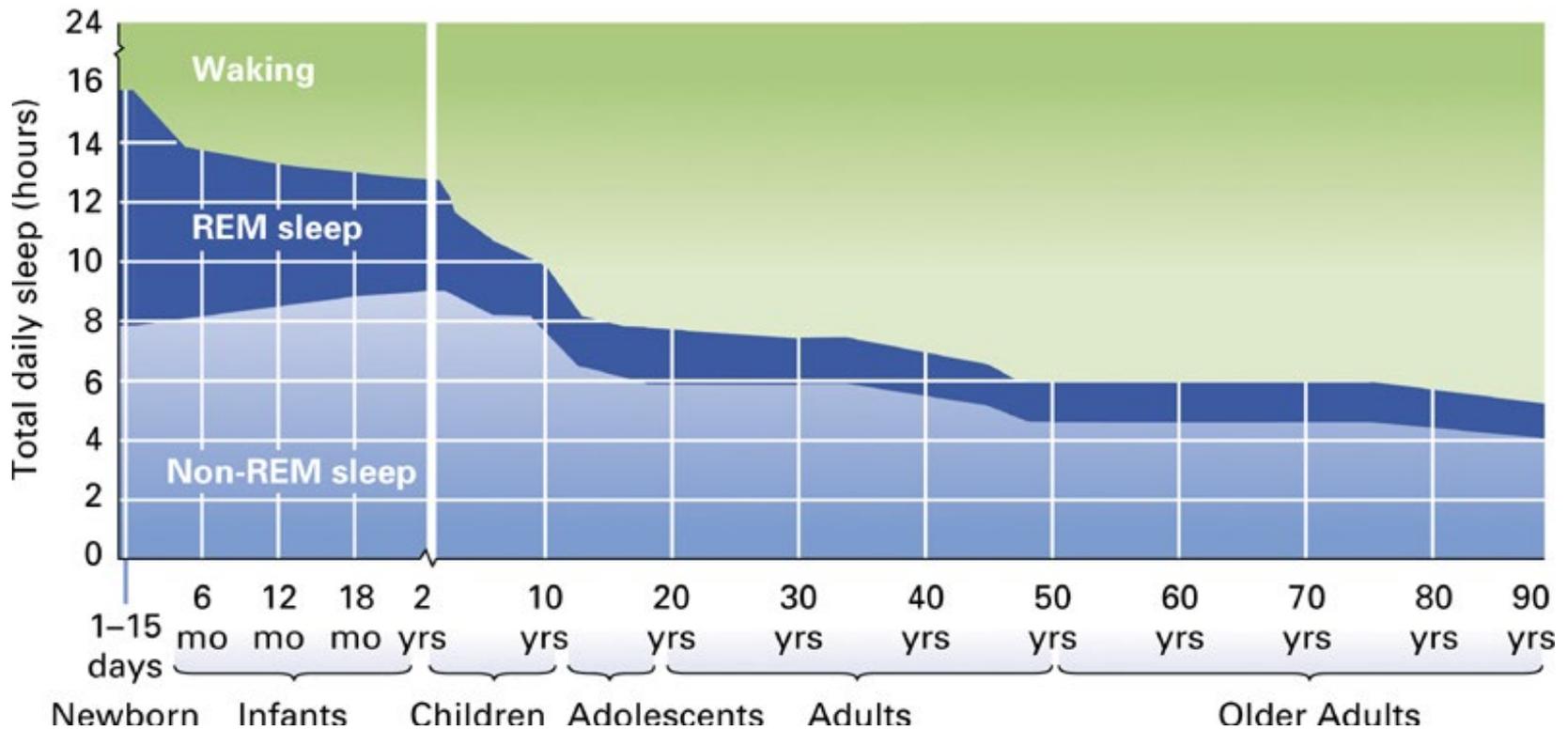
Wakeful periods at night, less deep sleep

Many older adults go to bed earlier at night and wake up earlier in the morning

Afternoon naps

Insomnia increases in late adulthood

# Sleep Across the Human Life Span



## Primary Causes of TBI with Aging

Falls-highest age 0-4 and age 70 and older – the most likely injury is hip fracture and subdural hematoma

Falls greater for older women than men

2/3 of those who fall will fall again within 6 months

At least 1/3 of all falls among older people involve environmental hazards in the home

Those who fall are 4 to 5 times more likely to be admitted to a long-term facility

**60% of falls occur at home**

**More likely to fall if taking 4 or more meds**

# Brain Injury and Aging

It appears that a brain injury makes the aging process even harder, causing epilepsy and increase the risk for conditions such as Alzheimer's disease, Parkinson's disease, and other brain disorders that become more prevalent with age. (CDC, 2014)

NFL – higher incidence of ALS than in the general population , with an increased risk of developing Alzheimer's Disease, non-Alzheimer's Disease-related dementia, and brain atrophy.

It seems that the coping mechanisms that were set up when a person with a brain injury was younger decay as the portions of the brain that were called up to replace the injured portions age and die away.

This means that older persons with brain injuries could have a greater need for in home supports and specialized care.

(ref: Pharmacopsychiatry DeDeyn et al)

# The Adapting Brain

# The Adapting Brain

Unlike a computer, the brain has repair capacity

Grows new brain cells throughout life

Dendrite growth continues through 70s

More myelination between frontal cortex and limbic system facilitates reflection

Extent depends on environment and activity

Neuropsychological research in 2010 revealed that a minimum of 30 minutes per day of physical and cognitive exercise may be sufficient to produce stability and improvement in the normal aging brain and may assist in brain injury as well.

# Adapting Brain

Activities of older adults can influence the brain's development

fMRI study: Erickson, et al (2009) revealed higher levels of aerobic fitness were linked with greater volume in the Hippocampus, better memory.

MRI study: Green, et al (2013) revealed that enriching environments reduce atrophy of the brain in moderate to severe injuries.

Wilkes & Gage (2009) revealed neurogenesis occurs in humans: hippocampus and olfactory bulb were noted in the study.

## Adapting Brain

From the 40s through the 70s the growth of dendrites can increase, but may be dependent on multiple factors and can occur with or without injury.

Eliasieh, et al (2007) Dendritic growth might compensate for loss of neurons.

This means that although the neurons may reduce in total number as we age, the importance may be in the total number of connections rather than the total number of neurons.

Higher number of connections may result in higher efficiency

# Adapting Brain

## Lateralization

Most older adults use both hemispheres more equally

Compensation for loss of processing capabilities

Use of cognitive activity to stimulate both hemispheres rather than localizing to one hemisphere or a region.

Concept – when you work out, do you just ride your bike with one leg?

When you lift weights, do you use one arm?

## Exception

T. Boone Pickens (81) – lateralization much more characteristic of younger adult; this may be a factor of the maturing brain.

# Adapting Brain: Exercise

# Exercise

The brain needs oxygen to function

Exercisers out perform “couch potatoes” in Long-term memory, Reasoning, Attention, and Problem Solving

Medina (2008) noted that exercise seems to be “one of the greatest predictors of successful aging”

Life time risk for general dementia is cut in half if you participate in regular physical exercise

- Aerobic exercise decreases risk of depression and anxiety

- Releases neurotransmitters: serotonin, dopamine, and norepinephrine

- Exercise beneficial short and long term for both men and women

- Effective for the elderly

# Adaptive Brain: Mental Activity

## Adaptive Brain: Mental Activity

Does participation in mentally challenging activities such as Sudoku or crossword puzzles slow cognitive decline as we age?

Research is equivocal until 2010, effect may be difficult to determine based on current methods because there is not standard of what constitutes “mental activity”

Research suggestive: lifetime of challenging mental activity result in less decline of intellectual skills as we age



# Recovery Has No Age Limit

An Examination of Post-Hospital Brain Injury Rehabilitation Outcomes Across the Age Spectrum

BASED ON THE STUDY BY FRANK D. LEWIS, GORDON J. HORN, AND ROBERT RUSSELL (2017)

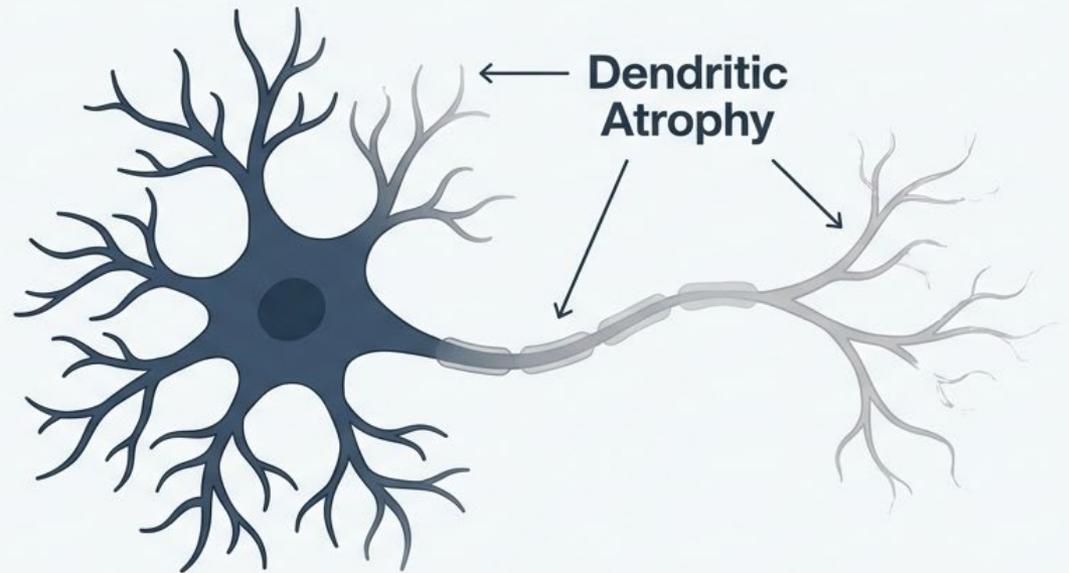


# The Plasticity Paradox

Neuroscience suggests that as the brain ages, it undergoes dendritic atrophy, myelin sheath deterioration, and a reduction in dopamine and serotonin—neurotransmitters critical for learning.

## The Assumption:

Clinical logic suggests older adults (60+) have declining neuroplasticity and should recover less effectively from TBI than younger patients.



## Challenging the Consensus

Does **biological aging** actually  
limit **functional recovery** in a  
post-hospital setting?

### Objective:

To evaluate functional changes from admission to discharge in chronic TBI patients and determine if Age is a statistically significant variable in the outcome.

# The Cohort

**N = 651 Participants**  
**32 Residential Programs**  
**15 States**



## Gender:



## Condition:



## Severity at Admission:



# The Yardstick: MPAI-4

## Mayo-Portland Adaptability Inventory-4



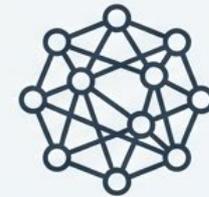
### Abilities Index

Measures physical and cognitive skills including mobility, memory, and verbal communication.



### Adjustment Index

Measures emotional and behavioral skills including anxiety, irritability, and impaired awareness.



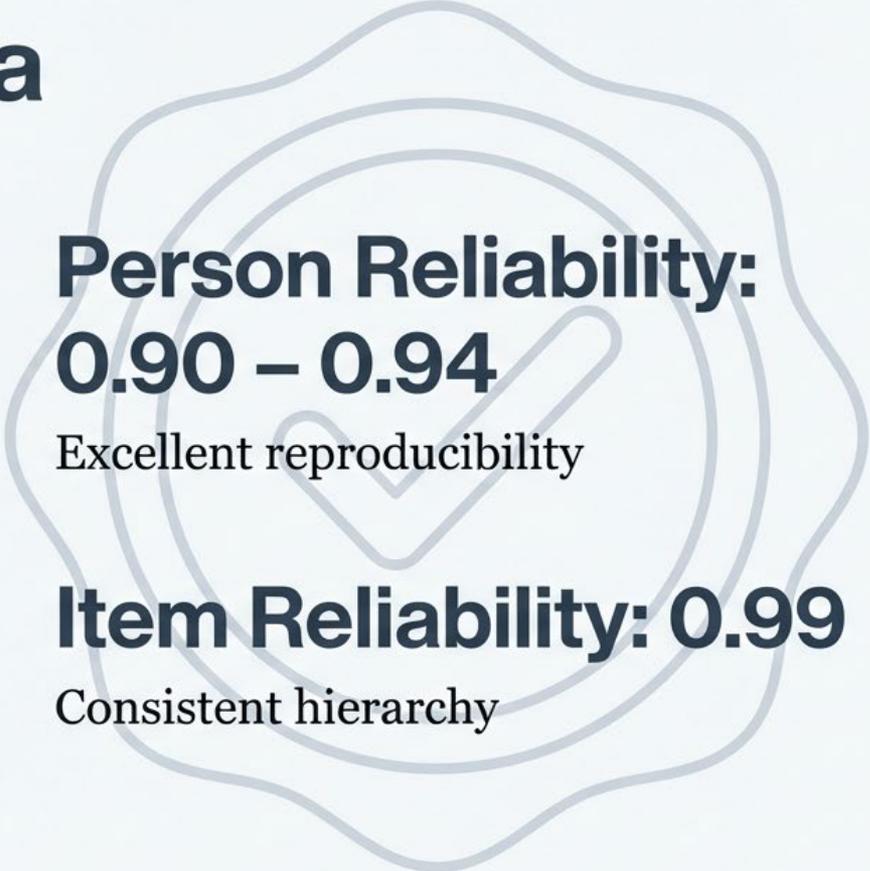
### Participation Index

Measures contextual application including social contact, paid employment, and leisure skills.

Scoring: 0 (No limitations) to 4 (Severe problem). Lower scores indicate higher function.

# Validating the Data

Before analyzing outcomes, Rasch analysis confirmed the psychometric stability of the MPAI-4 for this specific population. This ensures that the measurement tool is reliable and the item difficulty hierarchy is consistent.



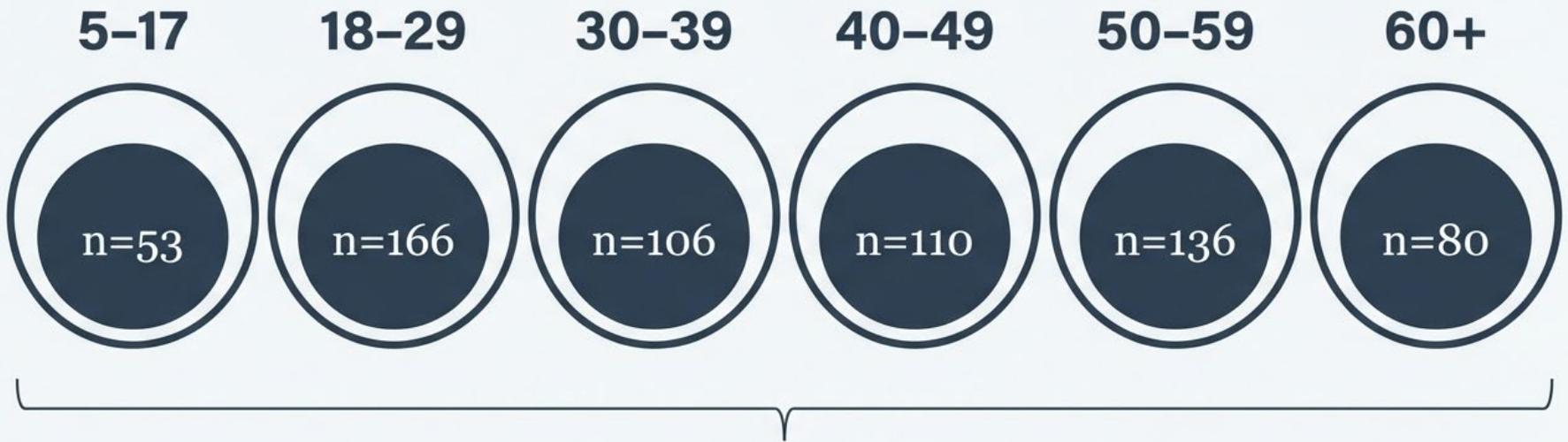
**Person Reliability:**  
**0.90 – 0.94**

Excellent reproducibility

**Item Reliability: 0.99**

Consistent hierarchy

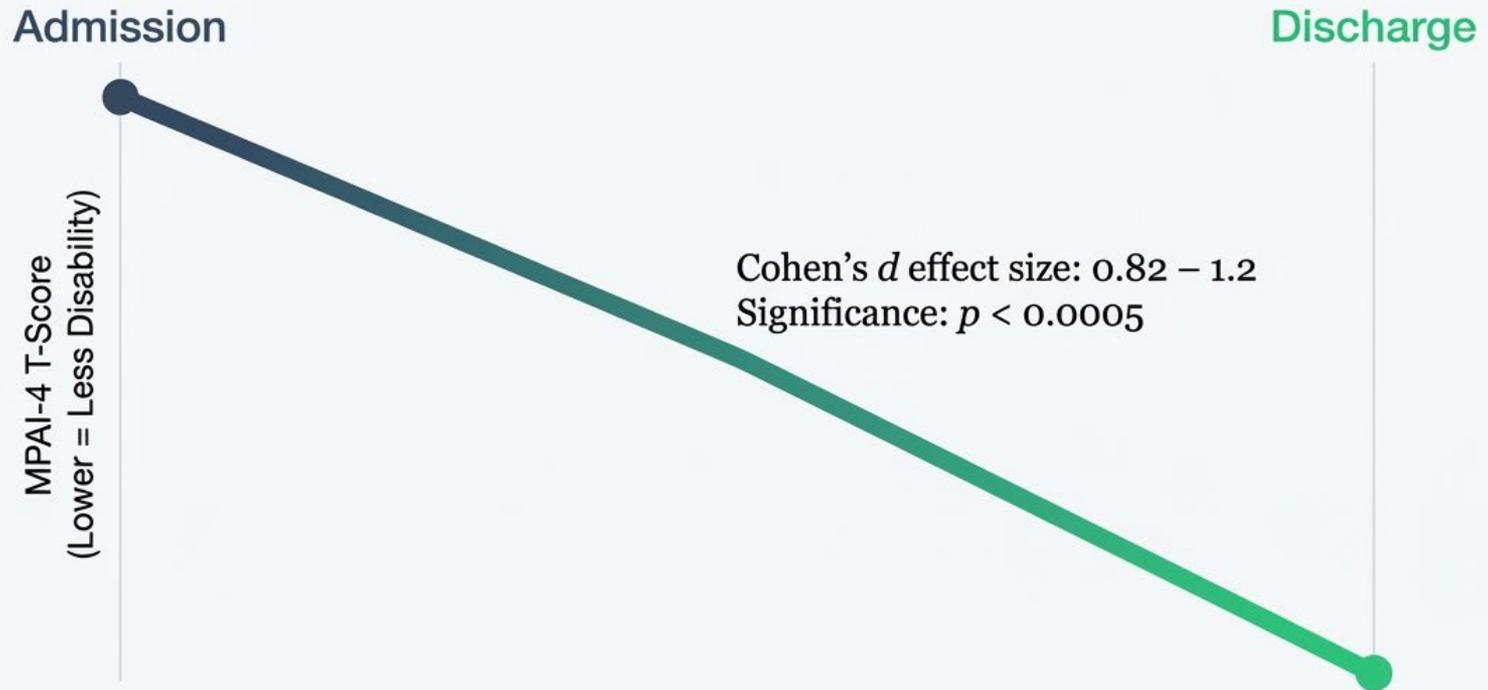
# The Spectrum of Age



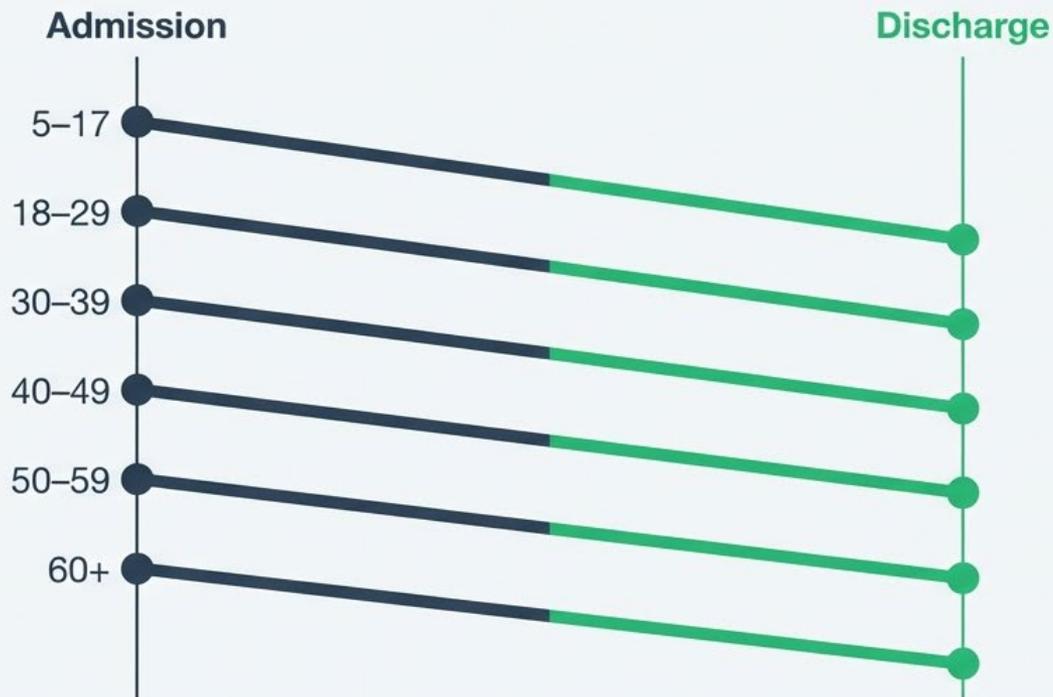
Study Range: 5 years to 81 years old

# The Universal Lift

Post-hospital rehabilitation effectively reduces disability for the entire population.



# The Flat Curve of Recovery



**Key Insight:  
No Significant Difference.**

A Repeated Measures MANCOVA revealed that improvement did not differ as a function of age group. The slope of recovery is identical regardless of biological age.

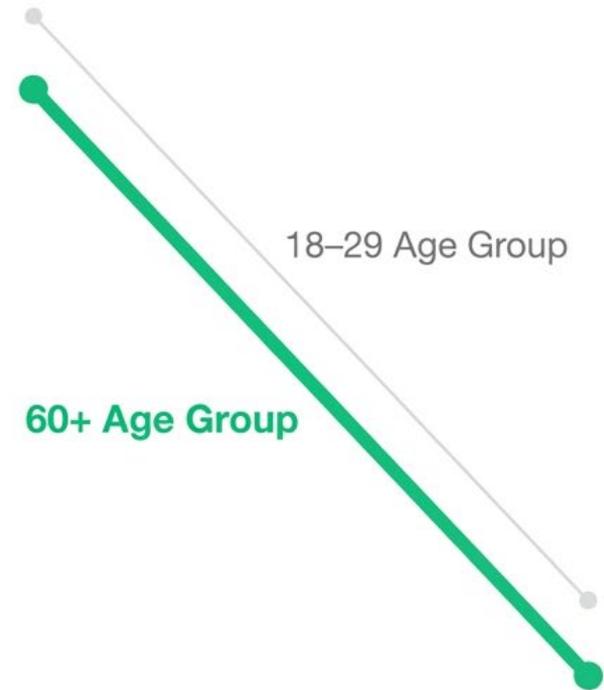
# Defying Biological Expectations (60+)

Despite biological factors like dendritic atrophy and decreased neurotransmitters, the 60+ cohort performed equivalently to the youngest cohorts.

Data controlled for Length of Stay (LOS) and Chronicity.

Admission

Discharge



# The Adolescent Anomaly



**The Sleeper Effect:** 79% of this group were aged 12-17. Residual effects from early childhood TBI often do not manifest until adolescence, when complex social and cognitive demands increase, leading to a delay in seeking treatment.

# Beyond Physical Capability

Improvement was significant across all dimensions of life.

**Abilities**  
(Mobility, Memory)



$p < 0.001$

**Adjustment**  
(Anxiety, Depression)



$p < 0.001$

**Participation**  
(Social, Employment)



$p < 0.001$

# Limitations



- **End Point:** The study concluded at the time of discharge; long-term durability of skills post-discharge was not measured.
- **Environment:** The study focused on residential neurorehabilitation; results may differ in outpatient settings.

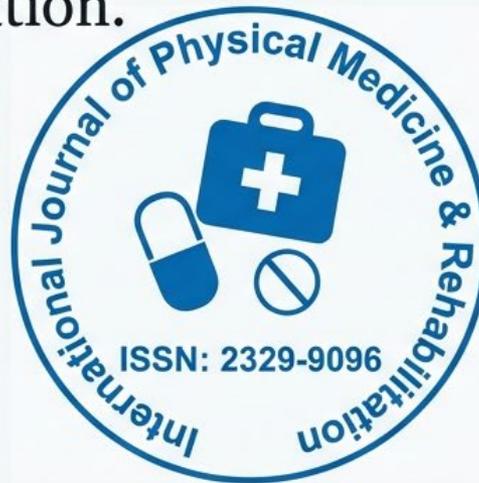
# Age Is Not A Barrier.

While age increases the risk of TBI, it does not reduce the benefit of treatment.

Post-hospital care effectively fills the gap between hospital and home, providing efficacious services for all age groups—from 5 to 81.

# References & Credits

Lewis, F. D., Horn, G. J., & Russell, R. (2017). Examination of Post-Hospital Residential Brain Injury Rehabilitation Outcomes Outcomes Across the Age Spectrum. II Journal of Physical Medicine & Rehabilitation.



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# | Questions



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