Comprehensive Dementia and Frailty Research at MFU: Integrating Oral Health, Cognitive Function, and Digital Interventions with COMFORTage

Prediction, Monitoring and Personalized Recommendations for Preventing and Managing Dementia and Frailty in Relation to Oral Health

What's COMFORTage All About?

COMFORTage is a European Union-funded initiative bringing together 39 organizations from 12 countries to tackle the challenges of cognitive decline and frailty. Running from 2024 to 2027, the project focuses on developing data-driven, personalized, and scalable healthcare solutions that support both patients and caregivers while alleviating the strain on healthcare systems.

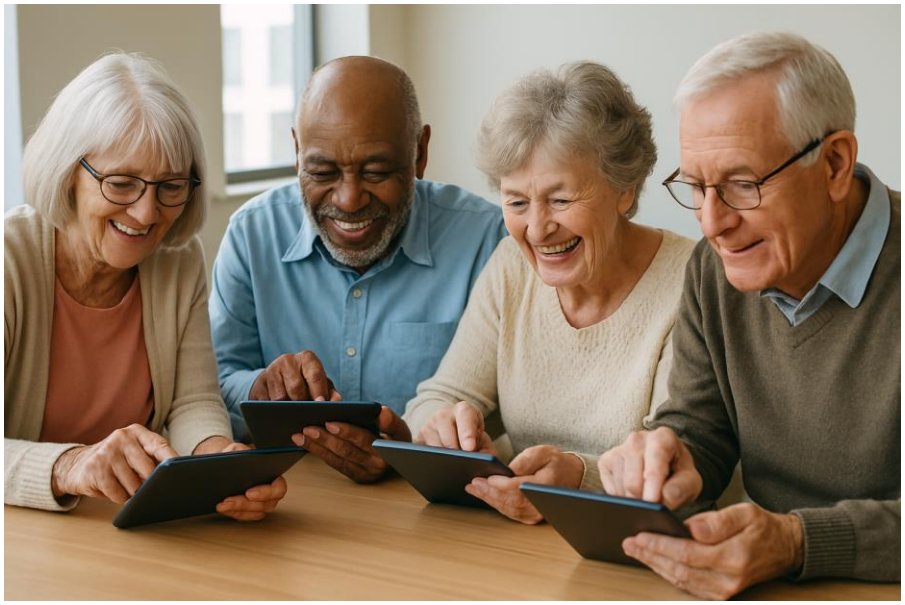
Introduction to MFU and Its Role in the COMFORTage Project

The Faculty of Medicine at the University of Ljubljana (MFU) is a leading institution in medical research, education, and clinical practice in Slovenia. With a strong commitment to scientific excellence, MFU plays a pivotal role in addressing major public health challenges, particularly those related to aging, cognitive decline, and frailty. The faculty is home to numerous internationally recognized experts who are dedicated to pioneering research and clinical advancements that shape the future of healthcare.

Through its participation in the European COMFORTage project, MFU is conducting ground-breaking research into the intricate relationship between oral health, cognitive function, and the aging process. This study seeks to bridge the gap between dental medicine and neurology by examining how oral hygiene, periodontal health, and the microbiota of the oral cavity contribute to cognitive well-being. By leveraging cutting-edge diagnostic tools, digital health solutions, and personalized interventions, the project aims to develop new strategies for preventing and alleviating dementia and frailty, ultimately improving quality of life for older adults and providing healthcare professionals with new clinical tools.

Introduction to VSTE and Its Role in the COMFORTage Project

Institute Everykind, education about nature and health (VSTE), is a non-profit, independent NGO specialising in education, training and research across social environments, education, culture, sport and business. Within the COMFORTage project, VSTE collaborates with and supports MFU's pilot case by employing participatory methods, building capacity, providing research support, analysing social impact, and addressing ethical implications on AI supported dementia and frailty care. VSTE's primary responsibility is facilitating co-creation and implementation of social learning interventions for those at risk of cognitive decline, with particular focus on carers, and for individuals with family history of cognitive decline. The organisation ensures people-centred design principles are integrated throughout all piloting phases.



Dementia and Frailty in Slovenia: A Growing Concern

Slovenia, like much of Europe, is experiencing a demographic shift marked by an aging population. As people live longer, the prevalence of neurodegenerative diseases continues to rise, bringing forth complex healthcare challenges. By 2025, it is estimated that nearly 40,000 Slovenians will be living with dementia, with this number expected to exceed 66,000 by 2050. The economic and social burden of dementia extends beyond the healthcare sector, affecting families, caregivers, and the overall well-being of society. This trend places immense pressure on healthcare systems and families alike, underscoring the urgent need for effective early interventions and innovative care models.

One critical but often overlooked factor in cognitive health is oral hygiene. Research increasingly suggests a strong correlation between poor oral health—such as periodontal disease, tooth loss, and altered oral microbiota—and the development or progression of dementia. Periodontitis and the presence of harmful bacterial strains in the oral cavity may contribute to chronic inflammation, which has been identified as a potential driver of neurodegeneration. Additionally, reduced chewing efficiency due to tooth loss has been linked to decreased cognitive stimulation, which may accelerate cognitive decline. As part of COMFORTage, MFU is at the forefront of investigating how oral health interventions may enhance cognitive resilience, slow neurodegenerative decline, and contribute to a holistic approach to aging, combining clinical interventions with public health strategies.

Clinical and Research Activities at MFU

The *MFU* study within *COMFORTage* is designed as a comprehensive, multidisciplinary investigation that integrates cognitive assessments, oral health evaluations, and digital health interventions. The study aims to develop a deeper understanding of how cognitive and oral health are interconnected, while also identifying practical solutions that can be implemented in clinical and caregiving settings. Key activities include:

- **Participant assessments**: A diverse cohort of individuals at different stages of cognitive health will be recruited to undergo in-depth clinical evaluations, allowing researchers to establish baseline comparisons and track changes over time.
- **Neuropsychological and physiological testing**: Participants will complete standardized cognitive tests, undergo EEG monitoring, and provide blood samples for biomarker analysis to identify early indicators of cognitive decline.
- **Oral health analysis**: Comprehensive dental examinations, including intraoral photography, radiographic imaging, microbiota sampling, and periodontal assessments, will be conducted to assess the impact of oral health on overall cognitive function.
- **Digital interventions**: Innovative technological tools, including AI-driven monitoring systems, wearable devices, and cognitive training applications, will be deployed to support participants in maintaining cognitive and oral health.
- **Longitudinal tracking and personalized health monitoring**: By following participants over extended periods, researchers will identify trends and key intervention points that may help delay the onset or progression of dementia and frailty.
- **Public health and policy recommendations**: Research findings will be compiled into actionable strategies to inform national and EU-wide public health policies aimed at improving dementia prevention and treatment.

By adopting an integrated research framework, *MFU* seeks to establish clear links between dental health, cognitive function, and overall well-being, paving the way for targeted, evidence-based interventions that can be used in preventive medicine and rehabilitation.

VSTE provides assessment and recommendations related to standardization activities, specifically guiding approaches as outlined in ISO 25552 and ISO TR 25555. Additionally, VSTE supports tool development by identifying and addressing risks perceived by individuals using COMFORTage solutions, analysing social, cultural, and ethical factors that impact digital health adoption, addressing social barriers that affect citizens' trust in digital health solutions, and evaluating specific impacts on social values.

MFU contribution to COMFORTage

The *MFU* study contributes to *COMFORTage* by addressing key questions such as:

- How does oral health influence dementia risk, and can targeted interventions improve outcomes?
- How does microbiota differ in cognitive decline, and how can we manipulate these changes to improve patient health?
- How effective are AI-driven and digital interventions in supporting both oral and cognitive health?
- How can digital therapeutics be integrated into routine dementia care and prevention strategies?

By integrating biological, psychological, and digital health data, *MFU & VSTE collaboration* contributes to a pioneering framework that enhances dementia prevention and care. This work aims to shift the paradigm of how aging and cognitive decline are managed in clinical and caregiving environments, emphasizing proactive, personalized healthcare approaches with strong community engagement.

Study Design & Data Collection

The research is structured as a multi-phase, comparative study involving participants across four groups:

1. **Persons at risk for cognitive decline and dementia, Relatives of dementia patients (40-75 years old)** who may be at increased risk due to genetic and environmental factors.

2. **Older adults (65+ years old) with subjective cognitive decline or mild dementia** residing in homes for older citizens, providing insights into disease progression and potential interventions.

Participants will undergo:

- Baseline and follow-up cognitive, neurological, and dental assessments.
- EEG measurements and blood biomarker analysis to detect early neurophysiological changes.
- Personalized digital interventions, including cognitive training exercises, oral hygiene tracking applications, and AI-driven behaviour monitoring.
- Periodic reassessments to monitor changes over time and evaluate intervention effectiveness.

By integrating traditional clinical evaluations with advanced digital health solutions, *social impact analysis,* MFU & *VSTE's collaboration* aims to refine predictive models for dementia risk, develop personalized treatment protocols, and establish best practices for early detection and intervention.

VSTE enhances the pilot through comprehensive evaluations of usability, user acceptance, and experience, focusing on the perceived usefulness of interventions, ease of use of digital tools, and attitudes toward new technologies. Additionally, VSTE implements dissemination strategies to raise awareness among relevant stakeholders, creating an effective bridge between clinical innovation and community adoption.

Why COMFORTage Matters to MFU and VSTE

The *MFU & VSTE collaboration* within *COMFORTage* represents a significant step forward in dementia prevention and treatment. Key innovations include:

- **AI-driven health monitoring**: The study incorporates artificial intelligence to analyse patient data, predict disease trajectories, and recommend personalized interventions.

- **Digital Twins technology**: By simulating patient health progressions using real-time data, clinicians can optimize care strategies and intervention timing.
- **Interdisciplinary collaboration**: The project unites neurologists, dentists, psychologists, and data scientists in a holistic effort to address aging-related health challenges.
- **Community engagement and knowledge dissemination**: Findings will be shared with healthcare providers, policymakers, and the public to facilitate widespread adoption of best practices.
- **Integration of AI in cognitive and oral health care**: The project explores how AI-based decision-making tools can enhance diagnostics and personalized patient management.
- **Potential expansion of preventive care models**: Research findings will be used to explore new care models that integrate digital health interventions into mainstream medical and dental practices.
- **Social acceptance and ethical frameworks** that ensures that technological innovations align with community values and ethical standards.

These advancements not only enhance *MFU*'s research capabilities but also contribute to shaping future healthcare policies and improving patient outcomes on a broader scale. By demonstrating how early interventions in oral health can positively impact cognitive function, while addressing the social dimensions of care, this research holds the potential to revolutionize geriatric medicine.

Looking Ahead: The Future with COMFORTage

By actively participating in *COMFORTage*, *MFU* and VSTE position themself at the forefront of innovative dementia research and care. The integration of AI, oral health science, and cognitive research, and social interventions paves the way for a new standard in personalized preventive healthcare for aging populations. As the study progresses, it will not only refine clinical treatment

protocols but also provide the foundation for long-term policy changes aimed at improving the health outcomes of aging individuals across Europe.

Through VSTE's focus on Values, Sustainability, Training, and Empowerment, the project ensures that technological innovations are accompanied by appropriate social learning, lifestyle adaptations, and support systems. This human-centred approach, combined with MFU's clinical expertise, creates a comprehensive framework for addressing the complex challenges of dementia and frailty.

The project holds the potential to revolutionize dementia care by highlighting the crucial role of oral health in maintaining cognitive function and overall well-being while simultaneously addressing the social and ethical dimensions of care.

Through this initiative, *MFU* and VSTE reaffirms its dedication to cutting-edge scientific inquiry, interdisciplinary collaboration, and patient-centred healthcare innovation—setting a new benchmark in dementia and frailty research while improving quality of life for future generations. This research holds the potential to fundamentally change how dementia is approached in clinical settings, bridging the gap between medical, dental, and digital health sciences and social care for a more holistic approach to patient wellbeing.