

D3.2 List of PM areas of mutual interest between Europe and Africa

INSERM AND WP3

DATE OF SUBMISSION: 30 JANUARY 2023

D3.2 List of PM areas of mutual interest between Europe and Africa

Project Acronym	EU Africa PerMed	
Project Title	BUILDING LINKS BETWEEN EUROPE AND AFRICA IN PERSONALISED MEDICINE	
Grant Agreement no.	964333	
Start date of the project	01/02/2021	
End date of the project	31/01/2025	
Work Package number	WP3 – CROSS BORDER COLLABORATION AND IDENTIFICATIONS OF FUTURE ACTIONS IN PM BETWEEN AFRICA AND EUROPE	
Deliverable Number	D3.2	
Deliverable title	List of areas of PM mutual interest between Europe and Africa	
Lead Beneficiary	INSERM	
Due date	M23 (December 2022)	
Date of delivery	30 January 2023	
Nature	R (Report)	
Dissemination level	PU (public)	
<p>DISCLAIMER This document reflects only the author's view. Responsibility for the information and views expressed therein lies entirely with the authors. The European Commission is not responsible for any use that may be made of the information it contains.</p>		
Version	Contributors	Comments
1.0	Raphaëlle RIOCHE (INSERM)	First draft
2.0	Monika Frenkel, Erika Sela, Rizwana Mia, Patrice Debre	Second draft
3.0	R. Ripoché	Third draft
3.0 DEF	Erika Sela	Final Edits



TABLE OF CONTENTS

	Pag.
EXECUTIVE SUMMARY	3
1. INTRODUCTION	4
2. DESCRIPTION OF IDENTIFIED AREAS OF INTEREST FOR AFRICA IN THE FIELD OF PERSONALISED MEDICINE (PM)	6
2.1 FINDINGS FROM THE PROJECT	6
2.1.1 First stakeholder workshop preparatory survey	6
2.1.2 Scientific and policy mapping activities'	9
2.1.3 Regional stakeholder engagement	9
2.1.4 Summary of the findings from project sources	11
2.2 FINDINGS FROM EXTERNAL SOURCES: ACTIVITIES IN AFRICA AND RECOMMENDATIONS CONCERNING PERSONALISED MEDICINE	11
3. DESCRIPTION OF IDENTIFIED AREAS OF INTEREST FOR EUROPE IN PM	14
4. COMPREHENSIVE LIST OF AREAS OF MUTUAL INTEREST BETWEEN EUROPE AND AFRICA	16
4.1. Areas and topics of mutual interest	17
4.2. Mutual interests Level of collaboration within Africa and collaboration between Africa and Europe	20
5. CONCLUSION	22
REFERENCES	24

Figures and tables

	Pag.
Figure 1: Planning of activities for WP3 towards cross border collaboration and identification of future actions in PM between Africa and Europe	5
Figure 2: Medical fields where personalised medicine approaches would be the most needed	6
Table 1: Classification of PM publications in Africa according to disease	7
Figure 3: Personalised medicine thematic priority areas	7
Figure 4: Areas in which collaboration between African and Europe could be mutually beneficial	8
Table 2: Main priorities identified throughout the mapping process	9
Table 3: Summary of the stakeholders' vision on main diseases and thematic areas	11
Figure 5: Key elements required for implementation of genomic medicine in clinical care (ref. AESA 2020)	12
Table 5: Priority areas to advance PM implementation at policy level (Jongeneel CV et al., 2022)	13
Table 6: Research activities from the ICPeMed Action Plan relevant for international collaboration	15
Table 7: Research-supporting activities from the ICPeMed Action Plan relevant for international collaboration	16
Figure 6: Representation of the PM/genomic capacities in African countries	17
Table 8: Preliminary list of areas of mutual interest for PM research for Africa and Europe	19
Table 9: Summary of topics of mutual interest for future collaboration	22



EXECUTIVE SUMMARY

This document describes the ‘List of Personalised medicine (PM) areas of mutual interest between Europe and Africa’ identified by EU-Africa PerMed through:

- Consultation of diverse African stakeholders for the African perspective. The deliverable considers output of WP2 mapping and WP3 activities: the survey launched in preparation and the conclusions of the first stakeholder workshop organised by EU-Africa PerMed (February 2022), and the SWOB analyses performed during the regional workshops.
- Analysis of strategic documents published by ICPeMed and the ICPeMed Family¹ international initiatives to present the European perspective.

The following topics and collaboration models of interest are summarised based on project findings and external sources:

TOPICS OF MUTUAL INTEREST	COLLABORATION MODELS OF INTEREST
<ul style="list-style-type: none"> ➤ DISEASES: cancer, cardiovascular diseases as well as diabetes/metabolic diseases and infectious diseases, together in the third position, are highlighted as top priority areas among African regions ➤ CROSS-SECTORAL AND MULTIDISCIPLINARY COLLABORATIONS: public/private sectors, research/practitioners ➤ DEVELOPMENT AND MAINTENANCE OF SUSTAINABLE INFRASTRUCTURE/S needed for PM implementation - e.g. data repositories, biobanks, analytical platforms, etc. ➤ ADVOCACY AND SENSITISATION: <ul style="list-style-type: none"> ▪ <i>Sensitisation efforts directed to policy makers shall help improving their understanding of the field, that should in turn help guiding political orientation.</i> ▪ <i>As PM is a patient-based approach, communication efforts also need to target civil societies to trigger or increase demand for PM among populations.</i> ➤ EDUCATION AND TRAINING activities at all levels 	<p>NATIONAL HUB: country collaboration in the form of think-tanks or PM dedicated forums,</p> <ul style="list-style-type: none"> - scope: policy development and advancement of PM-related fields at national level (relying among others on decision makers, hospital practitioners, researchers, universities, private partners) <p>REGIONAL HUBS:</p> <ul style="list-style-type: none"> - connection of all national hubs within one region of the continent - connection of all regional networks within a continent - scope: increase best practices and experience sharing, establish thematic networks (disease or discipline-oriented), facilitate training (exchange programmes, knowledge sharing, etc). <hr/> <p>AFRICA/EUROPE: collaboration between networks or hubs established on both continents.</p> <ul style="list-style-type: none"> - scope: broader collaborations allow for undertakings to be taken to a higher level - e.g. for biobanks and data: access to larger datasets and novel technologies; on governance: joint development of global strategic agenda; adoption / harmonisation of common standards, frameworks, etc.

¹ <https://www.icpermed.eu/en/related-initiatives.php>



1. INTRODUCTION

To explore and analyse the potential and advantages of collaboration in Research and Innovation (R&I) in the field of personalised medicine (PM) between Africa and Europe, in the first instance the identification and prioritisation of the PM needs in Africa is needed and was presented in D3.1.

The main challenges in PM were identified through extensive mapping activities in work package 2 (WP2) and via a direct exchange with African PM stakeholders in the first workshop and the related workshop preparatory survey.

This deliverable D3.2 will feed into the general EU-Africa PerMed objective 2:

To explore and analyse with relevant stakeholders, the potential for and advantages of collaboration in PM between Africa and Europe, identifying areas of mutual interest and added value for both regions and building sustainable links between both regions, as a means to integrate the African continent in the global PM agenda.

It will furthermore contribute to work package 3 (WP3) specific objectives:

- Explore and analyse the potential and advantages of collaboration of Africa and Europe in the field of PM.
- Identify areas of mutual interest and added value for future collaboration.
- Build sustainable links between Africa and Europe in PM research, development, innovation and implementation to better integrate the African continent in the global PM agenda.

The information provided in this document is a first starting point and further areas of mutual interest might be identified through different activities (stakeholder interviews, webinars, surveys, etc.) organised within WP3 between the time of writing of this report and the end of the project. New findings and updates will be incorporated in the Action Plan (D3.4), a document that will incorporate all the outputs and propose a set of actions to promote and strengthen the EU-Africa collaboration in PM, as explained below.

This is the second of in total five, interconnected deliverables within WP3 (fig. 1). The first three deliverables (D3.1, D3.2 and D3.3) contribute to the overall topic “Explore and analyse the potential and advantages of collaboration in PM between Africa and Europe”, developed in the first half of the EU-Africa PerMed project. In the second half of the project duration, WP3 will concentrate on “Defining and implementing actions for the future” and will develop two deliverables in this context (D3.4 and D3.5). Concretely:

Explore and analyse the potential and advantages of collaboration in PM between Africa and Europe

- D3.1: Outlines the first observations regarding the African needs in the field of PM identified by EU-Africa PerMed through mapping activities in WP2 and collected through direct exchanges with African stakeholders, i.e. the preparatory workshop survey and the 1st Stakeholder Workshop.
- D3.2: Outlines the outcome of discussions with African stakeholders on areas of interest to be developed for Africa. The revision of strategic documents to convey a European perspective regarding areas of mutual interest between Europe and Africa in the field of PM and is therewith going a step further than D3.1 by reflecting not only on the potential of collaboration in the field of PM to tackle the identified needs but more concretely on collaborations between Africa and Europe in this field.
- D3.3: will concentrate predominately on the African perspective with a gaps-and-needs assessment, setting the African needs (D3.1) in PM in the context of existing frameworks and the current status of the African PM ecosystem. The regional approach will serve to structure the discussions with the stakeholders and therewith the development of D3.3. EU-Africa PerMed will seek the validation of results to be presented in D3.3 through the second stakeholder workshop organised on 20-21 February 2023.



D3.2 List of PM areas of mutual interest between Europe and Africa

Defining and implementing actions for the future

- D3.4: will be based on the outcome of EU-Africa PerMed and more specifically on D3.1, D3.2 and D3.3. It will further develop an action plan to facilitate, foster and promote PM collaboration of Africa and Europe. This will include a prioritisation of the gaps previously identified and the identification of topics of collaboration in research, research supporting activities and strategic level. EU-Africa PerMed will seek the validation of the action plan presented in D3.4 through the third stakeholder workshop organised in 2024.
- D3.5: will present the results of the third stakeholder workshop and the overall observations collected during the EU-Africa PerMed project in the form of a policy brief: “Sustainable European and African collaboration”.

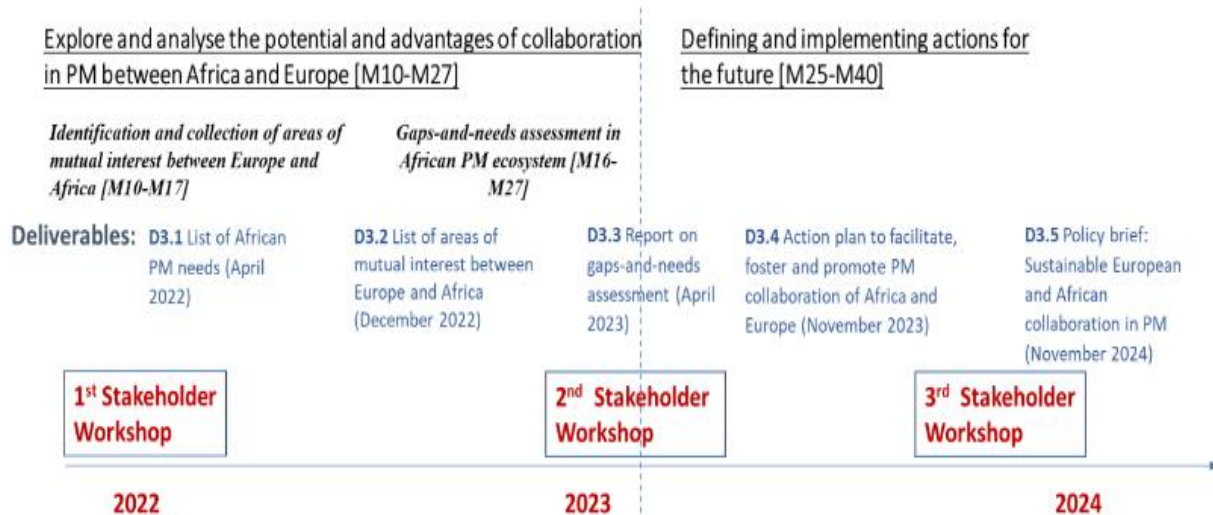


Figure 1: Planning of activities for WP3 towards cross border collaboration and identification of future actions in PM between Africa and Europe

This deliverable is based on information collected so far within the EU-Africa PerMed project, coming from both the mapping activities (Work Package 2) and the first activities planned in WP3 (as explained above). The regional stakeholder engagement, i.e. the coordinated approach initiated by EU-Africa PerMed to exchange with a vast number of stakeholders from the different African regions, have not all been finalised at the time this report was drafted. Reports will be made available upon completion of all regional workshops and the conclusions they include will provide additional material to enrich the present deliverable. The output of regional meetings for which reports have not been finalised at the time of writing will be included in deliverable D3.3.



2. DESCRIPTION OF IDENTIFIED AREAS OF INTEREST FOR AFRICA IN THE FIELD OF PERSONALISED MEDICINE (PM)

Findings for Africa are based on the work carried out as part of project mapping activities and the first stakeholder engagement for WP3. This information has been complemented with findings from documents and publications reviewed during the mapping exercise carried out by the project.

2.1 FINDINGS FROM THE PROJECT

2.1.1 First stakeholder workshop preparatory survey

This survey was carried out to **understand the needs and priorities related to personalised medicine in Africa** as part of the first stakeholder workshop to collect inputs from multidisciplinary respondents. It was shared with workshop participants and thus aimed at reflecting views from the different sectors involved in PM as part of this project. 76 responses from PM stakeholders from 19 African countries were received, covering all five African regions. South Africa had the highest number of respondents (20), followed by Kenya (13). Other countries had between 1 and 4 stakeholders responding to the survey.

This questionnaire serves as a baseline for further work: the definition and description of PM-associated needs presented in D3.1 are used as prerequisites to come up with areas of mutual interest, and comparing these results with prior output reported in D2.2. on the scientific and policy mapping report.

The survey provided information about medical fields (fig. 2) where personalised medicine approaches would be the most needed for African countries. **Cancer** emerged top as the disease where PM approaches would be most needed, followed by **cardiovascular diseases, infectious diseases, diabetes, and other metabolism-related conditions**. Other outlined intervention areas were **rare genetic diseases, immune diseases, mental health conditions, other non-communicable diseases**.

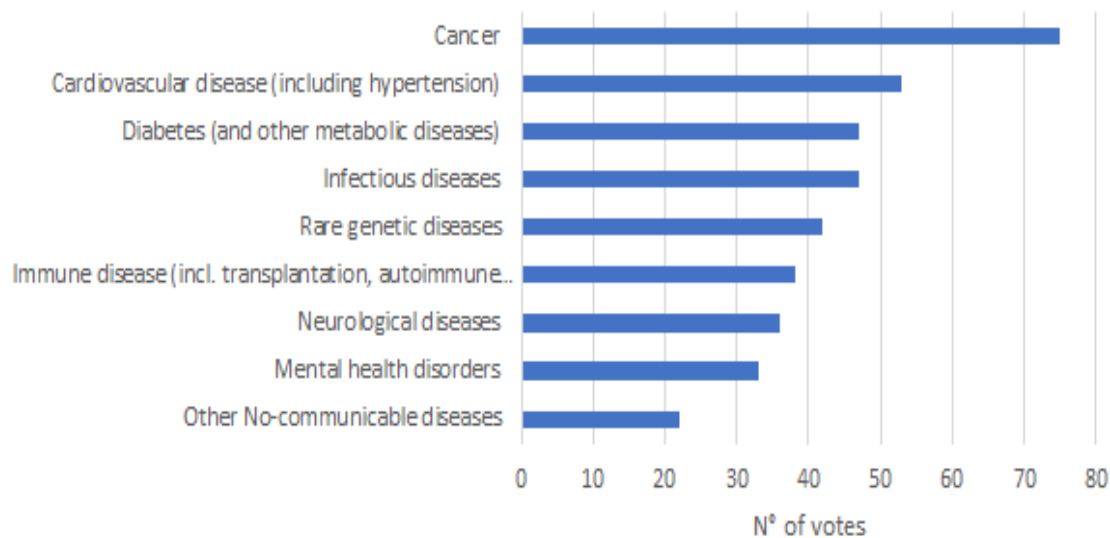


Figure 2: Medical fields where personalised medicine approaches would be the most needed

The stakeholder votes are in line with the scientific and bibliometric output from the D2.1 (Mapping the scientific and policy landscape of PM in Africa) when focusing on the classification of PM publications in Africa according to disease categories (table 1):



DISEASE CATEGORY	PERCENTAGE
Neoplasms	23,7%
Bacterial infections and mycoses	15,4%
Virus diseases	15,2%
Parasitic diseases	8,4%
Immune system diseases	15,0%
Congenital, hereditary, and neonatal diseases and abnormalities	14,4%
Nervous system diseases	13,2%
Skin and connective tissue diseases	11,2%
Nutritional and metabolic diseases	10,4%
Cardiovascular diseases	10,0%
Digestive system diseases	9,8%
Endocrine system diseases	6,6%
Hemic and lymphatic diseases	6,4%

Table 1: Classification of PM publications in Africa according to disease

Still, annual trends of scientific articles by disease category correlate to some extent to stakeholders' votes, as interest in infectious diseases, followed by cancer, immune system and nervous system diseases were more pronounced than other diseases.

Interestingly, during the East and Southern regional workshops, communicable diseases have been identified as “low hanging fruits” creating high disease burden but also high potential and opportunity to demonstrate evidence and the advantages of a PM solution.

When identifying PM needs in regions/countries, respondents prioritised targeted treatment, followed closely by improved diagnostics (fig. 3). Further, half of the respondents felt that targeted prevention and ethical, legal, and social frameworks should be prioritised. In developing the African PM agenda, 48% of the respondents noted that starting at the regional level would be the best option. However, 26% of the respondents preferred enhancing ownership globally and nationally.

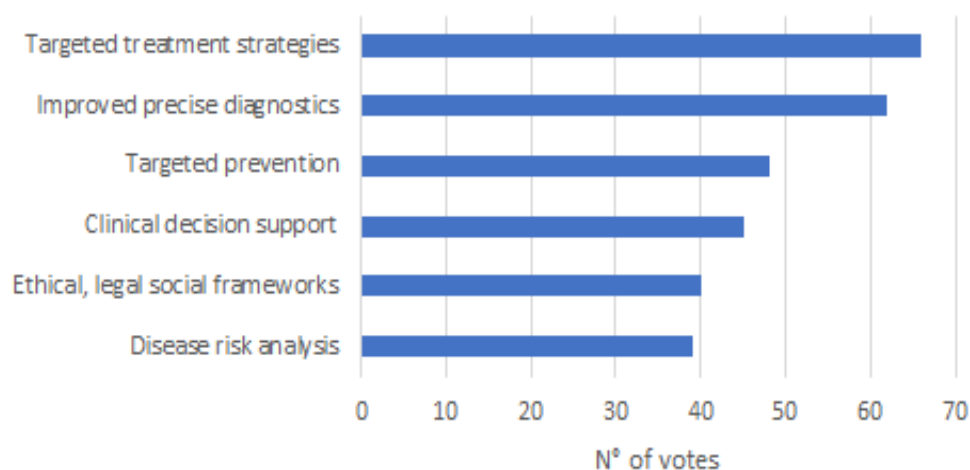


Figure 3: Personalised medicine thematic priority areas

Aspects needed to make PM a reality is another category where priorities vary depending on the region:

- Southern African participants placed efficiency in management of healthcare (e.g. electronic medical records, and other data driven systems) as top priority;
- North and West Africa shows the need for the maximisation of healthcare investments although both regions show contrasting needs as regards R&I;



D3.2 List of PM areas of mutual interest between Europe and Africa

- For East and West African countries, citizen and patient education were found to be important.

Yet, **creation of infrastructure appears on the top of the list for all African regions.**

Given the continents varying urban and rural context, the vision on aspects that ensure socio-economic returns from PM undertakings is comparable at regional and continental levels: to improve cost-effectiveness is placed first, followed by the reduction of poverty through equitable access to healthcare and increased relevance in healthcare reflecting patient’s individual needs. Respondents to the survey also broadly shared a common perspective on the contribution African countries can bring into global PM reflections and developments, being respectively the diversity of populations as well as a strong understanding in a dedicated disease field (such as understanding prognosis of disease, including host pathogenesis of infectious diseases within African populations). It was also widely accepted that PM development within Africa could be best fostered at regional level – vs national or continental approaches; and that efforts to strengthen collaboration should most importantly being increased on the scientific level and where possible to influence at a policy level.

Furthermore, though receiving a slightly different number of votes, the following areas are believed to need more efforts to make PM possible in different countries/regions: (i) Operational needs for better integrating PM into healthcare and clinical practice; (ii) Scientific and technological needs; (iii) Governance / regulatory / ethics needs. They shall guide the definition of areas of mutual interest and particularly the type of collaboration needed.

Finally, the survey indicates a collective agreement on the necessity to strengthen European and African collaboration in PM on topics such as sharing of knowledge / of infrastructure of research, common training and education activities (fig. 4). The nature of survey participants (coming mainly from research and clinics) may explain the prioritisation given to research or research supporting levels rather than on the policy and strategic level.



Figure 4: Areas in which collaboration between African and Europe could be mutually beneficial

To conclude, the survey shows that even though some elements are prioritised differently depending on the region at stake, there is a shared perception and validation from the publication and policy on the main working areas of interest and the method deemed as the most appropriate to tackle those challenges. The survey results also reveal that no regional differences were found in the main areas where collaboration is found to be more relevant.



2.1.2 Scientific and policy mapping activities

Findings from project mapping activities which include two surveys and a virtual stakeholder workshop, have shown that there are a set of priorities for the development and implementation of PM in Africa, that are summarised below (table 2):

CREATE AWARENESS:	Raise awareness and communicate the value of PM to the general public, policymakers, and even researchers, as well as engaging and empowering the community. There is still a lack of knowledge on what PM is and how it can improve and benefit the health of the population.
SKILLS AND INFRASTRUCTURE DEVELOPMENT	Training and educating sufficient people in specific areas to perform and interpret tests and support health systems. There is a need to invest in sequencing and genotyping facilities, biobanks for samples and their associated data, data infrastructure and information management systems (data generation/storage/ analysis pipeline), electronic health records, internet connectivity, and facilities for clinical action and clinical trials.
SUPPORT RESEARCH, DATA GENERATION, MINING, AND TRANSLATION INTO CLINICAL CARE	Build and support the setting up of infrastructure for the generation of genetic and other health data from African populations. Clinical translation of generated data to ensure generated and available data informs patient-centred care and other benefits that come with the implementation of PM approaches in health care.
ETHICAL AND REGULATORY FRAMEWORK DEVELOPMENT, STRENGTHENING, AND HARMONISATION	Establishing, strengthening, and harmonising a cohesive legal and regulatory framework. These frameworks will cover data and sample protection and use in research as well as patients' ownership of their health data and medical secrecy.

Table 2: Main priorities identified throughout the mapping process

2.1.3 Regional stakeholder engagement

The **East Africa stakeholder workshop** (13-14 July 2022) was the first regional approach organised by EU-Africa PerMed to understand the PM gaps and needs of an African region and identify areas of interest for collaboration. It provided very useful analysis and although it mainly reflects the situation of five East African countries (Kenya, Rwanda, Tanzania, Uganda and Ethiopia), workshop outcomes can be used to grasp a definition of the main areas of interest for PM. Country group sessions took place to identify areas of interest for PM. Discussions' outcomes were then merged and resulted in the following set of areas of interest that were common for all five countries:

- Pharmacogenomics;
- Training and Capacity Building: Bioinformatics and data analysis;
- Infectious diseases: Malaria, HIV, TB, Hepatitis B and emerging infectious diseases;
- Cancer (HPV, breast cancer, prostate and colon cancer): Screening, diagnosis, treatment and stem cell research;
- Population genetics: Adaptation of PM to African context.

The **Southern African stakeholder workshop** (5-6 Dec 2022) was the second workshop to provide a very useful outlook on the level of PM gaps and needs as well as areas of mutual interest were identified for South Africa,



D3.2 List of PM areas of mutual interest between Europe and Africa

Zambia, Zimbabwe and Namibia. The workshop outcomes may convey a view of the main areas of interest that may be nuanced in comparison with areas mentioned above in terms of the level of capacity development, focused funding, infrastructure, ethics and regulation and then the development of the fields of genomics/ proteomic science, data science, digital health. The level of development of needs that emerged for Zimbabwe, Zambia and Namibia were similar to the East African Regional context. However, South Africa emerged to be very strong as the country already has focused research programs in precision medicine, pharmacogenomics and genomic research and innovation portfolio with advanced infrastructure and skills in human genome sequencing, clinical research and data analysis and general research and innovation within the region. The maturity of their research and innovation system requires advanced interventions. The maturity of their health system to implement or incorporate newer technology that spurs the evolution of PM in any context also needs to be considered. Public healthcare with established tertiary research institutes as well as private sector healthcare are forging the way forward toward PM within the country. They have managed to build their portfolios of research through international collaboration/partnerships, especially focused funding partnerships. Some areas apart from those mentioned for development in East Africa are:

- Pharmacogenomics ⇒ to build on initial portfolios of research and develop clinical PM approaches.
- Training and Capacity ⇒ create market demand for uptake of skills to develop critical PM workforce required to advance a budding PM ecosystem.
- Infectious diseases ⇒ expand on host genomics in unpacking African Diversity.
- Cancer (HPV, cervical, breast, prostate, colon and esophageal cancer) ⇒ develop precision oncology at private sector level.
- Regulation around incorporation of PM approaches into healthcare.
- Warehousing of local genomic data and development of local genome phenome archive to enable localised data storage.
- Advancing the development of Bioinformatics and critical skills PM Industry in South Africa will afford sustainability in retaining skills in this region.
- Enable longer than 3-year transnational funding instruments to build momentum and address gaps within the South African ecosystem,
- Inter-regional partnerships within the region are strong and should be developed further to sustain regional capacity.

Regulation and governance with strong policy to protect personal information are strong areas in South Africa that enable good research outputs, however the entire region lacks focused regulation on genomic data management.

Regional online workshops and bilateral meetings for French speaking countries of **North Africa** on the one hand, and for **Western and Central Africa** on the other hand took place over the course of the months of December 2022 and January 2023.

The **North Africa stakeholder workshop** (9 January 2023) came as the result of a strong mobilisation among all 3 countries (i.e. Algeria, Morocco, Tunisia) where preparatory meetings were carried out at national level with a view to pool reflections on needs and areas of mutual interest. It appears that there is a shared vision of the benefits linked to PM approaches and that a number of actions are already in place mostly related to diseases that are considered as priorities. Challenges identified are linked to population studies and the main areas of interest converge with overarching schemes mentioned during workshops organised in Southern and East Africa, among which education and capacity building, data analysis and infrastructure, education and capacity building as well as access to testing.

Findings for Egypt have been collected by the Project partner based in Egypt (ECITD), as this country has already advanced in the identification of current needs for Genomic Medicine and Applications (El-Attar EA. Et al, 2022). The country has recently established national task forces on infectious diseases, cancer and obesity [others are under preparation at the moment], and have conducted a project for assessing and



D3.2 List of PM areas of mutual interest between Europe and Africa

identifying key priority areas in Egypt. A diversified list of 200+ experts based on predefined criteria from more than 30 institutions in Egypt participated in this exercise.

The workshop gathering stakeholders from **Central and Western Africa (25 January 2023)** came as one step in the efforts to mobilise professionals involved in the field of personalised medicine. The interest of collaborating around existing genomic platforms was put forward as they appear to be established in a broad number of countries, and they would consist in baseline structures to build upon existing capacity. Given the heterogeneous levels of advancement in PM observed in the countries composing both regions, education and training (and the issue of trained professionals retention) as well as policy and the definition of regulatory frameworks focusing notably on biobanking, ethics and protection of personal data.

2.1.4 Summary of the findings from project sources

The findings from the project work is summarised in the following table:

MAIN DISEASE AREAS	<ul style="list-style-type: none"> - Cancer (HPV, cervical, breast, prostate, colon and esophageal cancers) - Cardiovascular diseases - Infectious diseases (malaria, HIV, TB, Hepatitis B and emerging infectious diseases) - Diabetes and other metabolic-related conditions - Rare genetic diseases - Immune-system diseases - Mental health conditions - Other non-communicable diseases - Nervous system diseases
MAIN THEMATIC AREAS	<ul style="list-style-type: none"> - Pharmacogenomics - Population genetics - Training and capacity building: bioinformatics and data analysis - Treatment strategies, tailored diagnostics, prevention - Cancer screening, diagnosis, treatment and stem cell research - Regulation around the incorporation of PM approaches into healthcare - Data & other infrastructure/s

Table 3: Summary of the stakeholders’ vision on main diseases and thematic areas

2.2 FINDINGS FROM EXTERNAL SOURCES: ACTIVITIES IN AFRICA AND RECOMMENDATIONS CONCERNING PERSONALISED MEDICINE

To complement the findings from this project about areas of interest in PM research in Africa, findings from other publications focusing on the identification of areas in which African countries need to focus to accelerate the implementation of PM approaches are included. Collaboration with Europe could cover some of these areas. They are directly linked to the EU-AU Innovation Agenda, which has included Precision Medicine as one of the long-term actions of interest in the area of Public Health: *“1) Designing and implementing new and innovative methods and tools to counteract future health threats due to long standing, (re)emerging, or antimicrobial resistant pathogens, and to promote one health and precision medicine, in a changing environment.”*²

² The AU-EU Innovation Agenda proposes specific objectives with short-, medium- to long-term actions for four priority areas of the AU-EU High-Level Policy Dialogue on Science, Technology and Innovation HLPD, agreed by the Ministers in



D3.2 List of PM areas of mutual interest between Europe and Africa

One example related to genomics medicine: A relevant document was published in 2020 titled *A Framework for the Implementation of Genomic Medicine for Public Health in Africa* (AESA 2020)³. It outlines the challenges faced by African stakeholders aiming to implement genomic medicine in their healthcare systems, and makes specific recommendations to address these challenges in the areas of infrastructure, participants’ selection, clinical and demographic data collection, the actionability of linkages between genotypes and phenotypes, ethical legal and social implication (ELSI) issues and data governance, education and training, translation of research to clinical practice, and stakeholder engagement. Although the focus is mainly on the use of genetic or genomic information about individuals or populations to improve their healthcare, while PM approaches could consider all kind of health and lifestyle as well as environmental data, we find that extracting the main elements highlighted in this framework are useful points to work with, when trying to find the best and most productive areas for EU-AU collaboration in this field. The documents focus on a set of key elements required for implementation of genomic medicine in clinical care. These are shown in the figure 5 below:



Figure 5: Key elements required for implementation of genomic medicine in clinical care (ref. AESA 2020)

Complementing this framework, a recent article (*Jongeneel CV et al, 2022*) was published that, based on results from a survey, provided evidence from which to inform policy recommendations to African institutions seeking to implement precision, and more specifically, genomic medicine approaches in their healthcare systems. Main areas identified which should receive priority from a policy perspective are summarised in the table 5 below.

PRIORITISATION OF INFRASTRUCTURES	<ul style="list-style-type: none"> ● Simple point-of care (POC) platforms to enable sample acquisition and accurate data capture during first-tier genetic testing; ● more sophisticated facilities for high-throughput data generation and analyses; ● biobanks for long-term storage and retrieval of patient samples; ● databases for demographic and clinical data capture, archiving and retrieval that can be accessed from mobile devices; ● computational facilities for data analysis
NEED FOR MORE TRANSLATIONAL RESEARCH	<ul style="list-style-type: none"> ● Ensure that high quality epidemiological, clinical and omics research on the same study cohorts in their resident populations is being conducted, be it through local research initiatives or by participating in international efforts. This is needed to address the actual lack of information about genetic background, environmental effects and lifestyle among African individuals, especially in light of the high level of genetic diversity on the continent.

July 2020. One of this areas is Public Health https://knowledge4policy.ec.europa.eu/publication/au-eu-innovation-agenda-working-document-14-february-2022_en

³ REF AESA (2020) *A Framework for the Implementation of Genomic Medicine for Public Health in Africa* October 2020. Nairobi: Alliance for Accelerating Excellence in Science in Africa.



INFORMATION DISSEMINATION TO POTENTIAL USERS.	<ul style="list-style-type: none"> informing and educating the healthcare workforce about genomic medicine and other areas of precision medicine should be prioritised before starting a national program. define where genomic tests add value to standard pathology routinely applied in precision medicine.
TRAINING PROGRAMS FOR SPECIALISED PERSONNEL	<ul style="list-style-type: none"> Required specialties in areas such as: genetics, omics, statisticians, genetic/genomic counsellors, bioinformaticians, computer systems administrators, engineers capable of maintaining sophisticated instruments and technicians to operate them. Updating curricula in existing educational institutions and encouraging students to pursue training in these new fields
ENGAGE POLITICAL STAKEHOLDERS AND THE PUBLIC	<ul style="list-style-type: none"> engage policy makers and the general public, not only to provide financial and logistical means, but also to ensure broad popular support for the initiatives and to proactively address questions and concerns raised by the general public and healthcare clients.
REGULATORY FRAMEWORK	<ul style="list-style-type: none"> Data and sample governance policy, informed consent documents and tracking, material transfer and data sharing agreements, participant engagement and intellectual property disclosure to authorities

Table 5: Priority areas to advance PM implementation at policy level (Jongeneel CV et al., 2022)

Another valuable qualitative study was published in 2018⁴ that explored the views of 17 genomics researchers in Africa on the prospects and challenges of genomics medicine in Africa. The study asked the researchers what areas of genomics may easily make an impact on healthcare in Africa in the short term. Three broad areas emerged: improved diagnosis, pharmacogenomics and public health. An interesting finding from this study was *the need for genomics research in Africa to be tailored to the health priorities of the host countries. This may be a challenge for genomic research consortia in Africa, especially as most African countries are yet to articulate their health and health research priorities. The researchers also mentioned that genomics would have more impact on health in Africa if it adopts a disease-oriented approach at the population level and if it focuses on diseases that are major contributors to the disease burden in Africa.* The need to build capacity for genomics medicine in Africa, was also one of the findings from this study, which aligns with the previous documents mentioned, and with the findings of EU-Africa PerMed.

Finally, an area of PM research of core importance not only for Africa but also for Europe is increase the inclusion of genomics data from African population in Genome-wide association studies (GWAS) of common diseases and which has been proposed by several authors, as shown in the below extracts:

- African populations are understudied, and precision medicine approaches are largely based on data from European and Asian-ancestry populations, which limits the transferability of findings to the continent of Africa. African genetic diversity can help to understanding differences in disease association and causation, opening up opportunities for the discovery of novel biological pathways to inform therapeutic interventions (Pereira, L et al 2021) ;*
- Lack of diversity in genomics leads to unmet scientific needs and health disparities. Certain characteristics of underrepresented populations would undoubtedly benefit international efforts toward discovery of disease-causing variants (Fatumo S et al. 2022) ;*
- The lack of representation of diverse ancestral backgrounds in genomic research is well known, and the resultant scientific and ethical limitations are becoming increasingly appreciated. It is expected that greater representation of those with African ancestry in genomic research will bring novel insights into human biology, and lead to improvements in clinical care and improved understanding of health disparities (Bentley, AR et al 2018) ;*
- The need to expand the diversity of populations in GWAS has become increasingly apparent as new knowledge is gained about genetic variation. Inclusion of diverse populations in genomic studies is critical*

4



D3.2 List of PM areas of mutual interest between Europe and Africa

to a more complete understanding of human variation and elucidation of the underpinnings of complex diseases (Peprah E. et al 2015).

The value of African genomics to advance PM at global level was also pointed out by the African stakeholders that responded to the survey carried out by EU-Africa PerMed before its first stakeholder workshop. To the question; *In your opinion, do you agree that the contribution African countries can bring into global personalised medicine reflections and developments?:*

- 99% of the respondents agreed that the genetic diversity of African populations will contribute to enhancing the global knowledge in terms of genetic backgrounds and will enhance the development of broadly applicable PM approaches and efficacious drugs/vaccines/ biologics ;
- 90% of the respondents also agreed that Africa could strengthen the understanding of specific disease fields such as understanding prognosis of disease including host pathogenesis of infectious diseases within African populations.

3. DESCRIPTION OF IDENTIFIED AREAS OF INTEREST FOR EUROPE IN PM

The European Commission (EC) contributes as observer or active partner in various global partnerships in the health sector including the International Consortium for Personalised Medicine (ICPerMed). The EC outlines the need for global partnerships as followed:

“Most health-related issues have a global nature and require a global solution. The EU alone will not crack the challenge of implementing better healthcare for all. The ability to attract international stakeholders and their resources into EU-led collaborations will help the EU to combine best skills and outcomes, and deliver tangible results to patients. International cooperation is therefore not an option but a fundamental and inherent component of health research and innovation.”⁵

Under the current “Horizon Europe” scheme, the EU supports and is investing in health R&I and new technologies particularly in the areas:

- health throughout the life course,
- environmental and social health determinants,
- non-communicable and rare diseases,
- infectious diseases including poverty-related and neglected diseases,
- tools, technologies and digital solutions for health and care including personalised medicine,
- healthcare systems.

The overarching aim is to prepare Europe for potential future pandemics but also to ensure healthy lives for all at all ages and equal access to care for people across the European Union.

The EC underlines the diverse application fields in which PM approaches can contribute specifically, such as disease prevention, better diagnostics and more effective therapies, improved healthcare and wellbeing, and to improve the uptake of innovative (digital) health technologies.

Most importantly, it is highlighted that European research and innovation in health requires cross border collaborations, sharing of knowledge and resources, and improving health and care systems in a systematic and common approach.

More concretely, the above-described areas of mutual interest of African countries in health and in the field of PM are also in line with the ICPerMed Action Plan⁶, which puts into perspective common operational streams of action of EU Member States, Associated countries and European bodies through international collaboration.

⁵ https://research-and-innovation.ec.europa.eu/research-area/health/global-partnerships-health_en

⁶ <https://www.icpermed.eu/en/activities-action-plan.php>



D3.2 List of PM areas of mutual interest between Europe and Africa

The Action Plan sets out a discrete set of 22 research and 8 research-supporting activities, including indications regarding the time needed for taking steps to address these actions (short, medium and long term) and the scope indicating whether the respective action is regarded as suitable for implementation at a regional/national, European and/or international level.

The majority (20 actions in total) of the presented actions were identified to be relevant for international collaboration. This is the case for more than half of the presented research activities (table 5):

DATA	
A.2	Support research on data harmonisation in the context of personalised medicine needs
A.4	Support research on enabling the extraction of structured data from unstructured sources
A.5	Pilot projects to assess the impact of sharing data for researchers and other parties
A.6	Research projects to optimise data security, privacy and ownership within personalised medicine approaches
A.7	Research projects to develop innovative decision support tools for healthcare providers
TECHNOLOGIES, METHODS AND PROCESSES	
A.10	Implement translational programmes with shared access to, for example, genetically defined patient populations
A.11	Integrate actions aimed at supporting and developing research for clinical validation of pharmacogenomics. Global impact evaluations of these actions on health systems
A.14	Longitudinal cohort studies of disease outcomes
A.16	Support research in and development of health economics models and pharma-economic models for personalised medicine
A.17	Support research in post-marketing surveillance methodologies aimed at assessing patient outcomes
PEOPLE	
A.19	Research and develop the tools and modus operandi of a knowledge network for enhancing health and digital literacy
A.20	Develop and share best practices of patient engagement approaches for the needs of a variety of European citizens
A.21	Research and develop the instruments for the evaluation of the effectiveness and impact of public engagement initiatives in PM
CROSS-CUTTING	
A.22	Support interdisciplinary research in challenges and drivers that influence bringing PM innovation to the market, from ethical, legal and societal perspectives

Table 6: Research activities from the ICPeMed Action Plan relevant for international collaboration

The majority of research-supporting activities is also relevant for international collaboration (table 6):

STRUCTURES	
B.1	Promote the development of high-quality sustainable databases for personalised medicine-relevant data
B.2	Development and maintenance of biobanks and population/disease cohorts
METHODS & PROCESSES	
B.4	Develop common strategies in research to support comparative and effective research, and sustainable technology transfer capacities
B.5	Support strategies to identify financial and risk-sharing instruments to develop personalised medicine approaches
B.6	Support research to analyse, compare and optimise national and regional health systems in the light of personalised medicine implementation



PEOPLE	
B.7	Introduce curricula reforms to create new models of healthcare for patients and citizens and broaden the focus on basic and clinical sciences to include health systems sciences in the education of all healthcare professionals

Table 7: Research-supporting activities from the ICPeMed Action Plan relevant for international collaboration

As example: The Action Plan puts forward the need for studies on data harmonisation, integration and interpretation for multifactorial diseases (based on clinical studies’ public data, medical records, etc.) or research projects to develop innovative decision support tools for healthcare providers. The integration of existing action and programmes implemented in African countries to such activities shall help enrich the results, as would the co-design of research projects by European and African stakeholders on topics or fields of shared importance.

Adequate transparent regulatory structures and pathways to accelerate patient access are also identified as a necessary step to further implement PM. Laying out collaboration models between the EU and/or Member States with African countries to share good practices could contribute to facilitate the design and implementation of institutional frameworks and regulations focusing on PM-related areas to advance the field.

ICPeMed states that new collaborative funding organisation models should be designed to facilitate investment in disease prevention research and strategies to develop comparative research and technology transfer capacity to achieve the goals set in the Action Plan. These elements could be tackled at international level for their effectiveness to be maximised, hence being of interest when shaping future collaborations between Europe and Africa in the discipline.

A recently performed analysis of the PM landscape and policies published from the European Union⁷ and the EU Member States level demonstrated that policies developed concentrated on patient-tailored treatment and targeted prevention, education of healthcare workers, research and innovation, big data harmonisation and healthcare system sustainability. It was underlined that PM is a major priority of the EC research agenda but that the policy landscape is fragmented and requires coordination to align the future direction on PM.

4. COMPREHENSIVE LIST OF AREAS OF MUTUAL INTEREST BETWEEN EUROPE AND AFRICA

The areas of mutual interest detailed in the following section are elaborated and further outlined in fields of the needs summarised above and based on report D3.1 where deficiencies and challenges remain to be bridged for PM to become broadly adopted. All areas of mutual interest are intertwined and the order is not reflecting hierarchical ranking. They are to be adapted to each country’s level of advancement as the situation may vary nationally: there is not a one-way approach for all, but rather gradients/margins for action to be taken in respective areas.

The level of advancement and maturity of each country as regards PM needs to be taken into account when defining areas of collaboration as it might influence the main themes that are perceived as national or regional priorities.

The mapping exercise carried out as part of previous project activities led to the classification of African countries into 5 categories based on their strengths on a defined set of dimensions (1) Governance of health research (2) financing of health research (3) resources for health research (4) health research outputs (5) international collaborations in health research (6) PM/genomic research⁸ (fig. 6):

⁷ <https://www.ic2permed.eu/wp-content/uploads/2022/11/An-overview-of-Personalized-Medicine-landscape-and-policies-in-the-European-Union.pdf>

⁸ More details in D2.1. Report: Mapping the scientific and policy landscape of PM in Africa (<https://www.euafrika-permed.eu/project-deliverables/>)



D3.2 List of PM areas of mutual interest between Europe and Africa



GROUP	HEALTH RESEARCH, GOVERNANCE, FINANCE, RESOURCES, OUTPUTS AND INTERNATIONAL COLLABORATION	PM/ GENOMIC RESEARCH	COUNTRIES
1	Countries performing very well in health research. There is an important governmental commitment for health and PM research	VERY HIGH	South Africa and Egypt
2	Most countries have governance structure and funding for health research, and well-established international collaborations. There is already an important research activity in PM	HIGH	Algeria, Cameroon, Ghana, Kenya, Morocco, Nigeria, Tanzania, Uganda, Tunisia, Zimbabwe
3	This group of countries have, in general, a good performance in health research, but their capacity in PM/genomic research is not as high as group2, there is potential/capacity to improve.	HIGH/MEDIUM	Botswana, Burkina Faso, Ethiopia, Gambia, Malawi, Senegal, Zambia
4	These countries seem to be in a lower level of PM/genomic research capacity. They have an average performance in STI/health research. In some countries data are not available to score some dimensions.	MEDIUM/LOW	Benin, Mali, Mozambique, Congo, Cote D'Ivoire, Congo Dem. Rep., Eswatini, Gabon, Guinea, Guinea-Bissau, Mauritius, Namibia, Rwanda

Figure 6: Representation of the PM/genomic capacities in African countries

4.1. Areas and topics of mutual interest

The preliminary list of areas of mutual interest listed below (table 8) are not ranked by priority but should rather be considered as topics that emerged from collective discussions during stakeholder workshops and regional engagements, and other project activities (surveys) and findings (desk review). Prioritisation will be feasible based on the discussion and validation with stakeholders that are to take place during the second stakeholder workshop planned on 20-21 February 2023.



D3.2 List of PM areas of mutual interest between Europe and Africa

TOPIC NATURE	TOPIC	AFRICA	EUROPE
TARGETED	Diseases Fields	<p><u>Communicable diseases:</u></p> <ul style="list-style-type: none"> - infectious emerging diseases 	All disease areas ⁹
		<p><u>Non-communicable diseases:</u></p> <ul style="list-style-type: none"> - Cancer - Cardio-vascular diseases - Diabetes and metabolic related disease - Rare genetic diseases - Immune system diseases - Nervous system conditions - Mental health conditions 	
CROSS-CUTTING	Improved Diagnostics & Prevention	<i>information related to this section is being collected</i>	<ul style="list-style-type: none"> - provide patient tailored treatment and targeted prevention - develop and rely on innovative decision making support tools
CROSS-CUTTING	Targeted Treatment	<i>information related to this section is being collected</i>	
TARGETED	Samples & Data	<ul style="list-style-type: none"> - develop guidelines on tests and samples treatment - data treatment, analysis and interpretation with the use of AI/big data 	<ul style="list-style-type: none"> - data harmonisation - optimise data security, privacy and ownership (related to section on ELSI)
CROSS-CUTTING	Infrastructure & Frameworks	<p>Biobanks, data repositories, analytical platforms</p> <ul style="list-style-type: none"> - development of storage and infrastructure - data sharing and interoperability <p>Capacity-building:</p> <ul style="list-style-type: none"> - data analysis - data management 	<ul style="list-style-type: none"> - high quality sustainable databases - maintenance of biobanks
CROSS-CUTTING	GWAS / Population genetics (targets: researchers & healthcare practitioners)	<ul style="list-style-type: none"> - creation of cohorts: longitudinal studies of diseases outcomes - leverage and consider the diversity of the different populations in Europe and Africa to contribute to enhancing global knowledge 	
CROSS-CUTTING	Education, Training and Capacity Building (targets:	<p>* Identified disciplines:</p> <ul style="list-style-type: none"> - bioinformatics - data analysis - data management 	<ul style="list-style-type: none"> - increase education of healthcare workers on PM - introduce curricula

⁹ ERA PerMed: "(...) Personalised Medicine is non-disease-specific, but rather an overall approach that can be adopted and adapted to a multiplicity of medical conditions (...)", <https://erapermed.isciii.es/joint-calls/joint-transnational-call-2022/>



D3.2 List of PM areas of mutual interest between Europe and Africa

	researchers & healthcare practitioners)	* exchange of knowledge and best practices between countries and/or regions	reforms to create new healthcare models for patients and citizens
CROSS-CUTTING	Awareness & Advocacy (targets: citizens / patients)	<ul style="list-style-type: none"> - adopt a patient centred approach - communication efforts for a better understanding of PM and its contributions ⇒ trigger/increase demand	<ul style="list-style-type: none"> - increase public understanding of PM - increase patients' involvement in all phases of research and development - tools to enhance citizens' digital literacy
CROSS-CUTTING	Policy-Making (targets: decision makers)	<ul style="list-style-type: none"> - sensitisation of decision and policy-makers to improve their understanding of the field to guide political orientations - sensitisation on the benefits on public health and PM's cost-effectiveness 	<ul style="list-style-type: none"> - develop/share best practices of patient engagement approaches - strategies to identify financial and risk-sharing instruments
CROSS-CUTTING	Ethical, legal and social implications	Policy development and regulatory frameworks: <ul style="list-style-type: none"> - Regulation around incorporation of PM approaches into healthcare Harmonisation and/or alignment of strategies and development/adoption of common standards	
CROSS-CUTTING	Joint strategic development	cross-sectoral and multidisciplinary collaborations: <ul style="list-style-type: none"> - public/private sectors - research/practitioners - labs/universities 	
		<ul style="list-style-type: none"> - create industry for uptake of skills 	<ul style="list-style-type: none"> - attract investments by the healthcare industry in PM - foster innovation through public/private collaborations

Table 8: Preliminary list of areas of mutual interest for PM research for Africa and Europe



4.2. Mutual interests | Level of collaboration within Africa and collaboration between Africa and Europe

The following programs or initiatives could come in support of domestic and regional efforts to expand the field of PM in Africa and elaborate collaborations with Europe:

- Initiatives (co-)funded by the European Commission (under Horizon Europe or following framework programmes), e.g. coordination and support actions comparable to the EU-Africa PerMed (as follow-up project);
- Initiatives jointly funded between the EU and AU.
- National bilateral programmes funded by European countries or jointly between European countries and African countries.

Collaboration mechanisms similar to the European and Developing Countries Clinical Trials Partnership (EDCTP) would allow accommodating both European action and bilateral financing mechanisms that are part of EU Member States national strategies. Indeed, such a hybrid model of collaboration could combine strengths of African countries alongside that of European participating states while having a coherent and coordinated voice on the global scale and a common strategy for the advancement of PM as a discipline.

The format (funding requirements, stakeholder participation etc.) of the initiative might vary depending on the concrete topic to be tackled (e.g. disease field, medical application field, or other such as Education and Training, infrastructure, etc.).

Within the African continent, EU-Africa PerMed workshops carried out to this stage have reflected that parties' and stakeholders' interest in collaborating in the field of PM differs depending on their common interests or goals and the most appropriate collaboration model might vary depending on the level of cooperation, i.e. national, transnational/regional, international/inter-continental level. For instance, national collaboration is a way to facilitate the advancement of PM in Africa, while regional collaboration or collaboration between neighbouring countries can act as a tool for more advanced countries to support those at lower levels of development.

As such, PM is the natural development of health systems which builds on advanced technologies that are in part already installed in clinical practice and also translational approaches under implementation in various countries, e.g. sequencing platforms, information management systems, data centres, biobanks, etc.

National collaborations - development of Think Tanks or dedicated PM hubs

At the country level, a national strategic setting is needed to allow sustainable national funding mechanisms that are independent of external resources and priority setting. This goes hand in hand with the definition of national strategies and action plans that are in line with priorities observed depending on domestic context. When focusing on advocacy, medicine and politics are highly connected so this is one of many fields where cross-sectoral collaborations in PM is essential.

Setting up national "task forces" building on scientific, clinic, socio-economic and ethical expertise could allow for better articulation of efforts in designing PM-dedicated platforms. Some countries already have programs of research and innovation to build their PM agenda. Since PM builds on the use of high-end technology, whether for diagnostic, treatment, prevention or data management purposes, such an innovation-reliant field calls for cross-cutting initiatives around stakeholders involved in computing, data analysis together with biological laboratories, biobanks and hospital infrastructures to cover the whole spectrum that is required to have a patient centric healthcare. The engagement of public and private (biotech/industry and broader healthcare) sectors, health technology assessment, regulatory authorities and most importantly the citizens and patients is essential to cover the whole spectrum.

Furthermore, innovation calls for collaborations between public and industrial operators as well as and policy-makers to advocate for frameworks that encourage R&D and to ensure funding is secured as part of multi-year action plans to sustain R&I investment and gain visibility of future undertakings.



Regional collaboration

It is essential to map whether regional networks already exist and need to have their governance and/or structure strengthened, or whether professionals involved in the field of PM in a given region need to formalise their interactions in order to form such platforms.

EU-Africa PerMed contributes to this analysis by organising regional workshops, in order to best articulate efforts within and among the African regions, the agenda of already conducted or upcoming EU-Africa PerMed project regional workshops constitutes a focus on regional collaboration, i.e. North, Southern, Western, Central and Eastern Africa.

The outcomes of those discussions will contribute to guide the next steps to be taken to bring stakeholders together in the most effective way. Inter-country collaboration is found to be existing in different forms and levels of formalisation depending on the regions. For instance, regional platforms were found to be established informally around existing organisations (e.g. Pasteur Institute in North Africa), or emerging around a dynamic launched with the support of Deans of universities in West/francophone Africa. As regards Southern African region, South Africa has already formed a National Precision Medicine Think Tank and has focused funding programs to advance PM research and Innovation. The region is also home to core infrastructure such as the Human Heredity and Health in Africa (H3A BioNet) as well as headquarter to the most data intensive program on the continent – the Square kilometer Array (SKA) Radio Astronomy Centre, with dedicated bioinformatics cloud infrastructure and pipelines for data analysis.

EU-Africa PerMed workshops results shall also guide the direction that needs to be taken by regional initiatives depending on the PM needs experienced/expressed by countries (for instance: scientific consortium, reference centres, thematic consortium to share best practices, political clusters to facilitate lobbying or highlight investment priorities).

Importantly, the level of advancement of countries/regions in the implementation of PM approaches in the healthcare systems differs all across the European and African continents and some countries appear to be readier to implement PM endeavours. This observation should be considered when adopting regional approaches to ensure that support programmes do not only benefit countries that are best prepared and most advanced in the field. Relying on inclusive schemes based on the sharing of best practices at regional level would help to not leave any country behind in spite of heterogeneous levels of development of the discipline of PM.

Fostering joint activities between Africa and Europe

The importance of international collaboration, when aiming at overcoming global health challenges, is emphasised by the European Commission. The convergence between the IPerMed Action Plan priorities and the outcomes of the EU-Africa PerMed project's workshop so far calls for actions to be jointly carried out in the fields summarised in the above table 8.

Besides, the term "Precision Medicine" is already included in the EU-AU Innovation Agenda as one of the long-term activities under the heading of Public health¹⁰ :

"1) Designing and implementing new and innovative methods and tools to counteract future health threats due to long standing, (re)emerging, or antimicrobial resistant pathogens, and to promote one health and precision medicine, in a changing environment."

¹⁰ https://research-and-innovation.ec.europa.eu/system/files/2022-02/final_au-eu_ia_14_february.pdf



5. CONCLUSION

The table 9 below summarises areas of interest identified throughout the process:

AREAS OF MUTUAL INTEREST FOR PM	
Main Area	Sub areas/specific topics identified
Joint research (funding) activities	<ul style="list-style-type: none"> genome-wide association studies (GWAS) and next-generation sequencing collaborations (disease & population studies) joint clinical trials understanding of disease mechanisms (NCD and CD - raise awareness for lifestyle diseases) pharmacogenomics, pharmaco-metabolomics multimedication developments in diagnostics, treatment and prevention
Education and training activities	<ul style="list-style-type: none"> Data Bioinformatics sector
	Workforce: <ul style="list-style-type: none"> Integration of PM in existing curricula Train working healthcare professionals
	Trainees/exchange between clinics/programmes: <ul style="list-style-type: none"> Knowledge exchange (twining/mentoring calls) on fields such as technology, clinical applications, health system reforms, standards, etc.
Creation / raising of awareness & advocacy	Policy makers: <ul style="list-style-type: none"> Governance Sensitisation through inter-sectoral collaboration to guide policy-making Cost-effectiveness
	Civil society / patients: <ul style="list-style-type: none"> Education on advantages and benefits to trigger or increase demand
Development of new and connection of existing of infrastructures (at national, regional or inter-continental levels)	Capacity building: <ul style="list-style-type: none"> data management data analysis
	Infrastructure: development and/or maintenance of biobanks
Harmonisation/Alignment of strategies and development/adoption of common standards	<i>Further analysis is needed</i>
Determine and promote the socioeconomic value of PM	<i>Further analysis is needed</i>
Development of innovation and market access	<i>Further analysis is needed</i>
Development of a system allowing PM developments	<ul style="list-style-type: none"> multidisciplinary and inter-sectoral collaborations innovation (public-private collaborations) ethics, legal and social aspects / framework
Joint communication and dissemination activities	<i>Further analysis is needed</i>

Table 9: summary of topics of mutual interest for future collaboration



D3.2 List of PM areas of mutual interest between Europe and Africa

As detailed above, this deliverable is a living document based on ongoing work. The elements presented are not definitive and the evidence available at this stage does not allow to predetermine countries' willingness to collaborate prioritizing on one or more areas listed above. Those steps include notably in the short term:

- **Regional engagement:** reports for each regional engagement activity are expected to be finalised at the end of 2023's first quarter. The output provided will enable to add region-specific content as regards gaps, needs and preferred plan for action. It should also allow for a nuance of the elements that are presented above concerning Africa as a continent.
- The next **stakeholders' workshop** planned on 20-21 February 2023 in Cape Town is notably organised around restitutions of regional workshops findings, discussions about and work on the elements presented in this deliverable with the objective of moving towards validation, refinement and identification of areas of mutual interest between Africa and Europe in a more formalised manner as all involved stakeholders will be given the opportunity to reflect on what was surveyed and put it in perspective with the specific regional contexts. Opportunities for collaboration between Africa and Europe in Personalised Medicine and models for collaboration between Europe and Africa in Personalised Medicine will also be discussed at this occasion.

Regional engagement so far relies on the connection of stakeholders through project team members and project-related activities. The outputs and results of the stakeholders' workshop shall e.g. help in defining potential future actions to be carried out by or in support of such regional consortia. For instance, since these consortia are not established formally at this stage, an outcome of the project could be to draft terms of reference for such networks or to develop suggestions to define structures or stakeholders to be involved regionally in said consortia. Those ToRs could be part of the Action Plan developed in the frame of this WP3 and provide an organisational supporting document that each regional consortium could be free to adapt to best accommodate action that is relevant locally and focus on what is perceived as a regional priority (as per disease field or PM supporting activities).

Besides the regional organisation, other collaboration models, with a focus on Africa-EU collaborations and considering the diverse collected topics of interest for which PM approaches could be a solution, will be further discussed with stakeholders and part of the Action Plan developed by EU-Africa PerMed (D3.4).



REFERENCES

- AESA (2020) A Framework for the Implementation of Genomic Medicine for Public Health in Africa October 2020. Nairobi: Alliance for Accelerating Excellence in Science in Africa.
- Bentley, A.R., Callier, S.L. & Rotimi, C.N. Evaluating the promise of inclusion of African ancestry populations in genomics. *npj Genom. M ed.* 5, 5 (2020). <https://doi.org/10.1038/s41525-019-0111-x>
- El-Attar EA, Helmy Elkaffas RM, Aglan SA, Naga IS, Nabil A and Abdallah HY (2022) Genomics in Egypt: Current Status and Future Aspects. *Front. Genet.* 13:797465. doi: 10.3389/fgene.2022.797465
- Fatumo, S., Chikowore, T., Choudhury, A. et al. A roadmap to increase diversity in genomic studies. *Nat Med* 28, 243–250 (2022). <https://doi.org/10.1038/s41591-021-01672-4>
- Jongeneel CV, Kotze MJ, Bhaw-Luximon A, Fadlelmola FM, Fakim YJ, Hamdi Y, Kassim SK, Kumuthini J, Nembaware V, Radouani F, Tiffin N and Mulder N (2022) A View on Genomic Medicine Activities in Africa: Implications for Policy. *Front. Genet.* 13:769919. doi: 10.3389/fgene.2022.769919
- Munung NS, Mayosi BM, de Vries J. Genomics research in Africa and its impact on global health: insights from African researchers. *Glob Health Epidemiol Genom.* 2018 Jun 8;3:e12. doi: 10.1017/gheg.2018.3. PMID: 30263136; PMCID: PMC6152488
- Peprah E, Xu H, Tekola-Ayele F, Royal CD. Genome-wide association studies in Africans and African Americans: expanding the framework of the genomics of human traits and disease. *Public Health Genomics.* 2015;18(1):40-51. doi: 10.1159/000367962. Epub 2014 Nov 26. PMID: 25427668; PMCID: PMC4418477.
- Pereira, L., Mutesa, L., Tindana, P. et al. African genetic diversity and adaptation inform a precision medicine agenda. *Nat Rev Genet* 22, 284–306 (2021). <https://doi.org/10.1038/s41576-020-00306-8>
- EU Africa PerMed Consortium (2021). D2.1 - Mapping the Scientific Scientific and Policy Landscape of Personalized Medicine in Africa. <https://www.euafrica-permed.eu/wp-content/uploads/2022/05/Scientific-and-Policy-Mapping-of-Personalised-Medicine-in-Africa-240422.pdf>
- EU Africa PerMed Consortium (2022). D2.2 - The EU-Africa Personalised Medicine Stakeholder Mapping Report. <https://www.euafrica-permed.eu/wp-content/uploads/2022/02/D2.2-Stakeholder-Mapping-Report-EU-Africa-PerMed.pdf>
- EU Africa PerMed Consortium (2022). D3.1 - List of African personalised medicine needs. <https://www.euafrica-permed.eu/wp-content/uploads/2022/06/D3.1-List-of-African-PM-needs.pdf>

