



INTESA SANPAOLO
INNOVATION CENTER

INDUSTRY TRENDS REPORT **REHABILITATIVE ROBOTS**

FROST & SULLIVAN





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EXECUTIVE SUMMARY

Globally, social and demographic changes are creating a major disease burden and, in turn, driving demand for an evolution or even a revolution in healthcare.

There is some variation but outside of Africa countries in the Asia-Pacific region broadly have the largest aging populations in absolute and relative terms while the World Health Organization estimates that approximately 15% of the world's population is living with a form of disability.

The growing need for effective care stretches across the continuum and notably covers support with chronic disease management, including rehabilitation.

Overall, innovation represents a key element of the health industry's response to these challenges with assistive technologies one of four principal focus areas. Here, rehabilitative robots are central to a virtuous circle of technological convergence which promises to benefit healthcare providers and patients alike.

In broader terms, rehabilitative robots sit within the market for **rehabilitative devices**.

Vision rehabilitation devices manage diseases such as macular degeneration with VisionCare (US) developing implantable ophthalmic solutions while **cognitive** rehabilitation devices target, for example, neurodevelopmental disorders including those provided by Neuron UP (Spain) which hosts web sites for brain stimulation.

Speech and language rehabilitation devices address conditions like aphasia for which Lingraphica (US) supplies alternative communication methods while **audiologic** rehabilitation devices combat conditions including congenital hearing loss and include Advanced Bionics' (Switzerland) cochlear implant systems.

In addition to an aging population, uptake of rehabilitation devices is being driven by growing demand for active lifestyles across generations, but the prohibitively high costs and slow regulatory process restrain more rapid roll-out of next-generation systems and solutions.

In the longer term, **virtual** rehabilitation is expected to play a more prominent role while, in the short term, **manual** solutions will continue to dominate the overall market with robots taking further share in the **physical** rehabilitation device segment.

The commercialisation of **rehabilitative robots** has been enabled by the development of soft robotics which is characterised by the use of compliant materials. Within this, innovations in **exoskeletons** – wearable robotic technologies – represent a gamechanger for rehabilitation and boast applications across industries.

Exoskeletons can be classified according to the body part that they serve and their form as well as the actuation technology that they use. Overall, the market is growing by 41.1% compound annual growth rate (CAGR, 2018-25) globally and is expected to be valued at \$6.7 billion by 2025, an increase from just \$1.9 billion in 2022.

The healthcare and broader biomedical industry is driving exoskeleton adoption and shaping technological developments in the space. Rehabilitation applications, in particular, have been at the forefront of innovation and continue to attract significant research and development (R&D) dollars and commercial successes.

Players launching new rehabilitative robots include specialist like Robocare (Philippines) which is testing Hybrid Assistive Limbs on behalf of its national government. They are joined by big diversified industrial groups such as Toyota (Japan) which has released a robotic medical suit for healthcare clients while academia is also playing a role with researchers from MIT in the US developing a soft-assistive to help rehabilitate patients with hand muscle weaknesses. Established participants in the space include Wandercraft (France), Cyberdyne (Japan) and Rewalk Robotics (US) as well as the start-up UniExo (Ukraine/US).

Overall, the market is characterised by partnerships with Ekso Bionics (US) teaming up with US Physiatry and Kindred Healthcare to grow its exoskeleton range. In the future, they and other players will need to address technical challenges around actuator technologies to differentiate themselves. More generally, investment in untethered exoskeletons will allow the use of rehabilitative robots outside of conventional hospital settings.

For rehabilitative robots and devices, **stroke care** is a major and growing application area with more than 12.2 million cases recorded globally each year.

Overall, the segment generated revenues of \$5.6 billion in 2022 and this figure expected to reach \$8.6 billion by 2027, a CAGR of 9.1%, with rehabilitation key in the post-acute and post-hospital phase, covering speech, occupational and physical therapy.

Exoskeletons form part of the stroke care continuum and are joined by other rehabilitative robots as well as new non-invasive brain stimulation solutions. Here, Ottobock (Germany) is a market leader, providing stroke victims with robotic and more conventional orthopaedic rehabilitation devices.

Moving forwards, Artificial Intelligence has a growing role to play in improving stroke diagnoses and delivering better patient outcomes. Evolution Devices and Motus Nova (US) are notably deploying AI in the rehabilitation sector in their “EvoWalk” and “Hand and Foot Mentor” solutions while, in the future, robotic wearables will also contribute to post-stroke care with the De La Salle University (Philippines) leading the charge here.

This report examines the place of **rehabilitative robots** as a rapidly emerging solution suite in the context of a wider **rehabilitative devices** market. Greater innovation on the supply side combined with improved understanding on the demand side suggests that exoskeletons and related systems can play an immediate and enduring role in addressing **stroke care**. More broadly, robots have the potential to support a wide range of patients as the healthcare industry increasingly looks to technology to deliver effective and efficient rehabilitation.



INTRODUCTION

Globally, social and demographic changes are creating a major disease burden and, in turn, driving demand for an evolution or revolution in healthcare

Among the older population, there is a heightened risk of developing diseases like diabetes and hypertension which limits people's physical mobility.

In parallel, the elderly often experience social isolation and loneliness which can negatively impact an individual's mental health and/or quality of life.

Together, the physical and psychological effects of aging generate social and economic challenges for patients individually and the healthcare system generally. The growing disease burden is fueling innovations in virtual care and self-management devices which improve the care continuum and promote active and independent aging.

According to statistics by the World Health Organization (WHO):

- by 2030, 1 out of 6 people will be 60 years old or older
- in 2020, seniors aged 60 and over outnumbered children aged 5 and below
- the elderly population will almost double from 12% in 2015 to 22% in 2050 which corresponds to a total of 2.1 billion (b) people

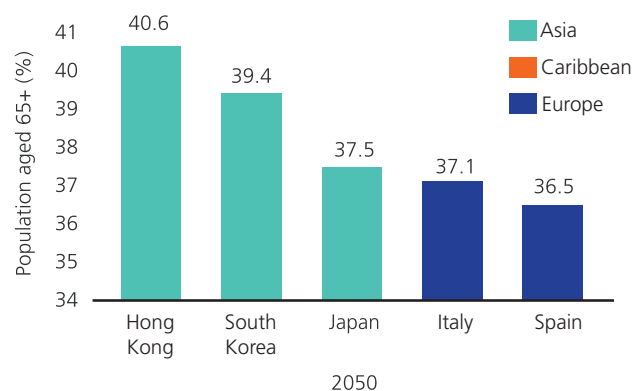
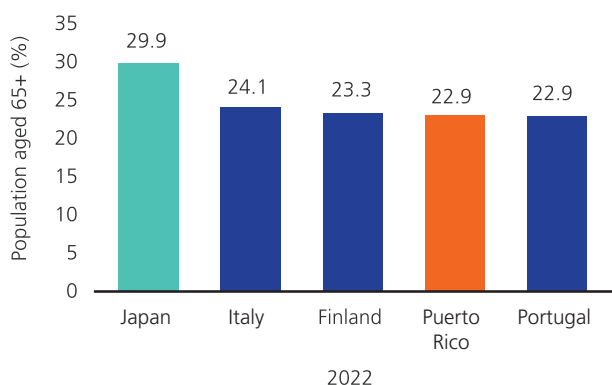
There is some variation but outside of Africa countries in the Asia-Pacific region broadly have the largest aging populations in absolute and relative terms ...

An analysis reveals that China, India and the United States have the most significant groups of adults over 65 years of age with 166 million (m), 85m and 53m respectively.

As a percentage and as shown in the graph below, Japan currently leads the way with 30%, followed by Italy (24%) and Finland (23%). By 2050, Hong Kong and South Korea will leapfrog the top 2.

The growth of the aging population is accelerating overall both in developed and developing countries prompting the UN to schedule a Decade of Healthy Ageing 2020-2030 to promote sustained and collaborative efforts toward healthy aging.

AGEING POPULATIONS IN RELATIVE TERMS, GLOBAL, 2022 AND 2050



... while the World Health Organization estimates that approximately 15% of the world's population is living with a form of disability

Patients requiring some degree of support include those suffering from *neurodegenerative diseases* (such as multiple sclerosis, Parkinsons or amyotrophic lateral sclerosis), *neuromuscular disorders* (like dystrophies, myopathies or neuropathies) and *neurovascular traumas* (for example strokes) as well the direct repercussions of accidents.

The growing need for effective care stretches across the continuum and notably covers support with chronic disease management, including rehabilitation

Elderly care includes:

- *chronic disease management*, which encompasses diagnostics, monitoring and **rehabilitation**
- broader *health monitoring*, which covers devices that track a senior person's sleep and day-to-day activities to help prevent falls and send emergency alerts
- *medication management*, which includes smart pill dispensers or virtual assistants to enable the older population to take medication
- *mental health and cognitive care*, which captures support for social well-being
- *mobility and independence management*, which comprises physical assistance

Overall, innovation represents a key element of the industry's response with assistive technologies one of four principal focus areas

Assistive Technologies help the elderly and others perform activities that frailty makes difficult. This includes hearing devices, mobility devices, prostheses, orthoses and communication aids. Emerging technologies, such as virtual care assistants, robotic assistants or smart pill dispensers, improve elderly care, promoting users' independence and supporting "active aging".

Health Monitors detect any anomaly in patients' vital signs and ensure caregivers or doctors act quickly to prevent the exacerbation of a disease or condition. Beyond healthcare, these solutions can also enable lifestyle monitoring, detect falls and help ensure that the user remains safe and also independent.

Point-of-care Diagnostics manage the health of patients without their needing to travel to diagnostic centers or hospitals. Online- and smartphone-based services, virtual consultations, digital biomarkers and lateral flow assays are among the solutions that can enable doctors to make diagnoses remotely.

Advanced Therapies treat largely age-related diseases, such as arthritis, pulmonary diseases, dementia and Alzheimer's.

The background is a dark blue gradient with several glowing blue lines and dots, resembling a network or data visualization. The lines are curved and intersect, with small dots placed along them. The overall effect is a sense of dynamic movement and connectivity.

PRINCIPAL ABBREVIATIONS

AAC	<i>Augmentative and Alternative Communication</i>	IMU	<i>Inertial Measurement Unit</i>
AI	<i>Artificial Intelligence</i>	M	<i>Million</i>
B	<i>Billion</i>	ML	<i>Machine Learning</i>
BES	<i>Bioelectric Signal</i>	MRI	<i>Magnetic Resonance Imaging</i>
CAGR	<i>Compound Annual Growth Rate</i>	PC	<i>Personal Computer</i>
CT	<i>Computed Tomography</i>	PDA	<i>Personal Digital Assistant</i>
GUI	<i>Graphical User Interface</i>	R&D	<i>Research & Development</i>
HAL	<i>Hybrid Assistive Limb</i>	SGD	<i>Speech-Generating Device</i>
HULC	<i>Human Universal Load Carrier</i>	VR	<i>Virtual Reality</i>

ABOUT INTESA SANPAOLO INNOVATION CENTER:

Intesa Sanpaolo Innovation Center is the company of Intesa Sanpaolo Group dedicated to innovation: it explores and learns new business and research models and acts as a stimulus and engine for the new economy in Italy. The company invests in applied research projects and high potential start-ups, to foster the competitiveness of the Group and its customers and accelerate the development of the circular economy in Italy.

Based in the Turin skyscraper designed by Renzo Piano, with its national and international network of hubs and laboratories, the Innovation Center is an enabler of relations with other stakeholders of the innovation ecosystem - such as tech companies, start-ups, incubators, research centres and universities - and a promoter of new forms of entrepreneurship in accessing venture capital. Intesa Sanpaolo Innovation Center focuses mainly on circular economy, development of the most promising start-ups, venture capital investments of the management company Neva SGR and applied research

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