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a PeRsOnalized Prevention roadmap for the future HEalThcare

FACTSHEET #1

OCTOBER 2024

Mapping biomarkers for risk prediction to enhance preventative strategies

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Rapid scoping reviews

Mapping biomarkers for cancer, cardiovascular and neurodegenerative diseases

Abstract

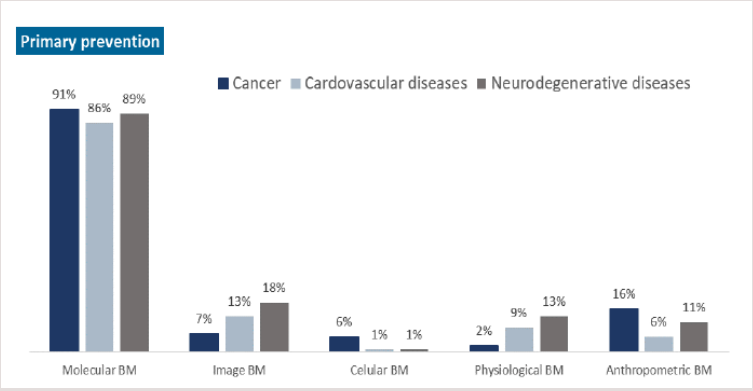
The paper presents the current research landscape of biomarkers, which can support the development of personalised medicine. This report offers an overview of biomarkers for personalised primary or secondary prevention in cancer, cardiovascular diseases (CVD), and neurodegenerative diseases.

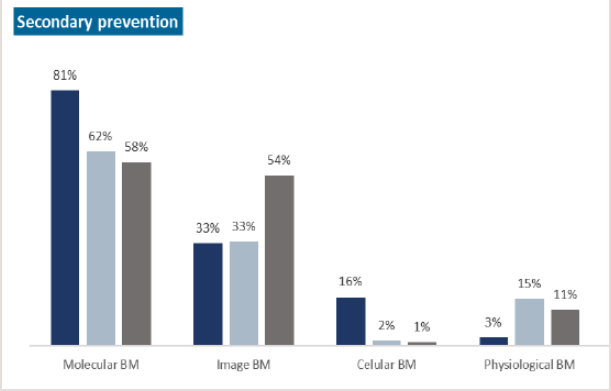
Identified studies

Cancer	**11,266** articles found	**843** selected for data extraction
Cardiovascular diseases	**5,288** articles found	**775** selected for fdata extraction
Neurodegenerative diseases	**2,014** articles found	**286** selected for data extraction

Outcomes

- Cancer - most extensively researched field for biomarkers in prevention, followed by CVD and neurodegenerative diseases
- The most frequently studied biomarkers are **molecular and imaging biomarkers**. They are particularly relevant in secondary prevention, especially in neurodegenerative diseases.
- **Cellular biomarkers** are mainly studied in cancer research, while **physiological BMs** in CVD compared.



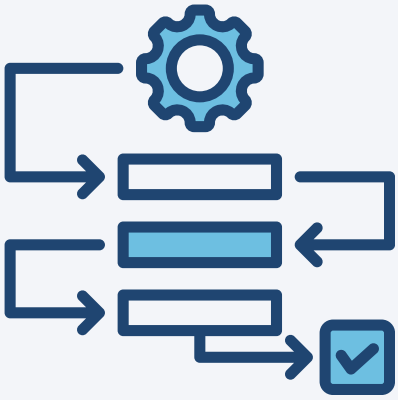


More about the PROPHET interactive biomarkers maps: **HERE**

The importance of mapping biomarkers

Non-communicable chronic diseases are a significant EU public health concern due to their rising incidence, mortality rates, and impact on disability-adjusted life years. To prevent diseases, identification of biomarkers (BM) in the body can support personalised medicine, aiming to stratify populations based on individual risk or resistance to disease and their potential response to treatments.

This document presents the current research landscape of BMs for personalised prevention in adult population, focusing on cancer, cardiovascular, and neurodegenerative diseases. To create a comprehensive overview of the current state of knowledge in this area, three rapid scoping reviews were conducted for each disease group to identify existing BMs and gaps in research. These reviews aim to inform the development of primary and secondary preventive strategies.



To grasp the scientific discussions, we provide definitions on the analysed BMs. Then, we present the results of each scoring review - cancer, cardiovascular, and neurodegenerative diseases. Lastly, we offer an overview combining insights from all three groups.

Primary prevention

Primary prevention is targeted at individuals that have not developed clinical manifestations of the diseases but are considered at risk of developing them,

Secondary prevention

Secondary prevention involves interventions aimed at avoiding the progression of a disease. Screening programs play a vital role as they proactively target population groups who are asymptomatic and have not sought medical assistance but are considered to be at risk of developing the disease.

Types of biomarkers

Biomarkers are classified into five categories:

Molecular Biomarkers

These include DNA, RNA, proteins, and metabolites. Subcategories include genetic/genomics, epigenetic epigenomics, transcriptomics, metabolites/ metabolomics, proteins/ proteomics, microbiological/ microbiomics, biochemistry, etc. Studies within genetic/genomics use genetic variants to explore causal relationships between lifestyle factors and disease outcomes.

Imaging biomarkers

These use medical imaging techniques like X-rays, MRI, PET, or CT scans to visualize and measure structural, functional, or molecular changes in organs or tissues.

Anthropometric biomarkers

These involve physical measurements of the body, such as BMI or waist circumference, often used as covariates in multivariate models.

Cellular biomarkers

These involve the analysis of cells or tissue samples to provide information about cellular processes or disease states, using techniques like staining or immunohistochemistry.

Physiological biomarkers

These reflect functional changes in the body, such as blood pressure or heart rate, and can also include patterns of movement derived from accelerometry.

The report explores how lifestyle factors and subpopulations influence disease risk and prevention. The report also examines how biomarkers are integrated with digital tools for personalised prevention, which encompasses the utilization of wearable technology, such as personal sensors, as well as AI methods like image processing and machine learning.

Scoring reviews results. Cancer

The scoping review shows that primary prevention research for cancer mainly focuses on molecular biomarkers, **predominantly genetics/genomics,** while imaging biomarkers are more common in secondary prevention papers. However, there is limited research on BM for primary and secondary prevention of certain cancers like corpus uteri, bladder, and kidney cancer.

Primary prevention

In primary prevention, the emphasis is often on identifying genetic risk. However, it's important to consider external exposures such as lifestyle choices and environmental factors, which also contribute significantly to cancer development. Integrating a broader perspective that encompasses **both genetic and environmental factors** can enhance our understanding of cancer prevention and enable more personalised approaches to primary prevention.

Secondary prevention

Secondary prevention research targets specific tumors like prostate and lung cancer. **Imaging BM**, like mammography, CT, ultrasound, and MRI, are crucial for early diagnosis and screening in secondary prevention strategies for cancer.

	Breast cancer	Prostate cancer	Lung cancer	Colo-rectum cancer	Gastric cancer	Pancreatic cancer	Liver cancer	Corpus uteri cancer	Cervical cancer	Kidney cancer	Bladder cancer
Molecular	138	73	101	141	61	39	62	22	36	21	31
Cellular	9	7	4	6	3	0	6	3	4	1	1
Imaging	17	2	6	3	2	2	4	1	1	0	0
Physio-logical	0	2	1	5	2	2	2	1	0	0	1
Anthropo-metric	27	7	12	32	9	6	9	5	2	4	2

Number of studies identified for each biomarker type for primary prevention of cancer

Scoring reviews results. Neurodegenerative diseases

There are noteable differences in BM research for preventing neurodegenerative diseases. The most notable finding is the extensive focus on Alzheimer's disease. In contrast, there is limited research available for other neurodegenerative diseases such as Lewy body disease and frontotemporal dementia.

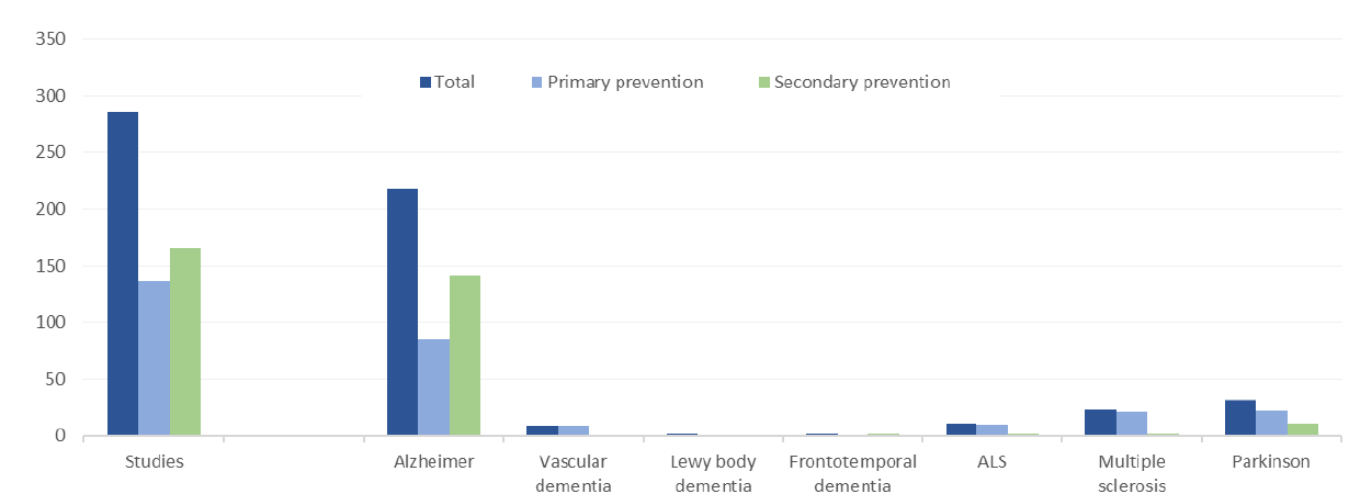
The research on Alzheimer's disease mainly concentrated on secondary prevention strategies, while for other diseases it was focused on primary prevention.

Secondary prevention

Again, **molecular BMs** were a major focus of the research. One key finding is that genetics and genomics are leading the current scientific research in this area. These fields are extensively explored, particularly in the context of secondary prevention along with **imaging BMs**.

Primary prevention

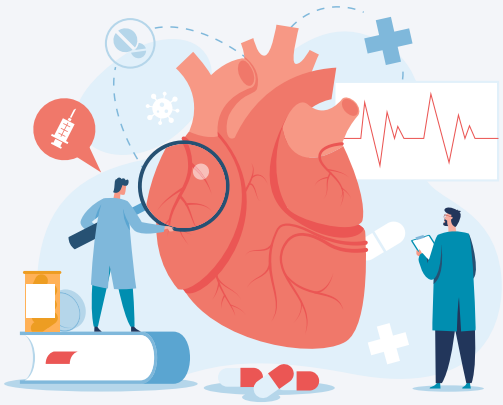
However, a notable gap in the scientific community is the lack of emphasis on studying gene-environment interactions for primary prevention within a public health framework. This aspect requires attention to develop comprehensive strategies for preventing neurodegenerative diseases.



Number of studies included in the data extraction for all and each neurodigenerative disease

Scoring reviews results. Cardiovascular diseases

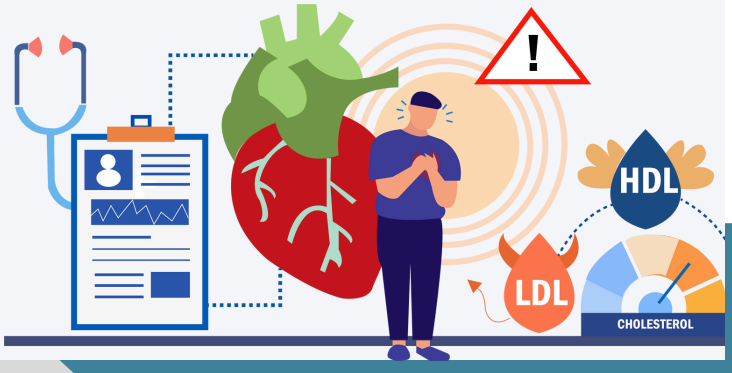
In cardiovascular disease (CVD), out of **5,288** articles found initially, **1,053** were screened for full text, and **775** were selected for final data extraction. The most commonly researched biomarkers, especially in ischemic heart disease (IHD) and stroke, are agian molecular biomarkers. This is significant as IHD and stroke are the leading causes of CVD death.



In primary prevention, the majority of research activity focuses on IHD and stroke within general and high-risk CVD populations, particularly in the categories of **molecular/genomics and imaging** biomarkers. Genomic BM offer potential for primary prevention since they can be measured in young, asymptomatic adults and present opportunities for implementation of preventive strategies earlier in the life course.

Similarly, in secondary prevention, the main focus is on IHD and stroke, with research activity primarily in the categories of **molecular/ biochemical and imaging** biomarkers. Novel methods for BM identification, such as infrared cameras and innovative mass spectrometry techniques, have been identified, although their clinical utility requires further evaluation.

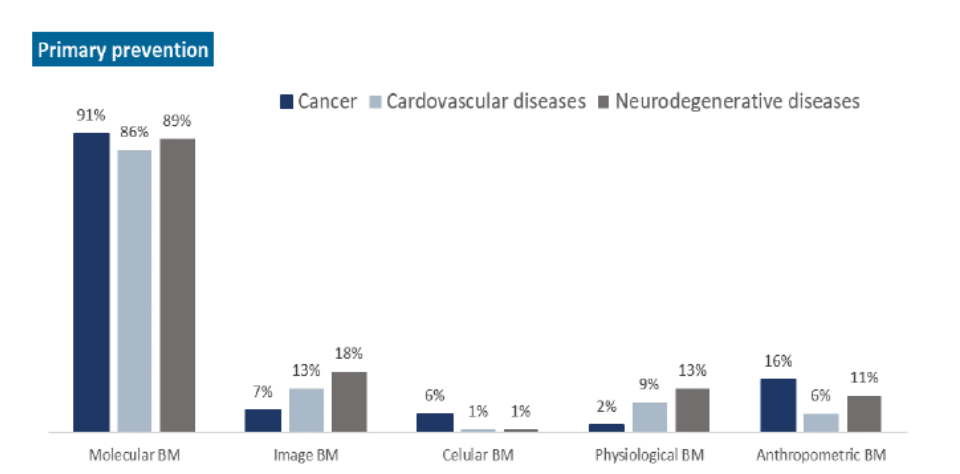
There are more imaging studies identified in secondary prevention compared to primary prevention, possibly because patients in secondary prevention are already on the disease pathway.

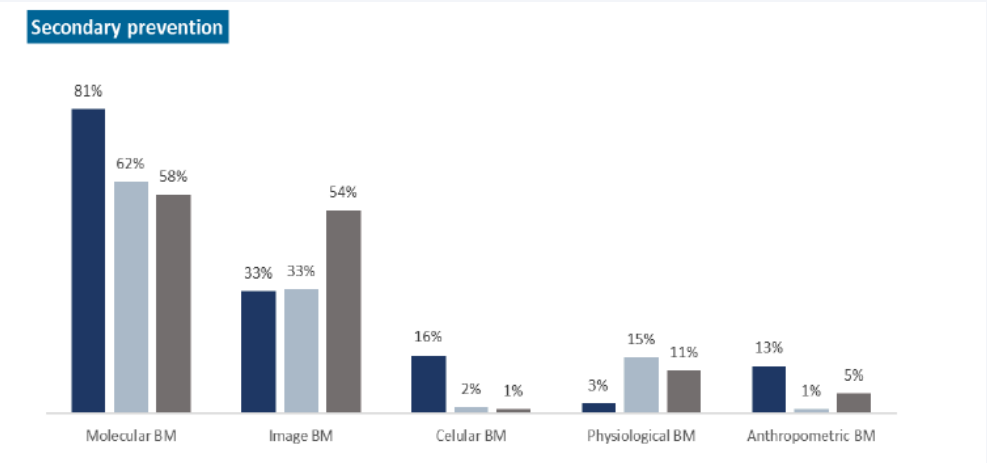


Main findings

The search indicates that cancer is the most extensively researched field for biomarkers in prevention, followed by CVD. Conversely, research on neurodegenerative diseases is notably less prolific, comprising less than a third of the articles found in cancer research. Their potential integration with digital technologies for prevention are less diverse and complex compared to research in other disease areas, such as cancer.

Molecular BMs emerge as the predominant focus of current scientific research and **imaging BMs** are the next most frequently studied. They are particularly relevant in secondary prevention, especially in neurodegenerative diseases. There was a notable research gap in the study of gene-environment interactions, as well as in the study of other omics that could be useful to integrate environment into biomarkers research (i.e. epigenomics or metabolomics).





Conclusion

This report offers an overview of research on biomarkers available for personalised primary or secondary prevention in cancer, cardiovascular, and neurodegenerative diseases. While there is some research on genetic and biochemical biomarkers, gaps remain. Since most biomarker research focuses on treatment, it is crucial to undertake further research to identify, evaluate, and validate various biomarkers for personalised prevention of cancer, cardiovascular diseases, and neurodegenerative disorders in public health settings.

The scoping reviews will be followed by a subsequent report focusing on the clinical utility of biomarkers. It will provide detailed information on the specific biomarkers identified, along with an analysis of the evidence supporting their clinical usefulness. Both reports are part of a comprehensive effort to understand the current state of knowledge and environment for personalised preventive medicine.
The results will contribute to the development of the concept paper for the Strategic Research and Innovation Agenda (SRIA).

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To find more about the PROPHET rapid scoping review, check the corresponding deliverable: **HERE**.

More about the project on our website: https://prophetproject.eu/
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