COMFORTage

Prediction, monitoring and personalized recomendations
for prevention and relief of dementia and frailty

INNOVATION INCEPTION REPORT

WP8 :Innovation and exploitation management
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LIST OF ABBREVIATIONS

AD - Alzheimer's Disease

ADDI - Alzheimer's Disease Data Initiative

ADPS - Alzheimer's Disease Prediction Service

AI – Artificial Intelligence

A-iADL - Amsterdam Instrumental Activities of Daily Living

API – Application Programming Interface

APOE - Apolipoprotein E

BADL - Basic Activities of Daily Living

BCT - Behaviour Change Technique

BCTT - Behaviour Change Technique Taxonomy

BM - Biomarkers

BRL – Business Readiness Levels

DoA – Description of Action

CFI - Combined Frailty Index

CVD - Cardiovascular Disease

DBS - Dried Blood Spots

DSI - Disease Severity Index

DSS – Decision Support System

EEG - Electroencephalography

EHDS – European Health Data Space

EHR – Electronic Health Record

FH – Family History

FTS-5 - Frailty Trait Scale-5

GDPR – General Data Protection Regulation

GPS – Global Positioning System

HAPA - Health Action Process Approach

HCAP - Harmonized Cognitive Assessment Protocol

ID – Identification

InCHIANTI - Invecchiare in Chianti (aging in Chianti)

IoT – Internet of Things

LASA - Aging Study Amsterdam

LCS - Longitudinal Cohort Study

LiFE - Lifestyle-integrated Functional Exercise

1 COMFORTage Innovation Promise

1.1 Introduction

This document is initiating the COMFORTage innovation and exploitation activities. It aims to support all Work Packages and all partners of the project to identify their potential key exploitation results and encourage them to take on board lessons learnt and recommendations from the many frailty related projects which have been implemented during the past decade.

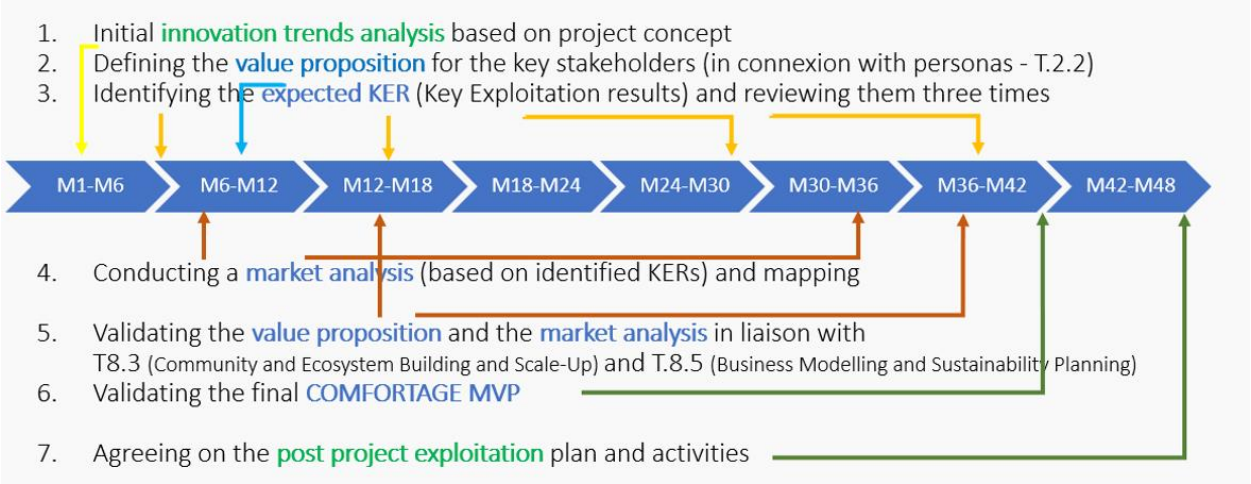
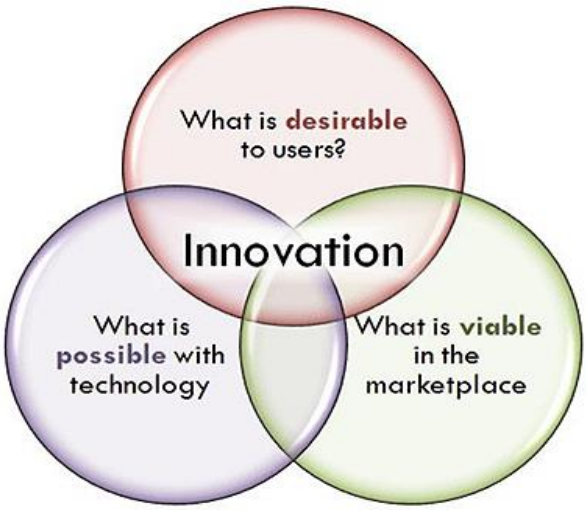


Figure 1: Major milestones of COMFORTage exploitation roadmap.

Although the project will be making use of many different technologies, it must be reminded that the focus of the call remains the targeted frail population itself. The main keywords of the call are: **consolidate, reuse, and improve**. In consequence, we must be sure that the project avoids the main usual pitfalls, such as inadequate or overkill interfaces and the use of components which have not been sufficiently tested and validated by the users. When shortly analysing the results of previous projects, it has unfortunately not always been possible to access documentation or resources which provide interesting inputs -not only on the technologies used- but more importantly also on the contribution to **innovative care processes,** and specifically on how to combine digital and human interventions in a flexible way which succeeds to capture the patient's preferences and capabilities. This needs to be much better captured in this very project.



The report has thus hopefully something for both technical and clinical partners. For some aspects, evidence is now sufficiently consolidated: some projects have for example devoted a lot of time and resources to assess all the different clinical assessment methods and scales. It is thus reasonable to expect that the pilot sites justify the choices made in full consideration of those published results.

Likewise, on the technological side, it is not reasonable to expect to propose AI supported solution if one cannot guarantee from scratch that it will have access to the volume of quality data to train the algorithms.

We thus need to look at innovation from a very wide angle: innovation is not only about creating a new product or service. Innovations are usually more adaptative than transgressive. Developing an original and efficient pre-testing. Adapting the role and profile of a healthcare or social professional. Developing smart and interactive care pathways. Re(using) smartly existing data sources. Contributing to improvement or enrichment of standards. All those are also innovations and can follow different exploitation paths, which are not necessarily business driven.

The project has thus an obligation to make a real difference and to work in parallel on different perspectives while still being able to integrate them.

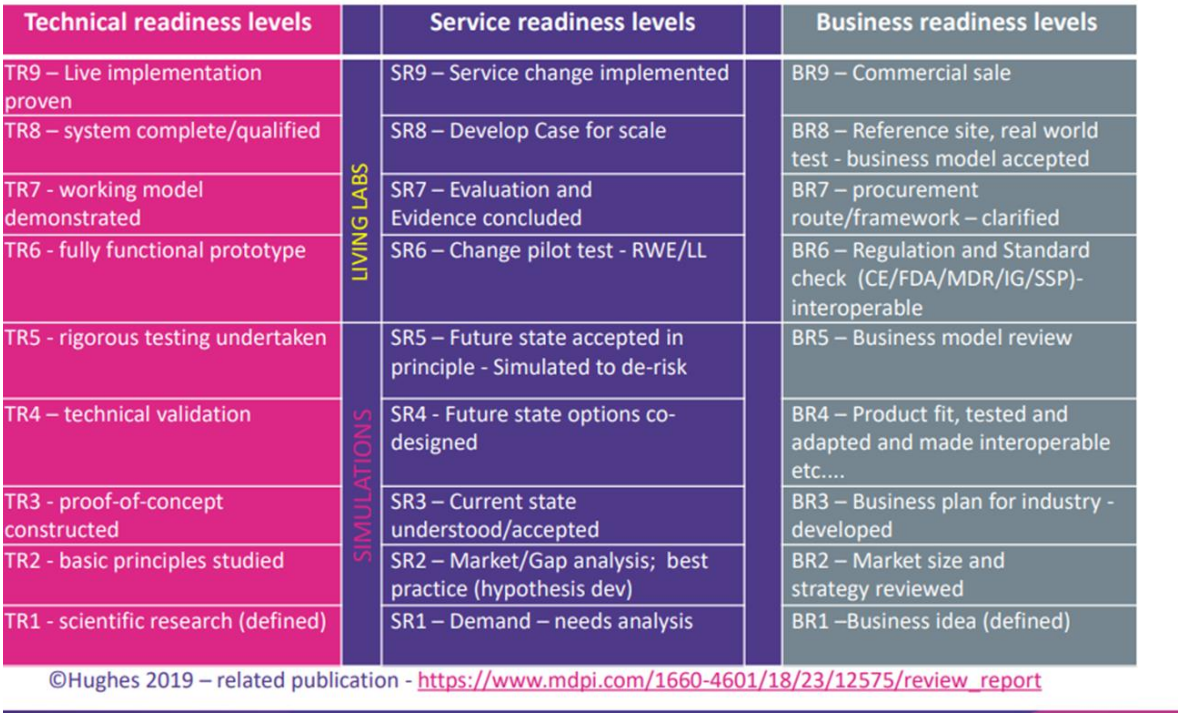


Figure2: TRL, SRL and BRL levels

1.2 COMFORTage overarching concepts

Prevention (mainly primary and secondary prevention), **frailty and AI** are the 3 overarching concepts at the core of the project.

Prevention

Three levels of prevention are usually referred to that we may summarise as follows:

- Primary Prevention: aims to prevent disease or injury before it ever occurs.

- Secondary Prevention: aims to reduce the impact of a disease or injury that has already occurred. However, screening to identify diseases in the earliest can also be associated to secondary prevention.
- Tertiary Prevention: aims to soften the impact of an ongoing illness or injury that has lasting effects.

The most mature and deployed digital innovations have up to now focused on either primary or tertiary prevention while a majority of the COMFORTage efforts will concentrate on secondary prevention.

COMFORTage is thus concentrating on the segment where there is a large innovation potential.

Frailty

Among the existing challenges in frailty science, one of the most critical concerns is the **shortage of an international normative description of frailty.**

Frail patients may ultimately develop multiple dysfunctions across several systems, including stroke, transient ischemic attack, vascular dementia, Parkinson's disease, Alzheimer's disease. Patients with dementia and frailty often develop malnutrition and weight loss.

Accurate diagnosis involving clinical evaluation, cognitive screening, essential laboratory evaluation, structural imaging, functional neuroimaging, and neuropsychological testing is necessary.

Varying types of physical exercise can aid the treatment of these disorders. Nutrition maintenance is a particularly significant factor, such as exceptionally high-calorie dietary supplements and a Mediterranean diet to support weight gain.

The dementia stage, including Alzheimer's Disease, is typically preceded by a phase during which cognitive impairment is evident, despite the fact that there is still some potential for independence in performing daily tasks. Mild cognitive impairment with Lewy bodies (MCI-LB) is the term given to this condition has become increasingly appreciated that preventing midlife cardiovascular disease (CVD) is a vital strategy to decrease the risk of dementia in old age.

Many projects have tried to operationalise the concept of frailty but attempts to design instruments for the scientific calculation of fragility has led to endless disputes over the conceptual construct to be assessed to determine which persons will gain from such techniques.

Some findings from literature:

1. **The organization's ability to effectively deal with the associated effects**. The healthcare environment has been recognized as the key driving factor which affects a healthcare personnel's ability to offer personalized care. Health care professionals, organisations and agencies may focus on achieving economic expectations at the cost of personalized care. Consequently, there is general inadequacy of e.g. hospital workers'

skills to manage adults who have dementia, given that many of the associated symptoms are troublesome, difficult to understand, and challenging to tackle appropriately. Improving screening methods and increasing awareness among healthcare professionals and the general public are essential for early detection and diagnosis.

2. A **novel cognitive biomarker technology** can provide information relating to the pathology of the brain. It should be made available at the healthcare level, facilitating slower cognitive decline, and preserving cognitive reserve. Such combination **with** intervention may increase our ability to tackle the challenges of dementia.

3. Population-based fragility screening may be costly and resource-intensive, and there is currently no firm indication of possible gain, cost-effectiveness, or improved performance. Screening for frailty should be **recommended for persons with disabilities or living in some specific environments.**

4. Developing **personalized interventions** tailored to individual needs and preferences is crucial for effective frailty management and dementia prevention.

5. **Addressing disparities in access** to healthcare services, including diagnostic tools, treatments, and support programs, is essential for improving outcomes and reducing the burden of frailty and dementia.

6. **Providing comprehensive support for caregivers**, including education, respite care, and counselling, is essential for ensuring the well-being of both caregivers and care recipients.

7. Many interventions for frailty management and dementia prevention have demonstrated effectiveness in research settings, but their l**ong-term sustainability and scalability in real-world settings remain uncertain**. Addressing issues related to cost-effectiveness, reimbursement mechanisms, and integration into existing healthcare systems is essential.

8. Managing multimorbidity and polypharmacy requires a **holistic approach** that considers the individual's overall health status, goals of care, and potential risks and benefits of treatment.

Artificial Intelligence

AI is presented as the main innovation driver of the project. Successful innovative AI implementation is complex and need to be apprehended from different angles, namely accuracy, robustness, scalability, interpretability, fairness, privacy and security, ethical and legal compliance, resource efficiency, generalisation, and human-machine Interactions.

Each of those aspects is thus a **vector** for innovation.

Using **AI in dementia, with early diagnosis, minimising its impact and/or slowing down its evolution, holds significant promise, but it also comes with potential biases and dangers that need to be carefully considered and are thus subject to innovation. Some key concerns include** data bias, algorithmic fairness, overreliance on technology, false positives and negatives or lack of transparency. Introducing AI into dementia prevention efforts may have unintended consequences, such as medicalization of normal aging or shifting resources away from other important aspects of

public health and social care. Addressing these biases and dangers require a multidisciplinary approach that involves stakeholders from diverse backgrounds, including healthcare professionals, ethicists, policymakers, and community representatives.

Among expected innovations, one may refer to the capacity to **ensure compliance** with data regulations and leveraging trusted solutions like the European Blockchain Services Infrastructure, the utilisation of validated methods and tools for identifying, quantifying, and measuring bias and the organisation of a marketplace supporting interoperability of the developed algorithms.

From the perspective of an innovation project, the capacity to reuse efficiently existing data sources - essential for the training and validation of algorithms - can also be considered as an important innovation, considering the foreseen evolution towards the EHDS.

The capacity of the project and its pilots to use existing tools such as e.g., the AI Assessment checklist and contribute to their improvement and enrichment is also an important possible innovation path.

More generally, the use of existing standards and **the use of the project inputs to contribute to their evolution** is also something to be considered at an early stage.

More specifically related to the project objective:

https://alz-journals.onlinelibrary.wiley.com/doi/full/10.1002/alz.13391

https://alz-journals.onlinelibrary.wiley.com/doi/full/10.1002/alz.13463

1.3 Innovation as stated in the DoA

The following elements are extracted from the COMFORTage DoA:

- The project will innovate at the level **of AI-based wearable and mobile medical devices** and applications: the project will take advantage of these devices to create an **integrated knowledge building approach**. **The Blockchain technology** will be used to store the data, to assure data provider's authentication (IDs integrity) according to the GDPR guidelines, data security and transparency handling, while also facilitating the secure and trustful exchange of data across all stakeholders and systems.
- The project promises **"comprehensive approaches"- including novel organisational models-** for delivering **personalised prevention and intervention measures** for **high-risk individuals** using advanced of mobile and wearable applications, smart Homes, and Digital Innovation Hubs, helping Patient with Dementia (PwD) to maintain their independence and enhance their QoL, while also reducing the burden on healthcare systems.
- The use of evidence-based applications such as cognitive **virtual games, virtual agents, and coaches to stimulate physical activity** to encourage behavioural changes. The project promises to deliver ML driven **narrative interventions** which require access to a large amount of quality and pertinent data and a sufficiently period of use of the supporting tools.

The main products, tools and technologies mentioned are: **Vire, Healthentia, nZEB Smart House, Luka, VR brain training games for MCI detection and Virtual Supermarkets**.

This Innovation Inception Report has been performed under T8.3 Innovation and Exploitation Management: each of the selected components and tools might have reached a different level of maturity and their innovation potential and **TRL level will be reassessed by task 2.1** while task 8.5

will analyse the current market situation for each of them. But COMFORTage promises first to innovate in the way it **integrates them** via its **Virtualized AI-Based Healthcare Platform** and make them available to a large variety of stakeholders.

The key expected immaterial innovations expected from the projects are here:

- Integrated Care Model Library of AI algorithms
- Explainable Models and Algorithms for Trustworthy AI
- Delivery Mechanisms for Personalised Healthcare
- Real-time Feedback and Behavioural Analytics
- Clinical DSS Suite with Visual Analytic Tools
- An advanced Training and Educational Toolkit

The proposed pilots differ significatively both in term of focus, method and expected outputs.

2 A selected summary of lessons learnt from previous projects

2.1 Data Analysis and Prediction Models

- **Limited Benefit from Text Analysis**: Inclusion of features from text analysis does not provide a significant benefit in prediction performance**.** (FRAILSAFE).
- **Robust Model Based on Slope Variables**: Final prediction model BEST based on slope variables from the Wireless Body Area Network - System and games only, because it showed to be more robust and relied on a more compact set of variables (FRAILSAFE).
- **Best Clinical and Technical Combination**: The best combination (considering also the minimum number of devices) of clinical and technical variables was the Wearable Wellness System (X)+Clinical raw variables, this set defined the Combined Frailty Index (CFI). (FRAILSAFE).
- **Precision in Motion Detection Needed**: Need of precise motion detection and machine learning models to interpret sensor data of physical activity monitoring.
- **Complexity of Neurodegenerative Diseases**: The heterogeneous nature of neurodegenerative diseases like Alzheimer's and Parkinson's, involving complex interactions between genetic, molecular, and environmental factors, makes developing a unified taxonomy and ontology challenging.
- **Data Integration and Standardization**: Integrating and standardizing vast amounts of diverse healthcare and research data from various sources is a significant challenge. Ensuring compatibility and comparability across datasets to support a cohesive understanding of disease mechanisms is complex.
- **Heterogeneity and Consensus Need in Frailty:** The frailty phenotype is highly heterogeneous, and stratification based on molecular markers showed only limited success, highlighting the need of a consensus definition of frailty and encouraging the use of already established criteria, such as the Fried phenotype in clinical praxis (Frail-Omic).

2.2 Communication and User Interface

- **Cautious language** to convey results and recommendations to the participants has as consequence that they are as specific as a healthcare professional's advice would be. This affected the perceived benefit of the recommendations.
- **Tools in the hand of patients:** the Alzheimer's Disease Prediction Service (ADPS) seems to be sufficiently mature to be used extensively: it can assist physicians in real-world clinical settings, opens.
- **Companion Robots in Dementia Care:** The MARIO project has shown the potential for the use of companion robots which proved to be an acceptable part of social care for people with dementia. They have an important role to play in combatting the perceptions of loneliness, can decrease the amount of time people with dementia spend alone, and increase levels of engagement.
- **User Adaptability:** Ensuring the robot's adaptability to a wide range of user preferences and needs, considering the diverse nature of dementia symptoms and the varying stages of the condition.
- **Emotional Attachment:** Managing the emotional attachment that might develop towards the robot and understanding its impact on users' psychological well-being, especially if the robot's availability is discontinued or if it malfunctions.

2.3 Technical and Environmental Challenges

- **Low quality of some signals** due to their acquisition in a real-life home environment and not in a controlled experimental setting Challenges in system acceptance due to small sample numbers and intervention duration which are inevitably small to provide robust conclusions.
- **Challenges in system acceptance** are the sample numbers and duration of interventions which are inevitably small to provide robust conclusions.
- **Advanced Computational Tools Development:** Creating innovative computational tools capable of managing, analyzing, and interpreting complex datasets involves challenges in software development, algorithm design, and computational capacity.

2.4 Application Compatibility and Usage

- **Cross-Platform Application Compatibility**: Importance of providing applications (GPS app, serious games) which would be compatible with multiple gateways and operating systems.
- **Demand for Customizable Interfaces:** There is a need for the availability of more customized options for the user interfaces.
- **Digital Solutions as Complementary Tools**: Digital solutions need to be presented as a complementary tool and not a replacement for healthcare professionals.
- **Clinician and Patients trust and reliance:** While the tool has shown to increase clinician confidence, ensuring consistent trust in the tool's recommendations, especially when they contradict clinicians' assessments, can be challenging. Furthermore, the acceptability of prognosis by patients can be problematic.
- **Social Acceptance:** Building broader social acceptance and understanding of companion robots as legitimate and beneficial tools in the care of individuals with dementia.

- **Usability for Individuals with Disabilities:** Wearable devices, although generally comfortable, posed usability challenges for participants with physical disabilities or cognitive impairments, indicating a need for more accessible design features.
- **Anxiety over Disease Detection:** The potential for wearable devices to detect preclinical signs of dementia raised concerns among participants about the implications of early detection, such as increased anxiety and fear of being institutionalized.

2.5 Comparative Analysis and Market Positioning

- **Necessity for Component Comparison:** It will be necessary to compare components selected by COMFORTage with SOFI, selected by eCare project, which will include different tools to detect frailty and pre-frailty in old adults. Likewise, the platform TELEVES should be studied in detail when defining the COMFORTage architecture.
- **Added Value of Affordable Monitoring**: Low price, monitoring features and novelty character on the market was meant to have a real added value.

2.6 Intervention Components and Screening

- **Integral Frailty Intervention Strategies**: The specific components of frailty interventions (both for prevention and treatment) include adequate physical activity and exercise, adequate nutrition, healthy lifestyles and review and optimization of drugs (joint action).
- **Targeting Early Stages of Frailty**: Screen opportunistically for frailty in populations aged over 70 years (Policy- advantage) but early stages of frailty are the most appropriate target for intervention because they are more likely to be reversible.
- **Innovative Approach to Cognitive Screening**: The doors to large-scale population screening for the early detection of cognitive impairment. It is deemed to be rapid, ecological and cheaper than current neuropsychological tests. The ADPS Neuro Motor Index (NMI) was included as a secondarailaboy outcome measure of cognitive ability and real-world function.
- **Global Blood Sample Collection and Data Sharing:** Availability of a blood sample collection in 12 SHARE countries while SHARE can also provide internationally comparable longitudinal micro data (based on 530,000 in-depth interviews with 140,000 people aged 50 or older).

2.7 Training and Health Professional Education

- **Focus on Comprehensive Training**: Training needs to target all social and health professionals with GPs identified as the most appropriate to identify frailty. However, few integrated care models are designed to prevent and tackle frailty in the community and interface between primary and secondary care (COMFORTage).
- **Scarcity and Need for Integrated Care**: The literature review reveals a scarcity of integrated care models specifically crafted to prevent and manage frailty both within community settings and at the primary-secondary care interface. The prevailing evidence advocates for a

more inclusive and salutogenic approach to addressing frailty. This involves merging chronic care strategies with educational initiatives, empowerment, and rehabilitative efforts to maximize functional abilities, especially during acute health declines or transitions between home, hospital, and care facilities. In every care scenario, it's critical that these strategies are underpinned by thorough assessments and multifaceted interventions, customized to address changeable physical, psychological, cognitive, and social elements.

2.8 Data Collection and Research Support

- **Support for Frailty Data Collection:** There is a need to better support data collection and projects that measure frailty trajectories and transitions between different levels of frailty severity at population-level in the EU. Utilizing data from longitudinal aging studies like SHARE and SAGE can aid in this. Additionally, decision support tools in the future could make clinicians more confident in their short-term prognosis by providing a decent second opinion in prognostic decision-making: the use of such a tool affects the prediction of progression for SCD and MCI both in terms of changing the clinicians' predictions and increasing their confidence.
- **Need for Technology Validation in Cognitive Health**: The effectiveness of technologies in measuring working memory and reducing cognitive load in identifying individuals at an elevated risk of AD but are asymptomatic but there is a need of further large-scale trials and integration into products aimed at individuals with Mild Cognitive Impairment (MCI).
- **Critical Evaluation of Frailty Scales**: The evaluation of the usefulness of frailty scales indicates that no single assessment instrument performs the best for all settings and outcomes. While in inpatients several commonly used frailty instruments showed good sensitivities (mainly for mortality and BADL worsening) but usually poor specificities, the contrary happened in geriatric clinic. None of the instruments showed a good performance in primary care. The FI-35 and the FTS-5 demonstrated the most favourable profiles among the instruments evaluated, suggesting a nuanced approach to frailty assessment is necessary for accurate and effective application.

2.9 Technology and Health Behaviour Models

- **Bridging Intentions and Actions:** The Health Action Process Approach (HAPA) model is recognized as the sole model of health behavior change that specifically aims to bridge the gap between the intention and actual execution of a new behavior. The Lifestyle-integrated Functional Exercise (LiFE) program exemplifies this by incorporating strength, balance, and physical activities into the daily lives of younger adults. However, addressing the medium-risk group for future functional decline remains a challenge, indicating a need for further studies that include a larger portion of this demographic. Additionally, some tools, like the EQ-5D quality of life measure, were found to lack sensitivity in detecting changes within the target group. Exploring access to datasets from the InCHIANTI and LASA studies could offer valuable insights for COMFORTage WP3.

2.10 Digital Exclusion and Literacy

- **Digital Exclusion Challenges**: Various inequities of the toolkit were uncovered such as digital exclusion relating to a lack of access to strong WiFi connection, compatible smartphones, and poor digital literacy.
- **Focusing on Excluded Populations:** The PRODEMOS Project primarily aimed to engage populations typically excluded from conventional prevention programs. Its use of a co-creation methodology—beginning with semi-structured interviews, followed by a six-week app testing phase with 77 participants, and concluding with product adjustments pre-trial—serves as a commendable practice. Insights from this project emphasize the importance of usability, personalization, and efficiency in developing health applications, underscoring the value of involving end-users in the development process to address their specific needs and enhance overall effectiveness.

2.11 Reusing Work and Benchmarking

- **Utilizing Aetionomy's Molecular Insights:** COMFORTage might consider reusing the work of the project Aetionomy which chose to seek molecular characteristics of Alzheimer's disease (AD) and Parkinson's disease (PD) that might contribute to a 'taxonomy' of these conditions, to advance understanding of disease mechanisms and identify potential targets for intervention using artificial intelligence and data-driven approaches.
- **RADAR-AD as a Benchmark for Tele-monitoring:** The results reached by the RADAR-AD platform could be used as benchmark for assessing the use of advanced tele-monitoring platform and associated AI based analytics. The A-iADL questionnaire provides a competitive alternative to traditional clinical assessments. It is potentially suitable for remote settings and offers time and cost efficiency. The RADAR-AD App-based augmented reality to assess cognitive impairment in early Alzheimer's disease is feasible in the home-setting. Neuronal competition as assessed with motor-cognitive dual-tasking can be used to detect early impairments not captured by cognitive or motor tests alone.

3 Conclusion: main innovation focus points for COMFORTage

Given the number of projects already implemented since more than a decade on frailty assessment, prevention, prediction, and treatment, COMFORTage has an obligation to:

- Demonstrate it has **captured key lessons learnt** from previous projects and make use of the resources and material available. This should also be partially facilitated by the participation of several COMFORTage partners in previous projects. The choice made by the project should thus clearly be documented from this perspective and indicate clearly where exactly innovation takes place (considering the why, what, how). This is true for both clinical and technical aspects and at all levels (e.g. criteria of inclusion/exclusion, parameters, and scales, expected impact etc.)
- Develop **an innovative co-creation approach which privileges users' adoption** with a clear focus on usability and simplicity. The challenges of digital exclusion and literacy

emphasize the importance of inclusive design and outreach strategies to ensure broad accessibility and effectiveness of health technologies. User interfaces should receive a top attention and offer as much as possible alternatives, ensuring adaptability to user needs. Managing emotional attachments are also crucial for long-term integration. Additionally, the reliance on digital tools as complements to healthcare professionals stresses the importance of trust and social acceptance in their adoption.

- Comparative analysis between different projects' components and tools underlines the **importance of novel features, monitoring capabilities, and cost-effectiveness** in creating market value and addressing frailty and pre-frailty among older adults (costs elements should also be considered from the start).
- Address frailty with efficacy interventions linked to targeted physical activity, nutrition, and lifestyle modifications. **Opportunistic screening, especially in early stages of frailty, is deemed crucial** for effective prevention and treatment.
- Develop a testing and validation strategy which should evaluate in real situation **the real capacity of selected/developed technology to be used** in a routine manner before validating it for the use by the real pilots.
- Position machine learning as a distinctive major element of the project. **Make sure the project has access to the volume and quality of data needed to train the algorithms** as one can hardly expect that data collected by the project alone will suffice. Aside from the technical components, a detailed list of databases which can be used by the project should be established.
- Deliver **advanced machine learning models** to interpret diverse data types and for consensus in clinical definitions to guide analysis, to overcome the complexity of neurodegenerative diseases and the heterogeneity of frailty phenotypes, which present substantial challenges in developing unified frameworks for analysis and prediction.
- Demonstrate that the reference architecture developed by the project **has a real capacity to scale and relate to major initiatives such as the EHDS** and with native systems. Connecting the project with the standards making community (e.g. documenting and contributing to HL FHIR development process).
- Document the **necessary changes in the clinical organisations** (processes, roles) is also an important innovation element which is often discarded. Furthermore, there is a critical need for **training and education among healthcare professionals** to identify and manage frailty. Integrated care models that blend educational, empowerment, and rehabilitative strategies are essential for a holistic approach to frailty management.
- **Integrate effectively inequalities** (access to services, digital skills, personal and social environment etc..) in the selection and use of the solutions.

Many initiatives such as previous Joint action have been calling for longer studies to collect more usable and validated evidence. The project needs thus also to:

- Position itself clearly in this regard.
- Make sure all data collected by the project can be reused by other.

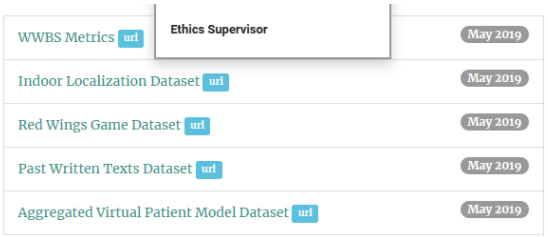
The Virtualized AI-based Healthcare Platform, Integrated Care Model Library of AI/ML and Training & Educational Toolkit are presented as the main and most visible Key Exploitation results of the project. Many other platforms have been created in the past and very few have survived the project lifetime. The capacity of COMFORTage to create early alliance with other major initiatives which are **not** project dependent is an essential condition to make sure COMFORTage legacy will be used at its best.

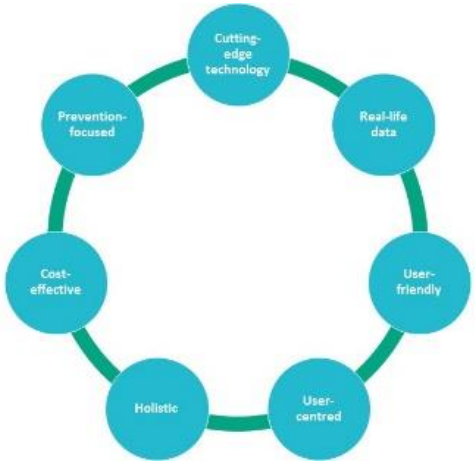
Annex 1: Analysis of results of previous projects

FRAILSAFE

PROJECT NAME	**FrailSafe - Sensing and predictive treatment of frailty and associated co-morbidities using advanced personalized patient models and advanced interventions**
STARTING / ENDING	2016-2019
TYPE OF FUNDING SCHEME	European Union's Horizon 2020
OBJECTIVES	Ensure the fusion of the relevant information from different sources and categories (data from social, behavioural, cognitive and physical activities) , is expected to **advance our understanding of frailty and the associated co-morbidities**, measure risk of frailty, and as such, risk of adverse outcome, **provide a model for testing interventions and treatments, provide a model to deliver rehabilitation, and ultimately lead to prediction, prevention or even reversal of frailty**. → Better understand frailty and its relation to co-morbidities and develop quantitative and qualitative measures to define frailty. → Develop real life tools for the assessment of physiological reserve and external challenges. → Use of Measures to Predict Short and Long-term Outcome. → Creation of "Prevent-Frailty" Evidence Based Recommendations. → Provide a model sensitive to change in order that will facilitate the testing of pharmaceutical and non-pharmaceutical interventions.

COORDINATOR / PARTNERS	 **University of Patras** GREECE, Academia UoP will participate in the project through three units (a) the Multidimensional Data Analysis and Knowledge Discovery (MDAKM) Laboratory Read More... University of Patras acts as the project coordinator of FrailSafe. **Brainstorm Multimedia** SPAIN, SME Brainstorm Multimedia is a SME software development company with over fifteen years' experience of 3D graphics and presentation within the broadcast television and multimedia industries. Brainstorm was founded initially as a company to provide graphics services for broadcast television stations in Spain. Currently Brainstorm systems are being used all over the world in some of the most highly respected broadcast organisations. Read More... **Smartex** ITALY, SME SMARTEX s.r.l is a small limited liability company founded in 1999 with the aim of developing e-textile or new electronics structures compatible with textile processes and manufactures. Core activity is the implementation of bio sensing apparels (Tshirts, bands, vests, etc.) able to monitor vital signals, as electrocardiograms, heart rate, respiration signal and rate, index of activity as well as bio-potentials like EMG. Read More... **AGE Platform Europe** BELGIUM, NGO AGE Platform Europe is a European network of more than 150 organisations of and for people aged 50+ representing directly over 40 million older people in Europe. Our work focuses on a wide range of policy areas that impact on older and retired people.Read More... **Center for Research and Technology Hellas/Information Technologies Institute** GREECE, Research Institute The Institute (ITI) was founded in 1998 as a non-profit organisation under the auspices of the General Secretariat for Research and Technology of Greece, with its head office located in Thessaloniki, Greece. Since 10.3.2000 it is a founding member of the Centre for Research and Technology Hellas (CERTH) also supervised by the General Secretariat for Research and Technology (GSRT). Read More... **Materia Group** CYPRUS, Ltd Materia Group (www.materia.com.cy) is a private sector social enterprise in Cyprus. It is a multi-shareholder organization, with 20 shareholders at the moment. It provides a wide range of Care, Nursing and Rehabilitation Services to the Elderly Population of Cyprus, either at the clients' homes or at Materia's three facilities in Nicosia. Read More... **Gruppo SIGLA.** ITALY, SME Gruppo SIGLA Srl, established in 1990 in Genova (Italy), is an Italian SME consisting of 70 specialists with high technical expertise and experience in the field of ICT. Gruppo SIGLA provides IT solutions, covering the entire lifecycle: from the analysis of the customer requirements to the implementation of feasibility studies, from the design (hardware and software) to the integration and configuration of the systems... Read More... **Hypertech** GREECE, SME HYPERTECH, founded in 1997, is one of the pioneers in the Internet and Mobile applications area. The business strategy of HYPERTECH focuses on applied research and innovation activities to create a full suite of services and products appealing to enterprises and organisations while at the same time being able to meet real customer needs. Read More... **University Hospital of Nancy and INSERM U1116 Nancy** FRANCE, Research Institute The territorial community hospital of Lorraine is composed by the University Hospital of Nancy and the Regional Hospital of Metz (the "sillon Lorrain" hospital). 2012 key figures of the university hospital of Nancy are the following: 1664 in-patient hospital beds and 68487 in-patient hospitalizations for an average stay of 7,1 days; 175 801 medical outpatient consultations. Read More...
SOLUTIONS / TECH PROVIDERS	The development of an ICT solution that will deliver rehabilitation, and ultimately lead to prediction, prevention, and self-management of frailty symptoms: • Design and development of hardware components. • Design and development of efficient signal processing algorithms for low level processing. • Self-adaptive virtual patient model offering optimal services for managing frailty. • Development of real-time data management and data mining methods effectively making decision assessing frailty levels. • Personalized and highly innovative Augmented Reality game consisting of different scenarios. • Synthesized AR game system. Force Analyzer, Redwings, Railway, Simon, Memory, Reflex and Supermarket. Furthermore, three AR games were developed, namely, Memory AR and Floating Archery, played through the AR glasses, and Gravity Ball.

	Measurable parameters and units of measurement Sensorized vest/strap with 9 DoF IMUs → Heart rate, respiration rate, posture and/or activity, steps/minute, falls, instability Smartphone → Indoor/Outdoor activities, Physiological state, Motor state, Social Interaction Questionnaires → Nutrition, Social Interaction, Cognitive state Medical record → Co-morbidities, etc Smart home sensors → Indoor activities, ... Dynamometer → Grip strength AR Serious Game → Cognitive state and Behaviour, Physiological state, Motor state Impedance scale → Body Weight / Body Mass Index Blood pressure monitor → Blood pressure Mobil-o-graph → Arterial stiffness
PILOTS / USE CASES DESCRIPTION	The FrailSafe study has been carried out in three pilot sites (**Nicosia, Patras, and Nancy**) where older people have been recruited by the clinical teams to test the serious games developed by the project and the devices selected by the technical partners.
ACHIEVED RESULTS (with evidence gained, documentation if available)	 ➢ **Rule-Based recommendations** tailored to each stakeholder and targeting all domains (cognitive, medical, nutritional, physical, functional, psychological, and social) incorporated in DSS and available on adapted UI. Individualized recommendations were based on participants' scores on various scales and examinations. ➢ From participants' measurements from the FrailSafe devices, a **predictive algorithm** was developed and incorporated in the FrailSafe platform to indicate the participants' risk for developing frailty. The training of the prediction model was performed by examining the temporal multi-dimensional profile captured by the multiple sensing modalities. ➢ Detailed definition of the **patient model representation format** adopted within the FrailSafe project using, **open EHR**, a multi-layer reference model for building VPM using archetypes (supported by an open-source community and a variety of tools), has been adapted. ➢ **Tailored intervention plan** based on summary of recommendations (and frailty index) leading to individualised report and "advice" (leaflets).

CHALLENGING POINTS	 ➢ Inclusion of features from **text analysis does not provide a significant benefit** in prediction performance. ➢ Final prediction model (Technical Frailty Index, FI) of the FrailSafe platform is the one **based on slope variables from the WWBS and games only,** because it showed to be more robust and relied on a more compact set of variables. ➢ The best combination (also considering the minimum number of devices) of clinical and technical variables was the **WWSX+Clinical raw variables, this set defined the Combined Frailty Index (CFI)**. ➢ Considering that the FrailSafe system was a device under testing we chose cautious language to convey results and recommendations to the participants and hence, they were n**ot as specific as a healthcare professional's advice** would be. This affected the perceived benefit of the recommendations ➢ **Low quality of some signals** due to their acquisition in a real-life home environment and not in a controlled experimental setting. ➢ Challenges in system acceptance are th**e sample numbers and duration of interventions** tested in this study which are inevitably small to provide robust conclusions. ➢ Need for the **availability of more customised options** for the vest equipment and enhancement of durability (i.e., water resistance) of RUSA devices. Also, users highlighted the importance of providing applications (GPS app, serious games) which would be compatible with **multiple gateways and operating systems.** ➢ Solution only as a **complementary tool** and not a replacement for healthcare professionals. See: https://frailsafe-project.eu/images/frailsafe/results/FrailSafe-D7.4-Field-Trials-Report--Socio-economic-Guidelines.pdf
WEB LINK	https://frailsafe-project.eu

OTHER

User requirement	Older adults	Families	Health care professionals	Researchers	Commercial organisations	IT developers
Need for improved understanding of frailty, its causes and ways to prevent it.	☑	☑	☑	☑	☑	☑
Need for individualized help from the healthcare professionals.	☑	☑				
Need for participation by the older people and sending feedback to the healthcare personnel.			☑		☑	
Need for enjoyable frailty-preventing activities that require physical and cognitive effort.	☑	☑				
Need for clinical assessment methods that are easy to perform.	☑		☑			
Need for predictive treatment functionalities in order to reduce the risk of frailty.	☑	☑	☑		☑	
Need for real-time monitoring and alerts in order to reduce the anxiety of family members.	☑	☑	☑		☑	☑
Need for sensory and measurement components that are safe to use by the older people.			☑			☑
Need for sensory and measurement components that are easy and comfortable to use.	☑	☑	☑			
Need for acceptable wearable components that are not obtrusive.	☑	☑	☑			
Need for frailty-related software components and games that are easy to use and learn.	☑		☑		☑	☑
Need for hardware interaction devices that are easy to use.	☑	☑	☑			☑
Need for extensive data collection for research.			☑	☑		☑

ECARE

PROJECT NAME	**eCARE - Preventing frailty in older adults goes high-tech**
STARTING / ENDING	02.09.2019-01.07.2024
TYPE OF FUNDING SCHEME	PCP - Pre-Commercial Procurement
OBJECTIVES	eCare looks for disruptive digital solutions for the prevention and comprehensive management of frailty in older adults. The target group are the pre-frail/frail old adults with an emphasis on those that feel lonely and/or isolated. The goal is to encourage independent living, wellbeing and to relieve health and care services budget pressure. The objective of eCare is to launch a **Pre-Commercial Procurement call for tender** to deliver disruptive digital solutions for the prevention and comprehensive management of frailty to encourage independent living, wellbeing and to relieve health and care services budget pressure.
COORDINATOR / PARTNERS	Coordinator SCIENCE & INNOVATION LINK OFFICE SL Address CALLE CLAUDIO COELLO 52 PLANTA 1 28001 Madrid Spain

	TICBIOMED TECNOLOGIAS DE LA INFORMACION PARA LA SALUD EN LA REGION DE MURCIA ASOCIACION Spain IRMANDADE DA SANTA CASA DA MISERICORDIA DA AMADORA IPSS Portugal AZIENDA SANITARIA LOCALE BENEVENTO Italy *SZPITAL SPECJALISTYCZNY IM A FALKIEWICZA WE WROCLAWIU* Poland CONSORCI SANITARI INTEGRAL Spain AYUNTAMIENTO DE SANTANDER Spain BRAVOSOLUTION ESPANA SAU Spain UNIVERSITAETSKLINIKUM AACHEN Germany
SOLUTIONS / TECH PROVIDERS (a brief description for each one)	**TELEVES Consortium** has designed a solution based on a set of technologies that comprises a monitoring sub-system for screening and follow-up, a digitalized older adult care model, and a virtual assistant for the delivery of preventive, therapeutic, and educational interventions. Supplier : TELEVES https://ecare-pcp.eu/suppliers/televes/ **Former Group PULSO** has designed SOFI, which will include different tools to detect frailty and pre-frailty in old adults. These technologies will make the solution capable of providing professionals with a tool to screen older adults and identify those who might have frailty or pre-frailty, not only from the clinical, physical, and psychological point of view but also from a socioeconomic perspective. Supplier: EVIDENZE https://ecare-pcp.eu/suppliers/grupo-pulso/
PILOTS / USE CASES DESCRIPTION	**TELEVES Consortium:** Televes Corporation Spain Fundación para la Investigación Biomédica del Hospital Universitario de Getafe Spain MGBiomed Spain Universidad Politécnica de Madrid Spain **Former Group PULSO:** atenzia Evidenze Knowledge in Health Atenzia Spain Evidenze Spain

ACHIEVED RESULTS	Still to be released/published
CHALLENGING POINTS	Still to be released/published
WEB LINK	https://ecare-pcp.eu https://ecare-pcp.eu/phase-3/
OTHER	Solutions selected during phases 1 and 2 were: 1. **Bilbest Bilişim Sağlık Eğitim Dış Ticaret ve San**. Ltd. Şti in consortium with Estudios Mega SL and Zadig SRL. Turkey, Spain and Italy. SmartFOR will offer a disruptive, innovative and comprehensive care management system powered by artificial intelligence to provide customized therapeutic solutions and early care interventions in monitoring, predicting and preventing frailty and frailty-related symptoms in older adults. 2.**TELEVES** in consortium with Foundation for Biomedic research from the University Hospital of Getafe, MG Biomed SL and Universidad Politécnica de Madrid. Spain. Their proposed solution is based on a set of technologies that comprises a monitoring sub-system for screening and follow-up, a digitalized older adult care model, and a virtual assistant for the delivery of preventive, therapeutic, and educational interventions. 3.**CERTH/ITI** in consortium with the Panepistimio Patron University of Patras, Gruppo SIGLA SRL, Brainstorm Multimedia SL and 112 Motion BV. Greece, Italy, Spain and Germany. FrailCare brings one step forward the research and technology on aiding the independent living of older people by providing real-time monitoring of physiological, behavioural, and social parameters, ensuring adherence to pharmacological treatments and offering innovative therapies based on serious games for maintaining/ enhancing their cognitive and motor functionalities. 4.**Pulso Ediciones** SL. Spain SOFI will include different tools to detect frailty and pre-frailty in old adults. These technologies will make the solution capable of providing professionals with a tool to screen older adults and identify those who might have frailty or pre-frailty, not only from the clinical, physical, and psychological point of view but also from a socioeconomic perspective. 5.**Foundation for Research and Technology Hellas** (FORTH) in consortium with Uni Systems Information Technology Systems. Greece. BONVITA moves far beyond the state of the art, offering a holistic technology platform, integrating all components that are essential for the effective screening, prevention and management of frailty and pre-frailty supporting integrated pathways and developing knowledge sharing. It is also able to support in practice shared care plans that involve various stakeholders. 6.**Fundació Eurecat** in consortium with Doole Health SL, Engineering Ingegneria Informatica S.p.A., Fundación FLS and Public Intelligence. Spain, Italy and Denmark. eMERIT solution self-management system works with a set of data coming from different sources that rely on an IoT-based system in which several devices and sensors can be integrated.

	7.Dedalus Italia in consortium with HUMAN FACTOR & INNOVATION srl, Euleria srl Società Benefit, Expert.ai S.p.A., Engineering Department of the University of Sannio and Economics Department University of Sannio. Italy. The proposed solution is an integrated digital solution that will take into account a holistic and user-centric approach for the management of the different aspects of the frailty, a continuous focus on the engagement, training and empowerment of the older adults and the possibility to guarantee continuity of care among care environments, from hospitals to home care, by pursuing cost-effectiveness, sustainability, and affordability. 8.NTT Data Spain in consortium with ASBAR S.L. Spain Their solution will be based on the Everis ehCOS platform and the telecare platform. This basis is fundamental to be able to focus on the gap that the PCP challenge presents and to enable us to focus on the development of innovative services and tools for the management of the frail user.

FRAIL

PROJECT NAME	FRAIL - Frailty assessment in daily living
STARTING / ENDING	2019 Pilot Phase
TYPE OF FUNDING SCHEME	EIT Health
OBJECTIVES	To develop a smartwatch app that supports elderly individuals who are in a pre-frail or frail state. The app will monitor for falls, level of physical activity and interruption of routine activities, to help detect the onset of frailty and to prevent its consequences among the wearers. **The app will be deployed on the market as a new key feature of LOLA**, an existing health-monitoring app for the elderly marketed by the project partner Qolware. Monitor of 3 parameters: 1. Fall detection and prevention 2. Physical activity indicators for frailty 3. Frailty detection in activities of daily living
COORDINATOR / PARTNERS	FRAIL is an international project lead by experts in rehabilitation research at the Technical University of Munich (TUM) in Germany. The team's specialist in digital health solution is the start-up Qolware, from Germany. CapDigital, from France contributes to business development in the digital ecosystem. MADoPA, from France, evaluates health and independent living solutions. IMEC, of Belgium, provides expert knowledge on data-analytics and performance measurement.
SOLUTIONS / TECH PROVIDERS	**LOLA App** is the first digital solution developed for commercial smartphones and smartwatches that provides a **continuous health and emergency assistance in everyday life** and supports you in daily planning — anytime, anywhere. With our

	compact and discreet solution, you can stay safe and independent no matter where you are and enjoy your active lifestyle.  Supplier: Qolware GmbH https://lola-health.com/
PILOTS / USE CASES DESCRIPTION	The frailty assessment includes other physical activity indicators outside of fall risk, and it will facilitate transferring detection of these indicators from a waist-worn device to a smartwatch device using the LOLA app. Frailty detection in activities of daily living: TUM has provided specific parameters for assessing frailty in daily activities using the LOLA app. The project's design, low price, monitoring features and novelty character on the market was meant to have a real added value.
ACHIEVED RESULTS	Not available in the Google Store / Link not available
CHALLENGING POINTS	• **Accurate fall detection:** The app must use advanced algorithms to minimize false positives and negatives, requiring sophisticated motion detection and machine learning models that can accurately interpret sensor data from various movements. • **Physical Activity Monitoring**: Monitoring and interpreting the level of physical activity accurately in the elderly, who may have diverse ranges of mobility and health conditions, requires complex algorithms. • **Wearability and Comfort**: Ensuring that the smartwatch is comfortable to wear all day, especially for elderly individuals who might have sensitive skin or other conditions, is important for continuous monitoring. • **User Engagement**: Motivating elderly users to regularly interact with the app and comply with monitoring requirements, without feeling overwhelmed or intruded upon, can be challenging.
WEB LINK	https://eithealth.eu/product-service/frail/
OTHER	NA

JA ADVANTAGE

PROJECT NAME	**ADVANTAGE - A comprehensive approach to promote a disability-free. Advanced age in Europe: the *ADVANTAGE* initiative**
STARTING / ENDING	2017-2019
TYPE OF FUNDING SCHEME	JOINT ACTION European Union's Health Programme (2014-2020)
OBJECTIVES	35 entities within 22 member states have worked together to attain two major objectives: • Summarise the current State of the Art for the different components of frailty and its management, both at individual and population level • Collect information on the development of programs to manage frailty in older adults in the EU.
COORDINATOR / PARTNERS	SERVICIO MADRILENO DE SALUD 22 MEMBER STATES

SERVICIO MADRILENO DE SALUD (999481987) **Coordinator**	Spain
MEDIZINISCHE UNIVERSITAT GRAZ (999836231) **Beneficiary**	Austria
SCIENSANO (906160809) **Beneficiary**	Belgium
NATSIONALEN CENTAR PO OBSHTESTVENO ZDRAVE I ANALIZI (986300754) **Beneficiary**	Bulgaria
HRVATSKI ZAVOD ZA JAVNO ZDRAVSTVO (998128255) **Beneficiary**	Croatia
Ministry of Health of the Republic of Cyprus (994267946) **Beneficiary**	Cyprus
TERVEYDEN JA HYVINVOINNIN LAITOS (996697893) **Beneficiary**	Finland
AGENCE NATIONALE DE SANTE PUBLIQUE (917843489) **Beneficiary**	France
MINISTERE DES AFFAIRES SOCIALES ET DE LA SANTE (998887377) **Beneficiary**	France
MEDIZINISCHE HOCHSCHULE HANNOVER (999878426) **Beneficiary**	Germany
COMPANY OF PSYCHOSOCIAL RESEARCH AND INTERVENTION (EPSEP) (923863988) **Beneficiary**	Greece
PANEPISTIMIO PATRON (999894528) **Beneficiary**	Greece

	NEMZETI EGESZSEGFEJLESZTESI INTEZET (954346335) **Beneficiary** — Hungary HEALTH SERVICE EXECUTIVE HSE (993521919) **Beneficiary** — Ireland AGENZIA NAZIONALE PER I SERVIZI SANITARI REGIONALI (959886490) **Beneficiary** — Italy ISTITUTO NAZIONALE DI RIPOSO E CURA PER ANZIANI INRCA (999630882) **Beneficiary** — Italy ISTITUTO SUPERIORE DI SANITA (999978821) **Beneficiary** — Italy REGIONE MARCHE (986340233) **Beneficiary** — Italy UNIVERSITA CATTOLICA DEL SACRO CUORE (999915771) **Beneficiary** — Italy LIETUVOS SVEIKATOS MOKSLU UNIVERSITETAS (972782446) **Beneficiary** — Lithuania MINISTRY FOR THE FAMILY AND SOCIAL SOLIDARITY (918357589) **Beneficiary** — Malta RIJKSINSTITUUT VOOR VOLKSGEZONDHEID EN MILIEU (999991431) **Beneficiary** — Netherlanc FOLKEHELSEINSTITUTTET (999478883) **Beneficiary** — Norway HELSEDIREKTORATE (974772304) **Beneficiary** — Norway NARODOWY INSTYTUT GERIATRII REUMATOLOGII I REHABILITACJI IM.PROF.DR HAB. MED. ELEONORY REICHER (917935154) **Beneficiary** — Poland CENTRUL NATIONAL DE SANATATE MINTALA SI LUPTA ANTIDROG (933059685) **Beneficiary** — Romania SCOALA NATIONALA DE SANATATE PUBLICA, MANAGEMENT SI PERFECTIONARE IN DOMENIUL SANITAR BUCURESTI (986042346) **Beneficiary** — Romania UNIVERSITATEA BABES BOLYAI (999860578) **Beneficiary** — Romania NACIONALNI INSTITUT ZA JAVNO ZDRAVJE (948891346) **Beneficiary** — Slovenia ASOCIACIÓN INSTITUTO DE INVESTIGACIÓN EN SERVICIOS DE SALUD-KRONIKGUNE (955006420) **Beneficiary** — Spain CONSEJERIA DE SALUD y FAMILIAS DE LA JUNTA DE ANDALUCIA (950939307) — Spain MINISTERIO DA SAUDE - REPUBLICA PORTUGUESA (986364095) **Beneficiary** — Portugal FUNDACION PARA LA INVESTIGACION DEL HOSPITAL CLINICO DE LA COMUNITAT VALENCIANA, FUNDACION INCLIVA (999637187) **Beneficiary** — Spain NHS LANARKSHIRE (962436426) **Beneficiary** — United Kingdom EMBERI EROFORRASOK MINISZTERIUMA (935813903) **Beneficiary** — Hungary NATIONAL UNIVERSITY OF IRELAND GALWAY (999978045) **Beneficiary** — Ireland NEMZETI NEPEGESZSEGUGYI KOZPONT (998706957) **Beneficiary** — Hungary
SOLUTIONS / TECH PROVIDERS	The frailty prevention approach should incorporate key components such as use of simple frailty specific screening tools in all care settings, tailored interventions by interdisciplinary teams in hospitals and community, case management and coordination of support across the continuum of providers, effective management of transitions between care teams and settings, information and technology enabled care solutions, and clarity about service eligibility care policies, procedures and processes.

	Further research is required to understand how to scale up integrated care for frailty in different systems and how to achieve optimal impact and value.
PILOTS / USE CASES DESCRIPTION	• Knowing frailty at individual level • Knowing frailty at population level • Managing frailty at individual level • Models of care to prevent and delay frailty • Extending and expanding knowledge of frailty
ACHIEVED RESULTS	The main outcome of the project is **a common European model to approach frailty**. This includes the development of a **road map** that will propose interventions for frail and at-risk people and **establish tailored milestones for each member state** in order to achieve a comprehensive approach to promote a disability-free advanced age in Europe. Furthermore, it is aimed to **identify gaps** if knowledge for further research. The main recommendations are: • **Screen opportunistically for frailty in populations aged over 70 years**, giving the possibility of designing and implementing preventive, population-based interventions targeting identified risk factors. • **General practitioners** have been identified as the preferred healthcare professional to identify physical health problems and risks and as such to potentially screen and monitor for frailty at population level. • Many **instruments have been proposed** and are used to identify (screen and diagnose) frail individuals in clinical practice and for public health level frailty detection programs. From all tools available, ADVANTAGE JA proposes those that fulfil certain characteristics. **For screening**: Clinical Frailty Scale; Edmonton Frailty Scale; Fatigue, Resistance, Illness, Loss of Weight Index (FRAIL Index); Gait Speed; Inter-Frail; Prisma-7; Sherbrooke Postal Questionnaire; Short Physical Performance Battery (SPPB) and Study of Osteoporotic Fractures Index (SOF). **For diagnosis:** Frailty Index of accumulative deficits, Frailty Phenotype and Frailty Trait Scale. • Individual **interventions,** either in the community or in every setting of care, often share a t**hree-step structure**: 1) frailty screening to identify frail older persons, 2) use of diagnostic tools to diagnose frailty, and 3) a CGA to assess individual needs and develop multidimensional interventions to match these needs in the frame of individual care plans. • **Early stages of frailty are the most appropriate target** for intervention because they are more likely to be reversible. • The s**pecific components** of frailty interventions (both for prevention and treatment) include a**dequate physical activity and exercise, adequate nutrition, healthy lifestyles and review and optimization of drugs**. • Models of care should consider the need to approach older people not just in terms of their diseases but also in terms of physical, cognitive and psychosocial care and support to prevent functional decline, frailty and disability. • **Key components to address frailty are those that define also integrated care**. A coordinated system able to provide the most effective care in the different settings (community, primary care, hospitals and residential or nursing homes) needs to be provided. • Health and social care professionals across settings and countries n**eed to be trained** to address future needs related to ageing, frailty, and disability. • Further research is needed not only to better understand the nature of frailty, but also to **improve screening and diagnostic tools and test the effectiveness of interventions**. In this regard, ADVANTAGE JA has identified a few areas that will benefit from EU research funding.

CHALLENGING POINTS	The evidence collected from literature showed that **few models of integrated care were specifically designed to prevent and tackle frailty in the community and at the interface between primary and secondary (hospital) care**. Current evidence supports the case for a more holistic and salutogenic response to frailty, blending a chronic care approach with education, enablement, and rehabilitation to optimise function, particularly at times of a sudden deterioration in health, or when transitioning between home, hospital, or care home. In all care settings, these approaches should be supported by **comprehensive assessment and multidimensional interventions** tailored to modifiable physical, psychological, cognitive, and social factors.
WEB LINK	State of the art: https://www.sanidad.gob.es/areas/promocionPrevencion/envejecimientoSaludable/fragilidadCaidas/estrategiaSNS/docs/Updated_state_of_the_art_report_on_the_prevention_and_management_of_frailty.pdf https://www.sciensano.be/en/projects/european-joint-action-frailty
OTHER	There is a need to **better support data collection and projects that measure frailty trajectories and transitions between different levels of frailty severity at population-level in the EU**. Existing data from ongoing longitudinal studies of ageing such as **SHARE and SAGE** might be used to better understand these in Europe. More data on predictors and risk factors for transitions are also required; better knowledge about these can foster policy action to reduce frailty at population-level. agreement on the timing of suitable intervals to assess frailty trajectories is important and recommendations to standardise these should be made. Well-designed incidence studies should also help inform this. Again, developing standardised approaches to defining and measuring frailty is important to ensure comparability of findings globally and across JA ADVANTAGE MSs.

PredictND

PROJECT NAME	**PredictND - From Patient Data to Clinical Diagnosis in Neurodegenerative Diseases**
STARTING / ENDING	01.02.2014-31.01.2018
TYPE OF FUNDING SCHEME	EU FP7
OBJECTIVES	PredictND provides an ICT-based approach for diagnostics of neurodegenerative diseases. It is based on the principles of evidence-based data-driven medicine and builds upon previous successful Virtual Physiological Human (VPH) projects. An existing decision support tool is enhanced to meet the needs of clinical practice and validated in real conditions across several EU regions. The first goal is to show that **modern computer-based models enable earlier and more objective clinical diagnostics**. The second goal is to **improve cost-efficiency of early diagnostics** by developing a low-cost test battery that detects persons at high risk of dementia and forwards these persons to more accurate (and expensive) clinical tests. Everything is implemented as **an ICT ecosystem** that integrates the clinical decision support tool with services for citizens for assessing the risk of diseases.
COORDINATOR / PARTNERS	1. VTT Technical Research Centre of Finland (Finland) 2. GE Healthcare (UK)

	3. Imperial College London (UK) 4. University of Eastern Finland (Finland) 5. Rigshospitalet (Denmark) 6. VU University Medical Centre (the Netherlands) 7. University of Perugia (Italy) 8. Alzheimer Europe (Luxembourg)
SOLUTIONS / TECH PROVIDERS (a brief description for each one)	The PredictND tool is a clinical decision support tool designed to assist clinicians in differential diagnosis of dementia and to predict whether the condition will progress or remain stable. The tool uses a data-driven classifier, which provides a scalar disease state index (DSI) value between zero and one. The innovation of the project is to test the decision-making tool for the detection and differentiation of memory diseases at earliest phases. Detecting signs of progressive memory disease in time will allow earlier interventions and treatments. Tools which support decision-making will be common into tomorrow's clinical practice. These tools can help a clinician to extract the most important information and profiles among the multitude of data.
PILOTS / USE CASES DESCRIPTION	The approach was tested within the project on 800 patients in four European hospitals: Kuopio (Finland), Copenhagen (Denmark), Amsterdam (the Netherlands) and Perugia (Italy) and compared with the existing diagnostic procedures.
ACHIEVED RESULTS	The PredictND tool affected the prediction of progression for SCD and MCI both in terms of changing the clinicians' predictions and increasing their confidence. Although no statistically significant difference was observed when using the tool, the results show potential for improvements especially for patients with most extreme DSI values (DSI classifications < 0.2 or > 0.8). The tool alone **showed an increase in accuracy** (statistically significant) compared with the situation when no tool was used in the patients with DSI < 0.2 or DSI > 0.8. In this subpopulation, stable patients were identified with high accuracy. Furthermore, results indicate that **decision support tools in the future could make clinicians more confident in their short-term prognosis** by providing a decent second opinion in prognostic decision-making. Findings from the scientific study (2019) conducted on 429 patients.
CHALLENGING POINTS	**Clinician and Patients trust and reliance**: While the tool has shown to increase clinician confidence, ensuring consistent trust in the tool's recommendations, especially when they contradict clinicians' assessments, can be challenging. Furthermore, the acceptability of prognosis by patients can be problematic.
WEB LINK	https://cordis.europa.eu/project/id/611005
OTHER	NA

ADDP

PROJECT NAME	**ADDP - Alzheimer's Disease Detect and Prevent**
STARTING / ENDING	2018-2023
TYPE OF FUND-ING SCHEME	Horizon 2020 research and innovation programme

OBJECTIVES	An innovative EU-funded project developing a robust digital tool that enables the early detection of Alzheimer's disease. Developing a **digital tool to improve early detection of Alzheimer's disease (AD)** and combining this with lifestyle programs for reducing lifestyle risk related to Alzheimer's dementia.
COORDINATOR / PARTNERS	Coordinated by BRAIN+ APS (DK) Simon Nielsen, Director of Research & Innovation: **sn@brain-plus.com** THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD – United Kingdom AARHUS UNIVERSITET – Denmark AARHUS UNIVERSITETSHOSPITAL – Denmark (IIRD-PARTY) ALZHEIMER EUROPE – Luxembourg THE EUROPEAN BRAIN COUNCIL AISBL – Belgium
SOLUTIONS / TECH PROVIDERS	The project aimed to gamify a novel method developed by Oxford University – a **cognitive test on working memory** (one of the first cognitive domains to be affected) that has been shown to be highly sensitive in i**dentifying individuals at an elevated risk of AD but are asymptomati**c, thus allowing for AD detection before overt clinical symptom onset.
PILOTS / USE CASES DESCRIPTION	• Study Brain+/Oxford aims at i**dentifying early subtle changes in cognition i**n people with a high risk of developing AD but who are currently asymptomatic. • Study Aarhus aims at **validating the precision of the AD Detect and Prevent detection tool** for detecting subtle cognitive changes in asymptomatic AD at-risk individuals (using PET and DW-MRI scans). • Study Nottingham will **examine the immediate and prolonged impact of AD Detect & Prevent training,** particularly for transfer effect to other real-world tasks.
ACHIEVED RESULTS	Two digital technologies were developed and tested: the **Starry Night cognitive test** and **Computerized Cognitive Training games**. Clinical trials conducted by various universities demonstrated the feasibility and effectiveness of these technologies, particularly in measuring working memory and reducing cognitive load. Plans for further large-scale trials and integration into products aimed at individuals with Mild Cognitive Impairment (MCI) signify promising directions for early detection and intervention in Alzheimer's disease.
CHALLENGING POINTS	Not documented
WEB LINK	https://www.addp.eu/ad-detect-and-prevent

	https://www.addp.eu/ad-detect-and-prevent-holds-webinar-on-the-potential-of-digital-tools-for-improving-the-detection-of-alzheimers-disease/ https://www.addp.eu/ad-detect-and-prevent/the-consortium/
OTHER	NA

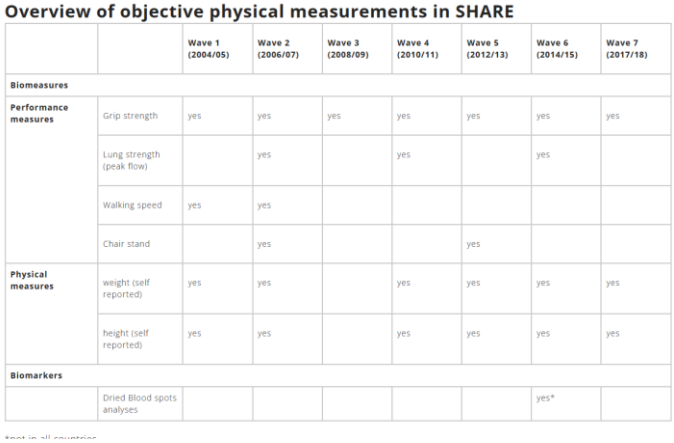
ADPS

PROJECT NAME	**ADPS - Alzheimer's Disease Prediction Service**
STARTING / ENDING	2016-2018
TYPE OF FUNDING SCHEME	EIT Health
OBJECTIVES	The Alzheimer's Disease Prediction Service (ADPS) employs an easy smartphone test to predict whether someone is likely to develop Alzheimer's in the next six years, using data that has shown 94% accuracy. It will be one of the first validated solutions to enter the EU market as a pre-symptomatic biomarker to predict Alzheimer's risk for people over 50.
COORDINATOR / PARTNERS	1. Trinity College Dublin, 2. University of Barcelona, 3. Ionian University (BiHeLab), SwissNeuroFoundation (SNF), 4. Global Brain Health Institute (GBHI), 5. EIT Health (EU institution), 6. Research Center for Computational Biomarkers (RCCBM), **7. Altoida AG**
SOLUTIONS / TECH PROVIDERS	Although some biological measures (biomarkers) can identify Alzheimer's-related changes before significant changes in cognitive function occur, such biomarkers are not ideal as they are only able to place individuals in rudimentary stages of the disease/cognitive decline and sometimes mistakenly diagnose individuals. Two tests, based on real-world functioning, which have been used to screen for pre-symptomatic AD are dual-task walking tests and day-out tasks. A multisite clinical trial financed by the European Institute for Innovation & Technology (EIT), the Global Brain Health Institute and Alzheimer's Association USA aimed to validate **a novel digital biomarker of cognitive decline, the Altoida ADPS app.**
PILOTS / USE CASES DESCRIPTION	A group of pre-identified healthy older adults that can be described as high-risk and individuals in prodromal stages of AD (n¼410) were being studied for a period of 36 months based on 6 domains (Demographics, Ab and Tau, MRI, Cognition, APOE status). **The ADPS Neuro Motor Index (NMI) was included as a secondary outcome measure of cognitive ability and real-world function**. ADPS is administrable by means of a tablet in less than 10 minutes and tracks 250 real-world metrics, while the individual places three-dimensional virtual objects in a real environment with their subsequent recovery after a distraction task.
ACHIEVED RESULTS	ADPS demonstrated high test-retest reliability and was able to accurately discriminate between healthy controls, high-risk individuals, and prodromal stages of AD. It could also differentiate between people with mild cognitive

	impairment who convert to AD and those who don't and correlated with existing measures of cognitive function and biomarkers. ADPS is **rapid, ecological, and cheaper than current neuropsychological tests** and, in case of complete validation as a tool to assist physicians in real-world clinical settings, opens the doors to large-scale population screening for the early detection of cognitive impairment.
CHALLENGING POINTS	**Accuracy Across Diverse Populations**: While the ADPS has shown 94% accuracy, ensuring this level of accuracy across diverse populations, including different ethnicities, genetic backgrounds, and health profiles, can be challenging.
WEB LINK	https://eithealth.eu/product-service/adps/
OTHER	Link to the APP: https://apps.apple.com/us/app/altoida/id1133610450

SHARE

PROJECT NAME	**SHARE - The Survey of Health, Ageing and Retirement in Europe**
STARTING / ENDING	2000- Now
TYPE OF FUNDING SCHEME	NA – Permanent infrastructure funded by Member States bodies and University Hospitals.
OBJECTIVES	SHARE is a **research infrastructure** for studying the effects of health, social, economic, and environmental policies over the life-course of European citizens and beyond. It exists in the last 24 years and has collected data from 28 countries (EU+ CH + Israël). It has gathered 530,000 in-depth interviews with 140,000 people aged 50 or older. SHARE is thus the largest pan-European social science panel study **providing internationally comparable longitudinal micro data which allow insights in the fields of public health and socio-economic living conditions of European individuals**. Access to the data collected by SHARE might be important to collect baseline information and/or to support the training of some aspects of the algorithms.
COORDINATOR / PARTNERS	28 countries participating Infrastructure sheltered by Tilburg University (NED) - Partner in COMFORTage.
SOLUTIONS / TECH PROVIDERS (a brief description for each one)	All waves of SHARE include objective **health data (bio measures)** in form of physical performance measures: grip strength, walking speed (both strong predictors of future disability), peak flow (associated with health conditions, including dementia) and the so-called chair stand measurement (its result is a predictor of subsequent disability or hospitalization). Additionally, we ask respondents for their height and weight. Not all the listed measures are collected in every wave, for more details see table. SHARE-HCAP (share-eric.eu): In-depth measurement of cognition according to the Harmonized Cognitive Assessment Protocol (HCAP) that has been developed for the HRS-style ageing surveys.
PILOTS / USE CASES DESCRIPTION	NA – New projects are started continuously.

ACHIEVED RESULTS	A cutting-edge innovation in SHARE Wave 6 was the implementation of a **blood sample collection in 12 SHARE countries.** Blood samples have been collected in form of dried blood spots (DBS). DBS are drops of blood dried on a special filter paper. The blood is taken by a simple prick into the respondent's fingertip which enables specially trained interviewers to conduct the blood collection. The following of the SHARE countries participated in the collection of DBS: **Belgium, Switzerland, Germany, Denmark, Estonia, Spain, France, Greece, Israel, Italy, Sweden, and Slovenia**. From these countries nearly **24.000 blood samples are available for analysis** from the same number of Wave 6 respondents. The analyses focus on markers related to diseases and conditions that are typical for older people and/or are influenced by lifestyle, for example cardiovascular diseases (CVD), diabetes, and markers for stress and cognition. These blood parameters will provide objective information about the respondents' health status, complementing the more subjective self-reports included in SHARE.
CHALLENGING POINTS	**Participant Compliance and Acceptance**: Although the DBS collection method is minimally invasive, gaining widespread acceptance and compliance from participants, especially the elderly who might have reservations about providing blood samples, can be challenging. **Ethical and Privacy Concerns**: Collecting and analyzing blood samples raises ethical and privacy concerns. Ensuring informed consent, secure handling of samples, and protection of participants' data across different regulatory environments is essential. **Analytical Limitations**: While DBS offers a convenient method for collecting blood samples, it may have limitations in detecting certain biomarkers compared to traditional venous blood samples. Ensuring the analytical methods are sensitive and accurate for the intended markers is critical. **Interpretation of Results**: The objective information obtained from blood parameters must be carefully interpreted, especially when complementing subjective self-reports. Understanding the implications of these biomarkers in the context of lifestyle and health status requires comprehensive analysis and expert knowledge.
WEB LINK	https://share-eric.eu/
OTHER	**Overview of objective physical measurements in SHARE**  SHARE data is provided in Stata and SPSS format. Easy SHARE is additionally available for the software R. For the use with other statistical software, the data must be transferred by users themselves.

		Wave 1 (2004/05)	Wave 2 (2006/07)	Wave 3 (2008/09)	Wave 4 (2010/11)	Wave 5 (2012/13)	Wave 6 (2014/15)	Wave 7 (2017/18)
Biomeasures								
Performance measures	Grip strength	yes	yes	yes	yes	yes	yes	yes
	Lung strength (peak flow)		yes		yes		yes	
	Walking speed	yes	yes					
	Chair stand		yes			yes		
Physical measures	weight (self reported)	yes	yes		yes	yes	yes	yes
	height (self reported)	yes	yes		yes	yes	yes	yes
Biomarkers								
	Dried Blood spots analyses						yes*	

AD-AUTONOMY

PROJECT NAME	**AD-AUTONOMY - Development of a training program for enhancing the autonomy of persons with Alzheimer**
STARTING / ENDING	01/10/17 to 30/09/19
TYPE OF FUNDING SCHEME	ERASMUS+
OBJECTIVES	Innovative approaches have been developed that allow Persons with Alzheimer (PWA) to develop a life as full as possible outside the healthcare environment, improving their Quality of Life (QoL), as well as ICT Tools (Apps and Assistive Technologies) that enhance their autonomy, in a secure environment with the precise supports. However, Autonomy, and therefore QoL, of these persons still nowadays limited or developed in non-self and supported environments. The project has the next specific objectives: • Aware and motivate this group on the importance of maintaining the autonomy of people, within a security and support environment, as an element of QoL for PWA and their families. • To increase the Autonomy of PWA for taking decisions and live independently with a global Wellbeing and QoL approach. • Transfer good practices and recommendations to this group to promote Autonomy through training in the execution of daily routines. • Transfer tools, including Apps and Assistive Technologies, to support the processes of empowering and increasing Autonomy of PWA. • Transfer techniques for the emotional management of impairment associated with illness and related problems, based on the concept of mindfulness. • Involve professionals and supports.
COORDINATOR / PARTNERS	**Coordinator** **ASOCIACIÓN PROVINCIAL DE FAMILIARES DE PERSONAS CON LA ENFERMEDAD DE ALZHEIMER Y OTRAS DEMENCIAS DE CASTELLÓN** Antiguo Cuartel Militar Tetuán 14 12004 Castellón Comunidad Valenciana ES **Spain** **Partners** ARISTOTELIO PANEPISTIMIO THESSALONIKIS GR Greece BOURNEMOUTH UNIVERSITY GB United Kingdom SLOVENSKO ZDRUZENJE ZA POMOC PRI DEMENCI - SPOMINCICA ALZHEIMER SLOVENIJA SI Slovenia Turkiye Alzheimer Dernegi TR Türkiye UNIVERSITAT POLITECNICA DE VALENCIA ES Spain

SOLUTIONS / TECH PROVIDERS	AD-AUTONOMY aims at **increasing the competences (attitudes, skills, knowledge) of Persons with Initial/Mild Alzheimer (PwA), Families and Caregivers**, about how to improve Quality of Life of PWA through Autonomy through an innovative training program.
PILOTS / USE CASES DESCRIPTION	In order to facilitate the process of eliciting daily life aspects of autonomy, a co-creation session was realized in the premises of the Thessaloniki Active & Healthy Ageing Living Lab [5]. Five (5) elderly participants (4 females, mean age 77.2 y.o.),1 either suffering from Mild Cognitive Impairment (MCI) or having subjective memory complaints participated. One of the elderly participants has a sister who is suffering from Alzheimer's Disease and provides daily care to her. In addition, three professional caregivers interacted and provided their perspectives on the caring of the PwA. The co-creation session lasted 120' and it was audio and video recorded, after all participants provided their consent. *(1) (PDF) Co-Creation of an Innovative Vocational Training Platform to Improve Autonomy in the Context of Alzheimer's Disease*. Available from: https://www.researchgate.net/publication/326188229_Co-Creation_of_an_Innovative_Vocational_Training_Platform_to_Improve_Autonomy_in_the_Context_of_Alzheimer%27s_Disease#fullTextFileContent
ACHIEVED RESULTS	All relevant stakeholders were involved in a co-creation session, allowing the collection of valuable insights about their everyday life and how technology can be used to improve their autonomy. Information not previously documented by experts was provided by PwA and professionals.
CHALLENGING POINTS	Main limitation of this study is that all participants had previous experience with technology artefacts, which subsequently could bias their attitudes towards the use of assistive technologies. A second co-creation session is planned, which will provide more details about how these technologies can be embedded in real life context and improve the competences of PwA and their carers.
WEB LINK	https://medphys.med.auth.gr/project/ad-autonomy
OTHER	https://www.researchgate.net/publication/326188229_Co-Creation_of_an_Innovative_Vocational_Training_Platform_to_Improve_Autonomy_in_the_Context_of_Alzheimer%27s_Disease#fullTextFileContent

FRAILTOOLS

PROJECT NAME	**FRAILTOOLS - A comprehensive validation of tools to screen and diagnose frailty in different clinical and social settings to provide instruments for integrated care in older adults**
STARTING / ENDING	2016-2018
TYPE OF FUNDING SCHEME	Funded by the European Commission Directorate General for Health and Consumer Affairs (DG SANTE) – Third Health Programme. Founding Health Initiatives (2014–2020), and Spanish Ministry of Economy, Industry and Competitiveness, cofinanced by FEDER (RD120001/0043) and CIBERFES (CB16/10/00464
OBJECTIVES	European project aimed at developing digital tools for assessing and managing frailty in older adults. It involves the development of mobile apps, sensors, and other technologies to monitor and intervene in the progression of frailty. FRAILTOOLS´ main objective is to **evaluate the usefulness of frailty scales** in the detection of frailty in different

	clinical and social settings, and its integration in management algorithms for the frail older patient. The FRAILTOOLS project is a prospective observational study conducted in 5 European countries. The study included people aged 75 and older. Each participating centre was required to recruit 388 patients, which corresponded to 97 subjects in each clinical setting by centre. The follow-up period was 18 months.
COORDINATOR / PARTNERS	FUNDACION PARA LA INVESTIGACION BIOMEDICA DEL HOSPITAL UNIVERSITARIO DE GETAFE (936387658) **Coordinator** — Spain SERVICIO MADRILENO DE SALUD (999481987) **Beneficiary** — Spain UNIVERSITA CATTOLICA DEL SACRO CUORE (999915771) **Beneficiary** — Italy CENTRE HOSPITALIER UNIVERSITAIRE DE TOULOUSE (999894819) **Beneficiary** — France DIABETES FRAIL LIMITED (937820251) **Beneficiary** — United Kingdom UNIWERSYTET JAGIELLONSKI (999642716) **Beneficiary** — Poland ASTON UNIVERSITY (999896953) **Beneficiary** — United Kingdom
SOLUTIONS / TECH PROVIDERS	Frailty was assessed using the following tools: Frailty Phenotype, SHARE-FI, 5-item Frailty Trait Scale (FTS-5), 3-item FTS (FTS-3), FRAIL scale, 35-item Frailty Index (FI-35), Gérontopôle Frailty Screening Tool, and Clinical Frailty Scale. Adverse outcomes ascertained at follow-up were as follows: falls, hospitalization, increase in limitation in basic (BADL) and instrumental activities of daily living (IADL), and mortality. Sensitivity, specificity, and capacity to predict adverse outcomes in logistic regressions by each instrument above age, gender, and multimorbidity were calculated
PILOTS / USE CASES DESCRIPTION	NA
ACHIEVED RESULTS	**No single assessment instrument performs the best for all settings and outcomes.** While in inpatients several commonly used frailty instruments showed good sensitivities (mainly for mortality and BADL worsening) but usually poor specificities, the contrary happened in geriatric clinic. **None of the instruments showed a good performance in primary care. The FI-35 and the FTS-5 showed the best profile among the instruments assessed**.
CHALLENGING POINTS	**Variability in Tool Performance**: The significant variability in the performance of different frailty assessment tools across various settings (inpatient, geriatric clinic, primary care) complicates the selection of the most appropriate tool for specific clinical contexts. **Variability in Tool Performance**: The significant variability in the performance of different frailty assessment tools across various settings (inpatient, geriatric clinic, primary care) complicates the selection of the most appropriate tool for specific clinical contexts.
WEB LINK	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/31061266/662887/3HP?programmePeriod=2014-2020&programId=31061266&freeKeywords=FRAILTOOLS&order=DESC&page=1&pageSize=10
OTHER	NA

MARIO

PROJECT NAME	**MARIO - Managing Active and healthy aging with use of caRing servIce robots** Digital tools, including virtual reality and artificial intelligence, to provide personalized interventions for dementia prevention and frailty management
STARTING / ENDING	01.02.2015-31.01.2018
TYPE OF FUNDING SCHEME	Horizon 2020 (RIA)
OBJECTIVES	MARIO addresses the difficult **challenges of loneliness, isolation, and dementia in older persons** through innovative and multi-faceted inventions delivered by service robots. The effects of these conditions are severe and life-limiting. They burden individuals and societal support systems. Human intervention is costly, but the severity can be prevented and/or mitigated by simple changes in self-perception and brain stimulation mediated by robots. From this unique combination, clear advances are made in the **use of semantic data analytics, personal interaction, and unique applications** tailored to better connect older persons to their care providers, community, own social circle and to their personal interests. Each objective is developed with a focus on loneliness, isolation, and dementia.
COORDINATOR / PARTNERS	UNIVERSITY OF GALWAY *ROBOSOFT Services Robots* Francia **R.U.Robots Limited** Regno Unito **ORTELIO LTD** Regno Unito **STOCKPORT METROPOLITAN BOROUGH COUNCIL** Regno Unito **CONSIGLIO NAZIONALE DELLE RICERCHE** Italia **R2M SOLUTION SRL** Italia **FONDAZIONE CASA SOLLIEVO DELLA SOFFERENZA** Italia **MILIOTI LOUKIA TOU ANASTASIOS** Grecia **UNIVERSITAT PASSAU** Germania
SOLUTIONS / TECH PROVIDERS	MARIO project develops **a companion robot** that builds resilience and reduces loneliness and isolation in older people with dementia. Launched in February 2015, the three-year MARIO project builds **upon the success of the DOMEO project, the first ever project to bring assistant robots into real homes with real people** for a period of more than a year. **Robosoft, the coordina-**

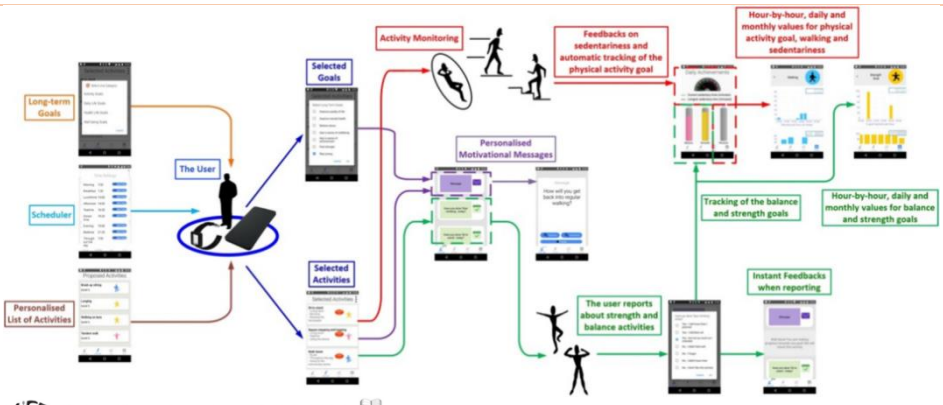
	tor of DOMEO, is now a partner in MARIO and is responsible for **achieving functional and system-related improvements of the new version of the Kompaï robot.** The legacy of DOMEO is relevant not only for the MARIO project but for an entire 'class' or 'generation' of projects that are now underway or planned in the future.' Several aspects of DOMEO will now be expanded upon through **MARIO's research** agenda. These include verbal interactions with the user, along with **Human Robot Interaction to support cognitive and memory assistance involving semantics.** The aim is that the MARIO project takes a step forward and **exploits natural language processing.**
PILOTS / USE CASES DESCRIPTION	A user-led design process was used, and the MARIO robot was tested in **three pilot sites:** 1. a **hospital in Italy** (Geriatric Unit of IRCCS "Casa Sollievo della Sofferenza", in the South of Italy). 2. a r**esidential care home in Ireland** (a purpose built residential care facility for older people and people with dementia). 3. a **community setting in the UK** (two different sites in the Stockport area. The first site was a community hospital that provides mental health and specialist care services for older people; the second site was the UK Alzheimer's Society3 offices in Stockport). Three phases of testing were undertaken where MARIO engaged with people with dementia in each pilot site. This resulted in the development of several personalised robot applications including: My Chat, My Memories, My Music, My Games, My News, My Calendar, and My Family & Friends. In the final phase, the impact of the MARIO robot was evaluated using questionnaires, observations, and interviews. People with dementia, their family members, formal carers, and managers across all three pilot sites were involved in the final evaluation.
ACHIEVED RESULTS	The Robot user-led design led to the development of applications that were tailored to the needs of people living with dementia. These applications allowed people with dementia to access the newspapers, listen to their favourite songs, provide reminders of upcoming events, store family photos and connect with their friends and families. Overall, attitudes towards the MARIO robot were positive. People enjoyed spending time with MARIO, saw him as a companion, a source of entertainment and a source of interaction. The findings from this study provide evidence related to the **potential for the use of companion robots.** The MARIO project established that companion robots are an acceptable part of social care for people with dementia. They have an important role to play in combatting the perceptions of loneliness, can decrease the amount of time people with dementia spend alone, and increase levels of engagement. The positive impact of MARIO on the quality of life, social and cognitive health, and loneliness in people with dementia is evident.
CHALLENGING POINTS	**User Adaptability**: Ensuring the robot's adaptability to a wide range of user preferences and needs, considering the diverse nature of dementia symptoms and the varying stages of the condition. **Emotional Attachment**: Managing the emotional attachment that might develop towards the robot and understanding its impact on users' psychological well-being, especially if the robot's availability is discontinued or if it malfunctions. **Social Acceptance**: Building broader social acceptance and understanding of companion robots as legitimate and beneficial tools in the care of individuals with dementia.
WEB LINK	https://cordis.europa.eu/project/id/643808/it

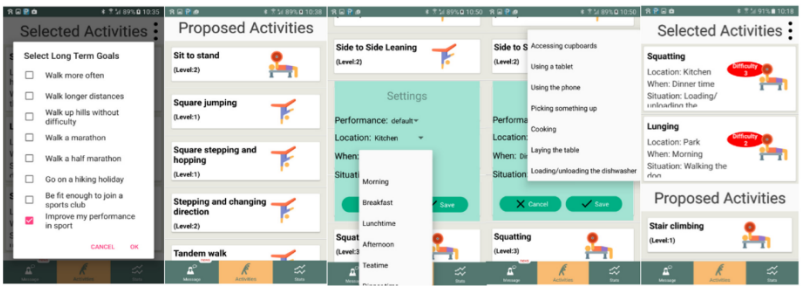
	http://www.mario-project.eu/portal/
OTHER	NA

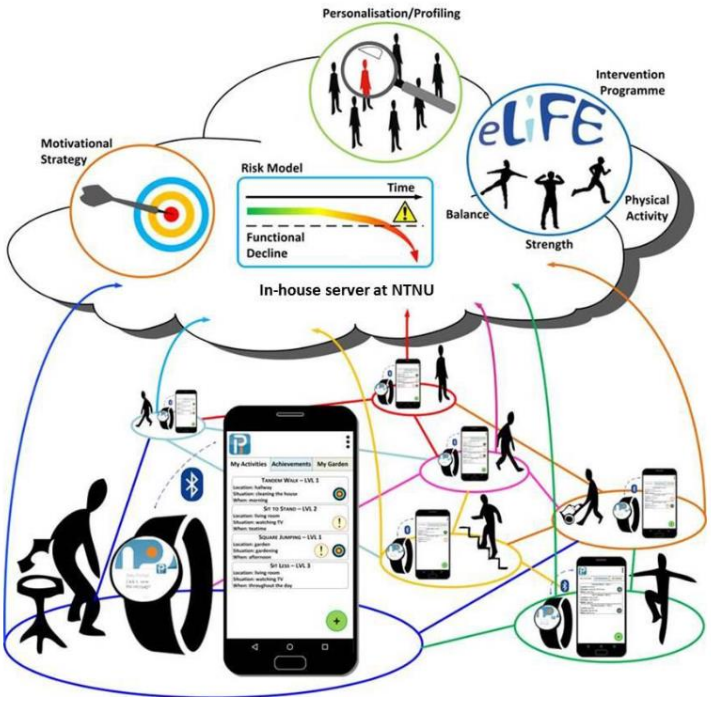
PREVENTIT

PROJECT NAME	**PreventIT**
STARTING / ENDING	2016-2019
TYPE OF FUNDING SCHEME	European Union's Horizon 2020 research and innovation programme TRL6-7
OBJECTIVES	PreventIT is a research project aimed at preventing frailty in older adults using digital technologies. It involves the development of **a mobile app** that provides **personalized exercise programs, nutritional advice, and cognitive training** to help older adults maintain their independence and mobility. The HAPA model was chosen as it is the only model of health behaviour change to specifically focus on how to bridge the gap between intention and actual performance of a new behaviour. HAPA recognises that adopting and maintaining a new behaviour is a long-term process, which must be supported by detailed planning and confidence in one's own ability to integrate strength, balance, and physical activities into daily life successfully. The Lifestyle-integrated Functional Exercise (LiFE) programme, focuses on integrating strength, balance and physical activities into everyday life and was originally developed as a fall prevention intervention for adults 75 years and over The LiFE approach targets self-efficacy, in that it encourages participants to master or improve a particular skill. The LiFE programme can only be successful if participants change their behaviour to integrate strength and balance activities into their everyday lives. As such, the starting point with **adapting the LiFE programme to younger older adults was to identify the behaviour change techniques (BCTs) that would be used**. To address the need to clearly specify the components of an intervention, with clear terminology, Michie et al (2013) developed the **Behaviour Change Techniques Taxonomy** (BCTTv1.0)37 describing **93 different techniques that can be used in behaviour change interventions**. We reviewed the PreventIT interventions against the taxonomy with the aim of mapping all elements of aLiFE and eLiFE to clearly defined BCTs. The project followed a three steps approach: 1. Developing the conceptual model and identifying theory 2. Implementing the model 3. measuring motivation and behavioural change.
COORDINATOR / PARTNERS	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU

	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA Italy STICHTING VU Netherlands ROBERT BOSCH GESELLSCHAFT FUR MEDIZINISCHE FORSCHUNG MBH Germany THE UNIVERSITY OF MANCHESTER United Kingdom AZIENDA UNITA' SANITARIA LOCALE TOSCANA CENTRO Italy ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE Switzerland DOXEE SPA Italy HEALTH LEADS BV Netherlands
SOLUTIONS / TECH PROVIDERS	An important difference between **aLiFE and eLiFE** is that the latter affords the opportunity to introduce r**egular prompts and real-time feedback to participants on their performance of planned activities**. Participants are asked to self-report on their performance of strength and balance activities, and they receive feedback regarding their achievements. Physical activity is recorded objectively by the sensors embedded in the Android smartphones and smartwatches. Graphical feedback is given to participants based on their personal goals (activities performed, time spent sedentary, minutes spent walking).



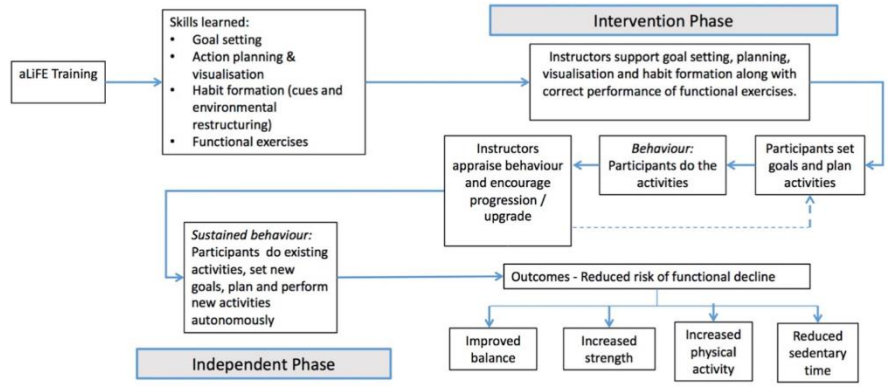




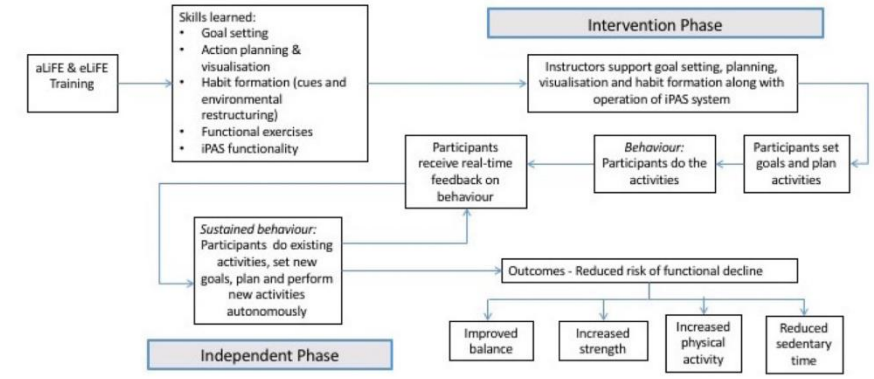
PILOTS / USE CASES DE-SCRIPTION	Fully functional App was developed and tested in **Dutch, German and Norwegian** in the eLiFE pilot study, which took place between October and December 2016. The PreventIT project includes the development and feasibility study of (i) a younger age (61–70 years) adapted intervention (aLiFE) and (ii) an Information and Communication Technology (ICT)-enabled version of aLiFE, named eLiFE, and testing a three-site, three-

armed feasibility randomised controlled trial (RCT). For eLiFE, all elements of the aLiFE intervention have been adapted to be delivered through smartphone and smartwatch applications (Apps), with progress monitoring and real-time feedback prompting participants to remain engaged in the programme.

aLiFE model



eLiFE model



ACHIEVED RESULTS

Table 2. Behaviour change techniques used in PreventIT.

Behaviour change techniques	aLiFE content	eLiFE content
1. Goals and planning		
1.1 Goal setting (behavioural – which activities and how often?).	Daily routine chart, activity planner.	App content (planning screens), instructor.
1.2 Problem solving.	Manual, instructor,	App content, instructor.
1.3 Goal setting (outcome – long term).	Paper form, instructor.	App content (planning screens), instructor.
1.4 Action planning.	Activity planner, instructor.	App content (planning screens), instructor.
1.5 Review behavioural goals.	Activity planner, activity counter.	App content (daily reporting).
1.6 Discrepancy between current behaviour and goal.	Paper form, activity planner.	App content (motivational messaging, activity reporting).
1.7 Review outcome goals.	Paper form, activity planner, activity counter, instructor.	App content (motivational messaging, activity reporting).
2. Feedback and monitoring		
2.2 Feedback on behaviour.	Instructor.	App content (real-time feedback).
2.3 Self-monitoring of behaviour.	Activity planner, activity counter.	App content (activity reporting).
2.4 Self-monitoring of outcomes of behaviour.	Activity planner, activity counter.	App content (motivational messaging).
2.6 Biofeedback	Not included.	System components (accelerometer) and app content (feedback screens).
2.7 Feedback on outcomes of behaviour.	Instructor.	App content (real-time feedback).
3.1 Social support	Instructor.	App content (motivational messaging).
4. Shaping knowledge		
4.1 Instruction on how to perform the behaviour.	Manual, instructor.	App content (text, pictures, videos).
5.Natural consequences		
5.1 Information about health consequences.	Manual.	App content (motivational messaging).
5.3 Information about social and environmental consequences.	Manual.	App content (motivational messaging).
6. Comparison of behaviour		
6.1 Demonstrate the behaviour.	Manual (text, pictures), instructor.	App content (text, pictures, videos).
6.2 Social comparison.	Not included.	App content (motivational messaging).
6.3 Information about others' approval.	Not included.	App content (motivational messaging).
7. Associations		
7.1 Prompts/cues.	Manual, instructor.	App content (planning screens).
8. Repetition and substitution		
8.1 Behavioural practice/rehearsal.	Manual, instructor	App content (planning screens, real-time feedback, motivational messaging).
8.3 Habit formation.	Manual, instructor, activity planner, activity	App content (planning screens, real-time feedback, motivational

8.6 Generalisation of a target behaviour.	Manual, instructor, daily routine chart, activity planner.	App content (motivational messaging).
8.7 Graded tasks.	Manual, instructor.	App content (planning screens, real-time feedback, motivational messaging).
10. Reward and threat		
10.10 Reward (outcome).	Instructor.	App content (real-time feedback, motivational messaging).
10.3 Non-specific reward.	Instructor.	App content (real-time feedback, motivational messaging).
12. Antecedents		
12.1 Restructuring the physical environment.	Manual, instructor.	App content (planning screens, motivational messaging).
12.2 Restructuring the social environment.	Manual, instructor.	App content (planning screens, motivational messaging).
15. Self-belief		
15.1 Verbal persuasion about capability	Not included.	App content (motivational messaging).
15.3 Focus on past success	Not included.	App content (motivational messaging).

The project developed a **risk screening tool that aims to predict functional decline** in adults aged **61-70 years.** They pooled the data of nearly 800 participants from two large, ongoing cohort studies on older people: the **In CHIANTI study** from Italy and the Longitudinal **Aging Study Amsterdam (LASA)** from the Netherlands.
The project also **developed a profiling tool** to be able to personalise the intervention to individual end users. This tool was included in the iPAS application on the smartphones and used different sources of information to rank all activities from the aLiFE programme in a personalised order for each participant.
The **aLiFE assessment tool** assessed the starting levels for all activities, from very easy (e.g.using hand support) to difficult (e.g. performing dual tasks). This was used to define the starting levels of the activities ranked in the profiling tool.

DESCRIPTION	PERFORMANCE REQUIREMENTS	STATUS AT THE END OF THE PROJECT
Version II of iPAS, including RiskScreen, instrumented self-administered tests of physical function, and the motivation assessment tools, integrated together with the profiling tool for personalisation of aLiFE and eLiFE interventions into one system	The system is mature enough to be tested in its full version in a future phase III definitive RCT.	We have developed the iPAS with all its described components. Based on the results from the feasibility RCT, the system components need a third iteration of development before being tested in a definitive clinical controlled trial. Further development is needed on the intervention and the smartphone application user interface. In addition, a further validation on the assessment tools are needed in order to be evidence based.
The PreventIT feasibility RCT	The study is performed with 180 participants, and the aLiFE and eLiFE interventions have demonstrated potential improvements in complexity and physical function and reduced disability compared to practice as usual such that effect sizes can be estimated for the future phase III RCT. Loss to follow-up following the 6 month intervention is less than 20% in the intervention arms of the study.	The study included 180 participants as planned and demonstrated feasibility of the interventions. Although we found overall improvement in function and complexity in the course of the trial, we did not find differences in change between the groups. Loss to follow up was less than 20 %, with 88 % completing the 6 months assessment. Furthermore, 77 % completed the 12 months assessment.
The complexity metric	The metric is found to be more sensitive than conventional measures to identify early risk related to ageing and to document change following a risk reduction intervention.	The complexity metric was found to be more promising to distinguish between groups and to measure overall improvement in function compared to more traditional outcome measures.
User acceptance of the technology that has been developed	At least 80% of participants in the PreventIT feasibility trial use the smartphone and smartwatch technology during the 6 month follow-up after the intervention period.	Over the 6 months intervention period, 58 out of 60 participants used the PreventIT app on average 130 days. Over 12 months, this number increased to 179.6 days, varying between participants from 1 to 362 days.
The eLiFE intervention	Participants receiving the eLiFE intervention perform the suggested personalised activities at least 50% of the time during the intervention study.	77.5% of the eLiFE participants completed all scheduled visits and phone calls. Participants set their own goals and chose the number of exercises to be performed. After the 6 months intervention, 29% had done more exercise than planned, 54% had done their exercises but not as much as intended, while 18% had not done their planned exercises. After twelve months, 23% had done more than planned, 50% had done their exercises but not as much as intended, while 27% had not done their planned exercise.
Exploitable results	The expected results are mature for exploitation at the end of the project in the form of selected products and services, and realistic business plans are available.	We have selected 3 marketable products; the Risk Screening Tool, the entire iPAS system, and the self-assessment tool. However, market analysis in order to commercialize the products showed that an intermediate step is needed before the industry is interested in investing in these products.

CHALLENGING POINTS

- NEED to improve the 'look and feel' of the smartphone interface, improving navigation and visualisations. Importance of coherent, underpinning psychological theory and explicit use of behaviour change techniques, the importance of plain language and short messages; 'gain-framing' messages to focus on positive outcomes; tailoring feedback to personalise messages; developing a plan for message delivery (time, frequency, length); ensuring

	there are sufficient messages to avoid excessive repetition; testing the messages with the target group; and visual representations of progress and achievements. • The participants were relatively fit and well-functioning at baseline, indicating that finding those who would benefit the most from an early intervention and behaviour change programme, that is, the group with **medium risk for future functional decline,** remains a challenge. • The technology was not fully developed and tested – and hence somewhat immature – when the study started, leading to some technical challenges for some participants in the eLiFE group during the intervention. This was also reported by these participants in the focus groups interviews and might have contributed to more negative results on usability and acceptability of the technology, as well as on adherence to the intervention. • Version 1.0 of the RiskScreen tool that was used to screen participants in the feasibility RCT had not been validated. When using it as part of the in- and exclusion procedure, it selected **too few people in the medium risk group** for functional decline to be included. Thus, we stopped using the tool for inclusion of participants, but continued to use it to estimate and describe the participants' specific risk for functional decline within the recruited cohort and to collect data for a future validation of V2.0 of the RiskScreen tool. • At the start of the study, little knowledge was available about the target population, namely people in the early phase of retirement, regarding suitable assessment tools. Even though we carefully **chose assessment tools that should be sensitive to change in a relatively fit population, most had not been validated in our target population**, and we experienced that some of the tools, such as **EQ-5D on quality of life, were not sensitive enough to change in our target group.** To be able to prevent later age-related functional decline from retirement onward, it is an essential research topic for the future to develop suitable assessment tools for this population. • **Limited cultural validation of translated material** was performed before the feasibility study. We used international accepted translation procedures for translation of all material that was prepared in English. However, feedback from participants particularly during focus groups interviews, demonstrated that the wording as well as preferred activities that people do were different between site, even within Central and Northern parts of Europe. For future development of the motivational messages embedded in the iPAS system, such cultural issues need to be taken into consideration. • The profiling tool we developed automatically presented the most beneficial activities to each participant based on his or her phenotype. However, p**articipants themselves chose and prioritised activities to be done based on their own preferences**. During the feasibility study, we experienced that many participants chose a**ctivities deemed less beneficial for them as assessed by the profiling tool,** maybe because they liked them better or found them easier to perform as part of daily routines. This may have reduced the potential effect of the intervention.
WEB LINK	Project WHITEPAPER
OTHER	https://www.sciencedirect.com/science/article/pii/S0033062019300325

EDON

PROJECT NAME	**EDON - Early Detection of Neurodegenerative diseases**
STARTING / ENDING	2018-2025
TYPE OF FUNDING SCHEME	Alzheimer's Research UK
OBJECTIVES	Early Detection of Neurodegenerative diseases (EDoN) is an ambitious project spearheaded by Alzheimer's Research UK to **develop an innovative approach to detect diseases like Alzheimer's years** before the symptoms of dementia start. EDoN brings together global experts in data science, digital technology and neurodegeneration to develop a digital tool for the early detection of diseases that cause dementia. EDoN aim's to **collect huge amounts of digital data generously donated by research study volunteers using smartphone apps and wearable devices,** like watches and headbands. By **linking the data to clinical tests,** such as brain scans, we aim to identify digital data patterns, or 'fingerprints', that allow us to detect the earliest signs of diseases like Alzheimer's. Ultimately, EDoN will develop and test a digital device that can pick up these 'fingerprints' in people who don't have any obvious symptoms of dementia. This could transform research efforts, helping scientists make faster breakthroughs in understanding the diseases that cause dementia and enabling them to test potential new preventions and treatments.
COORDINATOR / PARTNERS	Over 60 experts from 49 universities, research projects, patient cohorts, and technology providers to create machine learning models to detect the earliest stages of dementia-causing diseases. This includes clinical practitioners and researchers from University College London and the University of Cambridge, experts in the provision of data services from the Oxford Big Data Institute and the National Physical Laboratory, data scientists from the Alan Turing Institute and the University of Exeter, and technology providers from University College London and Mindstrong Health (US). Moreover, advice will be sought from a range of international experts in the areas of clinical research and digital technologies, both informally and through the EDoN Independent and International External Advisory Board.
SOLUTIONS / TECH PROVIDERS	As part of EDoN, digital data and low-burden clinical measures, such as blood tests, will be collected in thousands of people to create machine learning models that can detect specific dementia-causing diseases decades before noticeable cognitive symptoms emerge. This effort will be supported by the development of **a data platform and a digital toolkit** (likely consisting of wearables and smartphone applications) that will collect active and passive physiological and behavioural measures (e.g. cognition, mood, heart rate, gait, sleep, and navigation). After extensive testing, EDoN aims to introduce the digital toolkit into annual health checks, which will allow for the early detection of dementia-causing diseases in a cost-effective, low-burden manner on a population-wide scale. Moreover, the information derived from the digital data will be used to inform lifestyle changes and to triage and stratify individuals into clinical trials or further targeted medical testing. As such, the outputs of the EDoN initiative will benefit the public, patients, carers, and clinicians, as well as the broader healthcare system and the pharmaceutical industry. The project will develop and build **a robust digital platform to enable the capture and storage of the data generated by the EDoN tool**, as well as to support the machine learning analysis and the visualisation of the results. This platform will

	likely consist of a cloud-based environment, potentially with local data storage, which will follow robust governance, security and access standards and will be integrated with the data systems of EDoN's partner organisations. Open-source software will be used wherever possible, and custom code and deployment processes will be made available under a permissive open-source license. The development of the platform will be driven by the needs of researchers, clinicians, and public users, as well as by the requirements for the integration with other key organisations (e.g. HDRUK and the healthcare system). This will include the addition of visualisation capabilities to eventually allow users to easily view and understand key summary statistics of the collected digital data, including dementia risk scores derived from the machine learning model.
PILOTS / USE CASES DESCRIPTION	Published study "Usability and acceptability of wearable technology in the early detection of dementia": Recruitment was conducted across various UK networks such as Join Dementia Research. Participants received the EDoN toolkit, which includes a smartwatch (Fitbit Charge 4), EEG headband (Dreem 3) and two smartphone applications (Longevity and Mezurio). Guides were provided to support the setup process. Initial interviews were conducted approximately three days after the participant received the devices, to explore initial perspectives regarding the toolkit and experiences of the setup process. Follow-up interviews were conducted two weeks later to explore the acceptability and usability of the toolkit. NVivo was used to thematically analyse the interview transcripts. Emerging themes were discussed and refined by the research group.
ACHIEVED RESULTS	Published study "Usability and acceptability of wearable technology in the early detection of dementia": Sixteen semi-structured interviews were conducted with nine participants, at two-time points. Four participants had mild cognitive impairment, two had frontotemporal dementia, one had Alzheimer's and two were carers. We identified three key themes, which centred around usability, acceptability, and inequity. Participants expressed the wearable devices were comfortable but individuals with physical disabilities or cognitive impairments struggled to use some devices. Participants valued the feedback the devices provided such as information on sleep and heart rate, although some information was not fully understood. Participants also shared their concerns around detecting preclinical dementia and the increased anxiety around the consequences of this such as "being put in a home". Various inequities of the toolkit were uncovered such as digital exclusion relating to a lack of access to strong WiFi connection, compatible smartphones, and poor digital literacy.
CHALLENGING POINTS	**Usability for Individuals with Disabilities**: Wearable devices, although generally comfortable, posed usability challenges for participants with physical disabilities or cognitive impairments, indicating a need for more accessible design features. **Understanding of Feedback**: While participants valued the health feedback provided by the devices, such as sleep quality and heart rate information, some found the data difficult to understand, suggesting a need for simpler, more interpretable feedback mechanisms. **Anxiety over Disease Detection**: The potential for wearable devices to detect preclinical signs of dementia raised concerns among participants about the implications of early detection, such as increased anxiety and fear of being institutionalized.
WEB LINK	https://www.alzheimersresearchuk.org/about-us/how-we-do-it/big-initiatives/edon/
OTHER	NA

DEM-DISC

PROJECT NAME	DEM-DISC - DEMentia Digital Interactive Social Chart
STARTING / ENDING	2008-2010
TYPE OF FUNDING SCHEME	Dutch Ministry of Economic Affairs under contract BSIK 03025, Dioraphte Foundation, RCOAK, NHDI, Foundation Het Zonnehuis, Province Noord-Holland and Stichting Alzheimer & Neuropsychiatrie Foundation.
OBJECTIVES	The need for information about the disease and coping with the consequences, as well as on available care and welfare services, is frequently unmet in people with dementia and their carers. To provide carers of community-dwelling people with dementia with tailored information, **the DEMentia-specific dynamic interactive social chart (DEM-DISC)** was developed. It provides **a platform for caregivers to track and share information about the daily activities and preferences of dementia patients,** facilitating better communication and coordination of care. The impact on the daily life of people with dementia and their carers, the user friendliness and usefulness of a first prototype of DEM-DISC was evaluated. DEM-DISC is a demand-oriented web-based social chart for dementia care that aims to provide users with customized answers about potentially relevant care and support services in their region that may fulfil their needs.
COORDINATOR / PARTNERS	University of AMSTERDAM
SOLUTIONS/TECH PROVIDERS	NA
PILOTS / USE CASES DESCRIPTION	The DEM-DISC prototype was limited to information on diagnosing dementia, practical support, coping, and finding company, and was restricted to information provisioning; Inclusion criteria for the carers were: taking care of a community-dwelling person with dementia for at least four hours per week. Experiencing needs in the restricted areas DEM-DISC provided information on (getting a diagnosis for the person with dementia, coping, practical support, and finding company). Additional inclusion criteria for informal carers in the experimental group were that they had to be familiar with computers and the internet.
ACHIEVED RESULTS	People with dementia and informal carers reported more met and less unmet needs after DEM-DISC use and carers in the experimental group reported higher levels of competence than controls. Although they were not explicitly satisfied with this first prototype of DEM-DISC, carers found DEM-DISC easy to learn and relatively user friendly. Carers acknowledged the system's benefits. The positive effects might be caused by the systematic and tailored individual way of information provisioning by DEM-DISC.
CHALLENGING POINTS	Low satisfaction with the first prototype of DEM-DISC.
WEB LINK	https://www.tandfonline.com/doi/full/10.1080/13607860903311741
OTHER	NA

AETIONOMY

PROJECT NAME	**Aetionomy – Organising Mechanistic Knowledge about Neurodegenerative Diseases for the Improvement of Drug Development and Therapy**
STARTING / ENDING	01.01.2014-31.12.2018
TYPE OF FUNDING SCHEME	FP7 - EU/EFPIA Innovative Medicines Initiative Joint Undertaking AETIONOMY
OBJECTIVES	Innovative computational tools to manage and interpret the complex healthcare and research data environment. Developing a taxonomy and ontology for neurodegenerative diseases, including Alzheimer's disease. It aims to advance understanding of disease mechanisms and identify potential targets for intervention using artificial intelligence and data-driven approaches. AETIONOMY was initiated to explore the idea that conventional disease definition is an increasingly outdated concept in the current medical environment. Opportunities for so-called 'precision medicine', in which molecular features both identify and direct treatment for disease, have been observed in a range of disorders, most prominently in the oncology field. The AETIONOMY consortium **chose to seek molecular characteristics of Alzheimer's disease (AD) and Parkinson's disease (PD) that might contribute to a 'taxonomy' of these conditions,** and help our community move towards a precision-medicine approach. The project has developed innovative **computational tools** to manage and interpret the complex healthcare and research data environment. It was a Herculean task for the teams to clean, associate and relate data that had been collated to answer diverse research questions over the years, and to make them available for our cause. Among the legacies of AETIONOMY are the resultant 'cleaned' data, managed in a knowledge base that will support future researchers.
COORDINATOR / PARTNERS	UCB PHARMA FRAUNHOFER-GESELLSCHAFT E.V. ERASMUS MEDICAL CENTER UNIVERSITAETSKLINIKUM BONN ICM- INSTITUT DU CERVEAU ET DE LA MOELLE ÉPINIÈRE CONSORCI INSTITUT D'INVESTIGACIONS BIOMEDIQUES AUGUST PI I SUNYER LEIBNIZ UNIVERSITAET HANNOVER

	PHARMACOIDEA LTD. LUXEMBOURG CENTRE FOR SYSTEMS BIOLOGY ALZHEIMER EUROPE KAROLINSKA INSTITUTET NOVARTIS SANOFI BOEHRINGER INGELHEIM BOEHRINGER INGELHEIM INSTITUT DE NEUROSCIENCES DES SYSTÈMES BARCELONABETA
SOLUTIONS / TECH PROVIDERS	1) In-silico validation of the candidate mechanisms in NeuroMMSigDB, with a special focus on the seven shortlisted candidate mechanisms. Demonstrating the potential of these candidate mechanisms to identify strata of patients in patient-level data is a pre-requisite for the generation of the mechanism-based taxonomy of neurodegenerative diseases. 2) Wet lab validation of the seven shortlisted candidate mechanisms based on biomarkers representing these mechanisms. A particular challenge here is the link between the readouts in the shortlisted candidate mechanisms and readouts (variables) in patient-level data. 3) Implementation of a prototype of the Virtual Dementia Cohort (VDC). The concept of the VDC has raised a lot of discussion in the scientific community, reaching far out beyond the core community of neurodegenerative disease research. AETIONOMY will focus resources and effort on the goal of having a first demonstrable implementation of the VDC published at the end of the funded period of the project.
PILOTS / USE CASES DESCRIPTION	The clinical studies for the validation of the mechanism-based taxonomy are organised with two scenarios relevant for the SME partners in AETIONOMY: partner Pharmacoidea makes use of the insights gained into disease mechanisms to identify possible targets for preventive or interventional therapy; partner Neurorad tests to what extent a routine diagnostic imaging lab can utilize imaging-based indices for patient subgroup identification by means of image analysis. Clinic studies are led by partner ICM, and Novartis is the EFPIA partner lead in this work package.

ACHIEVED RESULTS	AETIONOMY prospective study finished recruiting 420 subjects were successfully recruited, giving available clinical data and samples to analyse chosen biomarkers
CHALLENGING POINTS	**Complexity of Neurodegenerative Diseases**: The heterogeneous nature of neurodegenerative diseases like Alzheimer's and Parkinson's, involving complex interactions between genetic, molecular, and environmental factors, makes developing a unified taxonomy and ontology challenging. **Data Integration and Standardization**: Integrating and standardizing vast amounts of diverse healthcare and research data from various sources is a significant challenge. Ensuring compatibility and comparability across datasets to support a cohesive understanding of disease mechanisms is complex. **Advanced Computational Tools Development**: Creating innovative computational tools capable of managing, analyzing, and interpreting complex datasets involves challenges in software development, algorithm design, and computational capacity.
WEB LINK	https://cordis.europa.eu/project/id/115568
OTHER	NA

RADAR-AD

PROJECT NAME	**RADAR-AD (Remote Assessment of Disease and Relapse - Alzheimer's Disease)**
STARTING / ENDING	2019-2023
TYPE OF FUNDING SCHEME	H2020 Innovative Medicines Initiative (IMI)
OBJECTIVES	RADAR-AD is an IMI (Innovative Medicines Initiative) project aimed at using **digital tools and wearable sensors to monitor Alzheimer's disease progression remotely.** It involves collecting real-world data from patients to better understand disease trajectories and identify digital biomarkers for early detection and intervention. The main goal of the RADAR-AD project is to **develop a digital platform to detect subtle functional deficits in early Alzheimer's disease (AD) individuals by integrating a meaningful combination of smartphone, wearable and/or home sensor based parameters.** The system developed is suitable for future longitudinal studies, including trials. The objectives are to 1) **Identify the most relevant functional domains and the most promising remote measurement tools** (RMTs) for these domains based on reviewing the literature and piloting of RMTs in small studies; 2) **Optimise the RADAR-CNS platform for use in AD studies (he project will include a generic data management and modelling infrastructure already in use (in the RADAR-CNS project**; 3) **Test the platform and selected RMTs in a real world environment** clinical study with 240 participants across the AD spectrum ranging from the preclinical AD to the dementia stage; 4) **Perform statistical modelling to estimate longitudinal predictions;** 5) **Discuss results with regulatory agencies** in order to obtain guidance about how to develop a path for formal qualification as outcome measurements in future therapeutic interventions. It relies upon **already available technology platforms and on available longitudinal datasets where possible**. The consortium includes experts in clinical dementia studies, computer science, bioinformatics, regulatory policies, ethics, and patient and public involvement (PPI). Additional strengths of the consortium are the deep and broad interface with RADAR-CNS and related IMI projects, and the access to large amount of patient-level data from key European cohort studies for modelling purposes.

COORDINATOR / PARTNERS	KING'S COLLEGE LONDON - United Kingdom
SOLUTIONS / TECH PROVIDERS	The project proceeded to a selection of existing solutions with an inhouse methodology adapted to the target groups producing interesting results:
PILOTS / USE CASES DESCRIPTION	The RADAR-AD team has identified and singled out from the literature a series of functional disabilities that potentially affect the subject daily life in early phases of the AD. Relevant outcome measures for the study have been selected through the following process:

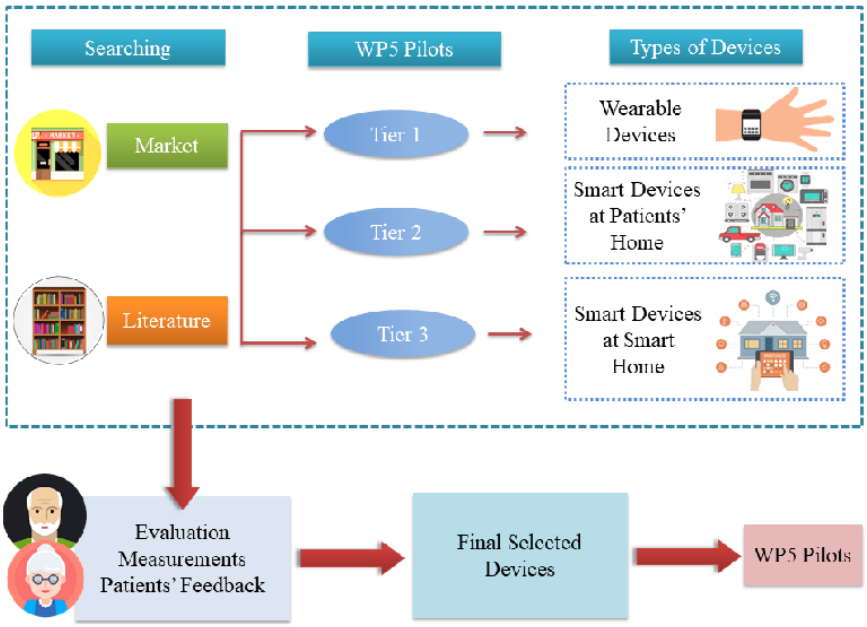
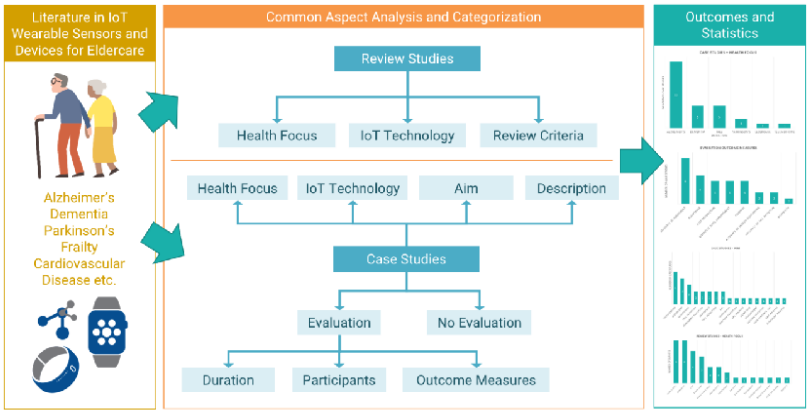


Figure 1 – Pipeline of the Searching and Evaluation for the three Tiers



https://ec.europa.eu/research/participants/documents/downloadPublic/alBiN0NEaTFRb3czaII3WTVDM2s3czdYNmp-tUm5neWhlVTZuSVVzemMvbWxEWUx3akg3eVNBPT0=/attachment/VFEyQTQ4M3ptUWRrbE84aGp3cFlJbnY2bk16QktydGg=

1. Identification of functional domains that meet one or more of the following criteria:
• Predicts conversion of MCI to mild-to-moderate AD.
• Impaired in early AD.
• Predicts functional decline in AD.
• Reported as important by an AD patient advisory board.
2. Identification of candidate RMT's to cover real-life measurement of the functional domains identified in step 1.
3. Identification of candidate tests to cover clinical measurement of the functional domains identified in step 1.

Functional domain	Relevance	Predicts MCI->AD conversion	Impaired in early AD	Predictive of decline	Reported by PAB
1. Difficulties at work	HR	x	X	x	x
2. Spatial navigation & memory	HR	x	X	x	x
3. Planning skills & memory required for task-completion	HR	x	X	x	x
4. Managing finances	R	x		x	x
5. Self-care	R		X	x	x
6. Self-management, e.g., running errands & shopping	R	x		x	x
7. Acquiring new skills	R		X	x	x
8. Sleep quality & circadian rhythms	R		X	x	x
9. Use of technology/devices	R		X	x	x
10. Dysnomia, word finding difficulties	N		X	x	
11. Gait	N		X	x	
12. Difficulties driving	N		X	x	
13. Interpersonal interaction	N		X		x
14. Motivation, signs of apathy or withdrawal	LR				X

The primary objective of this study is to assess the performance of selected Remote Monitoring Technologies against standardised rating scales of ADLs in subjects with preclinical AD, MCI due to AD, and mild-to-moderate AD. Secondary objectives are, (a) to evaluate associations between RMTs.
and standard clinical scales used to characterise people with AD diagnosis, (b) to investigate the patient acceptability of selected RMTs used for the duration of the study, and (c) to assess the technical performance of RMTs and digital platform in a real-life setting.
The study is a **multicentre, observational, cross-sectional, digital assessment** cohort study in subjects with preclinical AD, MCI due to AD, and mild-to-moderate AD. It consists of two parts: the main study (tier 1), where the subjects are provided with wearable digital devices, and a sub-study (tier 2), in which technologies are installed in the subjects' home. The duration of the main study (tier 1) is approximately 70 days (8 weeks of data collection) (Figure 1), while for the sub-study (tier 2), an additional 50 days (4 weeks of data collection) are expected (Figure 2), with a flexible time between the two studies for arranging home-device wiring. The sub-study will be performed on those volunteers whose home setting shows the necessary technical requirements.
PROTOCOL

ACHIEVED RESULTS

Remote Monitoring Technologies (RMTs) demonstrate substantial potential in discerning prodromal and mild-to-moderate stages of Alzheimer's Disease, with **Altoida, Fitbit,and Mezurio** emerging as the most promising tools.
Early-stage Alzheimer's Disease detection remains challenging for RMTs; however, **Axivity, a passive RMT, shows promising early-stage detection capabilitie**s.
The **A-iADL questionnaire provides a competitive alternative to traditional clinical assessment**s. It is potentially suitable for remote settings and offers time and cost efficiency.

	App-based augmented reality to assess cognitive impairment in early Alzheimer's disease: The AR app is feasible in the home-setting: It could distinguish HC from otherwise healthy Aβ-positive individuals, which is currently not possible with standard cognitive tests. The app differentiated HC from proAD participants equally well as a neuropsychological assessment. Future research should focus on further fine graining algorithms. **Neuronal competition as assessed with motor-cognitive dual-tasking can be used to detect early impairments not captured by cognitive or motor tests alone:** • Possible applications: predict and monitor changes in gait and use to prevent falls and hospitalisations in later stages of the disease. • Future studies should implement an adaptive cognitive load to improve sensitivity/specificity. • Cognitive impairment affects a range of gait features, with significant changes mostly emerging in the later stages. Link to key findings in POSTERS
CHALLENGING POINTS	Diagnostic groups could not be discriminated solely based on demographic data (Base). Combining RMTs with each other or with A-iADL/CFA showed some benefits in specific cases, although the effect was moderate and likely not practical for widespread use.
WEB LINK	https://www.radar-ad.org
OTHER	NA

MINDCROWD

PROJECT NAME	**MindCrowd**
STARTING / ENDING	2013-2019
TYPE OF FUNDING SCHEME	NA
OBJECTIVES	MindCrowd is an online research project that uses **crowdsourcing and AI technology** to gather **cognitive data** from participants to better understand brain health and aging. The platform collects data on memory, attention, and other cognitive functions to identify factors associated with cognitive decline and dementia risk. Researchers aim to understand how the human brain changes in function as people get older and as they develop age-related brain disorders, such as Alzheimer's disease. **Individuals aged 18 or older take a 10-minute online test and receive the results immediately.** The **test results will be used to create a registry of people who may be contacted for future research studies** of the aging brain. The MindCrowd test does not determine one's risk for Alzheimer's.
COORDINATOR / PARTNERS	MindCrowd is part of a research study conducted by the Translational Genomics Research Institute (TGen) in Phoenix, Arizona and the University of Arizona in Tucson, Arizona. Drs. Matt Huentelman and Lee Ryan are the founders and principal scientists behind the MindCrowd project. Dr. Huentelman is a Professor in the Neurogenomics Division at TGen and the head of its Neurobehavioral Research Unit. Dr. Ryan is Professor and Department Head of the Psychology Department at the University of Arizona. She is also Associate Director of the Evelyn F. McKnight Brain Institute at the University of Arizona.

SOLUTIONS / TECH PROVIDERS	NA
PILOTS / USE CASES DESCRIPTION	NA
ACHIEVED RESULTS	As of August 15, 2018, MindCrowd, haD **recruited 59,571 qualified participants from around the world**. The sample was 62.46% female and 37.54% male. An overrepresentation of women has been previously described in studies drawn from the general population (Krokstad et al., 2013) as well as for AD (Roberts et al., 2004). Across the entire sample, a FH of AD is present in 22.76% with the overall percentage swelling with age. This study finds that **having a first-degree relative diagnosed with Alzheimer's disease (FH) is associated with lower verbal learning and memory performance (i.e., paired-associates learning; PAL) below the age of 65**. Notably, FH men showed a greater reduction in cognition compared to FH women. This effect is not surprising since women, regardless of FH, perform better on PAL compared to men (Kaushanskaya et al., 2011), an effect replicated in this study. To that end, **we demonstrate the sex-effect for PAL extends across the entire adult lifespan**; indeed, the first time to the authors' knowledge that this has been demonstrated: 1) in a large cohort, 2) using the same test, and 3) in a single study. It is interesting that **the study found the associated disparity between women's and men's PAL scores enlarged around the 5th decade of life**. The 5th decade of life is the approximate age when women undergo menopause in developed countries. **Menopause-related changes to women's hormonal milieu, either endogenously or via hormone treatment or gynecological surgery have been found to alter cognition during this period.** Future studies of this cohort will dissect which medical choices at menopause, and medical choices earlier in a woman's lifespan, may underlie better preservation of verbal memory in middle aged women as compared to men. Lastly, educational attainment was associated with milestone-dependent higher learning and memory performance. Regardless of FH status, **education in women was associated with better PAL scores compared to men**, at all except the highest reported level of educational attainment (i.e., 16 vs. 20 years of education). The effect of education on PAL scores is in line with observations in a clinical study demonstrating that higher levels of education are associated with delayed AD onset (Vemuri et al., 2014; Wang et al., 2012). In terms of health, lifestyle, and genetic factors, this study found that diabetes modified the effect of FH on PAL. Specifically, in **both women and men, diabetes and FH were associated with reduced PAL performance**. It is not surprising that diabetes exacerbates the effects of FH on cognition since diabetes has been linked to worse cognitive deficits in AD (Takeda and Morishita, 2018). Several factors may underlie this effect: 1) there are differences in the risk of dementia for type one diabetes and type two diabetes, 2) specific type two diabetes treatments may reduce age-related declines in neural metabolism (Hamed, 2017; Kuo et al., 2018), and 3) vascular damage may combine with other genetic and environmental factors. As for genetic factors that modify FH, we supported our hypothesis whereby the presence of an APOE ε4 allele was associated with lower PAL performance in a dose-dependent-like manner in FH individuals. These data suggest **that APOE genotype is an important genetic factor that influences memory**. Our findings are in line with results from a voxel-wise study in humans noting a synergistic effect of

	FH and the APOE ε4 allele to intensify amyloid-beta deposition and reduce glucose use in regions of the MTL and other AD-related brain regions (Yi et al., 2018). At the systems level, these results suggest that the collection of heritable and non-heritable changes due to FH status alter the functioning of the MTL and associated structures (Yi et al., 2018). The fact that these effects were only observed in participants that were ≤65 years old could be due to age-related differences in the effect of FH or participation differences between younger and older FH test takers. The ≤65 years old effect is partially in line with earlier smaller and more age-specific studies of FH status and cognition demonstrating an effect of FH, but only in children and younger adults (Bloss et al., 2008; Parra et al., 2015; Zeng et al., 2013). Since the prevalence of AD rises after age 60, it is also possible that older FH participants consenting to our study are those that have remained cognitively intact. Thus, **participants that were experiencing noticeable age- or disease-related cognitive impairment may choose not to participate** https://elifesciences.org/articles/46179
CHALLENGING POINTS	FH risk is known to vary depending on the relationship of the diagnosed relative, and previous reports have demonstrated that first-degree FH results in higher risk for dementia compared to second- and third-degree FH (Cannon-Albright et al., 2019). In our study, we asked about the first-degree FH only; therefore, it is possible that individuals who have other FH risk from extended family members were included in our non-FH group. Additionally, it is possible that the form of AD, late-onset versus the rarer early-onset form, may encode different levels of FH risk. Future work is planned to investigate the FH effect in the study cohort, including an improved ability to separate late and early onset FH for each participant as well as to inquire about additional extended family member FH status. It is likely that we did not measure all demographic, lifestyle, and health factors that are associated with differential PAL performance. One such example is socioeconomic status (SES). SES has been shown to have an association with brain structure and cognitive measures during development (reviewed in Brito and Noble, 2014) and work also suggests SES could play a role in AD risk (Qian et al., 2014; Stępkowski et al., 2015; reviewed in Seifan et al., 2015). Importantly, while we did not measure SES directly, we did assess factors commonly used to construct the SES composite (e.g., Educational Attainment). In addition, due to the international recruitment of our study cohort, normalization of the SES construct is complicated due to differing definitions of the factors used to calculate SES across nations (Rose et al., 2005). Due to the large, distributed, and electronic nature of our study cohort, we rely on self-report answers to demographic, lifestyle, and health questions. Current studies comparing self-report data given over the internet versus in-person collected data show anywhere from a 0.3–20% discrepancy for height and weight measurements (Maukonen et al., 2018; Nikolaou et al., 2017). To investigate the potential role that such error may play on our FH AD effect, we re-analyzed the FH effect after introducing additional error into the coding of the FH self-report response. Additional error was added by randomly re-assigning FH status to various percentages of the cohort (stepwise from 2–30% of individuals) and re-analyzing the effect of FH using our complete statistical model. This was performed a total of 10,000 times for each error percentage, and the resulting influences on the p-value were reported using box-plots. With 8% additional introduced error we are able to show statistically

	significant effect of FH on PAL in 100% of the 10,000 tested iterations while an additional 24% error in FH status would still result in a statistically significant effect of FH on PAL in over 50% of the iterations. These results suggest that it is unlikely that FH self-report error is driving the significant effect of FH on PAL. Lastly, PAL was tested cross-sectionally in the cohort; therefore, determinations about the influence of collected factors on trajectories of change in performance across time within an individual subject are not possible. Additional longitudinal-based studies will be necessary to identify this class of variables.
WEB LINK	https://mindcrowd.org/
OTHER	NA

EPAD

PROJECT NAME	**EPAD: European Prevention of Alzheimer´s Dementia Consortium** EPAD was an interdisciplinary research program spanning public and private sector organizations across Europe, with 39 partners, ending October 2020
STARTING / ENDING	2018-2020
TYPE OF FUNDING SCHEME	EU/EFPIA Innovative Medicines Initiative
OBJECTIVES	EPAD was one of the largest dementia studies in the world. Led by the University of Edinburgh, it brought together research professionals and participants from across Europe to unlock the secrets of Alzheimer's disease. EPAD had two key aims: • to improve our understanding of the early aspects of Alzheimer's disease before dementia develops; • to rapidly develop new medicines which may be able to prevent or delay Alzheimer's disease.
COORDINATOR / PARTNERS	**University of EDINBURG (Scotland)**: and 39 partners (public and private) including major players of phrama industry. See the full list of investigators here.
SOLUTIONS/TECH PROVIDERS	The trial-ready proof-of-concept (PoC) platform was developed to **run Phase II clinical trials with research participants with preclinical and prodromal Alzheimer's disease**, with biomarker evidence of Alzheimer's disease pathology using a consistent set of outcomes. EPAD was unique in its ability to recruit from the EPAD readiness cohort, guaranteeing recruitment and ensuring a low (10%) screen failure rate. The platform was open for expressions of interest from pharmaceutical and biotechnology organisations, academic researchers, and funders which had suitable interventions ready for testing. The platform was designed to efficiently deliver early, accurate results utilising the power of adaptive design and Bayesian statistics. To support this process, EPAD developed three core strategies that offered support and guidance in selecting the optimal trial populations for a specific compound. 1 The Register EPAD has created the f**irst single, pan-European register of over half a million people across the risk spectrum for dementia**. 2 The Cohort

	From this register, participants were invited to join an EPAD cohort, the Longitudinal Cohort Study. **This group underwent standardised tests and follow-up over several years.** 3 The Trial EPAD aimed to select suitable participants to take part in streamlined PoC trials of drugs designed to prevent Alzheimer's dementia.
PILOTS / USE CASES DESCRIPTION	31 sites participated.
ACHIEVED RESULTS	A key achievement of the EPAD project was the **establishment of a Longitudinal Cohort Study (LCS) that has screened over 2,000 participants** and collected a wide range of cognitive, clinical, neuroimaging and biomarker data to help further our understanding of the early stages of Alzheimer's disease. EPAD has made this database open access and publicly available to the research community. EPAD offers a way of accessing the data, samples and image data collected during the EPAD Longitudinal Cohort Study (LCS), to academic researchers, institutions and companies from all over the world. This is shared through secure online Workspaces. To access the data, you will need to make an online request via the Alzheimer's Disease Workbench of the Alzheimer's Disease Data Initiative (ADDI) here. Oher aspects: Excellent **pre-trial characterisation of research participants to inform selection and reduce screen failure**, the establishment of the highest possible quality study sites across Europe, the rapid decision making on the likely success of a drug (or combination of drugs) in subsequent confirmatory trials as well as access to a shared placebo group.
CHALLENGING POINTS	Number one is identifying accurately that population in terms of who would benefit most from pharmacological intervention. And the second main challenge is then how does one make decisions on outcomes, as to whether drugs are effective in a population that may well be entirely asymptomatic.
WEB LINK	http://ep-ad.org/
OTHER	NA

PRODEMOS

PROJECT NAME	PRODEMOS - Prevention of Dementia using Mobile phone Applications
STARTING / ENDING	2018-2023
TYPE OF FUNDING SCHEME	Horizon2020 (RIA)
OBJECTIVES	The projected steep rise in global dementia prevalence will largely occur in low and middle-income countries (LMIC) and vulnerable populations in high-income countries (HIC). Up to 30% of all dementia is attributable to potentially modifiable risk factors. Mobile Health (mHealth) technology allows for scalable and widely implementable prevention programs using self-management for improvement of dementia risk factors.

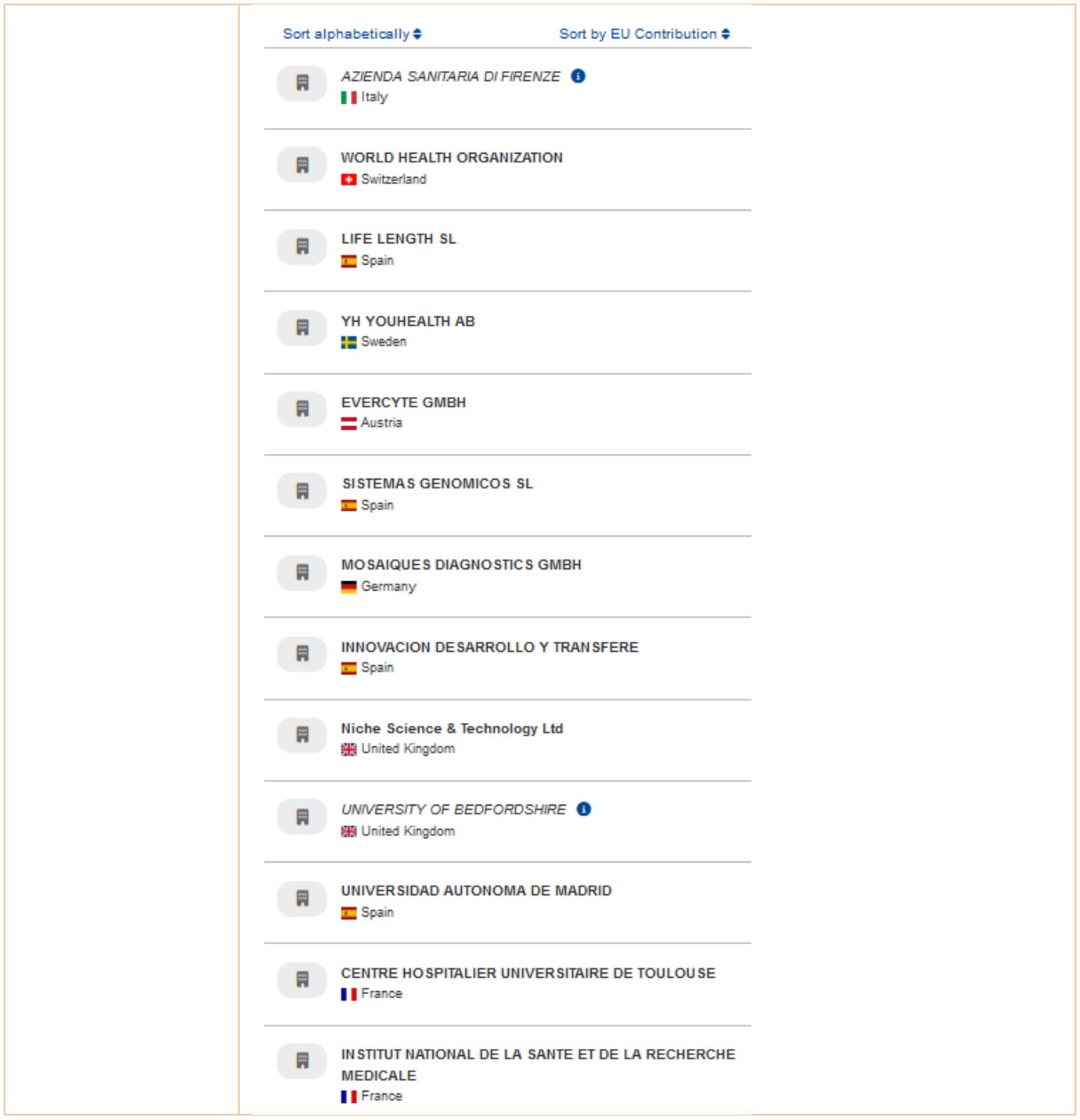
	The objective **is to make dementia prevention strategies accessible to populations in LMIC and vulnerable populations in HIC using mobile health technology** focusing on those at increased risk of dementia who **are usually not reached by preventive medicine.**
COORDINATOR / PARTNERS	**Coordinator** **STICHTING AMSTERDAM UMC** Address DE BOELELAAN 1117 1081 HV Amsterdam Netherlands **THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE** United Kingdom **CAPITAL MEDICAL UNIVERSITY** China **VITALHEALTH SOFTWARE BV** Netherlands **KAROLINSKA INSTITUTET** Sweden **INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE** France THIRD-PARTY **CENTRE HOSPITALIER UNIVERSITAIRE DE TOULOUSE** France **ALZHEIMER EUROPE** Luxembourg
SOLUTIONS/TECH PROVIDERS	The **operational 'Healthy Ageing Through Internet Counselling in the Elderly' eHealth platform for self-management of risk factors for dementia and cardiovascular disease** (See http:// www.hatice.eu). Within vulnerable populations in HIC and in LMIC the project assesses **barriers and facilitators to adapt the existing eHealth platform to a culturally appropriate mHealth (smartphone) platform** for self-management of dementia risk factors.
PILOTS / USE CASES DESCRIPTION	Participants receive remote **personalized support by a health coach** to improve their lifestyle and actively reduce their risk of dementia. The adapted mHealth platform is evaluated in a randomised implementation trial in 2400 older people at increased risk of dementia in China and a vulnerable population with **low SES in UK**. Main outcomes are implementation outcomes such as **acceptability, feasibility and sustainability** of our mHealth intervention, **costs, and effectiveness** on dementia risk reduction. The publication of the trial results is expected by **mid 2024**
ACHIEVED RESULTS	The **concepts from PRODEMOS are directly exploitable in new project**s, including MIND-PRO project. With the experiences in and the results of the PRODEMOS project the MIND-PRO study was started and funded by The Netherlands Organisation for Healthcare Research in which we further develop the mHealth intervention to the needs of people of low literacy and/or

	with an immigration background. They will assess the potential for implementation and the efficacy in this hard-to-reach groups in a **hybrid implementation-efficacy trial**. • The collaboration with the Chinese partners has been extremely rewarding, to prepare new collaborative funding for new projects in the realm of prevention of dementia and cardiovascular disease, with a focus on blood pressure treatment optimization. • The experiences with intercontinental mHealth and all challenges encountered will directly contribute to the design of future projects. • **Generic concepts about coach-supported mHealth** across the UK and Chinese populations can be used by other researchers in different countries in the world. • The trial results contribute to the **knowledge base with regards to the efficacy of mHealth interventions** as well as to the barriers and facilitators across a broad spectrum of implementation outcomes, enhancing the design of future interventions and preventive strategies. • Based on previous lessons learnt, the intervention was **easy-to-use** and included **features to personalize the intervention**.
CHALLENGING POINTS	See publication here: https://pubmed.ncbi.nlm.nih.gov/34975710/ Early involvement of end-users in the development process and during evaluation phases improved acceptability of the mHealth intervention. The actual use and usability of the PRODEMOS intervention has been assessed during the ongoing PRODEMOS randomized controlled trial, taking a dual focus on effectiveness and implementation outcomes.
WEB LINK	https://www.prodemos-project.eu/ https://cordis.europa.eu/project/id/779238
OTHER	No demo of the APP is currently available

FRAILOMIC

PROJECT NAME	FRAILOMIC - Utility of omic-based biomarkers in characterizing older individuals at risk for frailty, its progression to disability and general consequences to health and well-being
STARTING / ENDING	2013-2018
TYPE OF FUNDING SCHEME	FP7
OBJECTIVES	The forecasted increase in the number of older people for this century will be accompanied by an increase of those with disabilities. Disability is usually preceded by a condition named frailty that encompasses changes associated with ageing, life styles and chronic diseases. To detect and intervene on it is of outstanding importance to prevent disability, as recovery from disability is unlikely. Recent documents stress **the necessity of testing the clinical utility (in terms of risk prediction, diagnosis validity and prognostic significance) of the existing definition of frailty by using combinations of clinical criteria (current definition) and lab Biomarkers (BMs).**

	The project **measured the levels of blood and urine omic-based BMs in old people selected from eight cohorts, which include up to 75,000 participants, using standardized and innovative technology** . Combining these lab BMs with clinical BMs, the project **developed predictive, diagnostic and prognostic models** , with its **modulation by nutrition and physical activity**, in general old population and in old people showing some characteristics that confer a high risk for developing frailty (selected cardiovascular risk factors and diseases). After that, **a selected set of BMs have been validated prospectively and assessed to find the best-fitted models**. These models guided the development of the **ready-to-use kits to be implemented in the clinical settings.** The FRAILOMIC project aimed at identifying and developing clinical instruments (composed by clinical, -OMICs based laboratory. and classical laboratory biomarkers): 1) To **predict the risk** of frailty. 2) To **improve the diagnostic** accuracy of frailty in day to day practice. 3) **To assess the prognosis** of frailty in terms of disability and other adverse outcomes.
COORDINATOR / PARTNERS	**Coordinator** **SERVICIO MADRILENO DE SALUD** Address Paseo De la Castellana, 280 28046 MADRID Spain


Sort alphabetically
Sort by EU Contribution
AZIENDA SANITARIA DI FIRENZE
Italy
WORLD HEALTH ORGANIZATION
Switzerland
LIFE LENGTH SL
Spain
YH YOUHEALTH AB
Sweden
EVERCYTE GMBH
Austria
SISTEMAS GENOMICOS SL
Spain
MOSAIQUES DIAGNOSTICS GMBH
Germany
INNOVACION DESARROLLO Y TRANSFERE
Spain
Niche Science & Technology Ltd
United Kingdom
UNIVERSITY OF BEDFORDSHIRE
United Kingdom
UNIVERSIDAD AUTONOMA DE MADRID
Spain
CENTRE HOSPITALIER UNIVERSITAIRE DE TOULOUSE
France
INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE
France

	AZIENDA UNITA' SANITARIA LOCALE TOSCANA CENTRO Italy AZIENDA OSPEDALIERO-UNIVERSITARIA DI PARMA Italy UNIVERSITAET INNSBRUCK Austria CARDIFF METROPOLITAN UNIVERSITY United Kingdom *FRIEDRICH-SCHILLER-UNIVERSITÄT JENA* Germany UNIVERSITAT DE VALENCIA Spain SAN RAFFAELE S.p.A. Italy UNIVERSITE DE BORDEAUX France CONSIGLIO NAZIONALE DELLE RICERCHE Italy DIABETES FRAIL LIMITED United Kingdom DEUTSCHES INSTITUT FUER ERNAEHRUNGSFORSCHUNG POTSDAM REHBRUECKE Germany SERVICIO DE SALUD DE CASTILLA LA MANCHA Spain UNIVERSIDAD DE CASTILLA - LA MANCHA Spain
SOLUTIONS/TECH PROVIDERS	The project **measured the levels of blood and urine omic-based BMs in old people selected from eight cohorts, which include up to 75,000 participants, using standardized and innovative technology** . Combining these lab BMs with clinical BMs, the project **developed predictive, diagnostic and prognostic models** , with its **modulation by nutrition and physical activity**, in general old population and in old people showing some characteristics that confer a high risk for developing frailty (selected cardiovascular risk factors and diseases). After that, **a selected set of BMs have been validated prospectively and assessed to find the best-fitted models**. These models guided the development of the **ready-to-use kits to be implemented in the clinical settings.** .
PILOTS / USE CASES DESCRIPTION	FRAILOMIC sampled biospecimens from a pool of over 75,000 participants from nine established population-based cohorts participating in the study. Nested case-control samples from 4261 participants contrasting frail individuals to prefrail and robust controls were sampled and analyzed in 10 highly specialized European laboratories. **In total, 35312 candidate biomarkers were selected to capture the major known biological processes associated with ageing such as metabolics (muscle function, insulin, IGF1 signaling pathway, and stress response), cardiovascular homeostasis, inflammation,**

	regulation of cell proliferation, and regulation of gene expression.
ACHIEVED RESULTS	As a result, **FRAILOMIC identified 13 biomarkers with promising associations with the diagnosis of frailty beyond classical risk factors measured in the clinic, such as depression, adiposity, and prevalent diseases**. **These biomarkers moderately improved diagnostic accuracy between 2%-10% upon clinical parameters** usually assessed in medical practice. We conclude that the **benefit of analyzing OMIC markers to improve the diagnostic accuracy in frailty is limited**. A prevailing assumption and requirement for the success of precision or personalized medicine is the notion that molecular biomarkers will improve diagnostics markedly. But the **frailty phenotype is highly heterogeneous and stratification based on molecular markers showed only limited success**, highlighting the need of a consensus definition of frailty and **encouraging the use of already established criteria, such as the Fried phenotype in clinical praxis**.
CHALLENGING POINTS	NA
WEB LINK	https://www.frailomic.org/ https://cordis.europa.eu/project/id/305483
OTHER	

DISTINCT

PROJECT NAME	DISTINCT - Dementia: Intersectorial Strategy for Training and Innovation Network for Current Technology
STARTING / ENDING	2019-2023
TYPE OF FUNDING SCHEME	Horizon2020
OBJECTIVES	DISTINCT **wants to provide the evidence to show how technology can improve the lives of people with dementia** The EU-funded DISTINCT project focuses on **research on new technology solutions by creating a wide partnership of world leading research institutions and organisations from different sectors and fields**. They will work closely with **INTERDEM, a group of 180 outstanding academics and researchers from European countries**. The project Wanted to pave the way for developing an **effective approach for early detection of dementia and new strategies to support patients and their caregivers**. DISTINCT focused on the **promotion of social health in people with dementia through technology** that enables them to 1) fulfil their potential on a societal level, 2) manage their own life and 3) participate in social and meaningful activities, while investigating the usability of enabling technology for the target group, evaluating its (cost-)effectiveness and identifying conditions for successful implementation.

COORDINATOR / PARTNERS	**Coordinator** THE UNIVERSITY OF NOTTINGHAM Address University Park NG7 2RD Nottingham United Kingdom STICHTING AMSTERDAM UMC Netherlands UNIVERSITEIT MAASTRICHT Netherlands VRIJE UNIVERSITEIT BRUSSEL Belgium I MAS D Y EMPLEO SERVICONSULTING SL Spain UNIVERSITY COLLEGE LONDON United Kingdom DEUTSCHES ZENTRUM FUR NEURODEGENERATIVE ERKRANKUNGEN EV Germany UNIVERSITY OF GALWAY Ireland CESKE VYSOKE UCENI TECHNICKE V PRAZE Czechia UNIVERSITAET BREMEN Germany
SOLUTIONS/TECH PROVIDERS	The project is a RESEARCH project and as such has not developed or is not connected to specific IT solutions although technology use is at the core of the 16 research performed.
PILOTS / USE CASES DESCRIPTION	See the full list: https://www.dementiadistinct.com/projects/ The selevcted themes are specific and have each led to a susbstantial number of publications. The are classified in three categories: 1. **Technology to fulfil potential and obligations at a societal level** a. Adapting recovery-oriented approaches and technology to dementia (UK) b. Improving peer support for people with young onset dementia (YOD) (UK) c. An interactive website for advance care planning (ACP) for people with dementia and their family (BE) d. Acceptance and adoption of social robots into everyday life for people with dementia (GE) 2. **Technology to manage one's own life** a. Acceptance and Commitment Therapy in daily life for carers of people with dementia (NL) b. Cost and effectiveness evaluation of FindMyApps, a tool to find usable apps for self-management and social participation in Dementia (NL)

	c. Psychosocial applications of technology for health and wellness coaching of older adults with dementia and mild cognitive impairment and their carers in rural areas (SP) d. Design, development and testing of a low cost pet-like care-bot (CK) e. Smart home technologies supporting daily life for people with dementia and their informal caregivers to improve quality of life and social participation (GE) 3. **Technology enabling participation in social activities** a. Use of technology in disclosure of dementia by the diagnosed individual to their social networks (UK) b. Improving social participation in dementia with the Geographic Information system-based intervention 'Viamigo'(NL) c. Social robotics in dementia care to promote social health: ethical issues and implementation strategies (IE) d. Use of a Mini Robot as a new approach for cognitive and social stimulation in home care (SP) e. Evaluation of the effectiveness of a person-centred touch-screen based photo-activity for people with advanced dementia (NL) f. Implementation of AAL technology addressing communication and its impact on the underlying link between technology and the psychosocial effect of dementia on communication (GE)
ACHIEVED RESULTS	DISTINCT has contributed to a more inclusive society, better health and improved quality of life of people with dementia and family carers and decreased costs because of improved self-management and less crises and mental illness.
CHALLENGING POINTS	NA
WEB LINK	https://cordis.europa.eu/project/id/813196 https://www.dementiadistinct.com/
OTHER	NA

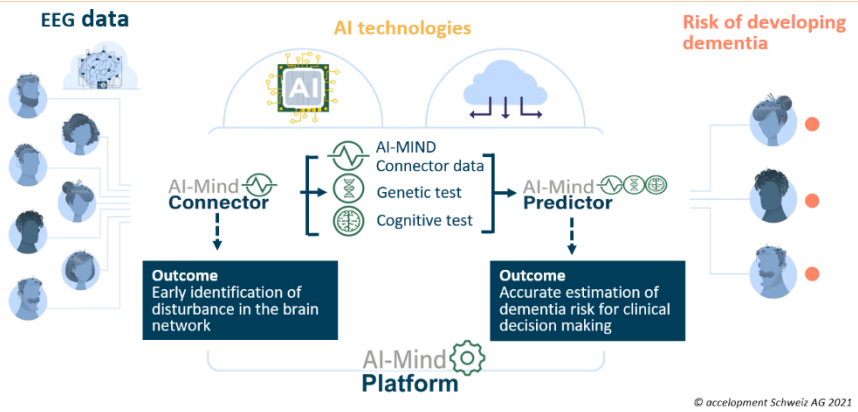
AI-MIND

PROJECT NAME	AI-MIND - Intelligent digital tools for screening of brain connectivity and dementia risk estimation in people affected by mild cognitive impairment
STARTING / ENDING	2021 - 2026
TYPE OF FUNDING SCHEME	Horizon 2020
OBJECTIVES	By screening brain connectivity and dementia risk estimation in people affected by mild cognitive impairment, the AI-Mind project will open the door to extending the 'dementia-free' period by offering proper diagnosis and early intervention. AI-Mind will develop two artificial intelligence-based digital tools that will identify dysfunctional brain networks and assess dementia

	risk. Personalised patient reports will be generated, potentially opening new windows for intervention possibilities.
COORDINATOR / PARTNERS	**Coordinated by** OSLO UNIVERSITETSSYKEHUS HF Norway **AALTO KORKEAKOULUSAATIO SR** Finland **ACCELOPMENT SCHWEIZ AG** Switzerland **ALZHEIMER EUROPE** Luxembourg **BRAINSYMPH AS** Norway **DNV AS** Norway **HUS-YHTYMA** Finland **IRCCS SAN RAFFAELE ROMA SRL** Italy **LURTIS RULES SL** Spain **NEUROCONNECT SRL** Italy **OSLOMET - STORBYUNIVERSITETET** Norway

	TALLINN UNIVERSITY Estonia UNIVERSIDAD COMPLUTENSE DE MADRID Spain THIRD-PARTY UNIVERSIDAD POLITECNICA DE MADRID Spain UNIVERSITA CATTOLICA DEL SACRO CUORE Italy STICHTING RADBOUD UNIVERSITAIR MEDISCH CENTRUM Netherlands UNIVERSITETET I OSLO Norway PRE DIAGNOSTICS AS Norway F. HOFFMANN-LA ROCHE AG Switzerland ROCHE DIAGNOSTICS INTERNATIONAL AG Switzerland
SOLUTIONS/TECH PROVIDERS	BrainSymph AS (Brainsymph) is a medical technology commercialisation enterprise founded by neuroscience researchers from Oslo University Hospital. It specialise in state-of-the-art electroencephalography (EEG), with a particular focus on functional brain connectivity and network techniques. BrainSymph's vision is to make brain health diagnostics easy and accessible by offering clinicians and hospitals the tools to provide better individually tailored care for their patients. The Nordic Centre for Sustainable and Trustworthy Artificial Intelligence Research (NordSTAR) is a centre of research excellence of the Oslo Metropolitan University (OsloMET). The focus of NordSTAR is on establishing and developing a new paradigm in Artificial Intelligence (AI) basic research, so-called Sustainable and Trustworthy AI (S&T AI). This paradigm will enable the development of new design principles for AI tools, which are sustainable and trustworthy by design. NordSTAR consists of five research groups: (i) Security and Reliability, (ii) Explainable AI, (iii) Human factors in AI, (iv) Biologically-inspired Computational Systems and (v) Quantum AI. These groups will coordinate cross-disciplinary activity aiming at sustainable and trustworthy AI tools for the present societal demands and at facilitating possible developments of AI technology in the future.

	Neuroconnect Srl (Neuroconnect) is a start-up and a spin-off of the Catholic University of the Sacred Heart of Rome, Italy. Neuroconnect was founded in 2018 by a team of researchers. The focus of Neuroconnect is to develop research and knowledge on brain connectivity and assess cognitive decline, mainly in MCI, Alzheimer and Stroke patients. The company's goal is to offer the team's experience and expertise as well as providing highly qualified services, in the field of neuroscience in general and in advanced analysis of signals/images in particular, in order to better understand the key mechanisms of the central and peripheral nervous system (dys) functions. Lurtis Rules S.L. (Lurtis) is an R&D-driven company, based in Spain and the UK, committed to creating AI-driven solutions for different engineering and science sectors. Lurtis provides an innovative application of the broad spectrum of AI techniques, selecting the best-suited approach for each problem. Lurtis research in the healthcare sector addresses a wide range of problems, such as traumatic brain injury (TBI), early dementia prediction, oncological treatments, and generative design of medical devices.
PILOTS / USE CASES DESCRIPTION	The study is taking place in Norway, Finland, Italy, and Spain, with a total of 1,000 participants. The study will help develop and validate two digital medical tools that will allow us to early assess whether a person is at risk of developing dementia, based on artificial intelligence (AI). In the EU, the diagnosis of MCI is still largely based on classical neuropsychological testing (NTP). However, NTP is unable to discriminate within the MCI population between those who will progress to dementia and those who will not. AI-Mind aims to establish an early population-based, cost-efficient screening method for synaptic pathology by empowering electroencephalogram (EEG) with a more sophisticated data interpretation and analysis. Thanks to artificial intelligence (AI)-based tools, AI-Mind will offer health professionals the opportunity to apply preventive interventions for modifiable risk factors and initiate treatment early in the course of the disease.
ACHIEVED RESULTS	The use of artificial intelligence (AI) in dementia diagnostics and treatment is a growing field of interest for both healthcare providers and policymakers. In AI-Mind, two new AI-based medical devices are being developed to rapidly and precisely identify and assess dementia risks in people with mild cognitive impairment (MCI). Through international collaboration, AI-Mind partners develop two AI-based tools: the AI-Mind Connector and the AI-Mind Predictor. These two tools will process routinely collected data innovatively.



To better assess the AI-Mind tools we use the early health technology assessment (HTA) framework for AI that aims to assist decision-makers in determining the value of AI-supported services. HTA provides a multidisciplinary assessment based on scientific methods and results, to promote an equitable, efficient and high-quality health system. Early HTA includes modelling of the potential cost-effectiveness of the implementation of new technologies and can give decision-makers an indication of which potential health gain and/or cost savings are associated with technology adoption.
The developed AI-Mind Connector and Predictor tools will be integrated into a cloud-based diagnostic platform, providing an easy-to-implement service for health professionals. The AI-Mind solution will be tested and validated through a research study involving 1,000 participants with MCI in five European clinical centres. Both tools will be evaluated in a clinical setting considering their software architecture, graphic display, user-friendliness and tools utility.

AI-Mind data will be:

- **Findable** – discoverable with metadata and a standard identification mechanism
- **Accessible** – accompanied with documentation and tools needed to access the data
- **Interoperable** – allowing data exchange and re-use between researchers and institutions
- **Reusable** – released with a copyright licence that will clarify how data can be re-used

The AI-Mind collected data include electroencephalography (EEG) and magnetoencephalography (MEG) data, digital cognitive testing, blood samples, and textual data from questionnaires and neuropsychological testing (NPT). The data is collected from participants enrolled in the AI-Mind study.

AI-Mind model is a program, algorithm or mathematical model derived from AI-Mind data using either classical machine learning (ML) or deep learning techniques (DL). ML is an artificial intelligence technique that can be used to design and train software algorithms to learn from and act on data with minimal human intervention. DL can be described as a machine learning technique that teaches computers to do what comes naturally to humans: learn by example.

CHALLENGING POINTS	**Heterogeneity of Data Sources:** The study involves participants from multiple countries (Norway, Finland, Italy, Spain), which may lead to variations in data collection methods, participant demographics, and environmental factors.

	Ensuring uniformity and consistency across different datasets is crucial but challenging. **Data Integrity and Accuracy:** The accuracy of AI models heavily relies on high-quality data. Inconsistent or noisy data from EEG, MEG, digital cognitive tests, and blood samples could impact the model's ability to accurately predict dementia risks. **Data Integration:** Combining and processing various types of data (EEG, MEG, cognitive tests, blood samples, textual data) into a cohesive system may present technical difficulties, especially regarding interoperability and standardization. **Bias and Fairness:** AI models might inadvertently introduce bias if the training data does not adequately represent all demographics. This could result in unequal access to accurate diagnosis and treatment across different population groups. **AI Model Development:** Developing robust AI models that accurately interpret complex EEG and MEG data to predict dementia risk is technically challenging. Ensuring these models are transparent, explainable, and reliable in real-world clinical settings is crucial. **Scalability and Implementation:** Integrating AI-Mind tools into existing healthcare infrastructures and ensuring they can be scaled across different healthcare settings (e.g., hospitals, clinics) could be a logistical challenge. **Software Usability:** Ensuring that the AI-Mind Connector and Predictor are user-friendly and intuitive for healthcare professionals to use in everyday clinical practice is important to encourage adoption and effective use.
WEB LINK	https://www.ai-mind.eu/project/
OTHER	NA

PREDICTOM

PROJECT NAME	PREDICTOM - PREDICTION OF ALZHEIMER'S DISEASE USING AN AI DRIVEN SCREENING PLATFORM
STARTING / ENDING	2023 - 2027
TYPE OF FUNDING SCHEME	Horizon IHI
OBJECTIVES	PREDICTOM will develop an open-source, interoperable and customisable biomarker screening platform, utilizing an existing online resource to save time and money, to generate an evidence base for general population screening for AD and related disorders. We will bring diagnostics closer to the patient by examining the feasibility of using samples which can be obtained at home (e.g. finger-prick blood, saliva (for genetics and epigenetics) and stool for microbiom) for diagnostic biomarker analysis. We will also evaluate innovative technologies for disease risk identification, including digital technologies and novel MRI, EEG, eye tracking, and blood-based biomarkers. The platform will use artificial intelligence models to analyse data from all biomarkers to identify users at high risk of developing dementia and to direct them to personalized intervention to prevent further cognitive decline and development of dementia.

COORDINATOR / PARTNERS	**Coordinated by** HELSE STAVANGER HF Norway **STICHTING LYGATURE** Netherlands **ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS** Greece **FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV** Germany **JOANNEUM RESEARCH FORSCHUNGSGESELLSCHAFT MBH** Austria **QAIRNEL SAS** France **LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN** Germany THIRD-PARTY **KLINIKUM DER UNIVERSITAT MUNCHEN** Germany **ALZHEIMER EUROPE** Luxembourg **PHARMACOIDEA FEJLESZTO ES SZOLGALTATO KFT** Hungary

NOVO NORDISK A/S
Denmark

GE HEALTHCARE GMBH
Germany

THIRD-PARTY
GE MEDICAL SYSTEMS SCS
France

THIRD-PARTY
GE HEALTHCARE MAGYARORSZAG KFT
Hungary

SIEMENS HEALTHCARE GMBH
Germany

THIRD-PARTY
SIEMENS HEALTHCARE DIAGNOSTICS INC.
United States

THIRD-PARTY
SIEMENS HEALTHCARE PRIVATE LIMITED
India

THIRD-PARTY
SIEMENS MEDICAL SOLUTIONS USA INC
United States

ICOMETRIX NV
Belgium

UNIVERSITATSKLINIKUM ERLANGEN
Germany

VRIJE UNIVERSITEIT BRUSSEL
Belgium

FUNDACION PARA LA INVESTIGACION DEL HOSPITAL UNIVERSITARIO LA FE DE LA COMUNIDAD VALENCIANA
Spain

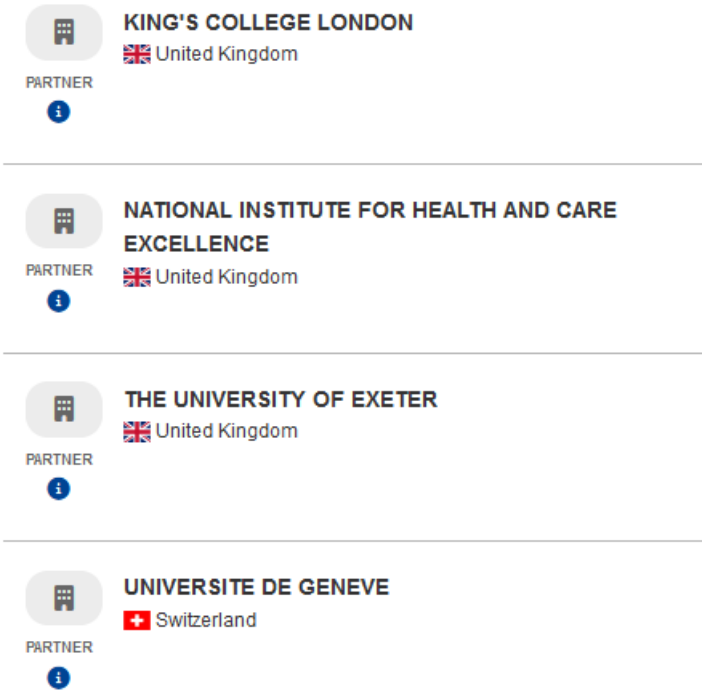
ALZPATH INC
United States

GN HEARING AS
Denmark

ALTOIDA INC
United States

BRAINCHECK INC
United States

MUHDO HEALTH LTD
United Kingdom

	
SOLUTIONS/TECH PROVIDERS	PREDICTOM is developing an Artificial Intelligence (AI)-screening-platform that can identify individuals at risk of developing dementia, even before symptoms manifest. Dag Aarsland, Professor of Old Age Psychiatry at King's College London and research lead at Stavanger University Hospital, is the driver behind the project.
PILOTS / USE CASES DESCRIPTION	Another crucial aspect of PREDICTOM's project is that much of the screening can be performed by participants themselves in the comfort of their own homes. By initiating the process at home, PREDICTOM aims to reduce strain on healthcare services and associated costs. Biomarkers, including saliva, stool, digital markers, and blood (via prick-tests), will be collected at participants' homes or GP offices, streamlining a process traditionally carried out in hospitals or specialised clinics. More than 4,000 participants will partake in PREDICTOM's trial project. The samples will be based on a pool of people from previous projects PROTECT UK, PROTECT Norway and Radar-AD, as well as people from the catchment area of other participating centres in Germany, France, Switzerland, Belgium, and Spain. After the home collection, samples will be sent to PREDICTOM, where their platform will process the participant data, integrating blood, cerebrospinal fluid, imaging, electrophysiological, and digital biomarkers. AI algorithms will then generate risk assessments, early diagnoses, and prognosis, which will lay the foundation for early intervention and treatment.
ACHIEVED RESULTS	PREDICTOM aims to establish scalable, cost-efficient diagnostic markers, tools and procedures that can identify people at increased risk, at point of care for stratification into personalized interventions to prevent or delay dementia.

	PREDICTOM will develop an open-source, interoperable and customisable biomarker screening platform, utilizing an existing online resource to save time and money, to generate an evidence base for general population screening for AD and related disorders. PREDICTOM will bring diagnostics closer to the patient by examining the feasibility of using samples which can be obtained at home (e.g. finger-prick blood, saliva (for genetics and epigenetics) and stool (for microbiom) for diagnostic biomarker analysis. PREDICTOM will also evaluate innovative technologies for disease risk identification, including digital technologies and novel MRI, EEG, eye tracking, and bloodbased biomarkers. Our platform will use artificial intelligence models to analyse data from all biomarkers to identify users at high risk of developing dementia and to direct them to personalized intervention to prevent further cognitive decline and development of dementia. PREDICTOM will seek to facilitate a change in current healthcare practice for early diagnosis of AD through development of new clinical practice guidelines based on evidence generated in the project. PREDICTOM will by improving the ease of identification of those with early signs of dementia, we expect to have a significant impact on personal and financial burden of dementia in Europe and across the world.
CHALLENGING POINTS	**Self-Collection Reliability:** While home-based sample collection (e.g., saliva, stool, blood via finger-prick) increases convenience, it may also lead to variability in sample quality. Participants may not follow standardized procedures accurately, potentially compromising data quality. **Data Accuracy:** The accuracy of AI-based predictions depends on the quality and consistency of the biomarkers collected. Ensuring that home-collected samples maintain the same level of accuracy as those collected in clinical settings is critical. **Biomarker Sensitivity and Specificity:** Identifying reliable biomarkers that can accurately detect early dementia risk before symptoms appear is challenging. Biomarkers must be validated to ensure they are specific to dementia and not other conditions. **AI Model Development:** Developing robust AI algorithms capable of integrating diverse data types (e.g., blood, cerebrospinal fluid, imaging, digital biomarkers) to provide accurate risk assessments and diagnoses is complex. Balancing sensitivity (identifying true positives) and specificity (avoiding false positives) is essential. **Data Integration:** Combining different types of biomarkers (e.g., biological samples, imaging data, electrophysiological data, and digital health data) into a coherent platform for analysis presents technical challenges, particularly regarding interoperability and data standardization. **Scalability:** Ensuring the AI-screening platform can handle large-scale data processing and analysis efficiently, especially with over 4,000 participants involved, is essential for its practical application in wider population settings. **Participant Adherence:** Ensuring participants consistently and correctly collect samples and use digital health monitoring tools is challenging. Non-compliance or errors in self-collection could lead to incomplete or inaccurate data.
WEB LINK	https://cordis.europa.eu/project/id/101132356
OTHER	N/A

Annex 2: High level assessment of technologies proposed for the Project

This section shows the categorization of existing relevant technologies considering the type of solution offered, tools and technologies used for the solution, challenge to be solved and value proposition of the solution as well as some potential technological providers for the solution.

TYPE OF SOLUTION	**Cognitive Training Apps**
TOOLS AND TECHNOLOGIES USED	Mobile Apps AI, Machine Learning, Cloud Computing, UI and UX (user interface and user experience design), gamification
CHALLENGE and VALUE PROPOSITION	Exercises and games designed to stimulate various cognitive functions, including memory, attention, and problem-solving. These apps can be beneficial for maintaining cognitive function and potentially reducing the risk of cognitive decline associated with aging and dementia but are usually built as stand-alone applications.
TECH PROVIDERS & PRODUCTS NAME	Lumosity, BrainHQ, and CogniFit, GRADIOR (by INTRAS)

TYPE OF SOLUTION	**Activity Trackers and Wearable Devices**
TOOLS AND TECHNOLOGIES USED	Devices like Fitbit, Garmin, and Apple Watch AI, Machine Learning, Cloud Computing, UI and UX (user interface and user experience design), gamification
CHALLENGE and VALUE PROPOSITION	Tracking physical activity, sleep patterns, and other health metrics. Providing valuable insights into an individual's overall health and well-being. Monitoring physical activity levels can help identify early signs of frailty and support interventions to maintain mobility and independence.
TECH PROVIDERS & PRODUCTS NAME	None identified so far

TYPE OF SOLUTION	**Telehealth Platforms**
TOOLS AND TECHNOLOGIES USED	Web-Platform Cross-platform app development, Cloud services, AI and machine learning, IoT, Data Encryption,
CHALLENGE and VALUE PROPOSITION	Remote consultations with healthcare professionals, allowing individuals to access medical advice and monitoring from the comfort of their homes. These platforms can be particularly beneficial for older adults and individuals with mobility limitations, facilitating regular check-ups and early intervention for health issues, including frailty and dementia.
TECH PROVIDERS & PRODUCTS NAME	None identified so far

TYPE OF SOLUTION	Smart Home Technology
TOOLS AND TECHNOLOGIES USED	Smart home devices, such as smart thermostats, lighting systems, and security cameras equipped with sensors Cloud computing, AI and machine learning, Encryption, App development, IoT
CHALLENGE and VALUE PROPOSITION	Monitoring activities of daily living and detect changes in behavior or routines that may indicate cognitive decline or frailty. These devices can provide support for aging in place and early detection of health issues.
TECH PROVIDERS & PRODUCTS NAME	None identified so far

TYPE OF SOLUTION	Medication Management Apps
TOOLS AND TECHNOLOGIES USED	Apps Cross-platform frameworks, Secure Cloud Storage, UI and UX design, AI and machine learning, Integration with health system database (APIs and EHRs)
CHALLENGE and VALUE PROPOSITION	Organization of patients' medication schedules, setting reminders for doses, and track adherence. These apps can be especially useful for older adults with dementia who may have difficulty remembering to take their medications as prescribed, reducing the risk of medication errors and adverse events.
TECH PROVIDERS & PRODUCTS NAME	Medisafe and Mango Health, Smart Pill Boxes

TYPE OF SOLUTION	Digital Health Platforms
TOOLS AND TECHNOLOGIES USED	Apps, Platform
CHALLENGE and VALUE PROPOSITION	Comprehensive programs for lifestyle modification, including exercise, nutrition, stress management, and sleep optimization. These programs can help individuals adopt healthy behaviours that support overall health and may reduce the risk of frailty and dementia.
TECH PROVIDERS & PRODUCTS NAME	Omada Health, Virta Health

TYPE OF SOLUTION	Virtual Reality (VR) Cognitive and serious games Rehabilitation
TOOLS AND TECHNOLOGIES USED	VR-based cognitive rehabilitation programs Motion tracking sensors, AI and machine learning, IoT, Cloud Storage, VR, Real time rendering
CHALLENGE and VALUE PROPOSITION	Immersive environments for cognitive training and rehabilitation. These programs can be tailored to target specific cognitive deficits associated with dementia and may help improve cognitive function and quality of life for individuals with the condition.
TECH PROVIDERS & PRODUCTS NAME	MindMaze, Jintronix or RendeverFit, GRADIOR Multisensory (by INTRAS)

	Serious games such as those developed by Imaginary are also increasingly used and adapted to an increasing number of pathologies, in particular to support to rehabilitation.

TYPE OF SOLUTION	**Virtual Coach**
TOOLS AND TECHNOLOGIES USED	Telehealth Platforms, Wearable devices and sensors, mHealth applications Data mining, AI and machine learning, IoT and Big Data, Cloud Computing, Security and Privacy Technologies
CHALLENGE and VALUE PROPOSITION	Contributing to frailty prevention efforts by promoting healthy behaviours and enhancing self-management skills among older adults, further research, including well-designed randomized controlled trials, is necessary to establish its efficacy conclusively.
TECH PROVIDERS & PRODUCTS NAME	None identified so far
RELATED EU PROJECTS	vCare project

TYPE OF SOLUTION	**Digital Twins**
TOOLS AND TECHNOLOGIES USED	Digital replication of a whole or partial aspect of a physical entity IoT, Cloud computing and Edge computing, AI and machine learning, Big Data and Data analytics, Advanced simulation tools, 3D modelling and visualisation, cybersecurity technologies, APIs, Blockchain
CHALLENGE and VALUE PROPOSITION	Improving precision healthcare by creating personalized models of individual patients which can ultimately lead to better outcomes. Identification of daily behaviours, trigger a notification system that alerts patients to take their medication based on their vital signs, detection when elderly people are in a stage of pre-frailty, to restore their health before they become frail.
TECH PROVIDERS & PRODUCTS NAME	None identified so far

Annex 3: Summary of Projects' innovation potential

The table below resumes and tries to connect the following elements highlighted before:

- **Identified key Innovations per type/category**: List down the innovations type/category (considering the previous desk research conducted above).
- **Technologies/Tools Available**: Specify which technologies and tools are available for each innovation. These could be software, frameworks, hardware, or methodologies crucial for the development or implementation of the innovation.
- **Link the innovation category to existing Innovations/Projects**: Link each key innovation to existing projects or research activities, including whenever possible gaps or critical aspects.
- **Further Tests/Research Required**: Identify what additional research or testing is needed for each innovation, in relation to the COMFORTAGE project.

KEY INNOVATION CATEGORY	TECHNOLOGIES/TOOLS AVAILABLE	LINK TO EXISTING INNOVATIONS/PROJECTS	POSSIBLE FURTHER TESTS RELATED TO THE PROJECTS
Cognitive Training Apps and Tools	• Cross-platform, Apps • AI and machine learning, Gamification and interactive design, Biometric sensors, VR/AR, Social integration, Security and Encryption, UI and UX design	• ADDP: Starry Night cognitive test and Computerized Cognitive Training games • ADPS: smartphone test for Alzheimer prediction • PreventIT: personalized exercise programs, nutritional advice, and cognitive training to help older adults maintain their independence and mobility; aLiFE tool: assessment of starting levels for all activities, from very easy (e.g.using hand support) to difficult (e.g. performing dual tasks)	• ADDP: Plans for further large-scale trials and integration into products aimed at individuals with Mild Cognitive Impairment (MCI) signify promising directions for early detection and intervention in Alzheimer's disease. • PreventIT: improving UX design, improvement of language used (personalised messages), considering possible bias of target groups involved
Activity Trackers and Wearable Devices	• Hardware, algorithms, data management/mining, AR, VPM (Virtual Patient Modelling)	• FRAILSAFE: ICT solution for prediction, prevention, rehabilitation, and self-management of frailty symptoms • ECARE: PULSO Screening and detection of frailty • FRAIL: new feature of LOLA App for frailty detection	• FRAILSAFE: Increase number of samples and duration of interventions, Need of more customized options
Telehealth Platforms	• Web platform, Mobile applications • Cloud computing and data storage, IoT, AI and Machine Learning, Security and Privacy Technology	• DEM-DISC: a platform for caregivers to track and share information about the daily activities and preferences of dementia patients	• DEM-DISC: improvement of the prototype following patients' and caregivers' needs
Digital Health Platforms	• Data platform, Wearable devices and sensors, Smartphone applications, Home based sensors • Data mining and storage, AI and Machine learning, Cloud computing and Big Data Analytics, IoT, Security and	• EDoN: a data platform and a digital toolkit collecting active and passive physiological and behavioural measures for early dementia detection	• EDoN: introduction of the digital toolkit into annual health checks, allowing early detection of dementia-causing diseases • RADAR-AD: improve the research with more data

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KEY INNOVATION CATEGORY	TECHNOLOGIES/TOOLS AVAILABLE	LINK TO EXISTING INNOVATIONS/PROJECTS	POSSIBLE FURTHER TESTS RELATED TO THE PROJECTS
	Privacy technologies, UI and UX design, Interoperability and Data Integration	• RADAR-AD: detection of subtle functional deficits in early Alzheimer's disease (AD) individuals. Altoida, Fitbit, and Mezurio as tools; Axivity, a passive RMT, promising early-stage detection capabilities; A-iADL questionnaire a competitive alternative to traditional clinical assessments; App-based augmented reality to assess cognitive impairment in early Alzheimer's disease	
Virtual Coach	• Technologies for monitoring sub-system for screening and follow-up, digitalization of an older adult care model, a virtual assistant for prevention and intervention	• eCARE – TELEVES: Virtual assistant for the delivery of preventive, therapeutic, and educational interventions for frailty in older adults	•
Digital Twins	• Computational Tools, Web-Platform • Data mining and simulation, AI and machine learning, Predictive modelling, Data Analytics, Virtual environment, Integration with real world-data,	• AETIONOMY: molecular characteristics of Alzheimer's disease (AD) and Parkinson's disease (PD) (taxonomy of these conditions). Creation of a Virtual Dementia Cohort (VDC)	• Increase of clinical studies and samples (420 subjects were successfully recruited)
Modern computer-based models for early diagnostics	• Data-driven classifier, Cognitive test battery, MRI scans and biomarkers • Statistical analysis, Deep learning algorithms, Natural Language Processing (NLP), Medical imaging technology, Predictive models and simulation, Cloud computing and Big Data analytics, IoT, Integration of platforms	• PredictND: Clinical decision support system for Dementia •	• Further research to allow the use of Decision support tools by clinicians to support short-term prognosis by providing a decent second opinion in prognostic decision-making

Funded by the European Union

KEY INNOVATION CATEGORY	TECHNOLOGIES/TOOLS AVAILABLE	LINK TO EXISTING INNOVATIONS/PROJECTS	POSSIBLE FURTHER TESTS RELATED TO THE PROJECTS
Socially Assistive Robots (SARs)	• SARs • Natural Language Processing (NLP), Machine learning and deep learning, Robotics and Mechatronics, Semantic Computing, Human-Computer interaction (HCI), Cognitive Modelling, IoT and Connectivity, Security and Privacy technologies	• MARIO: Human Robot Interaction to support cognitive and memory assistance involving semantics •	• MARIO: Exploitation of natural language processing and potential use of SARs as companion robots
Integrated Care Model Library of AI Algorithms	• Machine Learning and Deep Learning Platforms, Natural Language Processing (NLP), Data Management and Integration Tools, IoT Devices and Wearables, Blockchain for Data Security, Cloud Computing Infrastructure, Interoperability Standards and APIs •	• FRAILSAFE's development of an ICT solution that includes personalized virtual patient models for managing frailty symptoms showcases the application of AI algorithms in creating integrated care models • JA ADVANTAGE focuses on integrated care models to prevent and tackle frailty • ADPS aims at predicting Alzheimer's risk, illustrate the application of AI in developing comprehensive care approaches.	• Model validation using independent datasets, clinical trials in varied healthcare environments, usability evaluations with end-users, scalability and performance assessments • Compliance with ethical and regulatory standards, and interoperability testing with healthcare IT systems
Real-time Feedback and Behavioural Analytics	• Wearable devices and sensors for continuous health monitoring, real-time data processing platforms for instant data analysis, and personalized feedback systems powered by machine learning to deliver customized health insight	• The use of real-time data management and mining methods in FRAILSAFE for assessing frailty levels highlights the innovation in behavioural analytics and feedback mechanisms.	• Validating the accuracy and reliability of data analysis • Assessing the user experience to ensure intuitive and beneficial interactions, and confirming scalability to handle extensive data without loss of performance

KEY INNOVATION CATEGORY	TECHNOLOGIES/TOOLS AVAILABLE	LINK TO EXISTING INNOVATIONS/PROJECTS	POSSIBLE FURTHER TESTS RELATED TO THE PROJECTS
			• Compliance with data privacy and security regulations, and interoperability with existing healthcare systems
Advanced Training and Educational Toolkit	• E-learning platforms, augmented and virtual reality for immersive learning experiences, adaptive learning systems for personalized education, gamification to enhance engagement, and analytics dashboards for tracking progress	• The FRAIL project's development of a smartwatch app for monitoring indicators of frailty highlights the importance of training and educational resources for users to effectively engage with technological solutions.	• Usability evaluations to ensure accessibility and user-friendliness, assessments of the content's effectiveness in achieving learning goals, compliance checks for accessibility standards, technical performance reviews for stability across devices, and feedback collection for continuous improvement.

Annex 4: Initial TRL levels

As stated in the proposal, the core exploitable results of COMFORTAGE ecosystem aim to reach a **TRL level >=6-7** by the end of the project:

COMFORTAGE Results	TRL
[R1] – Blueprint Personas (O1)	6-7
[R2] – Digital Healthcare Reference Model (DHRM) (O1, O2)	5-6
[R3] – Patient Digital Twins (PDTs) (O2)	5-6
[R4] – DIHs and Living Labs (O2)	6-7
[R5] – Holistic Health Records (HHRs) (O3)	5-6
[R6] – Ageing European Health Data Space (Ageing-EHDS) (O3)	5-6
[R7] – Integrated Knowledge Bases for dementia and frailty (O3)	6-7
[R8] – Blockchain-based Information Exchange (O3)	6-7
[R9] – Virtualized AI-based Healthcare Platform (VHP) (O4)	5-6
[R10] – Integrated AI-based Care Model Library (O4)	6-7
[R11] – Delivery Mechanisms for Personalised Healthcare, Real-time Feedback and Behavioural Analytics (O4)	6-7
[R12] – Decision Support System (DSS) Suite (O5)	6-7
[R13] –Training & Educational Toolkit (TET) (O6)	6-7
[R14] – Training & Educational Marketplace (TEM) (O6)	6-7
[R15] – Serious Games and Gamification (SGG) (O6)	6-7
[R16] – HTA approach (O7)	6-7
[R17] – Policy Brief and Blueprints (O5, O8)	5-6
[R18] – Integrated Large-Scale Pilots (O8)	N/A
[R19] – Knowledge Transfer Twinning Symposiums (O5, O9)	5-6
[R20] – COMFORTAGE Ecosystem & Community (O9)	N/A

It is important to focus on the proposed research and innovation aspects mentioned in the call, to ensure the expected impacts and avoid contradictions with the proposed solutions (which are not proof of concepts), specifically:

- **Integration of Solutions**:
  - High-quality, innovative, digitally enabled health and long-term care solutions centred around older adults' needs.
  - Settings: Primary care, hospital, and home.
  - Focus Areas: Physical and mental health, well-being, disease prevention, rehabilitation, active and healthy aging.
- **Technologies and Approaches**:
  - Solutions: Integrated care solutions, serious games, wearables, ambient sensors, social robots, assistive technologies, age-friendly environments, diagnostic screenings, self-monitoring devices, robotics.
  - Objective: Address age-related physical and mental diseases and co-morbidities.
- **Development of New Approaches**:
  - Framework: Evidence-based, coordinated care models and pathways.
  - Nature: Person-centred health and long-term care solutions.
  - Goals: Increase physical, mental, and nutritional resilience among older adults; address health/care access inequality, societal and healthcare system changes.

- **Skills and Empowerment**:
  - Enhancement of skills, empowerment, health, and digital literacy.
  - Method: Through targeted training and activities.
- **Support for Innovation**:
  - Strategy: Foster adoption and market innovation of health and care solutions targeting older age-related conditions.
  - Methods: Large-scale testing, deployment piloting, guidance on HTA and CE procedures, demonstrating cost-effectiveness.
  - Engagement: Stakeholder involvement, policy collaboration at various levels (European, local, regional, international).
  - Collaboration and Exchange: Best practices sharing, collaboration with EC-funded Active and Healthy Living initiatives, and the Reference Sites Collaborative Network.