Differentiating subtypes of mild cognitive impairment and decoding their risk through cognitive, psychophysiological, dietary, and gut microbiota markers

Understanding how diet and lifestyle contribute to cognitive and emotional health has become a central concern in health psychology. Adherence to anti-inflammatory eating patterns - particularly the Mediterranean and MIND diets - and regular physical activity are associated with slower cognitive ageing, lower incidence of depression, and greater resilience to burnout. The present project addresses one of the most clinically significant outcomes of late-life neurocognitive change: mild cognitive impairment (MCI) - a transitional state between normal ageing and dementia, characterized by a decline in cognitive functions that exceeds typical age-related norms yet does not meet diagnostic criteria for dementia. Approximately 10–15% of MCI cases progress annually to Alzheimer's disease, although progression to vascular and other non-Alzheimer dementias is also possible. Individuals with MCI display specific microbiota alterations compared with cognitively healthy peers. Yet, it remains unclear whether these changes are a cause, a consequence, or an epiphenomenon of cognitive decline. Late-life depression shares many biological hallmarks - e.g., chronic inflammation and gut dysbiosis - suggesting that mood disorders constitute an additional axis of MCI heterogeneity. Cognitive difficulties in recurrent or late-onset depression - most prominently in executive function, memory, and processing speed - often persist beyond the acute mood episode and increase the risk of subsequent dementia. Yet people with depressive symptoms are rarely included in studies that examine gut microbiota or dietary influences on cognitive ageing. The proposed project will therefore incorporate this subgroup to determine whether depression-related cognitive changes represent a distinct MCI subtype or an alternative pathway to neurodegeneration. The main scientific objective of this project is to identify multidimensional (cognitive, psychophysiological, dietary, and gut microbiota) markers that differentiate subtypes of MCI and are associated with increased risk of progression to dementia. We hypothesize that differences in gut microbiota composition, dietary patterns, and selected environmental factors underlie the heterogeneity of mild cognitive impairment (MCI) and are associated with cognitive dysfunction and its progression toward dementia. In particular, we expect that individuals with vascular and non-vascular MCI subtypes, as well as those with a history of depression, will exhibit distinct gut microbial, cognitive, and dietary profiles. Furthermore, these factors are expected to interact with psychophysiological markers (EEG), jointly contributing to the differentiation of MCI subtypes and the prediction of dementia risk. We plan to answer these questions in a **prospective, longitudinal study (Fig. 1)**, where participants will undergo detailed neuropsychological and dietary pattern assessment, EEG recordings during memory and attention tasks, MRI scans, and laboratory-based analysis of blood-based dementia biomarkers together with gut-microbiota profiling and metabolic analyses.

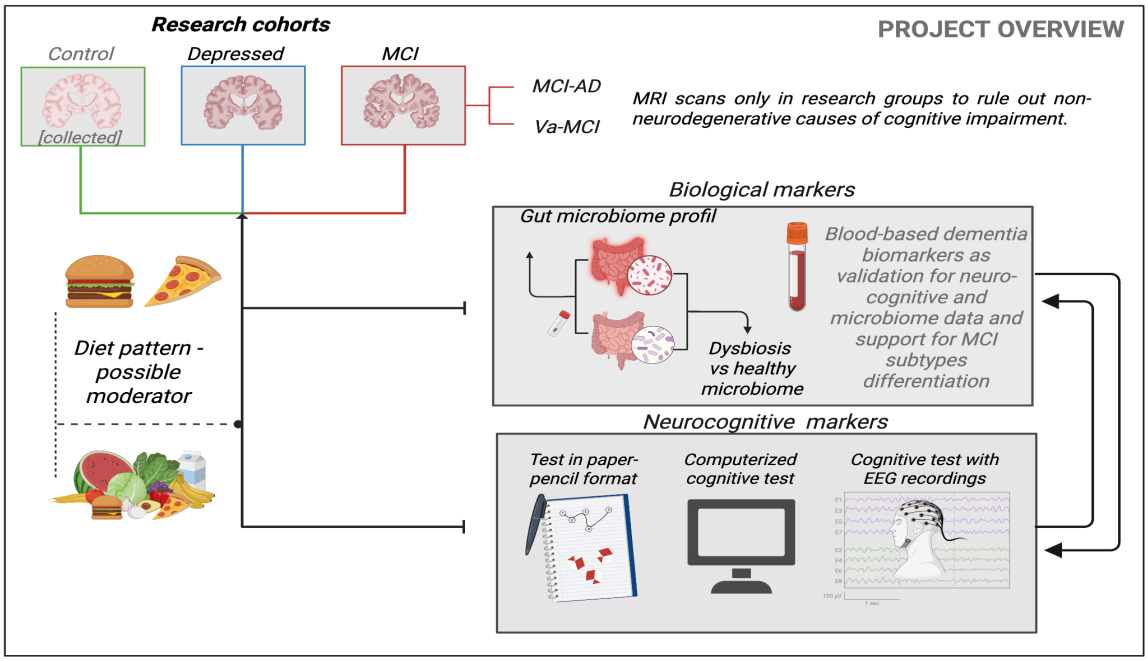

Fig. 1. The overview of the project. MCI-AD: Alzheimer's-related MCI, Va-MCI: vascular MCI; MCI: Mild Cognitive Impairment.