SPACEFLIGHT MEETS GERIATRICS

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European Innovative Partnership Active & Healthy Aging
Falls Prevention Task Force
Our Life Long Fight Against Gravity
The Gravity Dilemma

Launch (3g) → Space (μg) → Earth (μrg) → Re-entry (1.6g)
Deconditioning Time Course

Each physiological system acclimates to microgravity at a different rate
Muscles Affected in Microgravity

- Erector spinae m.
- Iliopsoas m.
- Quadriceps femoris m.
- Hamstrings
- Soleus m.
Bone Loss in Space

- 300-1900 N (Spine)
- 1400-2500 N
- 2000-3000 N
- 1500-2000 N

- + 0.6% /mo. (Skull)
- + 0.1% /mo. (Arm)
- - 1.07% /mo. (Spine)
- - 1.35% /mo. (Pelvis)
- - 1.16% /mo. (Femoral Neck)
- - 1.58% /mo. (Greater Trochanter)
- - 1.25% /mo. (Tibia)
- - 1.50% /mo. (Calcaneus)
Fluid Shifts in the Body

1. On Earth, blood tends to pool in the lower body.
2. Promptly upon entering weightlessness, fluids shift toward the head.
3. After a time, the body adapts to weightlessness. The kidneys reduce the volume of fluid, relieving pressure in the head and chest.
4. The body reacts immediately upon reentering Earth’s gravity; fluids are shifted from the head toward the feet.
Orthostatic Intolerance
Simulating Orthostatic Challenge

Head up Tilt

Lower body negative suction
Orthostatic Intolerance Testing

HUT + \implies\textbf{Presyncope}

LBNP
Aging and Healthcare Costs Trends

EU Aging Report, Brussels

17% 30% 2013 2060

Countries

Costs

EU Aging Report, Brussels
Experiencing unexplained falls or blackouts?

One in ten falls in elderly people are caused by syncope (faints)

Prevention and treatments are available
Immobilization in Older Persons
Bedrest Simulates Spaceflight Deconditioning

6° HDT
6° Head-down Bedrest Immobilization

ESA ©
Frailty: A Vicious Cycle

Immobilization ➔ further ➔ Falls / Fear of falling ➔ De-conditioning
Hospitalization in Older Persons

- 65+ year old patients → 40% acute hospitalizations
- Poor outcomes:
  - ... high 1 year mortality
  - ... 30% functional decline
  - ... high re-admission rates
  - ... higher home healthcare usage
• Keeping ambulatory persons mobile
• Getting bed-confined persons re-mobilized

Many studies: Ambulatory care

Lack of *bedrest immobilization* studies & *care strategies* in older persons
Exercising During Bedrest

Manual Physiotherapy
Exercising in Space

NASA ©
Prof Joern Rittweger, DLR, running in the supine position (DLR ©)
Vibration Exercise

Powerplate©)
Resistive Vibration Exercise During Bedrest

ESA©)
Resistive Vibration Exercise During Bedrest
Acute Immobilization ➔ Active and Healthy Aging

- Immobilization Screening
- Interventions
- Discharge Management
- Behavioral Change
- "Buddies"

Active & Healthy Aging
Impact and Outcomes

**MACRO LEVEL**
- Improving geriatrics care
- Saving in healthcare costs

**MESO LEVEL**
- Regional Falls prevention initiatives
- Establishing community based structures

**MICRO LEVEL**
- Falls prevention in older persons
- Effectiveness of interventions
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Aging and Spaceflight

Aging

Cardiovascular

Syncope

Musculoskeletal

Nutrition

Spaceflight
"Gravitational Physiology, Aging and Medicine" Unit

Geriatric Institutions

Space Agencies

Expertise

• Cardiovascular regulation
  - Hemodynamics
  - Hormones
  - Autonomic function

• Orthostatic intolerance

• Vascular health & function
Medical institutions
Social institutions
Companies & IT providers
Aging Platforms
Other Stakeholders in Geriatric care

National Partners
International Partners
Selected International Collaborators

- Daniel Devigo, Ciudad Autónoma de Buenos Aires, Argentina
- Patrick DeBoever, VITO, Mol, Belgium
- Paul Dendale, University of Hasselt, Belgium
- Andrew Blaber, Simon Fraser Univ., Vancouver, Canada
- Yunfang Gao, Northwest Univ., Xian, China
- Ines Drenjancevic, Univ. Josip Juraj, Osijek, Croatia
- Jörn Rittwegger, German Space Agency (DLR), Germany
- Laszlo Simon, Semmelweis Univ., Budapest, Hungary
- Giovanna Valenti, Univ. of Bari, Italy
- Satoshi Iwase, Aichi Medical Univ., Japan
- Inessa Kozlovskaya, IBMP, Moscow, Russia
- Rado Pisot, Univ. of Primorska, Slovenia
- Hans Strijdom, Univ. of Stellenbosch, Cape Town, South Africa
- Benedicta Chungag, Walter Sisulu University, Mthatha, South Africa
- Jean-Pierre Montani, University of Fribourg, Switzerland
- David Green, King’s College, London, UK
- Voyko Kavacic, Institute of Gerontology, Wayne State University, Michigan, USA
- Germaine Cornillessen, Halsberg Chronobiology Center, Minnesota, USA
International cooperation for Space life Sciences knowledge sharing & development in Africa

International Academy of Astronautics (IAA):
Commission 2 – Space Life Sciences Study Group Report
Spaceflight studies support geriatric health on Earth

Understanding the links between spaceflight physiology and the aging process can lead to improvements in human health not only for astronauts living in microgravity but also for older people living on Earth. This article provides a general overview of important physiological consequences of spaceflight, the aging process in humans on Earth, and important connections between these physiological states.

Ever since our ancestors started walking upright, the human body has adapted to the effects of gravity. For example, during standing the human heart—despite being located below the brain—is able to pump enough blood to the brain against the force of gravity to maintain proper brain function. The pooling of blood in the legs—which occurs due to gravitational forces—is counteracted by the muscle pump in the lower limbs by one-way leg venous valves as well as by the action of breathing. Additionally, the weight-bearing bones and anti-gravity muscles have adapted during evolution to ensure adequate support during standing. Thus humans can stand up without any real problems.

The real importance of gravity on physiological systems is, however, seen when gravity is reduced or taken away, as in the microgravity environment.