



Decoding Depression: Exploring the Environome Across Life Course

*Securing Mental Health Systems: Preparedness,
Innovation, and Policy for Global Resilience*

2025

Coecke, S.,
Panzarella, G.,
Firth, J.,
Sarris, J.,
Buckman, E. J.,
Toczyski, P.,
van Rijn, E.,
Quétel, C. R.,
Kephelopoulos, S.,
Briquet- Laugier, V.,
Vignes, M.,
Kourti, N.,
Bobach, C.,
Pladunova, S.,
Solmi, M.,
van Kamp, I.,
Ronchi, F.,
Pevere, M.,
Gallo, S.,
De Bernardi, F.,
Sachana, M.,
Laureys, S.,
Torres, F.,
Palacios-Sanchez, L.,
Cairney, S.,
Kaihsiang, Y.,

Charveriat, C.,
Pang, C.,
Vernetti, C.,
Baggio, M.,
Kovacic, M.,
Di Gioia, R.,
Munoz, A.,
Puertas-Gallardo, A.,
Takki, M.,
Petrillo, M.,
Gallo, A.,
Alcaro, S.,
Gawlik, B. M.,
Tavazzi, S.,
Lombardi, I.,
Hupont-Torres, I.,
Romeo, P.,
Schade, S.,
Barreda-Ángeles, M.,
Bakogianni, I.,
Maragkoudakis, P.,
Ceresa, M.,
Querci, M.,
Caldeira, S.,
Wiesenthal, T.

This document is a publication by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The contents of this publication do not necessarily reflect the position or opinion of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication. For information on the methodology and quality underlying the data used in this publication for which the source is neither Eurostat nor other Commission services, users should contact the referenced source. The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contact information

Name: Sandra COECKE
Address: Via E. Fermi,
2749. TP126, I-21027
Ispra (VA), Italy
Email: sandra.COECKE@ec.europa.eu
Tel.: +39 0332789806

EU Science Hub

<https://joint-research-centre.ec.europa.eu>

JRC139918

EUR 40185

PDF ISBN 978-92-68-23701-4 ISSN 1831-9424 doi:10.2760/9190776 KJ-01-25-006-EN-N

Luxembourg: Publications Office of the European Union, 2025

© European Union, 2025



The reuse policy of the European Commission documents is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Unless otherwise noted, the reuse of this document is authorised under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated.

For any use or reproduction of photos or other material that is not owned by the European Union permission must be sought directly from the copyright holders.

How to cite this report: European Commission: Joint Research Centre, Coecke, S., Panzarella, G., Firth, J., Sarris, J., Buckman, J., Toczyski, P., van Rijn, E., Quetel, C., Kephelopoulos, S., Briquet-Laugier, V., Vignes, M., Kourti, N., Bobach, C., Pladunova, S., Solmi, M., van Kamp, I., Ronchi, F., Pevere, M., Gallo, S., De Bernardi, F., Sachana, M., Laureys, S., Torres, F., Palacios-Sanchez, L., Cairney, S., Yo, K.M., Charveriat, C., Pang, C., Vernetti, C., Baggio, M., Kovacic, M., Di Gioia, R., Munoz Pineiro, A., Puertas Gallardo, A., Takki, M., Petrillo, M., Gallo, A., Alcaro, S., Gawlik, B.M., Tavazzi, S., Lombardi, I., Hupont Torres, I., Romeo, P., Schade, S., Barreda Angeles, M., Bakogianni, I., Maragkoudakis, P., Ceresa, M., Querci, M., Caldeira, S. and Wiesenthal, T., Decoding Depression: Exploring the Environome Across Life Course, Publications Office of the European Union, Luxembourg, 2025, <https://data.europa.eu/doi/10.2760/9190776>, JRC139918.

Layout: Giulia Panzarella and Sandra Coecke

JRC SCIENCE FOR POLICY REPORT

Decoding Depression: Exploring the Environome across Life Course

*Securing Mental Health Systems: Preparedness,
Innovation, and Policy for Global Resilience*

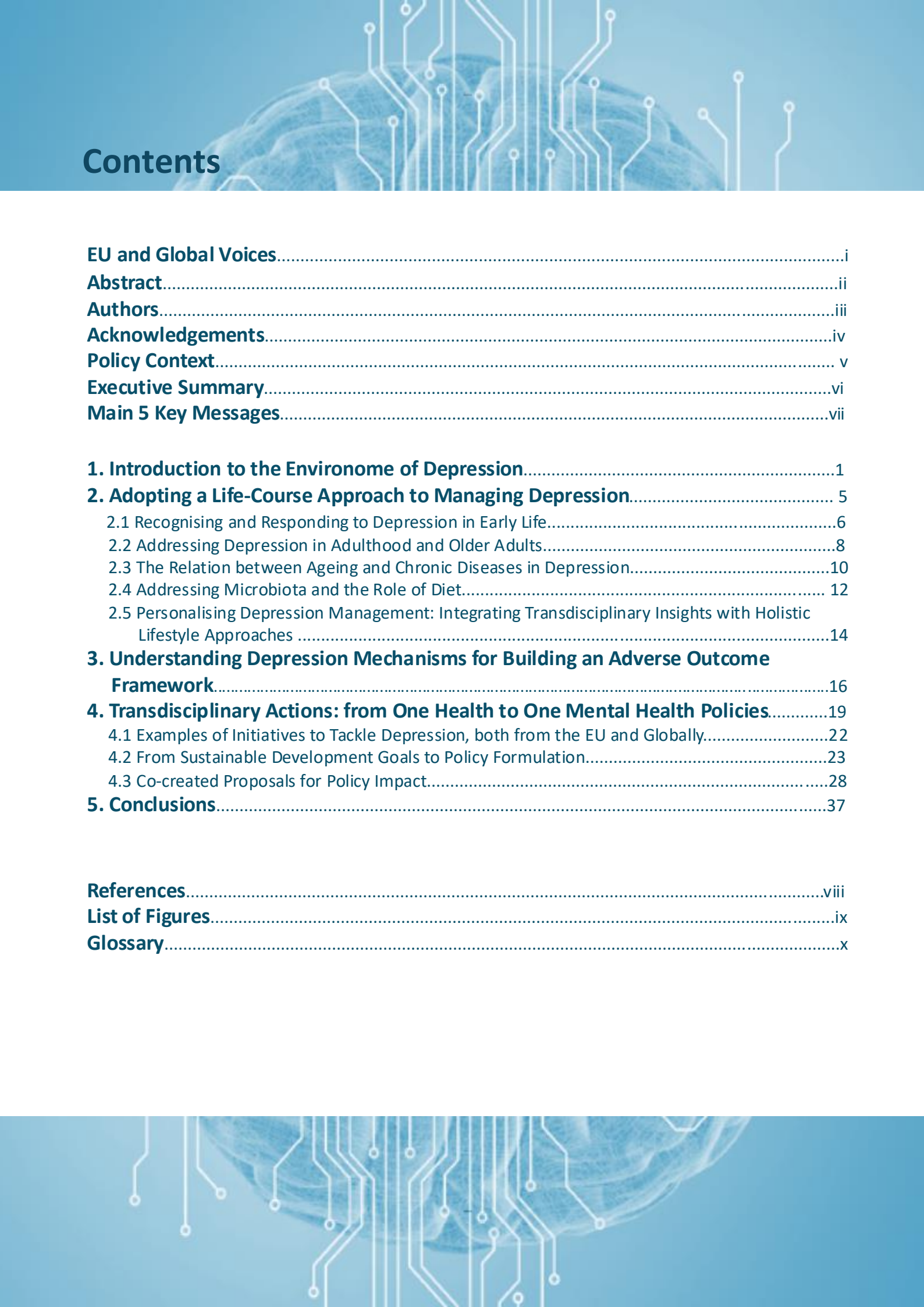
Coecke, S.,
Panzarella, G.,
Firth, J.,
Sarris, J.,
Buckman, E. J.,
Toczyski, P.,
van Rijn, E.,
Quétel, C. R.,
Kephalopoulos, S.,
Briquet-Laugier, V.,
Vignes, M.,
Kourti, N.,
Bobach, C.,

Pladunova, S.,
Solmi, M.,
van Kamp, I.,
Ronchi, F.,
Pevere, M.,
Gallo, S.,
De Bernardi, F.,
Sachana, M.,
Laureys, S.,
Torres, F.,
Palacios-Sanchez, L.,
Cairney, S.,
Kaihsiang, Y.,

Charveriat, C.,
Pang, C.,
Verneti, C.,
Baggio, M.,
Kovacic, M.,
Di Gioia, R.,
Munoz, A.,
Puertas-Gallardo, A.,
Takki, M.,
Petrillo, M.,
Gallo, A.,
Alcaro, S.,
Gawlik, M. B.,

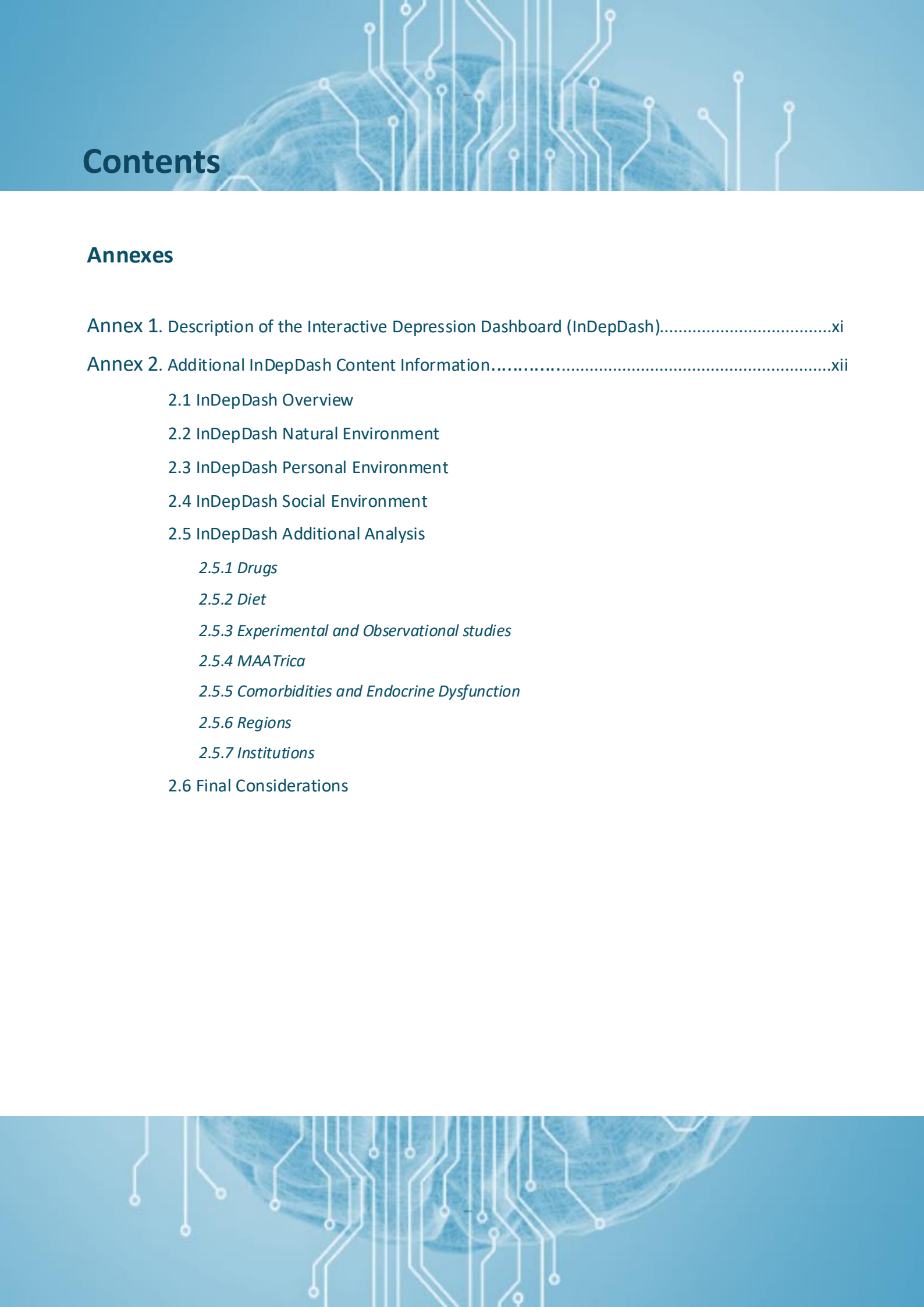
Tavazzi, S.,
Lombardi, I.,
Hupont-Torres, I.,
Romeo, P.,
Schade, S.,
Barreda-Ángeles,
M., Bakogianni, I.,
Maragkoudakis,
P., Ceresa, M.,
Querci, M.,
Caldeira, S.,
Wiesenthal, T.

2025



Contents

EU and Global Voices.....	i
Abstract.....	ii
Authors.....	iii
Acknowledgements.....	iv
Policy Context.....	v
Executive Summary.....	vi
Main 5 Key Messages.....	vii
1. Introduction to the Environome of Depression.....	1
2. Adopting a Life-Course Approach to Managing Depression.....	5
2.1 Recognising and Responding to Depression in Early Life.....	6
2.2 Addressing Depression in Adulthood and Older Adults.....	8
2.3 The Relation between Ageing and Chronic Diseases in Depression.....	10
2.4 Addressing Microbiota and the Role of Diet.....	12
2.5 Personalising Depression Management: Integrating Transdisciplinary Insights with Holistic Lifestyle Approaches	14
3. Understanding Depression Mechanisms for Building an Adverse Outcome Framework.....	16
4. Transdisciplinary Actions: from One Health to One Mental Health Policies.....	19
4.1 Examples of Initiatives to Tackle Depression, both from the EU and Globally.....	22
4.2 From Sustainable Development Goals to Policy Formulation.....	23
4.3 Co-created Proposals for Policy Impact.....	28
5. Conclusions.....	37
References.....	viii
List of Figures.....	ix
Glossary.....	x



Contents

Annexes

Annex 1. Description of the Interactive Depression Dashboard (InDepDash).....	xi
Annex 2. Additional InDepDash Content Information.....	xii
2.1 InDepDash Overview	
2.2 InDepDash Natural Environment	
2.3 InDepDash Personal Environment	
2.4 InDepDash Social Environment	
2.5 InDepDash Additional Analysis	
2.5.1 <i>Drugs</i>	
2.5.2 <i>Diet</i>	
2.5.3 <i>Experimental and Observational studies</i>	
2.5.4 <i>MAATrica</i>	
2.5.5 <i>Comorbidities and Endocrine Dysfunction</i>	
2.5.6 <i>Regions</i>	
2.5.7 <i>Institutions</i>	
2.6 Final Considerations	

EU and Global Voices



“During the pandemic, we saved 40 million jobs with SURE. And we can be proud of that. But many new challenges have emerged – from the impact of AI to mental health at work and new drivers of poverty. We need a new action plan for the implementation of the Pillar. We must ensure fair transitions and good working conditions for workers and self-employed people. And crucial for that is Social Dialogue – the hallmark of our social market economy. We will therefore work to increase collective bargaining and strengthen European Social Dialogue. And we will address those issues that Europeans feel the most in their daily lives. Take housing. Europe faces a housing crisis, with people of all ages and families of all sizes affected”.

Ursula von der Leyen, President of the European Commission, Statement at the European Parliament Plenary, selected for a second mandate 2024-2029, **July 2024^a**.



“At the start of the pandemic, the share of the population reporting symptoms of anxiety and depression increased in all OECD countries with available data, and as much as doubled in some countries. Persistently high levels of mental distress “beyond” the pandemic could reflect the confluence of multiple crises: the cost-of-living crisis, climate crisis and geopolitical tensions”

OECD, Health at a Glance: OECD Indicators, **November 2023^b**.



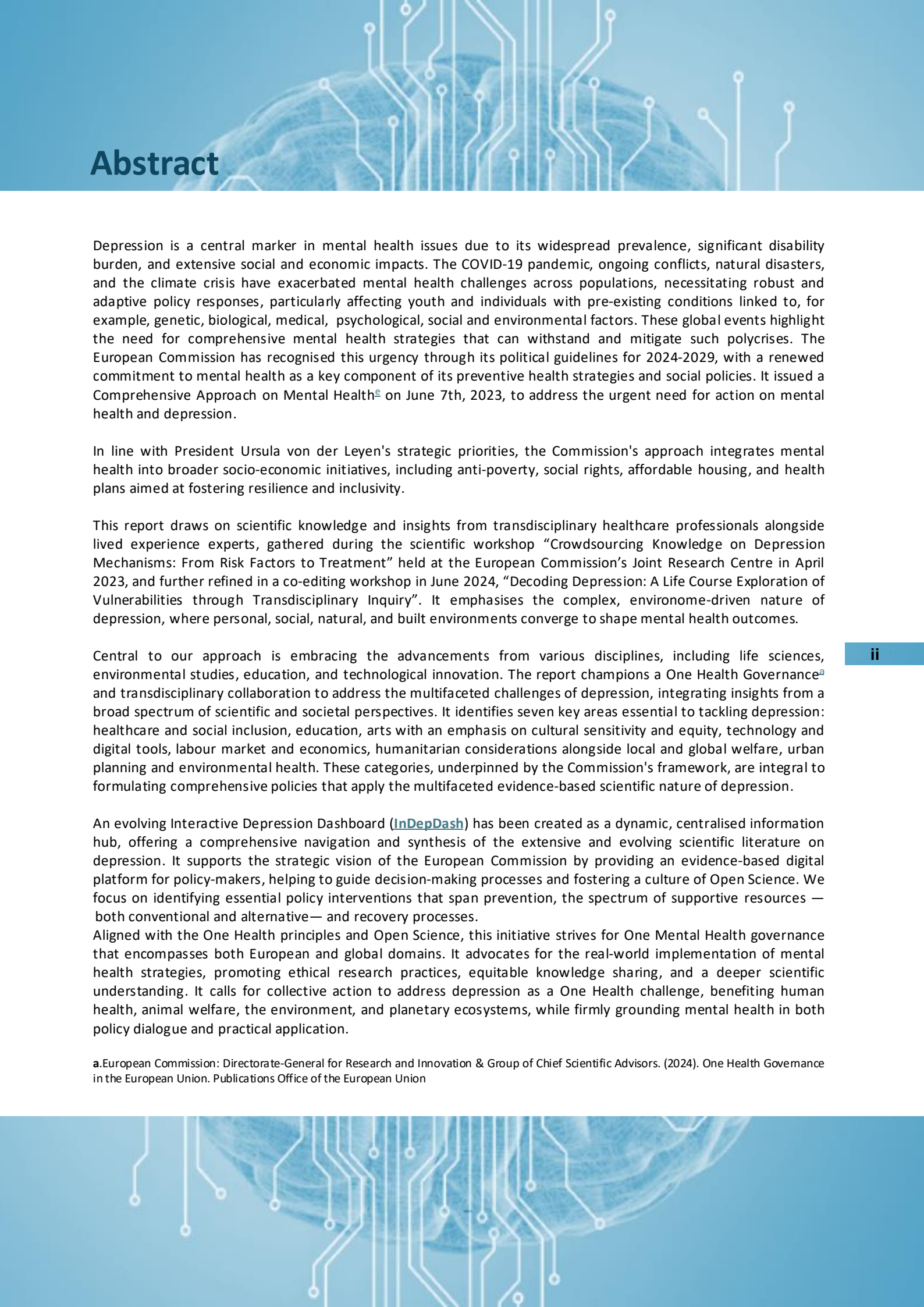
“Mental health is a fundamental issue that affects every European. The European Parliament is dedicated to advancing mental health policies and ensuring that mental healthcare is accessible and effective for all citizens”.

Roberta Metsola, President of the European Parliament, IAC Conference 2024, **June 2024^c**.



“The mental health impacts of living in a world in thrall to growth, obsessed with productivity and competitiveness, are increasingly recognised as contributing to ‘burnout’ among white-collar professionals. Yet it is people living in poverty, working mostly in informal or precarious jobs, that suffer from depression, anxiety, and other common mental illnesses, the most, while having the least resources to cope – creating a mental health crisis that is largely ignored and unseen. Shockingly, in today’s 24/7 gig economy, unemployment can sometimes be a healthier option than taking a job. While unemployment can increase the risk of mental health conditions, doing precarious work has been found to lead to even worse mental health outcomes – due to insecurity, lack of bargaining power, unfair pay and wildly unpredictable work schedules which make it impossible to manage a healthy work-life balance”.

Olivier De Schutter, UN Special Rapporteur on extreme poverty and human rights, United Nations Report: Promotion and protection of human rights, **July 2024^d**.



Abstract

Depression is a central marker in mental health issues due to its widespread prevalence, significant disability burden, and extensive social and economic impacts. The COVID-19 pandemic, ongoing conflicts, natural disasters, and the climate crisis have exacerbated mental health challenges across populations, necessitating robust and adaptive policy responses, particularly affecting youth and individuals with pre-existing conditions linked to, for example, genetic, biological, medical, psychological, social and environmental factors. These global events highlight the need for comprehensive mental health strategies that can withstand and mitigate such polycrises. The European Commission has recognised this urgency through its political guidelines for 2024-2029, with a renewed commitment to mental health as a key component of its preventive health strategies and social policies. It issued a Comprehensive Approach on Mental Health^a on June 7th, 2023, to address the urgent need for action on mental health and depression.

In line with President Ursula von der Leyen's strategic priorities, the Commission's approach integrates mental health into broader socio-economic initiatives, including anti-poverty, social rights, affordable housing, and health plans aimed at fostering resilience and inclusivity.

This report draws on scientific knowledge and insights from transdisciplinary healthcare professionals alongside lived experience experts, gathered during the scientific workshop “Crowdsourcing Knowledge on Depression Mechanisms: From Risk Factors to Treatment” held at the European Commission’s Joint Research Centre in April 2023, and further refined in a co-editing workshop in June 2024, “Decoding Depression: A Life Course Exploration of Vulnerabilities through Transdisciplinary Inquiry”. It emphasises the complex, environment-driven nature of depression, where personal, social, natural, and built environments converge to shape mental health outcomes.

Central to our approach is embracing the advancements from various disciplines, including life sciences, environmental studies, education, and technological innovation. The report champions a One Health Governance^a and transdisciplinary collaboration to address the multifaceted challenges of depression, integrating insights from a broad spectrum of scientific and societal perspectives. It identifies seven key areas essential to tackling depression: healthcare and social inclusion, education, arts with an emphasis on cultural sensitivity and equity, technology and digital tools, labour market and economics, humanitarian considerations alongside local and global welfare, urban planning and environmental health. These categories, underpinned by the Commission's framework, are integral to formulating comprehensive policies that apply the multifaceted evidence-based scientific nature of depression.

An evolving Interactive Depression Dashboard ([InDepDash](#)) has been created as a dynamic, centralised information hub, offering a comprehensive navigation and synthesis of the extensive and evolving scientific literature on depression. It supports the strategic vision of the European Commission by providing an evidence-based digital platform for policy-makers, helping to guide decision-making processes and fostering a culture of Open Science. We focus on identifying essential policy interventions that span prevention, the spectrum of supportive resources — both conventional and alternative— and recovery processes.

Aligned with the One Health principles and Open Science, this initiative strives for One Mental Health governance that encompasses both European and global domains. It advocates for the real-world implementation of mental health strategies, promoting ethical research practices, equitable knowledge sharing, and a deeper scientific understanding. It calls for collective action to address depression as a One Health challenge, benefiting human health, animal welfare, the environment, and planetary ecosystems, while firmly grounding mental health in both policy dialogue and practical application.

^a. European Commission: Directorate-General for Research and Innovation & Group of Chief Scientific Advisors. (2024). One Health Governance in the European Union. Publications Office of the European Union

Figure 1. Graphical abstract, illustrating the seven key transdisciplinary areas vital for investigating the environome of depression. The environome refers to the complex and dynamic set of environmental factors—spanning personal, social, and natural domains. Understanding the environome involves exploring how these environmental influences combine and contribute to the onset, progression, and experience of depression, emphasising the need for an integrated, holistic approach to address One (Mental) Health challenges.



Source: own production.

Authors

Sandra Coecke^{1,*}, Giulia Panzarella^{1,*}, Joseph Firth^{2,*}, Jerome Sarris^{3,*}, Joshua E. Buckman^{4,*}, Piotr Toczyski^{5,†}, Elaine van Rijn^{1,†}, Christophe R. Quétel^{6,†}, Stylianos Kephelopoulou^{1,†}, Maguelone Vignes⁷, Naouma Kourti⁸, Claudia Bobach⁹, Safiya Pladunova⁹, Marco Solmi¹⁰, Irene van Kamp¹¹, Francesca Ronchi¹², Margherita Peveri¹³, Stefania Gallo¹⁴, Francesca De Bernardi¹⁴, Veronique Briquet-Laugier¹⁵, Magdalini Sachana¹⁶, Steven Laureys^{17,*}, Felipe Torres¹⁸, Leonardo Palacios-Sanchez¹⁹, Scott Cairney²⁰, Kaihsiang Morton Yo²¹, Celine Charveriat²², Camilla Pang²³, Christine Verneti²⁴, Marianna Baggio²⁵, Matija Kovacic²⁶, Rosanna Di Gioia²⁷, Amalia Munoz¹, Antonio Puertas-Gallardo¹, Marianne Takki²⁸, Mauro Petrillo²⁹, Alessandro Gallo³⁰, Stefano Alcaro³⁰, Bernd Manfred Gawlik³¹, Simona Tavazzi³¹, Italo Lombardi³², Isabelle Hupont-Torres³³, Pietro Romeo³⁴, Sven Schade³⁵, Miguel Barreda-Ángeles⁸, Ioanna Bakogianni⁷, Petros Maragkoudakis⁷, Mario Ceresa¹, Maddalena Querci¹, Sandra Caldeira⁷, and Wiesenthal Tobias¹.

1. JRC.F7 - EC Directorate-General Joint Research Centre, Digital Health Unit, Ispra, Italy; Geel, Belgium; Seville, Spain.
2. Division of Psychology and Mental Health, University of Manchester, Academic Health Science Centre, Manchester, UK.
3. NICM Health Research Institute, Western Sydney University, Westmead, Australia; Florey Institute of Neuroscience and Mental Health, The University of Melbourne, Australia; Centre for Mental Health, Swinburne University of Technology, Melbourne, Australia.
4. Centre for Outcomes Research and Effectiveness (CORE), Research Department of Clinical, Educational & Health Psychology, University College London, London, UK.
5. Social Sciences, Maria Grzegorzewska University, Warszawa, Poland.
6. JRC.E6 - EC Directorate-General Joint Research Centre, Emerging Security Challenges Unit, Geel, Belgium.
7. JRC.F1 - EC Directorate-General Joint Research Centre, Disease Prevention Unit, Ispra, Italy.

8. JRC.S4 - EC Directorate-General Joint Research Centre, Scientific Development Programmes Unit, Ispra, Italy.
9. Digital Science, Halle, Germany.
10. SCIENCES lab, Department of Psychiatry, University of Ottawa, Ontario, Canada; Regional Centre for the Treatment of Eating Disorders and On Track: The Champlain First Episode Psychosis Program, Department of Mental Health, The Ottawa Hospital, Ontario, Canada; Ottawa Hospital Research Institute (OHRI) Clinical Epidemiology Program University of Ottawa Ottawa Ontario; Department of Child and Adolescent Psychiatry, Charité Universitätsmedizin, Berlin, Germany.
11. National Institute for Public Health and the Environment, Centre for Sustainability, Environment and Health, Netherlands.
12. Charité – Universitätsmedizin Berlin, Freie Universität at Berlin, Humboldt- Universität zu Berlin, and Berlin Institute of Health (BIH): Institute of Microbiology, Infectious Diseases and Immunology, (I-MIDI), Berlin, Germany.
13. Artist and independent researcher, Berlin, Germany.
14. ASST Sette Laghi, Otorhinolaryngology Unit, Head and Neck Department, Varese, Italy; University of Insubria, Varese, Italy.
15. Agence nationale de la recherche, ANR, Paris, France.
16. OECD - Organisation for Economic Cooperation and Development, Environment Health and Safety Division, Environment Directorate, Paris, France.
17. CERVO Brain Research Centre, Laval University, Québec, Canada; Coma Science Group, GIGA Consciousness, University of Liège, Belgium; Anesthesia, Critical Care and Pain Medicine Research, Harvard Medical School, Beth Israel Deaconess Medical Center, Boston, USA; Consciousness Science Institute, Hangzhou Normal University, Yuhang District, Hangzhou, Zhejiang, China.
18. Cell Regeneration Medical Organisation, Bogotá, Colombia.
19. Neuroscience Research Group (NeUROS), NeuroVita Center for Neuroscience; School of Medicine and Health Sciences; Universidad del Rosario, Bogotá, Colombia.
20. Department of Psychology, University of York, York, UK; York Biomedical Research Institute, University of York, York, UK.
21. National Expert Professional Training Program, NEPT, Taiwan.
22. Pro(to)topia: Imagineering a green caring society, Montpellier, France.
23. Independent Consultant in Biochemistry & Sustainable innovation, Author and Autism/ADHD Advocate, London, UK.
24. JRC.T6 - EC Directorate-General Joint Research Centre, Advanced Computing and ICT Services Unit, Ispra, Italy.

Authors

25. European Foundation for the Improvement of Living and Working conditions (EUROFOUND), Dublin, Ireland.
26. JRC.S3 - EC Directorate-General Joint Research Centre, Science for Modelling, Monitoring and Evaluation Unit, Ispra, Italy.
27. JRC.T2 - EC Directorate-General Joint Research Centre, Cybersecurity and Digital Technologies Unit, Ispra, Italy.
28. SANTE.B4 - EC Directorate-General Disease Prevention and Health Promotion, Public Health, Cancer and Health Security Unit, Luxembourg.
29. Seidor Italy S.r.l., Milan, Italy.
30. Dipartimento Scienze della Salute, Università Magna Graecia di Catanzaro, Germaneto, Italy.
31. JRC.D2 - EC Directorate-General Joint Research Centre, Ocean and Water Unit, Ispra, Italy.
32. HR.D5 - EC Directorate-General Joint Research Centre, Human Resources and Security, People First Unit, Ispra, Italy.
33. JRC.T3 - EC Directorate-General Joint Research Centre, Algorithmic Transparency Unit, Seville, Spain.
34. Periso SA, Lugano, Switzerland.
35. JRC.T1 - EC Directorate-General Joint Research Centre, Digital Economy Unit, Ispra, Italy.

**Contributed equally*

† Section lead authors

**Funding Support*

Joseph Firth (JF) is supported by a UK Research and Innovation Future Leaders Fellowship (MR/Y033876/1) and the NIHR Manchester Biomedical Research Centre (NIHR203308). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care. JF has received honoraria, consultancy and/or advisory fees from Atheneum, Informa, Bayer, HedoniaUSA, Strive Coaching, Angelini, ParachuteBH, Arthur D Little Ltd, and the Richmond Foundation, independent of this work. Stephen Laureys (SL) is Chairholder of the Canada Excellence Research Chair in Neuroplasticity, Laval University, CERVO Brain Research Centre, Quebec, Canada and Research Director at the National Fund for Scientific Research, Belgium. SL is supported by the National, Mind Care International Foundation. Natural Science Foundation of China (Grant no. 81920108023), European Foundation of Biomedical Research FERB Onlus, fund Generet of King Baudouin Foundation.

Acknowledgements

We extend our heartfelt gratitude to all those who inspired us with their work and **transdisciplinary** activities. Special thanks are due to Eva Grammatikaki (Public health nutritionist, Ispra, Italy), Yiannis Kranidiotis (Science and digital light and sound artist, Athens, Greece), Jürgen Bajorath (Chemoinformatician, Bonn, Germany), Martin Hofmann-Apitius (Bioinformatician, Bonn, Germany), Ignacio Tripodi (Computer scientist, Barcelona, Spain), Filip Idzikowski (Euro Youth Mental Health (EYMH), Digital Society student, mental health advocate/expert by experience, Poznań, Poland/Maastricht University, Netherlands), Caterina Mauri (Linguistics scientist, Bologna, Italy), Negin Hajizadeh (Integrated Evidence Generation Researcher, Madrid, Spain), Chiara Castelnuovo (Psychoanalytic psychotherapist, Milan, Italy), Cristina Rigamonti (Psychologist and psychotherapist, Varese, Italy), Ciro Occhiobuono (Caretaker and family mental coach, Gavirate, Italy), Evelyn Kimanthi (Founder and scientist of Kenya Association, Nairobi, Kenya), Afra Manfrin (High-school student, Varese, Italy), Mira Housen (Artistic director *Atopos* and advanced sustainability architect, Barcelona, Spain), Alessia Nuvoloni (Artist Nihililda, Stroncone, Italy), Deia Housen (nature-positive economist, Pollination Group, London, England), Rudi Manfrin (Architect and artistic director, Varese, Italy), Luka Sinkovec (International Business with a Soul, Ljubljana, Slovenia), Luca Gallelli (Clinical Pharmacologist, Catanzaro, Italy), Joyce Pepe (Consultant Agency for a Healthy World, Brussels, Belgium), Beth Peters (Psychology student, Barnet, England), Ingeborg Reichle (Art historian, science and sustainability passionate, Berlin, Germany), Davide Moscone (Medical doctor, CuoreMenteLab Medical, Rome, Italy), Michela Racca (Pediatric neuropsychiatrist, Torino, Italy), Surat Saravanan (Senior Strategist at Humane Society International India, Chennai, India), Charu Chandrasekera (Founder of the Canadian Centre for Alternatives to Animal Methods, Ontario, Canada), Anthea Indire Ong (Mental Health Advocate, Singapore), Ildiko M. Meny (Mental health education expert, Vienna, Austria), Thomas Hartung (Pharmacologist, Johns Hopkins Bloomberg School of Public Health, Baltimore, United States), Adam Widawski (Linguistic philosopher, Logos training lab, Malta), Antonia Sfrangeu (Professional pianist,

Acknowledgements

International Feldenkrais Federation – Italian Representative, Perugia, Italy), Susanna Primavera (Psychopedagogue, Varese, Italy), Francesca Pistollato (Biologist, Humane Society International, Padova, Italy), Gynécologie sans frontières Association (Le Raincy, France), Daniela Cosco and Claudia Turconi et al. (Comunità “il Pezzettino”, Social Cooperative, Varese, Italy).

We sincerely appreciate our colleagues from various European Commission Directorate Generals and Agencies who encourage us to pursue collaborative, **transdisciplinary** science for policy activities. We want to thank the colleagues from DG SANTE, Stefan Craenen²⁸, Yvette Azzopardi²⁸ for their policy advice. We would also like to extend our gratitude to Stephen Quest³² from DG HR for his invaluable insights and support when we initiated this **transdisciplinary** activity at DG JRC thanks to the portfolio concept. Our appreciation goes to Amanda Jane Ozin-Hofsaess³⁶ from REA for her contributions and expertise that greatly enhanced the insights in the work. Special thanks to Laia Quiros Pesudo³⁷ from HaDEA for her guidance and assistance identifying experts related to our research in health and digital sciences. Furthermore, we are grateful to Peter Chloupek³⁸ from DG CONNECT for his expert advice on connectivity and digital aspects, and to Michael Piff³⁹ from DG DIGIT for his technical expertise and support in the digital transformation considerations of our collective teamwork. We want to thank the DG JRC team, with special mention of: Bernard Magenmann⁴⁰, Salla Saastamoinen⁴¹, Krzysztof Maruszewski⁴², Sabine Henzler⁴³, Jolita Butkeviciene⁴⁴, Isabelle Krauss⁴⁵, Dace Kalnina⁴⁶, Ciarán Nicholl⁴⁷, Michele Vespe⁴⁸, Ursula Vincent⁴⁹, Francois Kayitakire⁵⁰, Koen Jonkers⁸, Catherine Simoneau⁵¹, Birgit Sokull-Kluettgen⁵¹, Geraldine Barry⁵², Lois Brett⁵³, Jutta Thielen-del Pozo⁵², Ana Ruiz Moreno⁵⁴, Sarah Mets¹, An Thijs⁵⁵, Guy van den Eede⁵⁶, Sergio Consoli¹, Gabriele Leoni¹, Nikolaos Stilianakis¹, Pascal Colpo⁵¹, Caterina Cacciatori³¹, Alba Bernini⁵⁷, Lea Schuh¹, Lia Orfei⁸, Indaco Biazzo⁸, Victoria Ruiz Serra¹, Dorelia Simona Lipsa³², Andrea Valsesia⁵¹, Valentin Comte¹, Antonio Marchini⁴⁹,

Aisha Sauer⁵¹, Joao Costa Leite⁵⁸, Ambra Maddalon⁸, Alex Patak¹, Federica Armas⁵¹, Paola Salarì⁵⁸, Stephanie Laduron³⁶, Caterina Benincasa⁸, Xavier Zaoui⁴⁹, Camilla Bernasconi⁵⁹, David Mair⁶⁰, Erica Bol⁶¹, David Martens⁶¹, Nicola Riccetti⁸, Barbara Rafael¹, Angela Cardinali⁸, Jann Martinsohn³¹, Virginia de Bernardi⁸, Nikolay Denin³⁶, Schnepf Sylke Viola⁶², Gregoire Dubois⁶³, Artur Furtado⁶⁴, Sara Comero³¹, Jan Wollgast⁵⁸, Bogdan Decu⁶⁰, whose collective expertise and **transdisciplinary** thinking have given us inspiration for the creation of our JRC portfolio EMBRACE “Societal Resilience, Systemic Disruptive Events & Risks: Enhancing Anticipation, Preparedness, and Response”.

Their commitment to preparing for and responding to societal threats has enriched this work immeasurably, ensuring its significance and impact. We are immensely grateful for their dedication to fostering societal resilience.

.....

36. REA.B2, Research Executive Agency, Brussels, Belgium.

37. HaDEA.A3, Health and Digital Executive Agency, Health Innovation & Eco-systems Unit, Brussels, Belgium.

38. CONNECT.R3, Communications Networks, Content and Technology, Knowledge Management and Innovative Systems Unit, Brussels, Belgium.

39. DIGIT.C2, Digital Services, Service Providers Unit, Luxembourg.

40. JRC.DDG1 - EC Directorate-General Joint Research Centre, Directorates A,G,J,R,T, Brussels, Belgium.

41. JRC.DDG2 - EC Directorate-General Joint Research Centre, Directorates B,C,D,E,F, Brussels, Belgium.

42. JRC.PA1 - EC Directorate-General Joint Research Centre, Research Policy and Standardisation Unit, Brussels, Belgium.

43. JRC.A - EC Directorate-General Joint Research Centre, Strategy, Work Programme and Resources, Brussels, Belgium.

44. JRC.S - EC Directorate-General Joint Research Centre, Innovation in Science and Policymaking, Brussels, Belgium.

45. JRC.ADV02 - EC Directorate-General Joint Research Centre, Organisational transformation, Brussels, Belgium.

46. JRC.CDMA - EC Directorate-General Joint Research Centre, Information and Communication, Brussels, Belgium.

47. JRC.F - EC Directorate-General Joint Research Centre, Health and Food, Geel, Belgium.

Acknowledgements

48. JRC.T1 - EC Directorate-General Joint Research Centre, Digital Economy Unit, Seville, Spain.
49. JRC.F5 - EC Directorate-General Joint Research Centre, Food and Feed Compliance Unit, Geel, Belgium.
50. JRC.D5 - EC Directorate-General Joint Research Centre, Food Security Unit, Ispra, Italy.
51. JRC.F2 - EC Directorate-General Joint Research Centre, Technologies for Health Unit, Ispra, Italy.
52. JRC.ADV01 - EC Directorate-General Joint Research Centre, Intellectual Property Unit, Brussels, Belgium.
53. JRC.R2 - EC Directorate-General Joint Research Centre, Support Services Petten Unit, Brussels, Belgium.
54. JRC.D5 - EC Directorate-General Joint Research Centre, Food Security Unit, Ispra, Italy.
55. JRC.DDG1.R.I.4 - EC Directorate-General Joint Research Centre, Infrastructure, Brussels, Belgium.
56. Ex Director JRC.F - EC Directorate-General Joint Research Centre, Health & Food, Geel, Belgium.
57. JRC.E5 - EC Directorate-General Joint Research Centre, Demography and Migration Unit, Ispra, Italy.
58. JRC.F1 - EC Directorate-General Joint Research Centre, Disease Prevention Unit, Ispra, Italy.
59. JRC.F3 - EC Directorate-General Joint Research Centre, Systems Toxicology Unit, Ispra, Italy.
60. JRC.S2 - EC Directorate-General Joint Research Centre, Science for Democracy and Evidence-Informed Policymaking Unit, Brussels, Belgium.
61. JRC.S1 - EC Directorate-General Joint Research Centre, Competence Centre on Foresight Unit, Brussels, Belgium.
62. JRC.S3 - EC Directorate-General Joint Research Centre, Science for Modelling, Monitoring and Evaluation Unit.
63. JRC.D6 - EC Directorate-General Joint Research Centre, Nature Conservation and Observations Unit, Ispra, Italy.
64. SANTE.B3 - EC Directorate-General Health Monitoring and Cooperation, Health Networks Unit, Luxembourg.

Policy Context

The European Commission's political guidelines for 2024-2029 reaffirm its commitment to advancing mental health initiatives, aligned with President Ursula von der Leyen's strategic priorities. These guidelines introduce several key measures, including the first EU anti-poverty strategy, an action plan for the European Pillar of Social Rights, the European Affordable Housing Plan, and a preventive health plan. Each of these initiatives acknowledges the importance of mental health, especially in the aftermath of the COVID-19 pandemic and other global challenges such as natural disasters, conflicts, and climate change. These factors have worsened mental health issues and increased the need for effective care.

The EU political guidelines call for a greater focus on preventive measures, including for mental health in the workplace and for cardiovascular diseases, as well as treatments for degenerative illnesses and research on conditions such as autism, thereby incorporating the concept of neurodiversity into mental health policies. They stress the importance of creating targeted plans to protect vulnerable groups, such as children and adolescents, from risks like cyberbullying and harmful online behaviours.

The action plan for the European Pillar of Social Rights highlights the need for preventive health strategies in schools, workplaces, and other settings to address the widespread disruptions to mental well-being experienced by people at all stages of life. Building on successful health strategies like the Beating Cancer Plan, the proposed approach suggests a more comprehensive, integrated policy.

In alignment with the European action plan on the cybersecurity of hospitals and healthcare providers, this report advocates for enhanced mental health related measures within healthcare services to embrace cybersecurity needs and patient protection. This report provides scientific insights and evidence to support the development of mental health policies, aiming to improve mental health services and outcomes across EU Member States and globally.

Executive Summary

This report delves into the complex and multifaceted nature of depression, highlighting the need for comprehensive, and transdisciplinary evidence-based policy responses to mental health challenges, within the European Union and beyond. It examines the complex interplay of diverse factors influencing depression, including environmental, lifestyle, physical, mental and socio-economic determinants. These insights are informed by structured discussions with healthcare professionals, scientific experts, and lived experience and transdisciplinary experts.

The approach taken in this report aligns with the principles of *One Health Governance* as emphasised in the European Union's latest issued Scientific Advice Mechanism (SAM) Opinion and the related extensive One Health Review Report^a. One Health, as defined in the Quadripartite Joint Action Plan^b, is “an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals, and ecosystems.” It recognises the interconnectedness of human, animal, and environmental health, advocating for collaborative strategies across disciplines and sectors to achieve sustainable health outcomes.

In this context, this JRC Science for Policy Report extends its focus to mental health, inspiring the development of innovative One Mental Health “environome”, building on the scientific understanding of personal, social and natural underlying transdisciplinary mechanisms of depression science across life course. These frameworks aim to support the creation of science-based policy proposals that are methodologically rigorous, highly relevant, and scientifically reliable.

Combined with digital age and technology transformations, the following aspects are highlighted as significant influencers of mental health: environmental factors such as natural disasters or disruptive events, polycrises like wars and conflicts, climate change, and access to green spaces.

The report stresses the importance of integrating mental health considerations into environmental and disaster response strategies, ensuring a robust and adaptive policy response to these challenges.

Physical health is also recognised as a cornerstone of mental well-being. Lifestyle factors such as diet, exercise, and sleep are identified as critical in preventing and managing depression.

The report calls for healthcare systems to adopt a holistic model of care, integrating mental and physical health services.

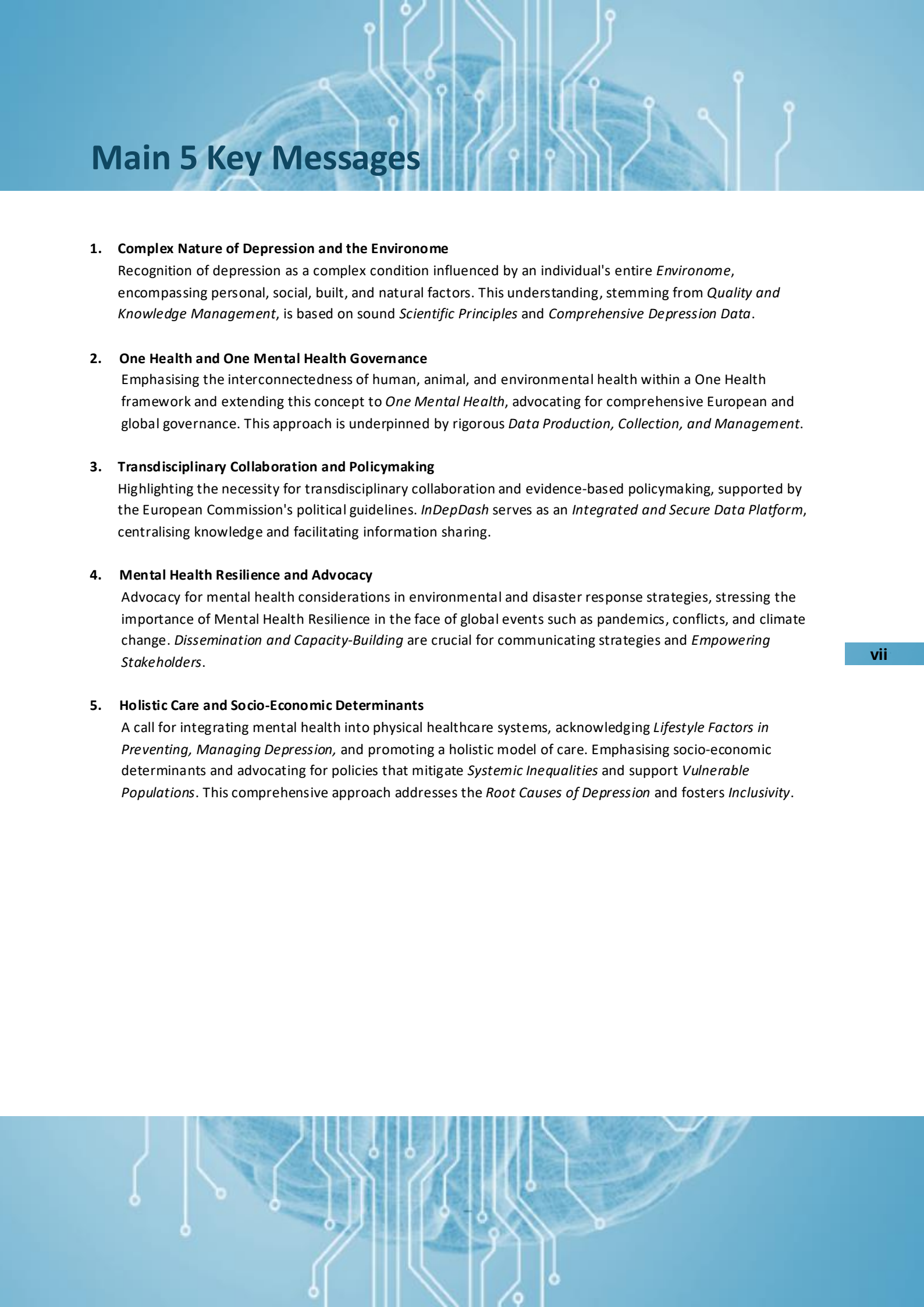
Socio-economic determinants, including income levels, employment stability, and education access, are shown to have profound effects on mental health. The report advocates for policies that address systemic inequalities, such as poverty and job insecurity, to mitigate the risks of depression, particularly among vulnerable groups.

By adopting a transdisciplinary One Health lens, this report presents the impact of various personal, social and natural factors (e.g. environome) influencing depression.

The report introduces *InDepDash* - a dynamic, centralised information hub that supports evidence-based decision-making - as a valuable resource for policymakers and scientific evidence-based policy responses to mental health challenges within the EU and around the globe.

a. European Commission: Directorate-General for Research and Innovation & Group of Chief Scientific Advisors. (2024). *One Health Governance in the European Union*. Publications Office of the European Union.

b. World Health Organization, UNEP United Nations Environment Programme, & World Organisation for Animal Health. (2022). *One health joint plan of action (2022–2026): working together for the health of humans, animals, plants and the environment*. World Health Organization.



Main 5 Key Messages

1. **Complex Nature of Depression and the Environome**

Recognition of depression as a complex condition influenced by an individual's entire *Environome*, encompassing personal, social, built, and natural factors. This understanding, stemming from *Quality and Knowledge Management*, is based on sound *Scientific Principles* and *Comprehensive Depression Data*.

2. **One Health and One Mental Health Governance**

Emphasising the interconnectedness of human, animal, and environmental health within a One Health framework and extending this concept to *One Mental Health*, advocating for comprehensive European and global governance. This approach is underpinned by rigorous *Data Production, Collection, and Management*.

3. **Transdisciplinary Collaboration and Policymaking**

Highlighting the necessity for transdisciplinary collaboration and evidence-based policymaking, supported by the European Commission's political guidelines. *InDepDash* serves as an *Integrated and Secure Data Platform*, centralising knowledge and facilitating information sharing.

4. **Mental Health Resilience and Advocacy**

Advocacy for mental health considerations in environmental and disaster response strategies, stressing the importance of Mental Health Resilience in the face of global events such as pandemics, conflicts, and climate change. *Dissemination and Capacity-Building* are crucial for communicating strategies and *Empowering Stakeholders*.

5. **Holistic Care and Socio-Economic Determinants**

A call for integrating mental health into physical healthcare systems, acknowledging *Lifestyle Factors in Preventing, Managing Depression*, and promoting a holistic model of care. Emphasising socio-economic determinants and advocating for policies that mitigate *Systemic Inequalities* and support *Vulnerable Populations*. This comprehensive approach addresses the *Root Causes of Depression* and fosters *Inclusivity*.

1. Introduction to the Environome of Depression

*To the inspired and inspiring people who
work together with passion,
respect, and vision,
to achieve sustainable health for all^a.*

In the 21st century, depression has become increasingly prevalent, drawing global attention, particularly during the COVID-19 pandemic^{1,2}. This mental health condition profoundly impacts emotions, thoughts, behaviours, and overall quality of life, contributing to significant societal distress.

As this report will demonstrate, there is an urgent need to identify modifiable factors for developing effective prevention and intervention strategies, aimed at reducing the burden of depression on both individuals and communities. Addressing these factors is also critical for mitigating the significant economic impacts of depression, including healthcare costs, lost productivity, and increased demand for social care. According to the World Health Organization (WHO), depression is a common mental disorder characterised by persistent sadness, a loss of interest or pleasure, feelings of guilt or low self-worth, disrupted sleep or appetite, fatigue, and difficulty concentrating^{3,4}. Depressive episodes can persist for multiple years, with around 50% of sufferers experiencing disabling physical comorbidities such as cardiac disease, hypertension, stroke, neurological disorders, diabetes, metabolic syndrome, or obesity⁵. These conditions contribute to a reduced life expectancy compared to the general population, with suicide also impacting on the early mortality due to depression^{6,7}. As such, depression is associated with a large overall health burden, contributing significantly to mental disorders having the largest global health-related burden of all health conditions in terms of disability-adjusted life years (DALYs). Depression has a profound disruption on

psychosocial functioning across all levels of society and throughout an individual's life course⁸.

The impact of depression extends from the intimacy of personal relationships to the broader socio-economic landscape⁹. Globally, mental disorders contribute to a substantial loss in workforce participation and a diminished quality of life¹⁰. The economic cost is considerable, with depression being a major contributor due to its high prevalence and enduring effects, shaped by a range of factors including trauma, societal challenges, environmental influences, and emerging threats such as pandemics¹¹. For example, the COVID-19 pandemic exacerbated the global mental health crisis, leading to a marked increase in the incidence of depression worldwide.

This surge has created a substantial unmet need for mental healthcare¹², highlighting the urgent and unprecedented challenges that must be addressed promptly^{13,14}.

The mental health crisis disproportionately affects vulnerable groups, including low-income populations, LGBTQIA+ individuals, underserved minority groups, neurodivergent people, children and those exposed to traumatic global stressors such as natural disasters, conflicts, climate-related events and displacement^{15,16,17,18,19}. Projections show that by 2030, depression will become the leading cause of global disease burden²⁰, indicating a concerning trend. This increasing burden is compounded by the clinical challenges in treating depression, which include its diverse clinical manifestation²¹, unpredictable course²², and inconsistent responses to conventional

treatments²³. These complexities make addressing depression effectively even more urgent. Approaches should encompass the entire depression management cycle, offering new insights and strategies for treatment, such as the development of effective and digitally supported personalised prevention schemes and health counselling^{24,25}. By doing so, these novel approaches have the potential to significantly impact European and global health policies, and become the cornerstone of successful public health initiatives, ultimately leading to a desired positive impact on society, promoting inclusivity and compassionate care²⁶.

This report consolidates knowledge about the condition of depression from multiple fields. It stems from the interdisciplinary workshop titled “Crowdsourcing Knowledge on Depression Mechanisms: From Risk Factors to Treatment,” held at the European Commission’s Joint Research Centre in April 2023, which as synthesised insights from healthcare and mental health professionals across 11 European and non-European countries (North and South America, Asia, and Oceania), alongside lived experience experts. A follow-up co-editing workshop held in June 2024 resulted in a set of policy suggestions grounded in scientific evidence. This task has never felt more urgent. It originates from a call for cooperation launched by the European Commission’s Comprehensive Approach to Mental Health initiative²⁷, which asked for coordinated efforts on mental health science for policy implementation among Member States, stakeholders, and international partners, including the World Health Organisation (WHO), the Organization for Economic Co-operation and Development (OECD), the European Centre for Disease Prevention and Control (ECDC), the European Food Safety Authority (EFSA), the European Medicines Agency (EMA), the International Committee of the Red Cross (ICRC), and the United Nations International Children’s Emergency Fund (UNICEF)²⁸. As highlighted by Herrman et al.²⁹, depression has catalysed a situation akin to a perfect storm - a convergence of adverse factors and events that collectively exacerbate the challenge - demanding multifaceted responses across various levels. In response, the political guidelines for the European Commission 2024-2029 aim to address

this challenge through a range of strategies and initiatives³⁰. These include the first-ever EU anti-poverty strategy, an action plan for implementing the European Pillar of Social Rights, the European Affordable Housing Plan, and a preventive health plan; all of which target mental health from multiple perspectives to mitigate the compounding effects of these converging challenges.

This collaborative effort emphasises the importance of tailored interventions for different age groups, with a special focus on young people, who are particularly susceptible to mental issues during their development^{31,32,33}. We advocate for a biopsychosocial framework that explicitly recognises the intricate interactions among genetic, biological, social, and environmental factors in the onset of depression and their impact on mental health across an individual’s lifespan. This approach reflects what could be referred to as the “environome” of depression, a term suggesting that the condition is shaped by an intricate web of macro-(societal), meso-(community), and micro-(individual) level influences^{34,35}. Figure 2 integrates these three perspectives with whole society interventions, supporting a “One **Mental Health**” approach³⁶ - a concept that advocates for a unified strategy in addressing mental health across human, animal, and environmental domains, emphasising the interconnectedness of these factors in overall health and well-being³⁷. This approach aligns with the growing recognition of the need for comprehensive mental health strategies that transcend traditional disciplinary boundaries. It contributes to gaining a comprehensive understanding of depression’s causes, mechanisms, consequences, and opportunities for prevention and intervention. Our discussions encompass global health research in depression, the risk-preventing behaviours and approaches to primary, secondary, and tertiary public healthcare, as well as the utilisation of neuro-psychiatric methods in different regions and hospitals worldwide. The landscape of depression research is wide and multidisciplinary, as evidently elucidated when performing in-depth semantic analysis of scientific literature using digital tools such as SciWalker³⁸ and MAATrica³⁹ (reported in Annex 1 of this report). By developing a comprehensive Interactive Depression Dashboard (InDepDash)

tailored for policymakers and scientists, we have categorised and analysed extensive data related to depression, which further reinforces the "One Mental Health" concept by illustrating the integration of diverse research areas and methodologies. This includes major clinical trials, population demographics, significant pharmacological and nutraceutical compounds, research methodologies, and critical environmental factors influencing the onset and treatment of depression (Annex 1).

This approach can inform policymaking and provide insights into targeted approaches, contributing to a broader understanding of depression mechanisms on a global scale. We will adopt a life course approach to manage depression, as described at the beginning of chapter 2. Drawing from clinical insights, Chapter 2 then presents the interrelationships between chronic diseases and depression. For instance, patients with chronic rhinosinusitis (CRS) are notably more prone to comorbid depression, a risk that is further exacerbated in individuals facing significant sleep disturbances with poor nutritional habits⁴⁰. We examine the gut-brain axis and mental health as a key case study, investigating how microbiota and host inflammasomes influence brain physiology and pathology.

By adopting a holistic One Health approach, we aim to identify the key factors that contribute to the environome of depression, fostering a unified framework for both scientific understanding and practical applications⁴¹.

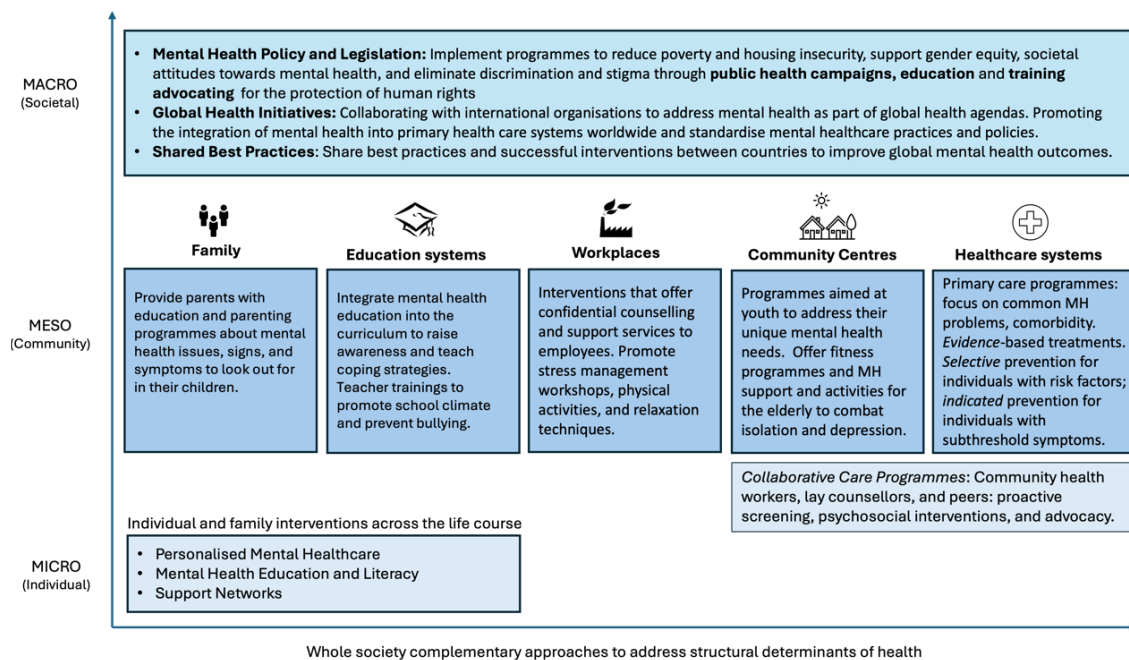
We further focused on the latter stages of the Adverse Outcome Pathway (AOP) framework, specifically identifying the key adverse outcomes (AOs) associated with the onset of depression. Special attention was given to the eco-global, interpersonal, and intrapersonal factors that contribute to the emergence of depression, including environmental stressors, socio-economic influences, and individual psychological and genetic predispositions, all of which collectively shape the risk of developing depression⁴² (Chapter 3).

We then explore potential prevention and intervention strategies, such as a patient-centered approach to mental healthcare outlined in the PROgram-project for precision

psychiatry (PROPSY)⁴³, which aim to assess the effect of the environome in mental health and cognitive development.

We emphasise the importance of digitalization in enhancing clinical care, developing novel therapies, repurposing medications, and addressing comorbidities among depression patients⁴⁴. Depression epitomises the transdisciplinary complexity of mental health conditions⁴⁵. Addressing it comprehensively necessitates the involvement of all societal sectors and government bodies, working together to support mental health policy development through research and evidence-based guidelines. This approach also highlights the critical role of digital technologies, combating stigma, and supporting digital healthcare delivery models. It identifies key needs for mental health preparedness and interventions, also considering societal and behavioural factors, in line with the United Nations (UN) Sustainable Development Goals (SDGs)⁴⁶ related to mental health (Chapter 4). These efforts require global, multifaceted approaches to effectively address the complexities involved, advocating for cooperation among diverse stakeholders, including national and regional entities, patient and civil society organisations, lived experience experts, actors from health and non-health policy domains, academia, and industry⁴⁷. Public health specialists, policy makers, and researchers need to integrate depression prevention and care into broader agendas. Beyond the individual, depression can have an impact on families and communities, and is an important barrier to the sustainable development of nations. Therefore, it is essential to include depression as a central focus in policies and interventions across sectors, not limited to the health sector alone. Researchers should adopt a life course perspective to better understand depression and develop innovative methods to optimise prevention, care, and recovery, ensuring accessibility across diverse resource contexts. Decision-makers should utilise the best available evidence discussed here and address the profound effects of depression on people of all ages in various ways.

Figure 2: The figure illustrates the interplay of the micro-, meso-, and macro-level factors in mental health policies and their integration with whole society interventions, adapted from Patel et al. (2023)⁴⁸. At the micro-level, the focus is on individuals and their immediate environments, such as family, personal relationships, and close social contexts. This perspective examines the role of genetics, personal health history, lifestyle choices, and coping mechanisms, and the impact of close social support networks on the individual's experience of depression. It also highlights the importance of evidence-based treatments tailored to the individual's specific needs across different life stages⁴⁹. The meso-level perspective expands to encompass community and organisational contexts, including workplaces, educational institutions, local healthcare systems, and community support structures. This view explores how community resilience, social capital, and local policies contribute to the prevalence and management of depression within these systems, emphasising the inclusion of evidence-based treatments within local healthcare practices. The macro-level considers societal, national, and global factors contributing to depression, including public health policies, social justice concerns, economic conditions, and cultural attitudes towards depression. It also underlines the necessity of adopting evidence-based treatments in national healthcare systems to provide a consistent and effective response to depression across diverse populations and life course cohorts.



Source: own production based on reference Patel et al. (2023)⁴⁸.

2. Adopting a Life Course Approach to Managing Depression

Depression stands as one of the most prevalent mental health disorders, posing significant risks if left untreated, including chronic depressive illness, the development of comorbid problems such as substance use disorders, anxiety disorders, and suicide⁵⁰. Over the past two decades, extensive research across various fields including genetics, neurology, immunology, and epidemiology has explored both risk and protective factors associated with depression. However, existing syntheses often focus narrowly on either social or biological factors, specific population sub-groups, or treat depression solely as a comorbidity rather than an independent disorder⁵¹. This fragmented and heterogeneous research landscape hinders prevention, intervention strategies for depression and efforts to unravel its complex determinants, and refinement of therapeutic approaches. Notably, physical determinants often serve as proximal causes of depression, influenced in turn by broader social factors including deprivation, environmental stressors, disparities in exposures and access to restorative environments, and social capital⁵². Reports from entities like the World Health Organization⁵³ and the Marmot Review for the UK government Department of International Development⁵⁴, highlight the profound impact of socioeconomic disparities on the development of depression and the outcomes of treatment for depression⁵⁵, emphasising the critical role of addressing social determinants and unequal exposure to environmental risks and resources to achieve health equity.

The literature identifies a spectrum of determinants affecting mental health, spanning age, gender, ethnicity, early family environment, social support networks, access to basic needs such as nutrition and clean water, and community-level influences. Addressing these determinants, and their complex interplays, is crucial for understanding the pathways leading to depression across individual life courses.

The life course perspective reveals that timing of exposure to stressors during critical developmental stages can significantly influence mental health outcomes⁵⁶. Genetic predispositions further interact with environmental factors to amplify the risk of depression⁵⁷. Thus, adopting a life course approach to managing depression necessitates a departure from solely addressing acute episodes of illness. Instead, it involves promoting mental well-being and implementing preventive measures^{58,59} throughout all stages of life, while also enhancing access to evidence-based treatments and recovery-focused interventions across age groups. In early childhood, adverse family circumstances and early life stress significantly increase the risk of mental health problems later in life⁶⁰.

Magnetic resonance imaging (MRI) studies have indicated that the volume of grey matter in the developing brain is influenced by family income and socioeconomic status during early childhood⁶¹. Childhood adversity, such as abuse or family conflict, can also lead to changes in brain structure and increase the risk of mental health issues like depression^{62,63}.

Early life stress (ELS) is linked to smaller brain areas, like the orbitofrontal cortex and hippocampus, and can affect brain chemicals, including those that regulate stress and inflammation. These long-term effects can contribute to cognitive problems and increase the risk of depression^{64,65,66}. For neurodivergent individuals, such as those with Autism Spectrum Conditions, ADHD, or learning disabilities such as Dyscalculia, Dyslexia, or Dyspraxia, the challenges of fitting into a neurotypical world can heighten stress and vulnerability to mental health issues⁶⁷. Understanding neurodiversity within an inclusive framework⁶⁸ emphasizes the need for tailored support, which can help reduce stress and improve well-being⁶⁹. Addressing these factors is crucial for better prevention and treatment of depression.

2.1 Recognising and Responding to Depression in Early Life

Diagnosing depression is a complex process that can be even more challenging when it comes to children and adolescents.

The following symptoms are part of the general diagnostic criteria for depression applicable to both adults and younger individuals. However, it is essential to tailor the interpretation and assessment of these symptoms according to the developmental stage of the child or adolescent⁷⁰:

- Feeling depressed for most of the day, every day;
- Loss of interest in activities once enjoyed;
- Changes in weight and appetite;
- Difficulty sleeping or oversleeping;
- Feeling restless or lethargic;
- Persistent lack of energy;
- Overwhelming tiredness;
- Feeling of loneliness
- Feelings of worthlessness or excessive guilt;
- Difficulty concentrating or making decisions;
- Persistent thoughts about suicide or death.

While these criteria are used for diagnosing depression across all age groups, the manifestation of symptoms can be notably different in younger populations. For instance, young children may exhibit symptoms through somatic complaints or behavioural issues, and adolescents may present with increased irritability or mood swings. The process of diagnosing depression includes assessing the number of symptoms present and their severity over a specific period. Mild depression may be indicated by the presence of two core symptoms (depressed mood and loss of interest) accompanied by at least two additional symptoms; moderate depression by

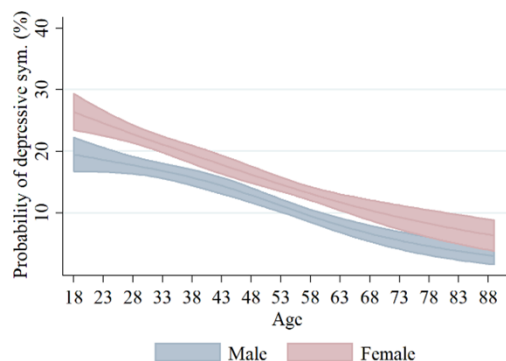
five or six symptoms; and severe depression by seven or more symptoms⁷¹.

Given the difficulties in recognising depression in early life, this report emphasises the need for heightened awareness and specific guidance when evaluating mental health in different age cohorts. The exact age group in question is not specified here, but it is implied that the diagnostic criteria are to be carefully considered for children and adolescents, considering age-appropriate expressions of depression. The intention is to lay a foundation for understanding how depression can be identified across various stages of life, subsequently leading to discussions on age-appropriate intervention strategies and policies. The recognition of depression in children and adolescents, as previously introduced, is a critical step in the formulation of effective mental health interventions. Early life presents a unique window of opportunity where parenting interventions targeting early life stressors and cognitive stimulation can significantly improve cognitive outcomes in children and reduce the incidence of mental health problems in later life^{72,73}. As children grow into adolescence, they experience significant developmental changes that impact their mental health. The transition from childhood into adolescence is marked by a shift in influence from family and parents to peers, making adolescents particularly sensitive to social stimuli and more prone to engage in risky behaviours⁷⁴. This period is characterised by the delayed maturation of the prefrontal cortex, which is responsible for impulse control and the reward system, contributing to behaviours related to impulsivity and risk-taking⁷⁵. Additionally hormonal changes such as increased levels of testosterone may moderate these risky behaviours, which can explain the sexual dimorphism observed during adolescence⁷⁶. Notably, emerging technologies, such as social media, virtual

reality and AI, might also negatively impact mental health, particularly in young people. Excessive social media use has been linked to increased loneliness⁷⁷.

Descriptive statistics indicate that individuals who feel lonely most of the time have a 24 percentage point higher risk of experiencing depression compared to those who do not feel lonely⁷⁸. A graph (Figure 3) from the EU Loneliness Survey⁷⁹ shows the predicted probabilities of suffering from depressive symptoms based on a logistic regression conditioning on gender and age.

Figure 3: The graph, based on the data from the EU Loneliness Survey^{79,80} presents the predicted probabilities of experiencing depression, derived from a logistic regression model adjusting for gender and age. Depression is measured through self-reported frequency, with respondents considered depressed if they reported feeling “always” or “frequently” depressed in response to the question, “Over the past week, how often have you felt this way: depressed?” This response is compared to other options such as “occasionally,” “rarely,” “very rarely,” or “never.” Across Europe, 14% of respondents reported feeling “always” or “frequently” depressed over the past week.



Source: based on reference Schnepf et al. (2024)⁸⁰.

The data highlight that females between the ages of 23 and 30 have a higher likelihood of experiencing depression, while males aged 18 to 22 are also more likely to suffer from depressive symptoms. Virtual reality and artificial intelligence (AI) technologies may also contribute to the disconnection from reality and may exacerbate feelings of isolation, loneliness^{81,82}, and a range of adverse health outcomes, including increased mortality^{83,84}. Future policies should account for the

psychological and societal implications of these technologies, ensuring safeguards are in place to mitigate their potential negative effects^{85,86}. Additionally, tailored interventions that address the unique vulnerabilities of different demographic groups are crucial. Programmes aimed at enhancing resilience, fostering meaningful social connections, and promoting emotional well-being—such as mindfulness, social-skills training, and community-building initiatives—are essential to counteract these risks. Such strategies should also integrate ethical considerations into the design and deployment of new technologies to ensure they serve as tools for support rather than contributors to mental health challenges⁸⁷. Mindfulness has been shown to induce structural changes in key areas of the social brain network, including the anterior cingulate cortex, medial prefrontal cortex, and amygdala, playing a critical role in reducing pathways that contribute to mental disorders during adolescence⁸⁸. Integrating support and screening programmes in schools is an effective strategy to address depression in children and young people. Screening for emotional and behavioural challenges, as well as identifying underlying neurodivergence linked to depression, helps identify risks, provide targeted support, and facilitate health planning while reducing barriers to learning^{89,90,91}. Equipping teachers with mental health knowledge is essential to promote overall child well-being, prevent stigmatisation, and avoid bullying of students with identified emotional needs. These initiatives aim to educate and reassure parents, children, and teachers about the positive dimensions of mental health, creating a more supportive environment. Care must also be taken to ensure that interventions do not inadvertently exacerbate symptoms of depression through labeling or social exclusion. Additionally, higher levels of education in early life have been associated with a lower risk of dementia in later years, likely due to enhanced brain development and cognitive reserve⁹². Studies suggest links between greater cognitive reserve and reduced dementia risk, as well as associations between skull circumference, leg length, and late-life cognitive health. Better-educated individuals often exhibit more efficient cognitive processing and

adopt brain-healthy lifestyles⁹³. However, there is a dose-response relationship between the cumulative depression burden across the lifespan and the risk of cognitive impairment and dementia⁹⁴. Hypothesized mechanisms include the toxic effects of chronically elevated adrenal glucocorticoids (hydrocortisone) on hippocampal cells, connections between

depression and cardiovascular disease pathways, and the impact of depression on cardiovascular risk behaviors and adherence to treatment⁹⁵. These findings highlight the importance of addressing mental health challenges early and comprehensively to promote lifelong well-being.

2.2 Addressing Depression in Adulthood and Older Adults

In adulthood, women are twice as likely as men to suffer from depression post-puberty, with implications for family dynamics and economic stability⁹⁶. Women play a crucial role in the workforce, but also in the broader spectrum of societal and familial roles, especially in caring for children and dependents. When a woman becomes ill, it can have significant implications not only for her own well-being, but also for her family and those she cares for. This shows the far-reaching impact of depression on women, affecting both family life and the economy⁹⁷. Primary care practitioners need to recognise these broader implications when women of all ages seek their assistance and advice for depression. It is also important to note that adults with neurodivergent traits or conditions, such as autism, ADHD, dyslexia, or other neurological differences, particularly women and people from stigmatised minorities, may mask depression. Masking behaviours can affect the presentation and characterisation of depression, as well as interact with other neurodivergent symptoms. In this regard, considering social support and the potential for neurodivergence in assessments of adults with depression in primary care could provide valuable insights for patients and clinicians, aiding in the clinical management of depression^{98,99}.

While there is no distinct type of "male depression," certain symptoms of depression are more frequently observed in men. These include irritability, sudden anger, loss of control, increased risk-taking, and the effects of work-related stress. Men are also more likely to

exhibit depression through aggression and are at a higher risk of suicide^{100,101}. It is crucial to recognise the different manifestations of depression in men and understand their coping strategies to better tailor mental health support. Men often attempt to manage depression on their own, without seeking professional help, which can lead to the use of substances like narcotics or alcohol to cope with symptoms¹⁰². Moreover, substance misuse disorders are more prevalent among men, though the gender gap is narrowing¹⁰³. This tendency toward self-management can lead to underdiagnosis, as men may not seek the necessary help and therefore may not receive appropriate treatment for depression. Factors such as being the victim of a violent crime and struggling with debts problems for instance have been found to be associated with depression diagnosis regardless of the type of treatment received and the severity of the depressive symptoms¹⁰⁴. These factors highlight the importance of considering the broader context of an individual's life when diagnosing and treating depression, particularly in men who might be less forthcoming about seeking professional help. This underlines the critical role of all healthcare workers, whether in primary or secondary care, and their families in recognising the symptoms and causes of depression and supporting them to seek early diagnosis and intervention. It is possible that some individuals are misdiagnosed, leading them to be treated for drug and alcohol problems while the underlying depression remains untreated¹⁰⁵. This oversight has significant implications

throughout a person's lifespan, affecting not only work, but also relationships with partners, children, and society as a whole. It has been well evidenced that treating depression even among those with comorbid

substance abuse disorders, is associated with optimal treatment outcomes. As such, substance misuse should be assessed but not considered an automatic exclusion to accessing treatment for depression unless otherwise indicated^{106,107}.

Interventions in Adults and Older Adults

Treatment options for depression vary depending on severity and patient preferences. Evidence-based therapies such as Cognitive Behavioural Therapy (CBT), Behavioural Activation, Diamagnetic Therapy¹⁰⁸ and problem-solving approaches are suggested for milder cases^{109,110,111}. These can be delivered in person or via digital platforms, providing flexibility and accessibility¹¹². For moderate to severe depression, higher-intensity psychological therapies are advised. Among older adults, depression is frequently underdiagnosed due to atypical presentations and the overlap with physical health conditions. Tailored approaches that address these unique challenges are essential, particularly as untreated depression in older adults can exacerbate comorbid conditions and reduce quality of life. In this scenario, technology is revolutionizing the diagnosis and treatment of depression. Tools such as AI-driven voice analysis, eye movement tracking, and wearable devices are enhancing diagnostic accuracy and enabling remote monitoring^{113,114}. Platforms like Woebot Health integrate CBT with artificial intelligence to expand access to care, while emerging generative AI technologies promise personalized, continuous support for patients^{115,116}. Despite these advancements, the role of family, caregivers, and the broader healthcare ecosystem remains crucial in ensuring sustained patient engagement, especially given the recurrent nature of depressive episodes¹¹⁷.

A life course perspective highlights the need to address depression's long-term consequences, including its links to cognitive decline¹¹⁸, cardiovascular disease, coronary heart disease¹¹⁸, and all-cause mortality¹²⁰.

Preventive interventions such as family-based cognitive behavioural therapy¹²¹ targeting modifiable risk factors—such as physical health conditions, nutritional deficiencies¹²², workplace stress, and life events¹²³—are vital in reducing the onset of depressive episodes; it has significantly reduced depression episodes among children of depressed parents, with sustained effects observed up to 24 months post-intervention¹²⁴.

By addressing the specific needs of each age group and accounting for individual and societal factors, comprehensive care can significantly reduce the burden of depression and improve quality of life for individuals and their families^{125,126}.

2.3 The Relation between Ageing and Chronic Diseases in Depression

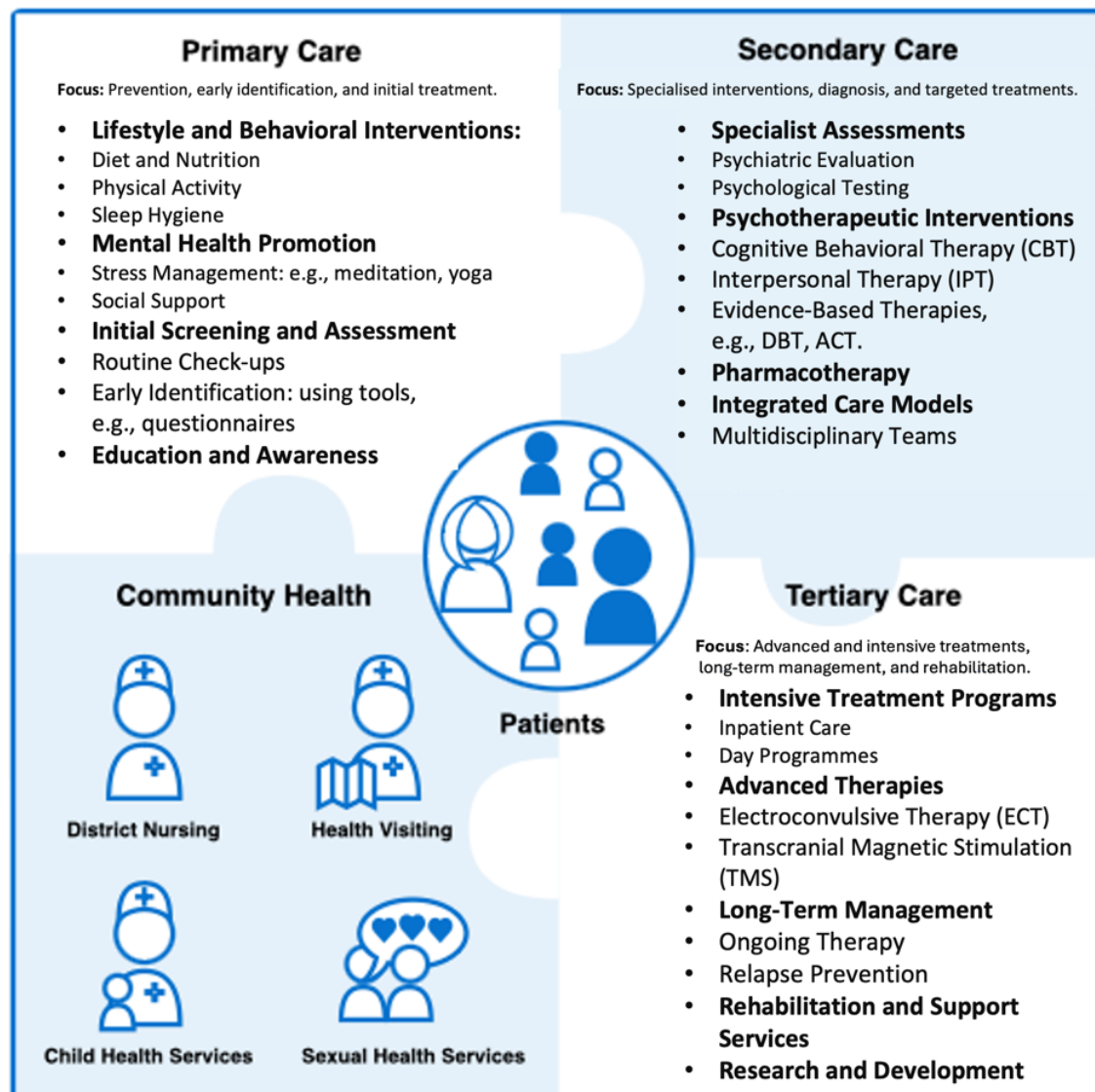
As individuals age, the interplay between chronic diseases and depression becomes more pronounced, affecting treatment compliance and outcomes¹²⁷. Depression often coexists with chronic diseases⁴⁰ like chronic rhinosinusitis (CRS)¹²⁸, asthma¹²⁹, fibromyalgia¹³⁰, diabetes¹³¹ and obesity¹³². Having depression can also affect microbiota and influence brain physiology and mental health pathology, as well as the compliance rates of treatment, as some patients may feel unwilling or unable to take certain medication or undertake investigations¹³³. This has implications for the type of treatment prescribed for individual patients. Also, if a patient is prone to depression, doctors must consider alternative treatments if the side effects of a prescribed medication for another condition are likely to exacerbate or induce depressive symptoms. This aspect should be considered particularly when the patient is an older adult and is already undergoing pharmacological treatment for other conditions¹³⁴. In this regard, psychiatric epidemiological studies demonstrated that older people are more likely to suffer from mental health problems particularly depression and dementia. In order to highlight the specific mental health needs of older people, a report titled ‘forget-me-not’^{135,136}, which focuses on mental health services for older adults, highlighted a variety of reasons why older people become depressed which included:

1. Disability
2. Poverty
3. Poor physical health
4. Lack of social support

Additional factors that warrant consideration include neurodiversity, dementia, alcohol abuse, and anorexia¹³⁷. Despite advancements in therapeutic modalities and increased

accessibility to mental health services, achieving optimal outcomes for people with depression remains a significant challenge. However, there is evidence from a large psychological therapy programme that older adults may be more likely to experience beneficial outcomes than their younger counterparts¹³⁸, and large effect sizes were found for reductions in symptoms of depression and anxiety for those with diagnosed dementia in receipt of psychological therapies for depression, despite this subpopulation having poorer outcomes than those without dementia diagnoses. In managing this complex condition, a network of care is essential, and family members or caregivers play a pivotal role within this network. These caregivers are often the ones that ensure the patient attends appointments, takes their medication or any other forms of interventions, and communicates with healthcare providers. Their active involvement is integral to the therapy process and the overall well-being of the patient. Collaborative care has emerged as an efficacious treatment option for adults and (particularly for) older adults with significant physical health problems, those experiencing social isolation, or those with chronic depression that have not responded to other specialist treatments¹³⁹. This model involves various healthcare professionals working together in a multidisciplinary manner to address the complex needs of people with depression and it plays an important role in the overall group of treatment options for adults¹⁴⁰. Aside from the collaborative care treatment protocol, transdisciplinary collaboration can play an important role in the provision of holistic care that includes prevention and treatments. Leveraging the collective knowledge of a range of healthcare professionals, from physicians and psychologists to social workers and nurses and caregivers, can inform the tailoring of treatment strategies which can be devised to tackle the complex facets of depression across all age groups (Figure 4).

Figure 4: A comprehensive scheme to manage depression disorder categorising various factors and interventions into primary, secondary, and tertiary care.



Source: own production.

An integrated healthcare system with the ability for cross-disciplinary collaboration can provide comprehensive care that not only aims to prevent disease, but also ensures early intervention and optimal management of chronic conditions. Primary care typically serves as the first point of contact within the healthcare system in many countries, focusing on general health promotion, disease prevention, and the management of common and chronic illnesses. At this level, preventive

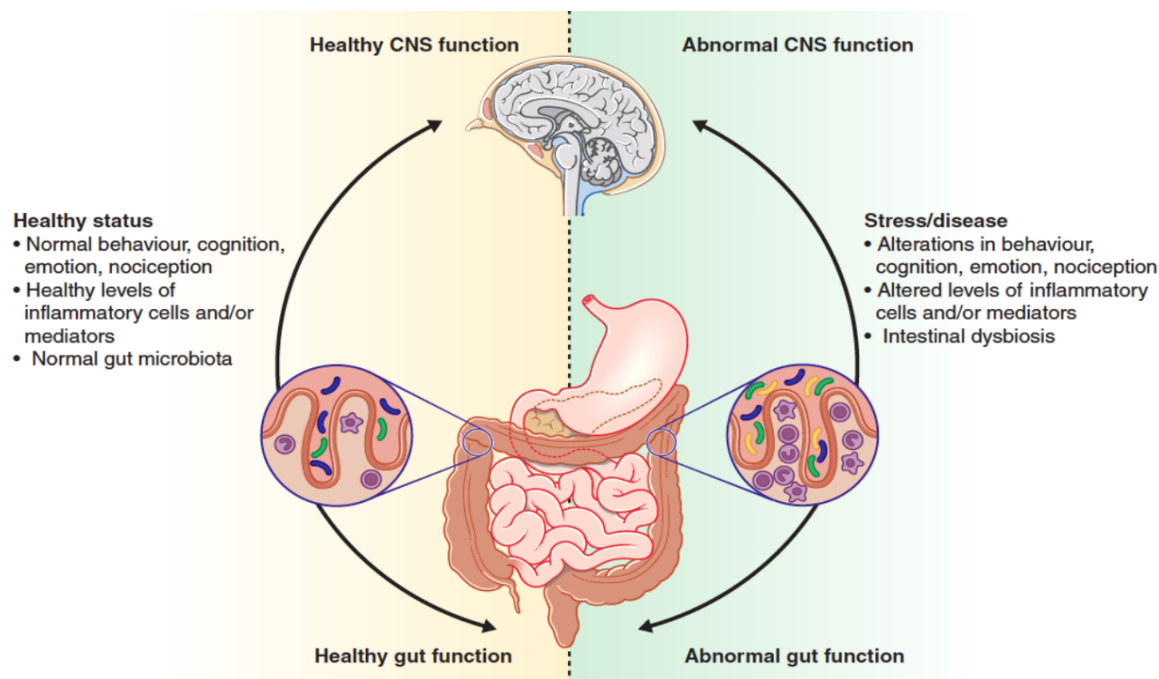
strategies are rooted in daily habits, where lifestyle and behavioural interventions play a crucial role in preventing or mitigating depressive symptoms¹⁴¹.

2.4 Addressing Microbiota and the Role of Diet

Diet and nutritional status for instance, are among the most important modifiable determinants of human health, with the nutritional value of food intricately linked to a person's gut microbial community (microbiota) and its constituent genes (microbiome). In 2001, Nobel laureate Professor Joshua Lederberg, renowned for his groundbreaking research on bacteria, introduced the terminologies microbiota and microbiome, which have since become pivotal in contemporary scientific discourse¹⁴². Since then, research has increasingly focused on the human gastrointestinal tract, home to approximately 100 trillion micro-organisms (most of them bacteria, but also viruses, fungi,

and protozoa)¹⁴³. These microorganisms are crucial for maintaining normal homeostasis and play a significant role in influencing the risk of various diseases, including anxiety, depression, and other mood disorders. Neuroscientists are increasingly recognising the 'bottom-up' influence of these microbes on central nervous system (CNS) function, with several studies highlighting the importance of commensal bacteria for brain health^{144,145}. Indeed, established pathways of bidirectional communication between the brain and the gut, such as the gut-brain axis, include the autonomic nervous system (ANS), the enteric nervous system (ENS), the neuroendocrine system, and the immune system (Figure 5).

Figure 5: The role of the gut-brain axis in depression.



Source: based on reference Doré et al. (2013)¹⁴⁶.

Clinically, depressive episodes are associated with dysregulation of the hypothalamic–pituitary–

adrenal (HPA) axis and resolution of depressive systems with normalization of the HPA axis¹⁴⁷.

It has become clear that gut microbiota plays a role in both the programming of the HPA axis early in life and stress reactivity over the lifespan. Stress has been shown to impact gut permeability, allowing bacteria to affect immune and neuronal cells, potentially contributing to the development of depression^{148,149}. The microbiome itself is a dynamic entity influenced by genetics, diet, stress, and other factors, and its imbalance is commonly observed in individuals with depression^{150,151,152}. The role of diet in managing mental health has also gained attention, with studies suggesting that a healthy diet rich in fruits, vegetables, lean meats, and fish may lower the risk of depression. Conversely, poor diet quality has been linked to an increased risk of depression^{153,154}. Indeed, epidemiological evidence associates poor diet consumption with an increased risk of depression¹⁵⁵.

Vice versa, eating a healthy diet rich in fruit, vegetables, fish and lean meat is associated with reduced risk of depression^{156,157}. Additionally, certain dietary components, such as calcium, chromium, folic acid, vitamin D, vitamin B12, zinc, magnesium and serine, have been used as management strategies in treatment or dietary interventions to help patients¹⁵⁸. Nutrition thus emerges as a complementary and effective approach in managing neurological diseases, because nutritional compounds can modulate biomarkers associated with depression such as insulin-like growth factor 1 (IGF-1), neuropeptide Y (NPY), brain derived neurotrophic factor (BDNF), leptin, and consequently the glucose metabolism and the accompanying microbiota as a modulator of nutritional absorption at the gut level¹⁵⁹. In this regard, dietary interventions have shown promise in improving metabolic and neuroinflammatory conditions such as depression, cognitive decline, drug-refractory epilepsy, autism spectrum disorder (ASD), Alzheimer's disease (AD), and multiple sclerosis (MS). A deeper understanding of the mechanisms by which diet can directly or

indirectly affect the host could potentially open new approaches for therapy, diagnosis, and monitoring of several medical conditions.

Few studies have investigated the impact of specific diets on depressive symptoms in humans, this is an emerging field and so the findings from the early-phase studies must be considered with caution.

However, if findings from these studies were replicated in larger-scale and more methodologically rigorous trials, there is cause for optimism. For example, there is preliminary evidence from animal studies and small observational studies that adherence to the Mediterranean, Norwegian, or Japanese diets; consuming high amounts of fruits, vegetables, legumes, whole grains, nuts, seeds, and foods rich in omega-3 polyunsaturated fatty acids might have some preventive effect and improve depression symptoms^{160,161}. Further, in a small randomised controlled study (n=56) a 12-week healthy diet intervention was associated with a larger improvement in depressive symptoms relative to a social support intervention. Similarly, a trial of n=101 younger adults (17-35 years old) with moderately severe depressive symptoms who followed a Mediterranean-style diet for three weeks reported lower depression symptoms, with improvements persisting for three months post- intervention¹⁶². These findings suggest that dietary interventions have the potential to reduce depressive symptoms. Studies involving bigger cohorts of patients and addressing the mechanism of action of different diets and the microbiota are needed in the field to be able to tackle depression and mood disorders with diets or microbial-based interventions. It is possible that promoting a balanced diet rich in fibers, probiotics, and prebiotics, primary care practitioners might help prevent and manage mental health disorders such as depression and anxiety, emphasising the modulating role of diet in overall well-being.

2.5 Personalising Depression Management: Integrating Transdisciplinary Insights with Holistic Lifestyle Approaches

An holistic approach, such as integrating dietary considerations and potential interventions to the toolkit available to healthcare professionals supporting patients with or at risk of depression, is just one aspect of a broader strategy based on a system-wide collaboration and focus on depression across healthcare teams and settings, as illustrated in Figure 4. According to National Institute for Health and Care Excellence (NICE) guidelines, collaborative care (CC)¹⁶³ is particularly effective as an intervention for depression, especially in cases where traditional approaches may not suffice. CC involves a coordinated effort across a multidisciplinary team, including case management and regular follow-up, ensuring that patients receive tailored care that meets their specific needs. This strategy is particularly vital at the primary care level, where educational initiatives play a significant role. Furthermore, social theatre, community-based interventions, and initiatives like the EAAD-Best in Poland¹⁶⁴ and WHO's Culture For Health¹⁶⁵ align with EU activities, emphasising the intersection of health, environment, art, and social interventions in combating neurological disorders. These efforts highlight the importance of a comprehensive approach to recovery from depression, which includes not only mental healthcare, but also elements like healthy nutrition, good sleep hygiene, physical exercise, mindfulness practices, and connection with nature. The EU has the potential to drive societal change towards prioritising mental well-being. It is imperative to continue exploring innovative solutions and transdisciplinary approaches to mental health policies. Collaboration among policymakers, healthcare professionals, researchers, and lived experience experts, educational institutions, and community stakeholders is essential to create a resilient and inclusive communities where mental health is a fundamental component of overall well-being. By working together, we can develop targeted preventative strategies and ensure that

everyone has access to the support and resources needed to thrive mentally and emotionally.

Advancements in predictive analytics and clinical tools have refined the personalisation of care.

By evaluating an individual's unique set of biopsychosocial factors, clinicians can better anticipate the course of depression and tailor interventions accordingly. The integration of neuroimaging technologies¹⁶⁶ has provided valuable insights into the neural underpinnings of depression, revealing structural and functional patterns associated with the disorder. This information enriches the decision-making process, guiding the selection of targeted therapeutic approaches that address specific neural pathways implicated in an individual's depression.

Moreover, emerging research indicates the potential of neuroimaging and neuromodulation techniques¹⁶⁷, to modulate brain activity and offer relief for treatment-resistant depression. These methods, together with the judicious use of alternative therapeutic settings¹⁶⁸, represent a frontier in depression treatment, aiming to catalyse profound cognitive and emotional shifts that can facilitate recovery. Moreover, the integration of neuroimaging into clinical practice facilitates the development of personalised treatment strategies. By understanding the individual neural signature of a patient's depression, clinicians can tailor interventions that target the specific brain regions involved^{169,170}.

Concurrently, the importance of lifestyle factors in managing depression has gained increasing recognition. Nutritional psychiatry explores the gut-brain connection, advocating for dietary patterns that support mental health. Physical exercise, recognised for its mood-enhancing effects, sleep hygiene, mindfulness practices, and fostering social connections, are all integral components of a holistic management plan¹⁷¹. These lifestyle interventions contribute to a supportive environment that not only addresses

the symptoms of depression, but also builds resilience and promotes long-term well-being¹⁷². In this context, assessment and survey tools such as the specific depression questionnaires serve as vital instruments for screening and monitoring depression, aiding in the identification of comorbid conditions and the evaluation of treatment efficacy. However, the utility of these tools extends beyond diagnostics; they facilitate a shared decision-making process, where patients are active participants in their care journey, aligning treatment plans with individual preferences and goals. Embracing a personalised, holistic, and transdisciplinary approach to depression management signifies a paradigm shift towards comprehensive care. It reflects a commitment to leveraging a broad array of clinical

tools, innovative therapies, and lifestyle interventions, all aimed at delivering care that is attuned to the complexities of each individual's experience with depression. This strategy not only enhances treatment outcomes but also strives towards the EU's and the global stakeholders community's dedication to fostering mental health as a cornerstone of overall health and societal well-being.

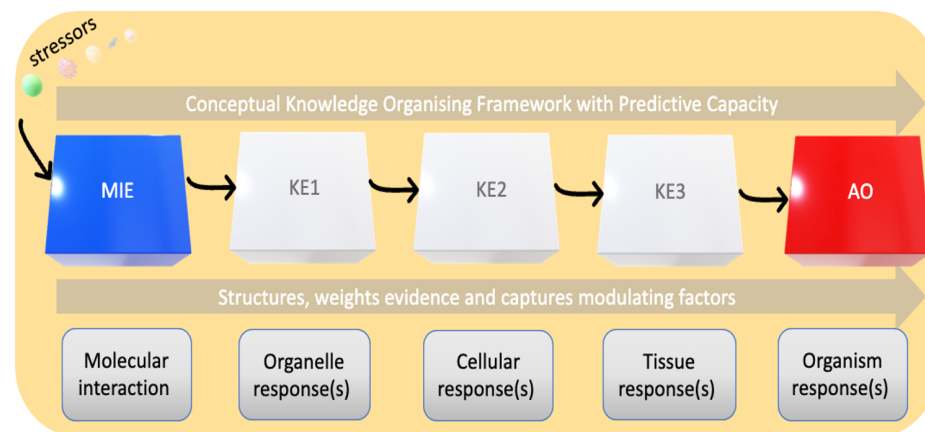
3. Understanding Depression

Mechanisms for Building an Adverse Outcome Framework

Beyond assessment tools, additional frameworks and resources are available to support physicians in bridging the gap between complex systems biology and practical application, simplifying biological and pathophysiological knowledge¹⁷³. This approach ensures that stakeholders with diverse scientific backgrounds, including policymakers, can grasp and utilise this knowledge effectively. One such framework, initially developed for toxicology, has gained significant recognition for its utility in organising scientific data relevant to major health threats. This framework - adverse outcome pathway (AOP) - has become a cornerstone of the OECD's Chemical Safety Programme¹⁷⁴ and has been instrumental in integrating scientific and molecular knowledge into routine chemical and pathogen risk assessments. Applied to various

domains, AOP has been used to facilitate the development of innovative tools and models that organise and apply scientific knowledge effectively into policy practices. Thus, AOPs appear as living frameworks, i.e., they can be continuously updated when new information becomes available, representing a solution to simplify the complexity of systems biology. These pathways aim to elucidate the sequential cascade of events originating from a molecular initiating event (MIE) for example, the interaction of the SARS-CoV-2 virus with the human body. This cascade progresses through essential and quantifiable biological key events (KE) occurring in cells, tissues, and organs, culminating in adverse outcomes like respiratory distress, multiorgan failure, or anosmia¹⁷⁵ (Figure 6).

Figure 6: What is an adverse outcome pathway?



Source: Organisation for Economic Cooperation and Development (OECD, 2024).

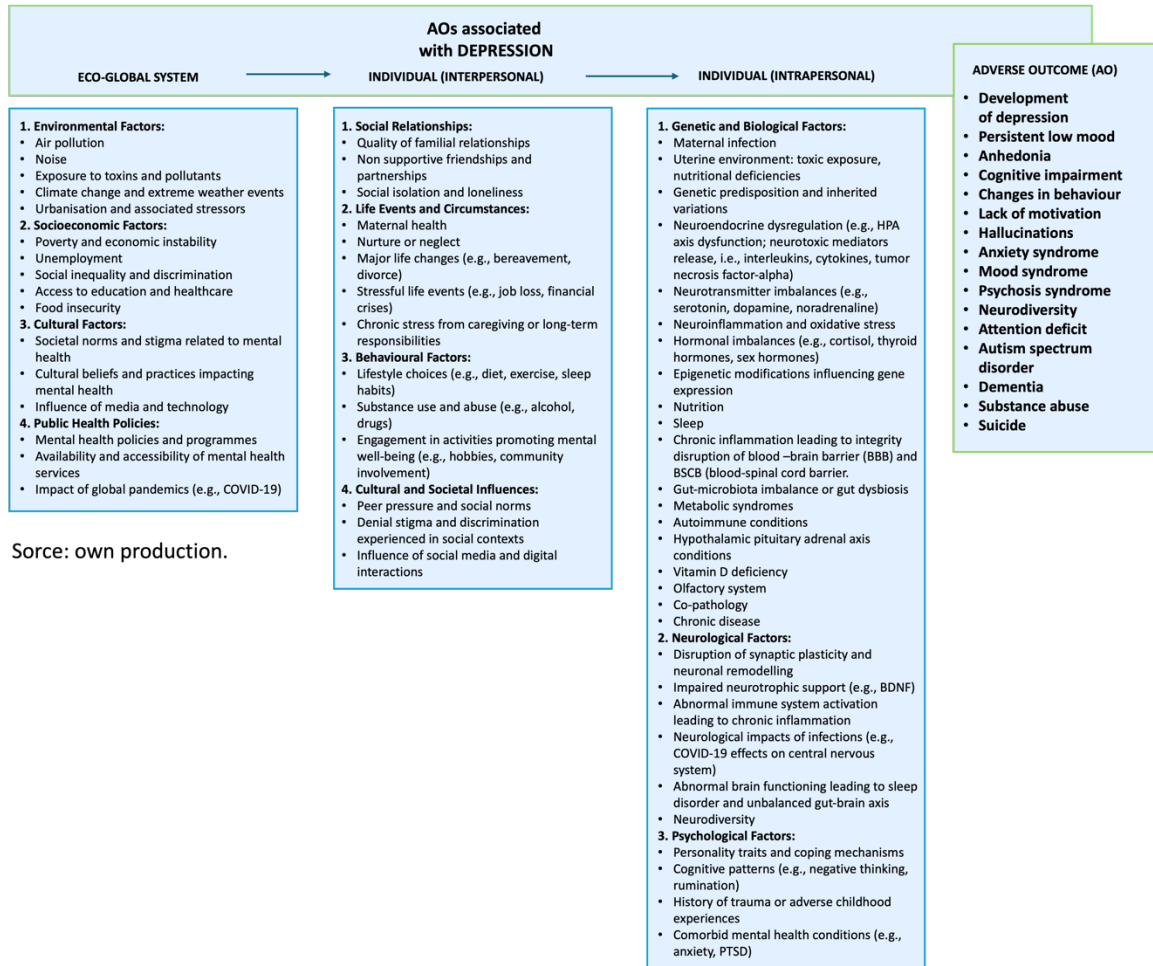
The use of AOPs offers a valuable framework for understanding and predicting the biological impacts of various agents, including pathogens, chemicals, and pharmaceuticals, on human health. This approach helps map out the chain of events linking environmental or biological exposures to adverse health outcomes, allowing for a more integrated understanding of complex diseases. In this report, the focus was placed on the latter stages of the AOP framework, specifically gathering the key adverse outcomes (AOs) associated with the onset of depression. Special attention was given to the eco-global, interpersonal, and intrapersonal factors that contribute to the emergence of depression. These factors include environmental stressors, socio-economic influences, and individual psychological and genetic predispositions, all of which collectively shape the risk for developing depression. Furthermore, emphasis was placed on the neurological and neuroendocrine pathways that underlie the development of depressive symptoms. Central to these processes is the hypothalamic-pituitary-adrenal (HPA) axis, which plays a crucial role in regulating the body's stress response. Dysregulation of the HPA axis, often triggered by chronic stress or environmental factors, can lead to a cascade of biological changes, such as neuroinflammation, oxidative stress, and disruptions in neuroplasticity, all of which contribute to the pathophysiology of depression. These changes may compromise the blood-brain barrier (BBB), allowing immune cells and inflammatory

mediators to infiltrate the central nervous system (CNS), thereby exacerbating the proinflammatory state within the brain.

Additionally, imbalances in key neurotransmitters, such as serotonin, dopamine, and noradrenaline, are strongly implicated in mood regulation and are commonly observed in individuals with depression. These neurotransmitter imbalances, coupled with alterations in synaptic plasticity and epigenetic modifications, can significantly impact the brain's neural circuits and its capacity to respond to stress. Variations in genes involved in neurotransmitter metabolism and neurotrophic factors also influence the neuroendocrine response to stress, further compounding the vulnerability to depression.

As depicted in Figure 7, the main adverse outcomes associated with depression encompass a broad range of cognitive, behavioural, and psychological impairments. These include cognitive impairment, changes in behaviour, hallucinations, lack of motivation, anxiety, neurodiversity conditions, ASD, dementia, substance abuse, and, in severe cases, suicide. These diverse outcomes highlight the multifaceted nature of depression and its far-reaching impact on an individual's health and quality of life.

Figure 7: Global, interpersonal, and intrapersonal factors contributing to adverse outcomes associated with depression.



Source: own production.

4. Transdisciplinary Actions: from One Health to One Mental Health Policies

Transdisciplinarity is a promising notion¹⁷⁶ and viewing depression as a One Health transdisciplinary global challenge represents an opportunity for transformative change, encouraging collaboration to enhance mental health globally and start working towards a comprehensive approach to healthcare¹⁷⁷.

It is not just about addressing somatic and mental aspects alone (or in isolation).

Transdisciplinarity extends beyond traditional academic boundaries, integrating diverse expertise—including non-scientific contributors such as citizens, patients, caregivers, and professionals—through participatory and collaborative approaches. This method ensures the alignment of research goals with stakeholder needs by involving patients early in the research process¹⁷⁸.

In mental health research, participatory approaches are increasingly employed to co-construct solutions with patients and caregivers, a strategy essential for avoiding stigmatisation, fostering ownership, and addressing the genuine needs of individuals experiencing depression. This approach aims not only to integrate knowledge and methodologies from diverse fields into a unified framework, but also to transcend the barriers between them, seeking a new understanding that surpasses the limitations of any single perspective¹⁷⁹.

Transdisciplinarity should be viewed as a "way of thinking"¹⁸⁰ that fosters holistic approaches to complex issues. In the context of the current global crisis, this mindset promotes the idea of a fundamental shift in human thought and consciousness^{181,182}.

In 2004, Cook et al.¹⁸³ established the principles of "One World, One Health," emphasising the need for transdisciplinary collaboration in addressing global health challenges.

No individual nation has the capability to reverse the trends of habitat loss and extinction, air, water, soil pollution and lack of green spaces, which directly impact the health of both

humans, animals and the entire planet earth. Breaking down barriers among agencies, individuals, scientific communities, specialties, and sectors is essential to unlock the innovation and expertise needed to address the numerous challenges affecting the well-being of people, animals, wildlife, and ecosystems. The solutions to today's threats and tomorrow's problems cannot rely on outdated approaches. We are in the era of "One World, One Health," which demands adaptive, forward-thinking, and transdisciplinary solutions.

The One Health approach stimulated funding mechanisms (e.g. Wellcome and Bill & Melinda Gates Foundation) promoting transdisciplinary research applied to health and environment. So far, however, mental disorders have not been practically addressed. Neglecting this area may lead to greater amounts of human misery, the loss of healthy life years, and to economic losses. Data from WHO's Mental Health Atlas 2017 survey¹⁸⁴ suggest that most low-income and middle-income countries spend less than three euro per-person on the prevention and treatment of mental disorders, compared with an average of more than fifty euro per-person in high-income countries. As a result of this limited investment in public mental health, a substantial gap exists between the need for treatment and its availability¹⁸⁵. However, the challenge extends beyond just financial investment. In high-income countries, where mental health spending is significantly higher, mental health issues remain highly prevalent¹⁸⁶. This suggests that investment alone may not be sufficient to address the mental health crisis¹⁸⁷.

The *WHO Mental Health Atlas 2017* also emphasises the underrepresentation of mental health services in national health plans and budgets, particularly in countries with limited resources.

Many countries, especially in low-income settings, lack mental health professionals, with only one psychiatrist per 100,000 people in

several regions. The WHO's findings call for a more integrated approach to mental health care, where mental health is addressed as part of overall health and development strategies, particularly in light of the social determinants that contribute to mental illness, such as poverty, inequality, and conflict. In addition to financial disparities, the *WHO Mental Health Atlas 2017* revealed that mental health services are often fragmented, with a heavy reliance on institutional care rather than community-based services, which are shown to be more effective in addressing long-term mental health issues. This institutional bias may stem from cultural stigmas surrounding mental illness, inadequate policies, and a lack of mental health professionals trained to deliver services outside traditional settings.

The challenges presented in the *WHO Mental Health Atlas 2017* demonstrate that addressing mental health requires not just increased financial investment, but also a transformation in policy, infrastructure, and cultural attitudes towards mental illness.

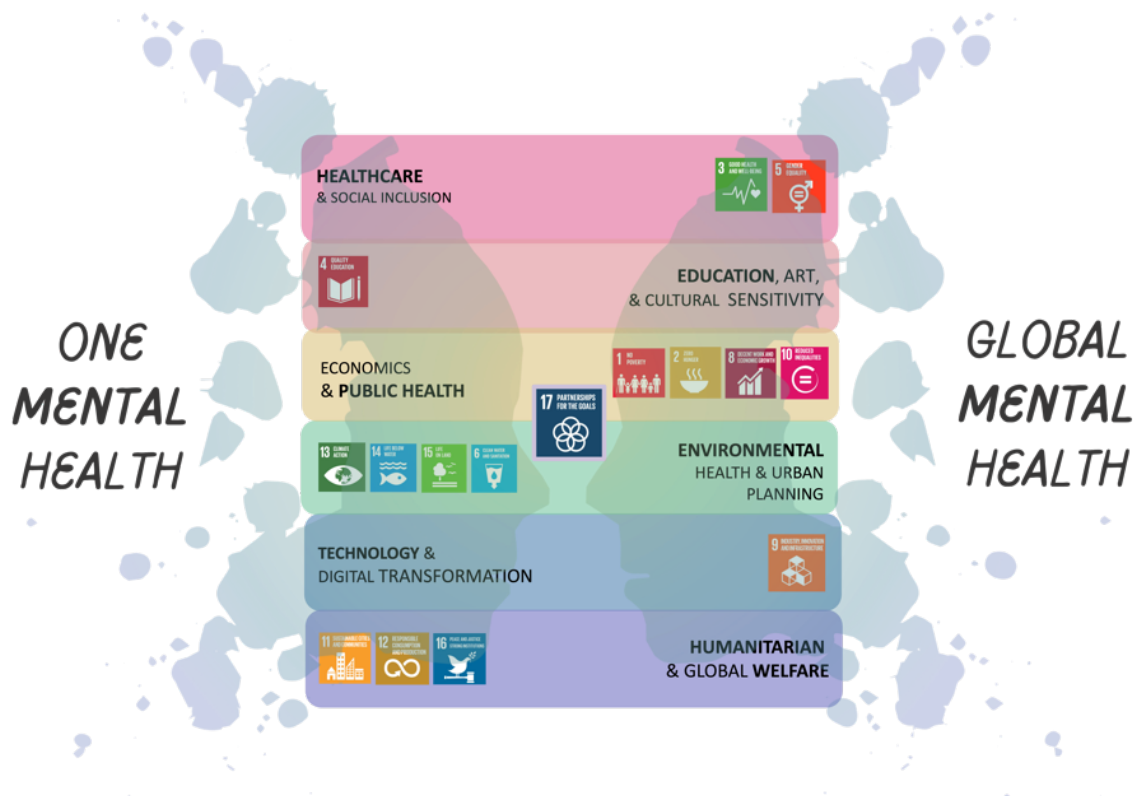
By incorporating insights from a variety of disciplines—ranging from neuroscience and psychology to public health, natural and social science—new, targeted interventions can be developed that better address the complex factors contributing to mental health disorders. Moreover, technological advancements such as semantic data analysis platforms (e.g. InDepDash) allow for the integration of vast amounts of research across multiple fields. This approach can help identify previously overlooked patterns and potential solutions by analysing thousands of scientific studies, offering more nuanced and innovative strategies for mental health interventions. By promoting multidisciplinary and leveraging technology, developed countries can move beyond merely increasing expenditure and instead focus on more effective, personalised, and holistic mental healthcare strategies.

In this regard we acknowledge the usefulness of achieving a comprehensive understanding of depression mechanisms and mental health through transformative frameworks. Approaches such as EcoHealth, Planetary Health, Human Health, and Social and Public Health provide holistic, transdisciplinary perspectives that emphasise the need for ongoing collaboration and efficient governance to facilitate integrated solutions^{188,189} which demand a constant concertation and an efficiency in governance to facilitate transdisciplinarity to bring solutions.

The "One Mental Health" approach offers a transformative framework for addressing the multifaceted factors that influence mental health and contribute to the onset of depression. This approach recognises the interconnectedness of key domains such as healthcare, social inclusion, education, the arts, public health, environmental health, and technology. By integrating these sectors into a cohesive and strategic plan, it becomes possible to reduce the risk of depression.

This concept builds upon the established principles of the One Health framework by expanding its scope to include the social, cultural, and environmental determinants of mental health. Such an approach emphasises the importance of fostering transdisciplinary research that considers the intricate biological, psychological, and socio-environmental factors underlying mental disorders. By leveraging expertise from multiple disciplines, the One Mental Health framework aims to provide a more comprehensive understanding of mental health challenges and more effective interventions. Crucially, the One Mental Health approach aligns with the United Nations Sustainable Development Goals (SDGs), ensuring its relevance to global development priorities¹⁹⁰ (Figure 8).

Figure 8: One Mental Health (OMH) framework grouping the sustainable development goals (SDGs). It reflects a global perspective on mental well-being that originates from individual mental health - One Mental Health - to become global - Global Mental Health, encompassing key intervention areas such as healthcare, social inclusion, education, art, public health, environmental health, and technology.



Source: own production.

The necessity to consider simultaneously the organism and its environment is a crucial dimension of the “One Mental Health” concept, for tackling mental disorders, particularly depression. Mental health is shaped by a complex interplay of factors beyond human control, necessitating the care and consideration of the broader biological and environmental systems to ensure its preservation^{191,192}. By situating depression within the broader context of human existence, we seek to create

cohesive links between seemingly unrelated but inherently connected domains of One Health. In line with the European Commission's recent “A Comprehensive Approach to Mental Health”²⁷, there is a strong emphasis on integrating mental health across policy areas beyond healthcare. This initiative advocates for transdisciplinary approaches to address mental disorders in the EU, encouraging the development of innovative governance solutions.

4.1 Examples of Initiatives to Tackle Depression, both from the EU and Globally

As our world becomes increasingly interconnected and complex, myriad initiatives to tackle mental health and depression unfold across the globe, each playing a pivotal role in addressing diverse challenges. Capturing the full spectrum of initiatives tackling depression with absolute comprehensiveness remains an intricate endeavour. The information presented offers only a small glimpse into some noteworthy European and global activities. For a more in-depth exploration, we encourage the utilisation of advanced resources such as the interactive dashboard InDepDash (Annexes 1 and 2), along with other AI-powered tools designed to sift through grey literature. Moreover, a broader array of sources encompasses academic journals, governmental health organisations, mental health charities, clinical trials registries, healthcare provider resources, and more.

These sophisticated platforms enable a more nuanced and expansive grasp of ongoing initiatives beyond the scope of this document, providing comprehensive insight into the global effort to understand and combat depression.

The European Programme for Mental health Exchanges, Networking and Skills (EU-PROMENS)¹⁹³ addresses mental health challenges within the European Union.

Focused on depression and related disorders, the initiative supports the exchange of the best practices among mental health professionals and policymakers. It encourages the adoption of innovative, person-centered care models and integrates the latest research into practical strategies to improve prevention, diagnosis, and treatment.

The Co-Design Living Labs Programme, on mental health research, established in 2017 by the University of Melbourne (Australia) is another promising initiative¹⁹⁴. It aims to innovate new models of care, improve care experiences, and redesign services through

collaborative efforts with those who have firsthand experience of mental health challenges. The programme gathers near 2,000 persons, bringing together people living with trauma and mental ill health and caretakers/family, and kinship group members together with university-based researchers, to drive end-to-end research design to translation in mental healthcare and research sectors. In the EU, the initiative known as the European Alliance Against Depression (EAAD), which began with funding from the European Commission (EC) in 2001, has evolved into a legal entity that unites members across 20 countries. The EAAD endeavors to coordinate efforts against depression by fostering collaboration among various stakeholders to implement evidence-based strategies and community-focused interventions. Recognised as a Best Practice (EAAD-Best) by the WHO and the EC, the EAAD's approach includes activities ranging from raising public awareness and providing education about depression to establishing guidelines for healthcare providers and supporting patients directly. However, the approximately 20% increase in rates of depression, suicidal thoughts, and mental disorders more broadly as a result of the COVID-19 pandemic¹⁹⁵ indicates that there is still a pressing need for further efforts.

This emphasises the necessity for new types of transdisciplinary initiatives and research that can address the complex and evolving challenges presented by mental health disorders. This evolution is illustrated with the project launched in Poland in 2021, based on the EAAD methodology and with the goal of destigmatising depression locally, particularly in relation to mitigating the mental health impacts of the COVID-19 pandemic¹⁹⁶. By October 2022, eighteen months later, over a dozen district mayors of Warsaw, the capital city, had publicly signed a declaration in support of this initiative.

An inner-city alliance branded as *#AliansPrzeciwDepresji* was created, to tackle depression and to help prevent suicidal behaviour. Stakeholders on-board this alliance included individuals, institutions, and various types of media. Metrics for the Alliance's impact include the number of public events held, with each event attracting up to 1,000 online views. Mentions in the local mayor's newspaper reached approximately 30,000 readers, indicating significant exposure within the community. The main conclusions from this initiative launched during the COVID-19

pandemic, include (1) local alliances can be launched quickly, especially in urban contexts, (2) a versatile mix of media can enhance public visibility and engagement, and (3) early community engagement can lead to more significant support.

4.2 From Sustainable Development Goals to Policy Formulation

Policy proposals have been formulated based on expert scientific knowledge, emphasising interventions designed to benefit society at large. These proposals structured around the key domains presented in Figure 8, which integrates the Sustainable Development Goals (SDGs) within the One Mental Health framework.

This framework clusters related SDGs, demonstrating how tackling interconnected challenges—such as poverty, education, social equity, and environmental sustainability—can collectively improve mental health outcomes.

It emphasises the importance of coordinated, cross-sectoral efforts to ensure that mental health strategies are inclusive and deliver meaningful, global impact.

1. Healthcare and Social Inclusion. This encompasses healthcare access and equity, and the destigmatisation of depression. Ensuring equitable access to integrative care models, which combine mental health services across primary to secondary and tertiary care sectors, is essential.

This includes (1) promoting regular screening for physical disorders and associated risk factors among patients with mental illness supported by evidence-based health promotion initiatives for

staff and service users; (2) providing integrated care through primary care settings and implementing lifestyle interventions from the initiation of treatment to protecting against the risk of long-term health difficulties; (3) developing large-scale interventions targeting dual risk factors for physical and mental health disorders in at-risk groups (e.g. obesity, smoking, inactivity, and poor diet) to reduce the prevalence of both conditions;

(4) emphasising the significant impact of physical health and lifestyle interventions on genetic predisposition to mental health conditions; (5) recognising and accommodating neurodiversity, particularly autism, ADHD, Tourettes and related conditions (due to their association with communication difficulties), in mental health policies, and (6) improving access to psychological therapies and providing specialised training for clinicians working across the healthcare sector, including training on how best to support neurodiverse people. Clinicians should have access to online resources in addition to face-to-face training, also provided by individuals with experiential knowledge – lived experience experts, this might include others supporting patients too such as parents of neurodivergent children and family members of mentally ill parents. This comprehensive approach aims to enhance mental health

services to effectively address the rising global prevalence of depression. It will ensure that everyone has access to high-quality care when needed and is supported in reducing the risks of developing depression or experiencing its harmful effects. This will further support efforts to reduce inequity in access to care and will ensure clinicians and the services they work in are well equipped to meet the needs of all people in the population, including those with neurodiversity, ultimately enhancing mental health outcomes and the quality of life of the population as a whole.

2. Education from early age. When people are educated about mental health, they have the opportunity to gain awareness and understanding of depression and other mental health conditions. Such knowledge helps them recognise the signs and symptoms in themselves and others, and when coupled with information on how to act when such signs and symptoms are recognised it can help foster prevention, early detection and early intervention^{197,198}.

These are all associated with better long term outcomes for people with depression^{199,200}. Understanding mental health problems and the way in which everyone of us is capable of experiencing a mental health problem reduces stigma and dispels misconceptions, encouraging those affected to seek help without feeling ashamed or judged²⁰¹.

Access to accurate information is another critical benefit of education. It provides individuals with reliable resources about mental health, treatment options, and coping strategies. This empowers them to make informed decisions about their care while promoting better self-management of their conditions. Education on mental health also promotes the adoption of healthy lifestyle choices and practices that can prevent or mitigate depression. From an early age people should learn about the importance of emotion regulation and self-soothing, effective social support and the role of loneliness in mental health, how to manage patterns of ruminative thinking, worries, and both cognitive and behavioural avoidance, these might be taught alongside information about nutrition, exercise, good sleep hygiene, and stress management. Learning such techniques might have an important impact on general health and

more specifically might equip people with the tools to mitigate the risks of depression when they face difficult periods in life^{202,203,204}.

To this end (1) implementing education-based programmes on mental health from young age, in school and in the context of informal educational settings (i.e. cultural and sport clubs) can be extremely important. Breaking the stigma surrounding mental health is one of the most significant outcomes of education and is key for patients and caregivers, as well as for healthcare professionals. In addition to education initiatives on depression and other mental health issues, policies can (2) integrate activities that promote emotional well-being, such as mindfulness exercises and music therapy, into school curricula. (3) Addressing issues like bullying and harassment through anti-bullying policies and promoting inclusive school environments can also help prevent depression. Such an approach might include regular workshops and training sessions for students, staff, and parents, to recognise, prevent, and respond to bullying.

An anti-bullying ethos should be incorporated into the school curriculum to foster empathy, respect, and kindness^{205,206,207}. Additionally, creating and maintaining a positive school culture where diversity is respected, and all individuals feel safe and valued, is vital. Furthermore, (4) recognising and accommodating neurodiversity, is an important part of mental health policies particularly as proportion of the population recognised as being neurodiverse is far greater now than ever before and the knowledge of the difficulties faced and ways to support neurodivergent people is also far greater than it was in the past. This requires ensuring access to tailored support services, promoting awareness and understanding among healthcare providers, and developing interventions that address the specific challenges faced by neurodivergent individuals. These individuals are more likely to face stigma and discrimination, and the strategies developed should aim to improve their overall mental well-being and quality of life. To achieve this, school and employment programmes must be implemented to appropriately address the needs of neurodiverse individuals, including those on the autism spectrum and those with learning disabilities. These programmes should consider their unique ways of interacting with people,

their different sensory needs, and their requirement for consistency and routine and navigating logistics and expectations of the system.

Public awareness campaigns should be launched to reduce the stigma associated with depression and mental health issues, utilising diverse media, including social media, to reach a broad audience. By integrating these elements, policies can effectively address the multifaceted nature of depression, ensuring that treatment and prevention efforts are culturally sensitive, equitable, and inclusive.

3. Art, cultural sensitivity. Addressing depression through the lens of art and culture requires a multifaceted approach that integrates mental health policies with cultural and artistic interventions. (1) Promoting art therapy and community art programmes is one way of doing this, offering participants tools for communication and expression and even a space to address topics that for some people are otherwise too difficult to tackle. Art and cultural programmes, then, can provide audiences with safe spaces for meaningful conversations about relevant topics of society, including mental health and depression and are associated with reduced risks of developing depression²⁰⁸. Moreover, contemporary art dealing with research, technology, and ecology offers entry points to complexity and how the interplay of diverse factors affects the experience of the world. While the contexts of professional, institutional, independent, or community art are different, cultural experiences and engagement at large are powerful means of communication that can attract diverse groups. Involving community members in the planning and development of art programmes, exhibits and theater performances, ensures they reflect local cultures, traditions, and values.

To this end, (2) developing and promoting art programmes that are culturally sensitive and inclusive, reflecting the diversity of the community through community engagement and participation, can also play an important role in the system-wide effort to tackle depression. Further, supporting art and cultural programmes in general might contribute to healthier and happier societies²⁰⁹.

4. Equity. Barriers such as cost, transportation, and language must be identified and mitigated to ensure preventive interventions and mental health services are affordable and accessible to all, regardless of socioeconomic status. Increasing the availability of evidence-based interventions to prevent and treat depression requires scalable and affordable methods of provision which might allow for greater access for vulnerable groups^{210,211,212,213}. Such options might include telehealth consultations or access to guided digital therapies for those who cannot easily travel or are experiencing long waiting times for treatment. It is also crucial to recognise the rural-urban divide, where rural populations often face additional challenges in accessing mental health services, including fewer providers, longer travel distances, and reduced infrastructures²¹⁴. In rural areas, targeted telemedicine solutions and mobile health units can address these gaps, providing necessary care that is both accessible and effective.

5. Environmental health and urban planning. Natural systems do not exist without people and social systems cannot exist in isolation from nature. These systems are interconnected and coevolve across temporal and spatial scales²¹⁵. The adoption of One Health methodologies, with an intensified focus on the environmental dimension, is gaining traction. This approach acknowledges the interconnectedness of human, animal, and environmental health, especially considering the rapid environmental changes that significantly impact overall health, including mental health and depression. The *environome*, comprising the intricate interplay of personal, social, natural, and built environments, stands as a crucial determinant of neurobiology and individual susceptibility to depression. This interconnectedness underscores the necessity of comprehensively understanding mental health within a broader environmental context.

Projects highlighted in the EU's *Research Project and Policy Link Explorer*²¹⁶ emphasise the growing importance of biodiversity preservation as a key element in promoting both mental and physical health. For example, "BiodivERsA," the European network of program managers and research funders focused on biodiversity,

ecosystem services, and nature-based solutions, highlights the connections between biodiversity, health, and well-being. Their findings demonstrate that biodiversity-rich ecosystems help mitigate stress, anxiety, and depression. Such evidence embraces the One Health approach, reinforcing that safeguarding biodiversity is essential not only for environmental sustainability but also for public health, particularly mental well-being.

The impact of the natural environment on mental well-being is profound. For urban populations, factors such as access to green spaces, pollution, noise levels, and exposure to climate change-related stressors (e.g. natural disasters) shape mental health outcomes²¹⁷. However, it is equally important to address the mental health needs of rural communities, where access to protective environmental factors may be limited, and where additional stressors such as isolation and limited access to services may compound mental health challenges²¹⁸.

Studies linked to the EU research projects²¹⁹ indicate that communities in rural areas may also suffer from the loss of biodiversity due to urban sprawl, deforestation, and other human activities that disrupt natural habitats. These issues contribute to both environmental degradation and a decline in mental health.

Challenges related to environmental degradation, such as climate change, population growth, unequal access to green spaces, and biodiversity loss, further exacerbate mental health issues²²⁰. Large-scale studies demonstrate that eco-anxiety, anger, depression, and feelings of helplessness are common, especially among younger populations, 16-25 year olds, who feel powerless in tackling these global environmental challenges^{221,222}. Additionally, nutrition and lifestyle choices, including diet, physical activity, and sleep patterns, intertwine with environmental influences to further impact mental well-being. Climate change and its consequences, particularly disruptive events like hurricanes, floods, droughts, and heat waves, also increase the risk for mental health disorders such as post-traumatic stress disorder (PTSD), depression, and anxiety²²³.

Globally, the additional societal costs of mental disorders due to changes in climate-related hazards, air pollution and inadequate access to

green space are estimated to be almost US\$47 billion annually in 2030. These estimated costs will continue to grow at an alarming rate, estimated to be US\$537 billion in 2050, relative to a baseline scenario in which these environmental factors remain at 2020 levels²²⁴.

Therefore, policies should (1) promote environmental well-being to mitigate the impact of natural disasters on mental health; (2) integrate mental health support into disaster preparedness plans that might include the establishment of mobile mental health units or the training of health staff to provide psychological first aid and other safety, and well-being promoting preventive interventions in the context of mass-trauma events²²⁵. Such initiatives have also been successfully utilised to support the well-being of healthcare staff working in challenging circumstances during healthcare emergencies and pandemics^{226,227};

(3) utilise wastewater surveillance to provide early warnings on depression indicators^{228,229};

(4) establish services able to provide support with a long-term outlook focused on sustained mental wellbeing, this might include preventive interventions, therapies during acute depressive episodes, and planning longer term management with continuation or maintenance phase interventions, and relapse prevention focused interventions after the end of a depressive episode^{230,231,232}.

Furthermore, the integration of biodiversity-rich green spaces into urban and rural planning, as highlighted by EU biodiversity initiatives, such as *The EU Biodiversity Strategy for 2030*²³³, should be a priority for promoting both environmental sustainability and mental health.

Addressing these challenges is urgent not only to mitigate environmental stressors, but also to safeguard mental health and well-being. Through concerted efforts to combat climate change and promote sustainable practices, we can protect ecosystems, marine resources, and our collective overall well-being, fostering a harmonious coexistence with the natural world. Furthermore, ensuring that both urban and rural populations receive tailored support in these efforts will be critical in achieving equitable mental health outcomes^{234,235}.

6. Technology and digital tools are pivotal in supporting mental health within the One

Health framework, providing innovative tools for prevention, early detection, diagnosis, treatment, and education. This emphasis on technology is critical for understanding and addressing depression, as it facilitates new approaches to mental healthcare and education within the broader environmental context and allows a means of scaling access to care that is otherwise likely to be unachievable. The integration of technology in mental healthcare enables greater access to resources and support, particularly for individuals in remote or underserved areas. Indeed, telehealth platforms enable remote access to therapy sessions and consultations, helping to break down barriers to access due to distance, stigma and shame²³⁶. Mobile apps provide personalised support and resources, empowering individuals to monitor their mental health and access help when needed. Digital therapeutics, such as immersive virtual reality-based exposure therapy²³⁷, offer evidence-based interventions through software applications, complementing traditional treatment methods. Wearable devices, voice and face analysis technology, brain computer interfaces, eye movement detection, and AI-based diagnosis are emerging novel digital diagnostic tools. These tools track personal data, offering insights into mental well-being, and can serve the purposes of diagnosing, triaging, and tracking behavioural health conditions and data from such devices can be leveraged to deliver precision mental healthcare^{238,239}. However, it is also important to consider that some technologies, such as social media, can negatively impact mental health, leading to issues like anxiety, depression and decreased self-esteem. Thus, policies should (1) promote the integration of personal sensing devices with careful attention to ethical, legal and environmental implications, ensuring that these technologies are accessible and user-friendly for individuals of all ages, including older adults who may not be as familiar with such devices; (2) ensure these technologies contribute to sustainable health outcomes globally; (3) address issues like personal data protection, access disparities and digital competences development for ensuring equitable and ethical

use of digital mental health solutions²⁴⁰; (4) promote digital literacy to mitigate negative mental health impacts.

7. Humanitarian, local and global welfare. There is a need to assess mental health challenges in the perspective of the interconnectedness of environmental, social, and economic factors at global and local scales. This is particularly crucial for the 1.9 billion people living in “fragile contexts,” as defined by the OECD—a quarter of the global population²⁴¹. This figure is projected to grow to 2.2 billion people by 2030 and 3.1 billion people by 2050 (*ibid.*). More generally, while the causal impact of poverty on mental ill health and depression is well-established, fragility and poverty are closely linked. Estimations are that by 2030 86% of people in extreme poverty could be living in fragile contexts. The six-dimensional framework considered by the OECD for the analysis of fragility encompasses economic, environmental, human, political, security and societal aspects. Populations are exposed to challenges both daily and exceptionally, that affect their economic and mental well-being. There is a need to acknowledge the toll on mental health of destabilising processes and situations such as religious tensions, struggles for power and geopolitics, bad governance, informal economies and the absence of social safety nets, protracted conflicts, pandemics, industrial accidents, ecological damage, climate change, and natural hazards. Psychological First Aid (PFA) for instance, offers immediate support to individuals dealing with trauma, grief, and stress after emergencies, provided by trained volunteers and professionals in various settings. Wars also create trauma and moral injury. Trauma-Informed Care integrates an understanding of trauma’s impact into service delivery, ensuring sensitive and culturally appropriate support²⁴². Capacity building initiatives empower frontline workers and communities to recognise and respond to mental health needs effectively. Integration of mental health into Humanitarian Response ensures depression considerations are embedded throughout emergency preparedness, response, and recovery efforts. Advocacy efforts should place greater emphasis on addressing depression within global health agendas,

ensuring resource mobilisation and the implementation of evidence-based interventions. Platforms and frameworks should be developed within the EU and globally to ensure equitable access to treatments and expert consultation for individuals of all ages, genders, and ethnicities, both online and in person. To build resilience in impoverished households, policies should be implemented that protect and assist them in overcoming poverty, in alignment with global welfare initiatives that include mental health interventions. These measures should be integral to the renewed commitment to enhancing European social action, as outlined in the political guidelines for the next European Commission (2024-2029). This includes the implementation of the first-ever EU anti-poverty strategy, ensuring that essential protections and services are accessible to all.

8. *Labour market and economics.*

Focusing on labour market and occupational health is critical, as unemployment is associated with a greater risk of developing depression²⁴³, experiencing poor outcomes from treatment for depression^{244,245}, and with long-term depressive illness²⁴⁶. On the other hand, understanding environmental and psychosocial factors within the workplace, we can develop strategies to mitigate work-related stressors, support mental health resilience, and promote positive work environments²⁴⁷.

This aligns with the Quality Jobs Roadmap proposed in the political guidelines for the next European Commission (2024-2029), which emphasises that "People and their jobs must always remain at the heart of our social market economy even as our industries and economies change shape." Such a roadmap could address factors such as job strain, workplace stress, organisational culture, work-life balance, and job insecurity to provide a comprehensive understanding of the psychosocial determinants of mental health. Creating healthier, more supportive and more inclusive workplace environments will contribute to the prevention and management of depression²⁴⁸. Additionally, recognising the pivotal role of socioeconomic factors in mental health, policies must address issues such as poverty and housing instability to foster a supportive environment for mental well-being. This includes ensuring access to work, training, and fair job transitions for workers and self-employed individuals, notably by increasing collective bargaining coverage. In addition, creating neuroinclusive practices both in recruitment and employee development schemes for neurodivergent individuals is pertinent²⁴⁹. Currently, just 29.2% of individuals with autism (without severe learning difficulties) are employed. This highlights an unmet need to educate workplace management teams and to create neuroinclusive programmes to meet the needs of new talent, along with employee retainment.

4.3 Co-created Proposals for Policy Impact

In drafting this science for policy report "Decoding Depression: Exploring the Environome Across Life Course", we have engaged a transdisciplinary consortium of distinguished experts, each bringing a wealth of knowledge and experience from their respective fields. Together with the dynamic analytical prowess of the InDepDash tool, these experts have conducted a thorough investigation into the environome's multifaceted impact on depression. The insights derived from InDepDash, when combined with the collective intelligence of our contributing experts, have

been instrumental in identifying the key environome factors that influence depression across various domains.

Our exploration highlights the profound effects of natural elements like disasters and climate, indicating the need for policies that ensure robust disaster response mechanisms and promote environmental resilience²⁵⁰. In the realm of personal health, the intricate connections between physical well-being, sleep, and emotional regulation emphasise the necessity for healthcare models that integrate mental and physical health services. Social

factors, such as socioeconomic status, employment, and education, demonstrate how foundational a stable and supportive community is for mental health.

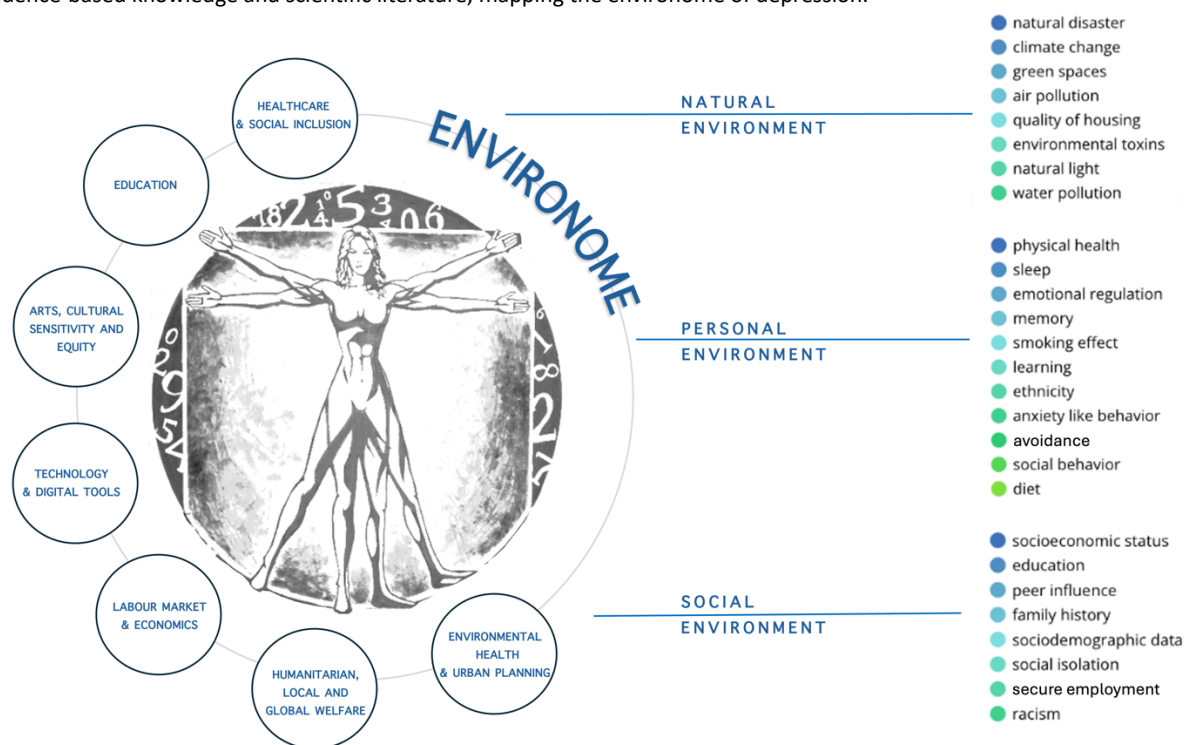
The rich tapestry of expert contributions has resulted in a diverse array of policy recommendations that reflect a deep understanding of depression's complexities. These proposals are the culmination of in-depth discussions, where healthcare professionals, individuals with lived experience, and various stakeholders have come together to refine and validate each proposed measure. The collaborative and co-creative nature of our approach ensures that the policy suggestions presented are not only scientifically sound but also deeply attuned to the human experiences that underpin mental health challenges.

The Panel "Navigating the Environome" details the specific environomal factors subsequent sections of this report detail the specific environome factors highlighted by our experts and outline their associated policy directions. These provide a comprehensive framework for policymakers, signifying our collective endeavor to address depression with the nuanced consideration it demands. As we embark on a unified journey towards "One World, One Mental Health," our dedication to adaptive, forward-looking, and transdisciplinary strategies remains steadfast.

It is through the amalgamation of expert wisdom, advanced digital analytics, and a commitment to open science, co-creation, sharing, ethical, fair and sustainable practices that we aim to pave the way for accessible, effective, and equitable mental health support for all.

Panel "Navigating the Environome": Evidence-Based Policy Proposals for Tackling Depression

Figure 9: The InDepDash - Interactive Depression Dashboard - is designed to synthesise the vast and continuously evolving evidence-based knowledge and scientific literature, mapping the environome of depression.



Source: own production.

The figure illustrates the frequency and impact of various "environome" factors influencing depression, as evidenced by extensive literature data compiled through InDepDash. By integrating a large volume of research findings with insights from a broad network of experts, we gain a deeper understanding of the wide-ranging influences of depression across multiple domains. Among environmental factors, natural disasters emerge as the most significant, followed by climate change and green space access. Within the personal environment, physical health, sleep disturbances, emotional regulation, memory, and substance use (e.g. smoking) are key contributors. In the social domain, influential factors include socio-economic status, education level, peer influences, social isolation, secure employment, and experiences of racism.

The quantitative findings provided the basis to develop the following evidence-based policy proposals, which were elaborated and discussed in structured expert meetings with input from healthcare professionals, lived experience experts, and diverse stakeholders. This integrated approach ensures that the policy suggestions are both methodologically robust and enriched by transdisciplinary perspectives.

Natural Disasters

Natural disasters, such as floods, earthquakes, heatwaves, wildfires, landslides, avalanches, droughts, storms or hurricanes, cause severe stress, trauma, and significant psychological impacts on affected individuals.

The findings suggest the following potential directions for policy development:

- Consider incorporating evidence-based practices such as psychological first aid into disaster preparedness plans, while evaluating the feasibility and effectiveness of mobile mental health units (e.g. helplines) to provide timely and beneficial assistance.
- Explore the use of innovative research methods like wastewater surveillance to enhance data collection for early warning systems and develop informed intervention strategies for depression and mental health issues.
- Assess the potential for implementing long-term counselling services to offer sustained mental health support, particularly for individuals experiencing environmental anxiety and challenges associated with local environmental threats.
- Encourage initiatives aimed at promoting environmental well-being as a means to mitigate the mental health impacts of natural disasters, alongside reviewing strategies to provide adequate housing and relocation services to ensure safety and physical shelter where necessary.

The natural environment—including factors such as climate change, access to green spaces, air and water quality, and housing conditions—has a profound influence on mental health outcomes. Research indicates that access to natural green spaces can significantly improve mental health by lowering rates of depression, anxiety, and stress, while encouraging physical activity and interaction with biodiversity. The phenomenon known as the “extinction of experience,” which refers to the growing disconnection from nature especially in urban areas, is increasingly recognised as a contributor to mental health issues and to reduced environmental concern. Addressing these challenges requires policies aimed at enhancing exposure to nature, particularly in urban settings²⁵¹. Initiatives such as green infrastructure (GI)²⁵², BiodiverCities²⁵³, and nature-based solutions are essential for expanding access to green spaces. These initiatives also encourage public engagement through greening projects, vision-building activities, and citizen science, including participatory mapping of urban nature. Evidence suggests that these measures can reduce the risk of mental illness, boost immune function, and improve overall well-being.

Physical Health, Sleep, Emotional Regulation, Memory

Physical health emerges as a first global determinant of depression, followed by sleep, emotional regulation and memory. Physical health encompasses several key areas, including cardiovascular, respiratory, musculoskeletal, neurological, endocrine, immune, digestive, reproductive, sensory, metabolic, dental, and dermatological health. Maintaining good physical health involves regular exercise, a nutritious diet, sufficient rest, maintaining a healthy weight, avoiding harmful behaviours, and undergoing routine medical exams. Diet and nutritional status for instance, are among the most important modifiable determinants of physical health. Eating a healthy Mediterranean diet rich in fruit, vegetables, fish and lean meat is associated with reduced risk of depression and resulted in a reduction in the dietary inflammatory index (DII)²⁵⁴. Additionally, certain dietary components, such as calcium, chromium, folic acid, vitamin D, vitamin B12, zinc, magnesium and serine, have been used as management strategies in treatment or dietary interventions to help patients^{255,256}. Nutrition thus emerges as a complementary and effective approach in managing neurological diseases because nutritional compounds can modulate biomarkers associated with depression such as insulin-like growth factor 1 (IGF-1), neuropeptide Y (NPY), brain derived neurotrophic factor (BDNF), leptin, and consequently the glucose metabolism and the accompanying microbiota as a modulator of nutritional absorption at the

gut level. In this regard, dietary interventions have shown promise in improving metabolic and neuroinflammatory conditions such as depression, cognitive decline, drug-refractory epilepsy, autism spectrum disorder (ASD), Alzheimer's disease (AD), and multiple sclerosis (MS)^{257,258}. The interplay between these aspects of health is critical, as good physical health not only prevents diseases but also supports mental well-being, potentially mitigating risks for conditions such as depression. Integrated health care approaches that address both physical and mental health are therefore important for holistic well-being.

Sleep is a fundamental biological process essential for cognitive functioning, emotional regulation, and overall health. The relationship between sleep and mental health is bidirectional; poor sleep can exacerbate mental health issues, while conditions like depression and anxiety can disrupt sleep patterns²⁵⁹. Research has consistently shown that sleep disturbances, such as insomnia or hypersomnia, are both symptoms and predictors of mental health disorders. Consequently, improving sleep hygiene and treating sleep disorders are vital components of mental healthcare. In this regard it would be important to incorporate sleep assessments into routine health check-ups: encourage healthcare providers to routinely assess sleep patterns during medical appointments²⁶⁰. Early identification of sleep issues should lead to interventions, including referrals to sleep specialists or the provision of evidence-based sleep therapies.

Memory is also intricately connected to sleep, with sleep playing a crucial role in the consolidation and retention of memories. During sleep, particularly in the stages of slow wave sleep (SWS) and rapid eye movement (REM) sleep, the brain processes and organises information gathered throughout the day, solidifying it into long-term memory. This process is essential not only for learning and cognitive functioning, but also for emotional regulation and mental health. Research has shown that sleep deprivation can significantly impair memory function. When individuals do not get enough sleep, they struggle with attention, working memory, and the ability to consolidate new information. This can lead to difficulties in learning and problem-solving, and over time, chronic sleep deprivation can contribute to cognitive decline. In the context of mental health, disrupted sleep can exacerbate symptoms of depression and anxiety, creating a vicious cycle where poor sleep leads to impaired memory, which in turn worsens mental health. In clinical settings, addressing sleep disturbances is an important component of treatment for memory-related issues and mental health disorders. Cognitive-behavioural therapy for insomnia (CBT-I) and other sleep interventions can help improve sleep quality, which in turn can enhance memory function and overall mental health. Additionally, promoting good sleep hygiene—such as maintaining a regular sleep schedule, creating a restful sleep environment, and reducing exposure to screens before bedtime—can support both cognitive functioning and emotional well-being.

Emotional Regulation is the ability to manage and process emotions. Effective emotional regulation strategies, such as cognitive reframing, mindfulness, and adaptive coping strategies, can protect against mental health challenges, particularly depression and anxiety. Conversely, difficulties in emotional regulation can lead to heightened emotional reactivity and impulsivity, contributing to stress, conflict in relationships, and susceptibility to mental health disorders. Coping strategies refer to the specific methods individuals use to manage stress and emotional challenges. These strategies can be adaptive, such as problem-solving and seeking social support, or maladaptive, such as avoidance and substance use. The choice of coping strategies plays a critical role in determining the impact of stress on mental health. Effective coping mechanisms can mitigate the negative effects of stress and reduce the likelihood of developing mental health disorders, while maladaptive coping can exacerbate these conditions. For example, individuals high in neuroticism might be more prone to using maladaptive coping strategies, such as avoidance or rumination, which can exacerbate stress and contribute to the development of mental health disorders. In contrast, those with higher resilience may be more likely to use adaptive coping strategies, such as problem-solving or seeking social support, which can mitigate the effects of stress and protect against mental health issues. By tailoring therapeutic approaches to an individual's personality profile and preferred coping mechanisms, clinicians can enhance the effectiveness of treatment, support the development of healthier coping strategies, and ultimately improve mental health outcomes. This personalised approach acknowledges that there is no one-size-fits-all solution in mental healthcare, and that interventions must be adaptable to the unique psychological makeup of each individual²⁶¹.

As emphasised by The Lancet Commission on Physical Health in Mental Illness²⁶² and our findings, policy directions could include:

- Exploring the feasibility of implementing regular screening for physical disorders and associated risk factors among patients with mental illness, coupled with evidence-based health promotion initiatives for staff and service users.
- Considering ways to enhance integrated care through primary care systems, while examining the benefits of lifestyle interventions initiated early in treatment to support metabolic health.
- Evaluating the potential for large-scale interventions targeting shared risk factors for physical and mental health disorders in at-risk groups (e.g. obesity, smoking, inactivity, and poor diet), with the goal of reducing the prevalence of both conditions.
- Addressing the importance of recognising and accommodating neurodiversity, particularly autism, within mental health policies. Considering improvements to access to psychological therapy services and enhancing specialised training for people such as care takers and clinicians working with neurodiverse individuals.

Clinicians should have access to online resources in addition to face-to-face training, also provided by individuals with experiential knowledge, such as parents of autistic children. This comprehensive approach will ensure that mental health services are better equipped to meet the needs of neurodiverse populations, ultimately enhancing their mental health outcomes and quality of life.

Socioeconomic Status

Findings emphasise the profound influence that income, employment stability, and education levels have on mental health, especially within vulnerable populations facing chronic stress and limited resources²⁶³. Given that poverty and socioeconomic fragility are strongly linked to mental health outcomes, addressing these factors through policy is vital for effective, long-term prevention and management of depression within Europe²⁶⁴. Possible EU policy directions could include:

- Integrating mental health considerations into anti-poverty strategies: ensuring that mental health support is embedded within broader poverty alleviation efforts. This may involve emphasising stability, access to social safety nets, and capacity-building for community and frontline workers. The upcoming EU anti-poverty strategy (2024–2029) presents an opportunity to explore ways to incorporate mental health services, focusing on resilience and early intervention in communities affected by poverty.
- Promoting economic stability and secure employment, with an emphasis on creating stable job opportunities and supportive work environments. The European Commission's Quality Jobs Roadmap could explore ways to address workplace stressors, organisational culture, and work-life balance, potentially reducing depression linked to job strain and insecurity. Additionally supporting inclusive workplaces: Addressing mental health within the workplace is essential for both prevention and management of depression. Policies should emphasise the need for neuroinclusive practices to support neurodivergent individuals, such as autistic employees, who are significantly underrepresented in the workforce.
- Support access to education and skill development: Education and vocational training can provide individuals from lower socioeconomic backgrounds with critical opportunities to improve their socioeconomic position, thereby potentially reducing risks of depression. Access to affordable education and skill-building programmes can enhance social mobility, fostering resilience and mental well-being across vulnerable demographics.
- Establish comprehensive social safety nets, such as accessible health services, housing stability programmes, and unemployment benefits.
- Enhance mental health integration into humanitarian responses: prioritise mental health within emergency preparedness, response, and recovery efforts, ensuring that mental health needs are met throughout crisis responses.

Education

Education about mental health is crucial for awareness and understanding of depression and other mental health conditions. Educational initiatives are fundamental in enhancing mental health literacy, particularly in the context of depression. Policies aimed at education should promote awareness of mental health issues, facilitate early detection, and encourage timely interventions²⁶⁵.

By demystifying symptoms and reducing stigma, individuals are more likely to seek assistance without fear of judgment. Providing comprehensive information on mental health, including treatment options and self-care strategies, empowers individuals to make informed decisions about their health. Moreover, embedding healthy lifestyle education into curricula—covering nutrition, exercise, and stress management—and addressing pressing social issues like bullying are critical steps towards fostering a supportive environment for mental well-being. Additionally, informed discussions about the use and side effects of antidepressants can guide responsible medication management. Together, these educational efforts can significantly contribute to both preventing and mitigating the impact of depression²⁶⁶.

Policy proposals could include:

- Promoting mental health education to help individuals recognise the signs and symptoms of mental health challenges, encouraging early detection and intervention.
- Addressing stigma and misconceptions surrounding mental health, fostering an environment where those affected feel supported in seeking help without fear of judgment.
- Providing access to accurate information on mental health, treatment options, and coping strategies, empowering individuals to make well-informed decisions about their care.
- Encouraging healthy lifestyle choices, including promoting good nutrition, regular physical activity, sleep hygiene, and stress management techniques, which may help prevent or mitigate depression.
- Incorporating emotional well-being activities such as mindfulness exercises and music therapy into school curricula, fostering resilience and coping skills from an early age.
- Addressing bullying and harassment in schools, which are significant social environment concerns. Policies could focus on implementing anti-bullying measures and promoting inclusive school environments to help prevent depression.
- Recognising and accommodating neurodiversity, including autism and comorbid conditions like eating disorders, as essential components of mental health policies. This could include ensuring access to tailored support services, raising awareness among healthcare providers, and developing interventions to address the unique challenges faced by individuals with neurodevelopmental conditions²⁶⁷. Such individuals may face increased stigma and discrimination, so strategies should aim to enhance their overall mental well-being and quality of life.
- Implementing school and employment programmes to address the specific needs of neurodiverse individuals, including those on the autism spectrum, with attention deficit hyperactivity disorder (ADHD), and those with learning disabilities. These programmes should be designed to accommodate their unique ways of interacting with others, sensory needs, and preference for defined expectations, consistency, and routine.

Population Groups in Depression Research

In the realm of depression research, there is a notable emphasis on specific demographic groups. Historically, older adults have been the primary focus, as depicted in figure 4, with adolescents, women, and children also receiving considerable attention. However, the distribution of research is not entirely even across these populations or across other vulnerable groups, which may lead to gaps in our understanding and the support available for these groups.

To rectify this, policies should advocate for a more equitable representation of all age groups within depression research. This approach is crucial for several reasons:

Children: Despite being a less common focus, children's mental health is foundational for their development and future well-being. Research into the onset, progression, and treatment of depression in children can lead to early intervention strategies that may prevent more severe issues later in life²⁶⁸.

Adolescents and Emerging Adulthood: This period is a critical time marked by significant physical, emotional, and social changes. As such, it is a pivotal time for mental health issues to emerge or escalate. Increasing research in this demographic can uncover unique stressors and developmental factors that contribute to depression, leading to age-appropriate interventions.

Women: Women experience depression at nearly twice the rate of men, partly due to hormonal fluctuations, reproductive events, and social pressures. Enhanced research can shed light on gender-specific causes and treatments of depression, acknowledging the role of these unique biological and societal influences.

Neurodiverse Individuals: Masking symptoms is one of the most problematic causes and effects of depression, as this reduces the likelihood in getting help and being treated. Being able to study the impacts of depression, symptoms in vulnerable demographics is essential to characterising how it may present differently in people with different social pressures to conform.

Older Adults: While current research often focuses on this group, it is essential to continue investigating how aging-related changes, comorbidities, and social factors like isolation contribute to depression. This can improve the quality of life and mental health support for older adults²⁶⁹.

By ensuring a more balanced distribution of research efforts, we can develop interventions that are better tailored to the needs of these diverse groups and other vulnerable identified cohorts like the neurodiversity cohort. Policies should support and fund studies that address the distinct factors affecting children, adolescents, women and specific vulnerable cohorts. Furthermore, by understanding the nuances of depression across different life stages, genders and neurodiversity, we can create a comprehensive mental health support system that is accessible and effective for everyone.

Policies could consider:

- Ensuring balanced representation of all age groups and genders in depression research, with a focus on increasing support for studies involving children, women, and adolescents, in order to address the unique factors affecting these groups and inform more targeted interventions.
- Developing youth-friendly materials and communication strategies to enhance the participation of young people in research, ensuring that their perspectives are included in the development of mental health activities.
- Prioritising research on issues relevant to young people, such as the impact of social media, bullying, and academic stress, which are increasingly recognised as significant contributors to mental health challenges in this demographic.
- Providing training for researchers on Equality, Diversity, and Inclusion (EDI) principles, to promote inclusive and equitable research practices in the mental health field.
- Offering training workshops on neurodiversity for teachers and workplace managers to raise awareness and understanding of neurodiverse individuals, helping them to manage challenges related to depression, autism, and ADHD burnout more effectively.
- Establishing recruitment and employee development programmes that focus on leveraging individual strengths and promoting authenticity in the workplace, ensuring that neurodiverse individuals feel supported and valued in their roles.

Technological and Ethical Integration

In depression research, novel digital diagnostic and therapeutic tools are emerging among in-silico methods. These tools include voice and face analysis technology, brain-computer interfaces, eye movement detection, wearable interfaces, AI-based diagnosis tools, and virtual reality-based exposure therapy.

They are designed for diagnosing, treating, triaging, and tracking behavioural health conditions^{270,271}.

Policies could consider:

- Promoting the integration of personal sensing devices while considering their ethical and environmental implications. This includes advancing personalised and precision mental healthcare, which is pivotal given the current lack of significant improvement in average treatment outcomes for depression. Precision mental healthcare aims to tailor treatment strategies to individual needs, optimising therapeutic efficacy and enhancing patient outcomes.
- Ensuring that these technologies contribute to sustainable health outcomes globally, by supporting the development of personalised interventions that address specific individual characteristics and needs^{272,273}. This approach holds promise for more effective treatment strategies compared to traditional methods.
- Adhering to ethical and sustainable principles within established frameworks, such as Eco-Health, Planetary Health, Human Health, and Social and Public Health, as integral components of "One World, One Mental Health" policy implementations. Ensuring that precision mental healthcare adheres to these principles will support equitable and ethical advancements in treatment.
- Promoting digital literacy to mitigate their potential negative mental health impacts. Balancing technological advancement with the promotion of digital literacy will safeguard against the risks associated with these technologies while maximising their benefits.

We are navigating an era characterised by the principle of "One World, One Mental Health," necessitating adaptive, forward-looking, and transdisciplinary approaches to meet future challenges. The integration of technological advancements must align with ethical and sustainable principles to ensure comprehensive mental health support for all.

5. Conclusions

*Feeling science with a soul of art, we
nurture a caring culture, ready to address
societal tipping points like the depression
epidemic—our commitment to One
(Mental) Health for all.*

In today's globalised world, no single discipline or sector possesses sufficient knowledge and resources to fully prevent the emergence or resurgence of mental health conditions like depression. Effective mental health policies must therefore be built on a foundation of integrated, evidence-based approaches that are tailored to the needs of citizens and designed for health promotion and disease prevention. A key aspect of addressing depression lies in fostering transdisciplinary collaboration, bridging research, policy, and practical implementation. This report highlights the importance of creating platforms that facilitate the exchange of knowledge across all levels and provide stakeholders with the necessary methods and skills to engage in transdisciplinary efforts.

To this end, we have developed the InDepDash platform, an innovative interactive dashboard that synthesises the vast body of scientific literature into a comprehensive, transdisciplinary perspective on depression. InDepDash centralises critical, up-to-date information in a user-friendly interface, making it accessible to policymakers and health authorities in one consolidated location. This platform operates according to the TRUE (Tracked, Reasonable, Understandable, and Ethical) principles, ensuring that the data is not only machine-readable but enriched with context and provenance to support responsible AI practices^{274,275}. InDepDash, therefore, not only advances knowledge management, but also enhances the capacity of policymakers to inform strategic planning and create policies that address both current and emerging mental health challenges.

Key findings from our work highlight the complexity of depression, which is shaped by a multitude of interconnected factors spanning across the social, environmental, and biological domains. Socioeconomic status, for instance, is a significant determinant of mental health, with a bidirectional relationship between poverty and depression. Environmental factors, such as natural disasters and climate change, also play a profound role in exacerbating mental health challenges, further illustrating the need for integrated approaches to mental health policy that consider these external influences. Current research primarily focuses on adult populations, with particular attention given to women and older adults.

Physical health, including physical activity and nutrition, is critically linked to mental well-being, highlighting the essential interplay between the body and the mind. Our findings suggest that promoting early-life prevention programmes, including higher levels of formal education, can significantly reduce the likelihood of developing depression later in life. This is especially important as adverse early-life circumstances, including socioeconomic challenges and family stress, are key determinants of future mental health outcomes, impacting brain development and cognitive function.

The influence of adolescence on mental health, particularly through the transition from family to peer influence, further consider the importance of interventions aimed at enhancing social and emotional competencies. Programmes such as life-skills education, mindfulness, and yoga have shown promising preventive effects. Additionally, technology's dual role in mental

health – both as a potential exacerbator of depression through social media and as an emerging tool for intervention via innovations like virtual reality – highlights the complexity of the issue and the need for thoughtful integration of technological solutions. Evidence also points to the growing recognition of the microbiome's role in depression, with diet and gut health emerging as important factors in both prevention and management. By integrating these diverse factors into a holistic framework, our findings reinforce the importance of a comprehensive approach to mental health that addresses not only biological but also

environmental, social, and technological influences.

By offering a transdisciplinary perspective and synthesising critical evidence from a wide array of scientific disciplines, this report empowers policymakers and health authorities to implement more effective, context-sensitive strategies that address the complexities of depression in the modern world. It supports the need for continuous refinement and innovation in both research and policy, as well as a commitment to transdisciplinary collaboration, in order to develop more effective strategies to prevent, manage, and treat depression.

References

The references cited within this document are not intended to provide an exhaustive review of the relevant literature but rather to offer supportive context to the statements presented. For a comprehensive collection of scientific references and a full overview of the evidence base underpinning these statements, please refer to *inDepDash*, which houses an extensive database of relevant studies and resources.

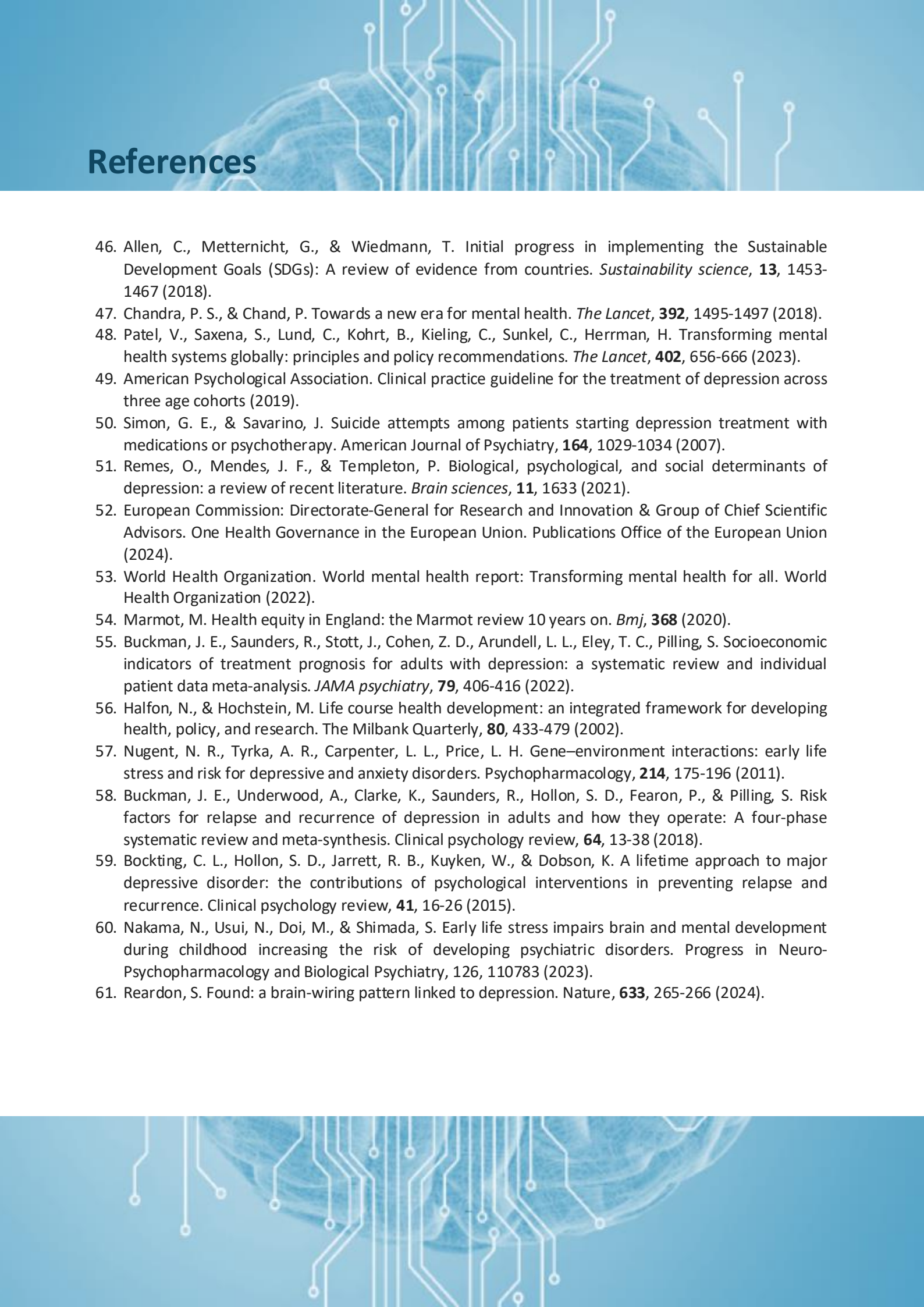
1. Choi, K.W., Lee, Y.H., Liu, Z. *et al.* Social support and depression during a global crisis. *Nat. Mental Health*, **1**, 428–435 (2023).
2. Mazza, M. G., De Lorenzo, R., Conte, C., Poletti, S., Vai, B., Bollettini, I., COVID-19 BioB Outpatient Clinic Study Group. Anxiety and depression in COVID-19 survivors: Role of inflammatory and clinical predictors. *Brain, behavior, and immunity*, **89**, 594-600 (2020).
3. Arias, D., Saxena, S., Verguet, S. Quantifying the global burden of mental disorders and their economic value. *EClinicalMedicine*, **54** (2022).
4. World Health Organization. The World Health Report 2001: Mental health: new understanding, new hope (2001).
5. Chesney, E., Goodwin, G. M., Fazel, S. Risks of all-cause and suicide mortality in mental disorders: a meta-review. *World psychiatry*, **13**, 153-160 (2014).
6. Bachmann, S. Epidemiology of suicide and the psychiatric perspective. *International journal of environmental research and public health*, **15**, 1425 (2018).
7. Walker, E. R., McGee, R. E., & Druss, B. G. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. *JAMA psychiatry*, **72**, 334-341 (2015).
8. Deuschl, G., Beghi, E., Fazekas, F., Varga, T., Christoforidi, K. A., Sipido, E., Feigin, V. L. The burden of neurological diseases in Europe: an analysis for the Global Burden of Disease Study 2017. *The Lancet Public Health*, **5**, 551-567 (2020).
9. Wittenborn, A. K., Rahmandad, H., Rick, J., & Hosseinichimeh, N. Depression as a systemic syndrome: mapping the feedback loops of major depressive disorder. *Psychological medicine*, **46**, 551-562 (2016).
10. Kessler, R. C., Aguilar-Gaxiola, S., Alonso, J., Chatterji, S., Lee, S., Ormel, J., Wang, P. S. The global burden of mental disorders: an update from the WHO World Mental Health (WMH) surveys. *Epidemiology and psychiatric sciences* **18**, 23-33 (2009).
11. Angst, J. Epidemiology of depression. *Psychopharmacology*, **106**, 71–74 (1992).
12. Santomauro, D. F., Herrera, A. M. M., Shadid, J., Zheng, P., Ashbaugh, C., Pigott, D. M., Ferrari, A. J. Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. *The Lancet*, **398**, 1700-1712 (2021).
13. Stice, E., Ragan, J., and Randall, P. Prospective relations between social support and depression: Differential direction of effects for parent and peer support?. *Journal of abnormal psychology*, **113**, 155 (2004).
14. Daly, M., & Robinson, E. Depression and anxiety during COVID-19. *The Lancet*, **399**, 518 (2022).

References

15. Charlson, F., Ali, S., Benmarhnia, T., Pearl, M., Massazza, A., Augustinavicius, J., Scott, J. G. Climate change and mental health: a scoping review. *International journal of environmental research and public health*, **18**, 4486 (2021).
16. Santini, M., Armas, F., Carioli, A., Ceccato, P., Coecke, S., Panzarella, G., Voukouvalas, E. Hurricane Beryl—JRC emergency report. (2024).
17. Mongelli, F., Georgakopoulos, P., Pato, M. T. Challenges and opportunities to meet the mental health needs of underserved and disenfranchised populations in the United States. *Focus*, **18**, 16-24 (2020).
18. Fried, E. I., Nesse, R. M. Depression is not a consistent syndrome: An investigation of unique symptom patterns in the STAR* D study. *Journal of affective disorders*, **172**, 96-102 (2015).
19. Russon, J., Washington, R., Machado, A., Smithee, L., & Dellinger, J. Suicide among LGBTQIA+ youth: A review of the treatment literature. *Aggression and violent behavior*, **64**, 101578 (2022).
20. Lépine, J. P., Briley, M. The increasing burden of depression. *Neuropsychiatric disease and treatment*, **7**, 3-7 (2011).
21. Otu, M. S., and Sefotho, M. M. Examination of emotional distress, depression, and anxiety in neurodiverse students: A cross-sectional study. *World Journal of Psychiatry*, **14**, 1681 (2024).
22. Moriarty, A. S., Meader, N., Snell, K. I., Riley, R. D., Paton, L. W., Chew-Graham, C. A., McMillan, D. Prognostic models for predicting relapse or recurrence of major depressive disorder in adults. *Cochrane Database of Systematic Reviews*, **5** (2021).
23. Cuijpers, P., Noma, H., Karyotaki, E., Vinkers, C. H., Cipriani, A., & Furukawa, T. A. A network meta-analysis of the effects of psychotherapies, pharmacotherapies and their combination in the treatment of adult depression. *World Psychiatry*, **19**, 92-107 (2020).
24. Deisenhofer, A. K., Barkham, M., Beierl, E. T., Schwartz, B., Aafjes-van Doorn, K., Beevers, C. G., Cohen, Z. D. Implementing precision methods in personalizing psychological therapies: Barriers and possible ways forward. *Behaviour research and therapy*, **172**, 104443 (2024).
25. Cohen, Z. D., DeRubeis, R. J. Treatment selection in depression. *Annual Review of Clinical Psychology*, **14**, 209-236 (2018).
26. World Health Organization. Mental health in Europe: stop exclusion, dare to care (No. WHO/EURO: 2001-3970-43729-61519). World Health Organization. Regional Office for Europe (2001).
27. European Commission. A comprehensive approach to mental health (2023).
28. Arias-de la Torre, J., Vilagut, G., Ronaldson, A., Serrano-Blanco, A., Martín, V., Peters, M., Alonso, J. Prevalence and variability of current depressive disorder in 27 European countries: a population-based study. *The Lancet Public Health*, **6**, 729-738 (2021).
29. Herrman, H., Patel, V., Kieling, C., Berk, M., Buchweitz, C., Cuijpers, P., Wolpert, M. Time for united action on depression: a Lancet–World Psychiatric Association Commission. *The Lancet*, **399**, 957-1022 (2022).
30. Ursula von der Leyen. Europe's Choice. Political Guidelines for the next European Commission. 2024-2029.
31. Ormel, J., Cuijpers, P., Jorm, A. F., & Schoevers, R. Prevention of depression will only succeed when it is structurally embedded and targets big determinants. *World Psychiatry*, **18**, 111 (2019).

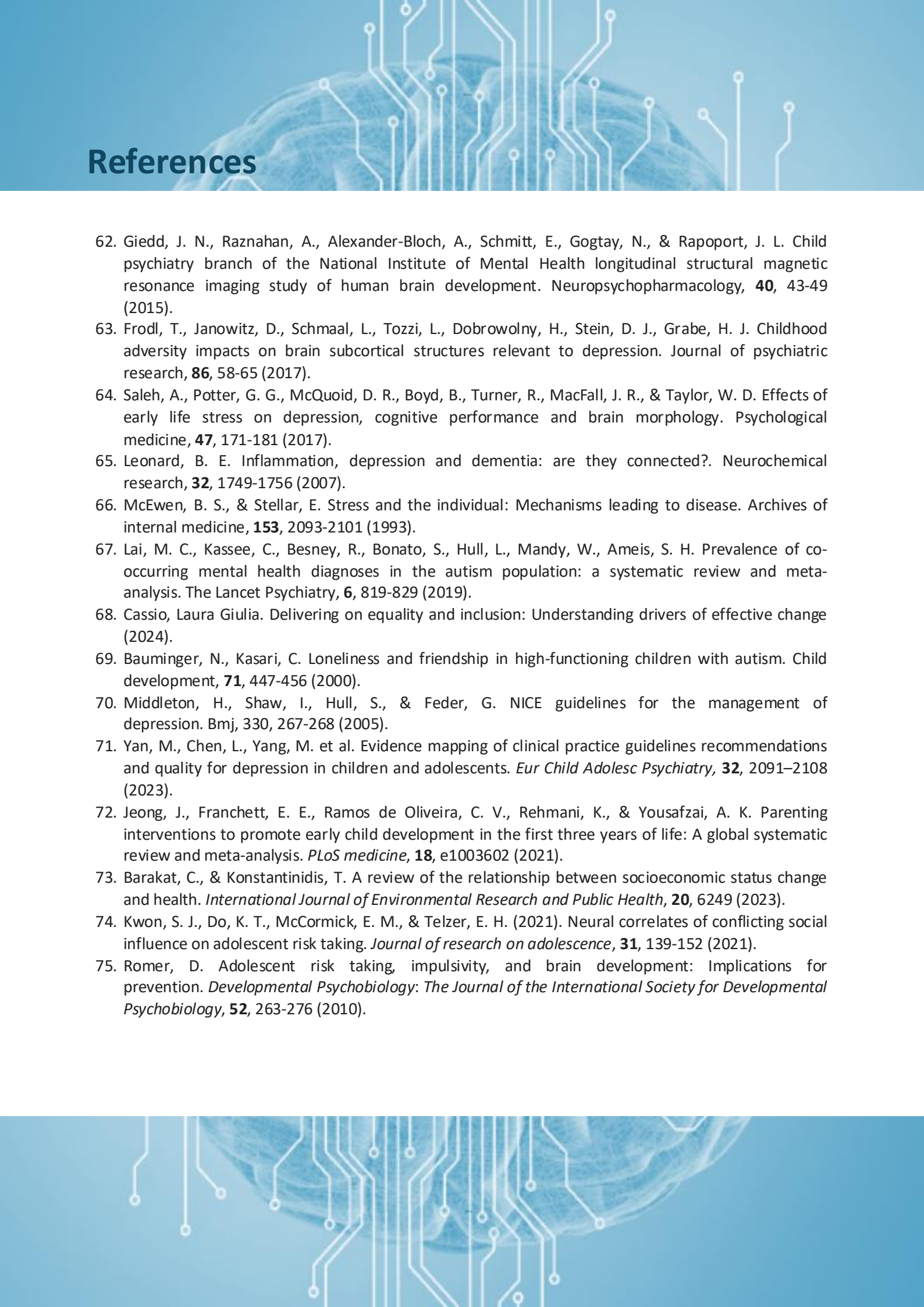
References

32. Patel, V., Saxena, S., Lund, C., Thornicroft, G., Baingana, F., Bolton, P., Unützer, J. The Lancet Commission on global mental health and sustainable development. *The Lancet*, **392**, 1553-1598 (2018).
33. Herrman, H., Patel, V., Kieling, C., Berk, M., Buchweitz, C., Cuijpers, P., Wolpert, M. Time for united action on depression: a Lancet–World Psychiatric Association Commission. *The Lancet*, **399**, 957-1022 (2022).
34. von Stumm, S., & d’Apice, K. From genome-wide to environment-wide: Capturing the environome. *Perspectives on Psychological Science*, **17**, 30-40 (2022).
35. Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., Fusar-Poli, P. Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular psychiatry*, **27**, 281-295 (2022).
36. European Commission: Directorate-General for Research and Innovation & Group of Chief Scientific Advisors. One Health Governance in the European Union. Publications Office of the European Union (2024).
37. World Health Organization, UNEP United Nations Environment Programme, & World Organisation for Animal Health. One health joint plan of action (2022–2026): working together for the health of humans, animals, plants and the environment. World Health Organization (2022).
38. www.sciwalker.com last access December 4th, 2024.
39. Panzarella, G., Gallo, A., Coecke, S., Querci, M., Ortuso, F., Hofmann-Apitius, M., Alcaro, S. MAATrica: a measure for assessing consistency and methods in medicinal and nutraceutical chemistry papers. *European Journal of Medicinal Chemistry*, 116522 (2024).
40. Chapman, D. P., Perry, G. S., & Strine, T. W. The vital link between chronic disease and depressive disorders (2008).
41. van de Weijer, M. P., Pelt, D. H., Baselmans, B. M., Ligthart, L., Huider, F., Hottenga, J. J., and Bartels, M. Capturing the well-being exposome in poly-environmental scores. *Journal of Environmental Psychology*, **93**, 102208 (2024).
42. Sobieraj, D. M., Martinez, B. K., Hernandez, A. V., Coleman, C. I., Ross, J. S., Berg, K. M., Baker, W. L. Adverse effects of pharmacologic treatments of major depression in older adults. *Journal of the American Geriatrics Society*, **67**, 1571-1581 (2019).
43. Llorca, P. M. PROPSY: a new strategy to implement precision psychiatry in France. *European Psychiatry*, **66**, S4-S4 (2023).
44. Gold, S.M., Köhler-Forsberg, O., Moss-Morris, R. et al. Comorbid depression in medical diseases. *Nat Rev Dis Primers*, **6**, 69 (2020).
45. James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Briggs, A. M. et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, **392**, 1789-1858 (2018).



References

46. Allen, C., Metternicht, G., & Wiedmann, T. Initial progress in implementing the Sustainable Development Goals (SDGs): A review of evidence from countries. *Sustainability science*, **13**, 1453-1467 (2018).
47. Chandra, P. S., & Chand, P. Towards a new era for mental health. *The Lancet*, **392**, 1495-1497 (2018).
48. Patel, V., Saxena, S., Lund, C., Kohrt, B., Kieling, C., Sunkel, C., Herrman, H. Transforming mental health systems globally: principles and policy recommendations. *The Lancet*, **402**, 656-666 (2023).
49. American Psychological Association. Clinical practice guideline for the treatment of depression across three age cohorts (2019).
50. Simon, G. E., & Savarino, J. Suicide attempts among patients starting depression treatment with medications or psychotherapy. *American Journal of Psychiatry*, **164**, 1029-1034 (2007).
51. Remes, O., Mendes, J. F., & Templeton, P. Biological, psychological, and social determinants of depression: a review of recent literature. *Brain sciences*, **11**, 1633 (2021).
52. European Commission: Directorate-General for Research and Innovation & Group of Chief Scientific Advisors. One Health Governance in the European Union. Publications Office of the European Union (2024).
53. World Health Organization. World mental health report: Transforming mental health for all. World Health Organization (2022).
54. Marmot, M. Health equity in England: the Marmot review 10 years on. *Bmj*, **368** (2020).
55. Buckman, J. E., Saunders, R., Stott, J., Cohen, Z. D., Arundell, L. L., Eley, T. C., Pilling, S. Socioeconomic indicators of treatment prognosis for adults with depression: a systematic review and individual patient data meta-analysis. *JAMA psychiatry*, **79**, 406-416 (2022).
56. Halfon, N., & Hochstein, M. Life course health development: an integrated framework for developing health, policy, and research. *The Milbank Quarterly*, **80**, 433-479 (2002).
57. Nugent, N. R., Tyrka, A. R., Carpenter, L. L., Price, L. H. Gene–environment interactions: early life stress and risk for depressive and anxiety disorders. *Psychopharmacology*, **214**, 175-196 (2011).
58. Buckman, J. E., Underwood, A., Clarke, K., Saunders, R., Hollon, S. D., Fearon, P., & Pilling, S. Risk factors for relapse and recurrence of depression in adults and how they operate: A four-phase systematic review and meta-synthesis. *Clinical psychology review*, **64**, 13-38 (2018).
59. Bockting, C. L., Hollon, S. D., Jarrett, R. B., Kuyken, W., & Dobson, K. A lifetime approach to major depressive disorder: the contributions of psychological interventions in preventing relapse and recurrence. *Clinical psychology review*, **41**, 16-26 (2015).
60. Nakama, N., Usui, N., Doi, M., & Shimada, S. Early life stress impairs brain and mental development during childhood increasing the risk of developing psychiatric disorders. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, **126**, 110783 (2023).
61. Reardon, S. Found: a brain-wiring pattern linked to depression. *Nature*, **633**, 265-266 (2024).



References

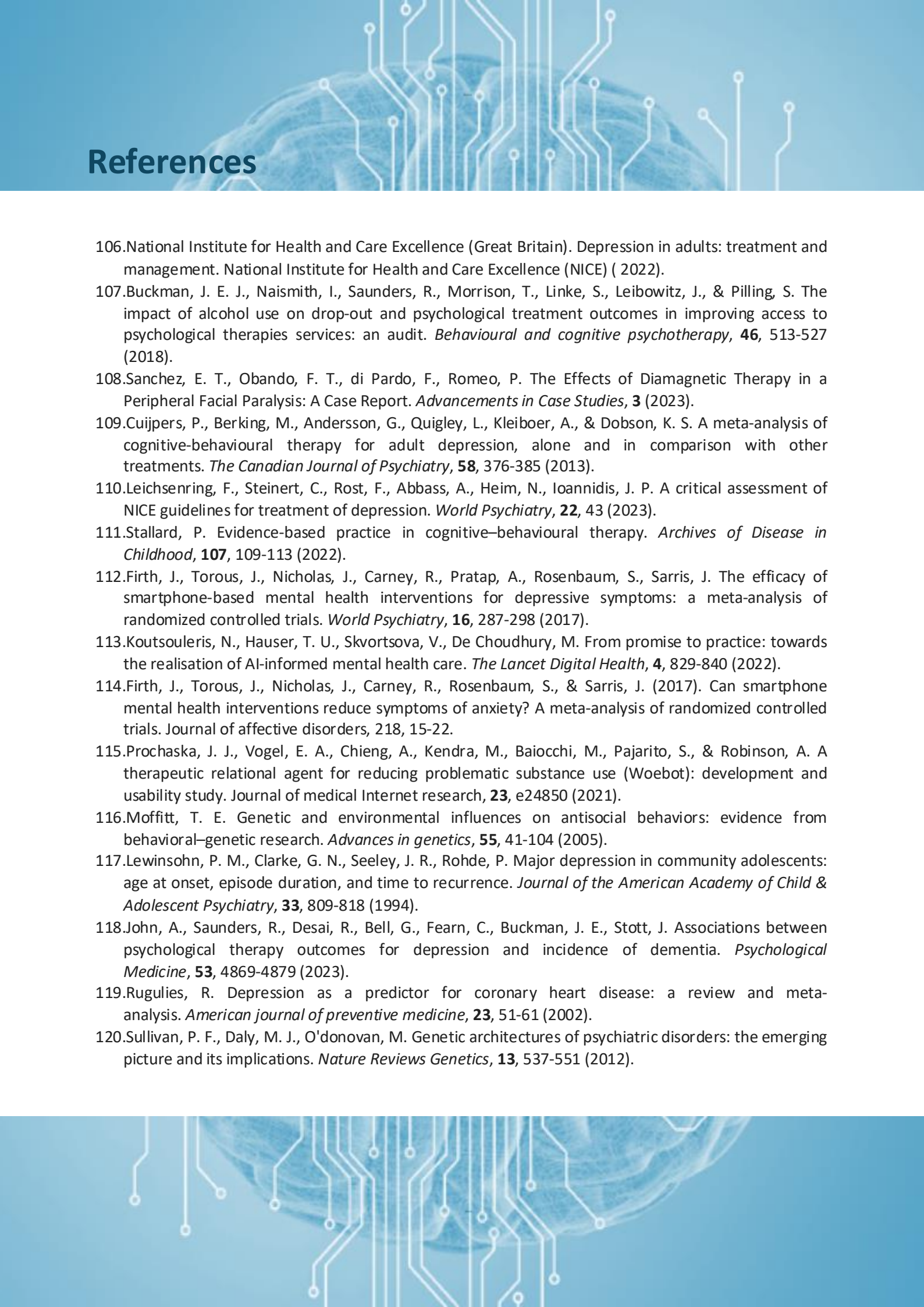
62. Giedd, J. N., Raznahan, A., Alexander-Bloch, A., Schmitt, E., Gogtay, N., & Rapoport, J. L. Child psychiatry branch of the National Institute of Mental Health longitudinal structural magnetic resonance imaging study of human brain development. *Neuropsychopharmacology*, **40**, 43-49 (2015).
63. Frodl, T., Janowitz, D., Schmaal, L., Tozzi, L., Dobrowolny, H., Stein, D. J., Grabe, H. J. Childhood adversity impacts on brain subcortical structures relevant to depression. *Journal of psychiatric research*, **86**, 58-65 (2017).
64. Saleh, A., Potter, G. G., McQuoid, D. R., Boyd, B., Turner, R., MacFall, J. R., & Taylor, W. D. Effects of early life stress on depression, cognitive performance and brain morphology. *Psychological medicine*, **47**, 171-181 (2017).
65. Leonard, B. E. Inflammation, depression and dementia: are they connected?. *Neurochemical research*, **32**, 1749-1756 (2007).
66. McEwen, B. S., & Stellar, E. Stress and the individual: Mechanisms leading to disease. *Archives of internal medicine*, **153**, 2093-2101 (1993).
67. Lai, M. C., Kasse, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Ameis, S. H. Prevalence of co-occurring mental health diagnoses in the autism population: a systematic review and meta-analysis. *The Lancet Psychiatry*, **6**, 819-829 (2019).
68. Cassio, Laura Giulia. Delivering on equality and inclusion: Understanding drivers of effective change (2024).
69. Bauminger, N., Kasari, C. Loneliness and friendship in high-functioning children with autism. *Child development*, **71**, 447-456 (2000).
70. Middleton, H., Shaw, I., Hull, S., & Feder, G. NICE guidelines for the management of depression. *Bmj*, **330**, 267-268 (2005).
71. Yan, M., Chen, L., Yang, M. et al. Evidence mapping of clinical practice guidelines recommendations and quality for depression in children and adolescents. *Eur Child Adolesc Psychiatry*, **32**, 2091–2108 (2023).
72. Jeong, J., Franchett, E. E., Ramos de Oliveira, C. V., Rehmani, K., & Yousafzai, A. K. Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. *PLoS medicine*, **18**, e1003602 (2021).
73. Barakat, C., & Konstantinidis, T. A review of the relationship between socioeconomic status change and health. *International Journal of Environmental Research and Public Health*, **20**, 6249 (2023).
74. Kwon, S. J., Do, K. T., McCormick, E. M., & Telzer, E. H. (2021). Neural correlates of conflicting social influence on adolescent risk taking. *Journal of research on adolescence*, **31**, 139-152 (2021).
75. Romer, D. Adolescent risk taking, impulsivity, and brain development: Implications for prevention. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*, **52**, 263-276 (2010).

References

76. Apicella, C.L., Carré, J.M. & Dreber, A. Testosterone and Economic Risk Taking: A Review. *Adaptive Human Behavior and Physiology*, **1**, 358–385 (2015).
77. Sala, A., Porcaro, L., & Gómez, E. Social Media Use and adolescents' mental health and well-being: An umbrella review. *Computers in Human Behavior Reports*, **14**, 100404 (2024).
78. Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., Stephenson, D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. *Perspectives on psychological science*, **10**, 227-237 (2015).
79. Berlingieri, F., Casabianca, E., Colagrossi, M., Dhombres, B., Kovacic, M., Mauri, C., Nurminen, M., Schnepf, S.V., Stepanova, E., EU loneliness survey — methodological report, publications office of the european union, luxembourg, (2024).
80. Schnepf, S. V., d'Hombres, B., & Mauri, C. Loneliness in Europe: Determinants, Risks and Interventions (2024).
81. UNICEF. The metaverse, extended reality and children. United Nations Children's Fund (2023).
82. Hupont Torres, I., Charisi, V., De Prato, G., Pogorzelska, K., Schade, S., Kotsev, A., Sobolewski, M., Duch Brown, N., Calza, E., Dunker, C., Di Girolamo, F., Bellia, M., Hledik, J., Nai Fovino, I. and Vespe, M., Next Generation Virtual Worlds: Societal, Technological, Economic and Policy Challenges for the EU, Publications Office of the European Union, Luxembourg, (2023).
83. Vuorre, M., & Przybylski, A. K. Estimating the association between Facebook adoption and well-being in 72 countries. *Royal Society open science*, **10**, 221451. (2023).
84. Twenge, J. M., Joiner, T. E., Rogers, M. L., Martin, G. N. Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical psychological science*, **6**, 3-17 (2018).
85. Orben, A. The Sisyphean cycle of technology panics. *Perspectives on Psychological Science*, **15**, 1143-1157 (2020).
86. Orben, A., Meier, A., Dalgleish, T. *et al.* Mechanisms linking social media use to adolescent mental health vulnerability. *Nat Rev Psychol* **3**, 407–423 (2024).
87. Clarke, K., Mayo-Wilson, E., Kenny, J., Pilling, S. Can non-pharmacological interventions prevent relapse in adults who have recovered from depression? A systematic review and meta-analysis of randomised controlled trials. *Clinical psychology review*, **39**, 58-70 (2015).
88. Marchand, W. R. Neural mechanisms of mindfulness and meditation: Evidence from neuroimaging studies. *World journal of radiology*, **6**, 471 (2014).
89. Miller, D., Rees, J., & Pearson, A. "Masking is life": Experiences of masking in autistic and nonautistic adults. *Autism in Adulthood*, **3**, 330-338 (2021).
90. Weist, M. D., Rubin, M., Moore, E., Adelsheim, S., & Wrobel, G. Mental health screening in schools. *Journal of School Health*, **77**, 53-58 (2007).

References

91. Miller, D., Rees, J., & Pearson, A. "Masking is life": Experiences of masking in autistic and nonautistic adults. *Autism in Adulthood*, **3**, 330-338 (2021).
92. Sharp, E. S., Gatz, M. Relationship between education and dementia: an updated systematic review. *Alzheimer Disease & Associated Disorders*, **25**, 289-304 (2011).
93. Lövdén, M., Fratiglioni, L., Glymour, M. M., Lindenberger, U., Tucker-Drob, E. M. Education and cognitive functioning across the life span. *Psychological science in the public interest*, **21**, 6-41 (2020).
94. Nichols, E., Steinmetz, J. D., Vollset, S. E., Fukutaki, K., Chalek, J., Abd-Allah, F., and Liu, X. Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: an analysis for the Global Burden of Disease Study 2019. *The Lancet Public Health*, **7**, e105-e125 (2022).
95. Grippo, A. J., Johnson, A. K. Stress, depression and cardiovascular dysregulation: a review of neurobiological mechanisms and the integration of research from preclinical disease models. *Stress*, **12**, 1-21 (2009).
96. Altemus, M., Sarvaiya, N., Epperson, C. N. Sex differences in anxiety and depression clinical perspectives. *Frontiers in neuroendocrinology*, **35**, 320-330 (2014).
97. Carmen, E., Russo, N. F., Miller, J. B. Inequality and women's mental health: An overview. The gender gap in psychotherapy: Social realities and psychological processes, 17-39 (1984).
98. Buckman, J. E., Saunders, R., O'Driscoll, C., Cohen, Z. D., Stott, J., Ambler, G., Pilling, S. Is social support pre-treatment associated with prognosis for adults with depression in primary care?. *Acta Psychiatrica Scandinavica*, **143**, 392-405 (2021).
99. National Collaborating Centre for Mental Health (UK). Common Mental Health Disorders: Identification and Pathways to Care. Leicester: British Psychological Society (2011).
100. Shi, P., Yang, A., Zhao, Q., Chen, Z., Ren, X., Dai, Q. A hypothesis of gender differences in self-reporting symptom of depression: implications to solve under-diagnosis and under-treatment of depression in males. *Frontiers in psychiatry*, **12**, 589687 (2021).
101. Branney, P., & White, A. Big boys don't cry: Depression and men. *Advances in Psychiatric Treatment*, **14**, 256-262 (2008).
102. Ross, H. E. Alcohol and drug abuse in treated alcoholics: A comparison of men and women. *Alcoholism: Clinical and Experimental Research*, **13**, 810-816 (1989).
103. Fonseca, F., Robles-Martínez, M., Tirado-Muñoz, J. et al. A Gender Perspective of Addictive Disorders. *Curr Addict Rep*, **8**, 89-99 (2021).
104. Bhattacharyya, S., Schoeler, T., Di Forti, M., Murray, R., Cullen, A. E., and Colizzi, M. Stressful life events and relapse of psychosis: analysis of causal association in a 2-year prospective observational cohort of individuals with first-episode psychosis in the UK. *The Lancet Psychiatry*, **10**, 414-425 (2023).
105. Walitzer, K. S., & Dearing, R. L. Gender differences in alcohol and substance use relapse. *Clinical psychology review*, **26**, 128-148 (2006).



References

106. National Institute for Health and Care Excellence (Great Britain). Depression in adults: treatment and management. National Institute for Health and Care Excellence (NICE) (2022).
107. Buckman, J. E. J., Naismith, I., Saunders, R., Morrison, T., Linke, S., Leibowitz, J., & Pilling, S. The impact of alcohol use on drop-out and psychological treatment outcomes in improving access to psychological therapies services: an audit. *Behavioural and cognitive psychotherapy*, **46**, 513-527 (2018).
108. Sanchez, E. T., Obando, F. T., di Pardo, F., Romeo, P. The Effects of Diamagnetic Therapy in a Peripheral Facial Paralysis: A Case Report. *Advancements in Case Studies*, **3** (2023).
109. Cuijpers, P., Berking, M., Andersson, G., Quigley, L., Kleiboer, A., & Dobson, K. S. A meta-analysis of cognitive-behavioural therapy for adult depression, alone and in comparison with other treatments. *The Canadian Journal of Psychiatry*, **58**, 376-385 (2013).
110. Leichsenring, F., Steinert, C., Rost, F., Abbass, A., Heim, N., Ioannidis, J. P. A critical assessment of NICE guidelines for treatment of depression. *World Psychiatry*, **22**, 43 (2023).
111. Stallard, P. Evidence-based practice in cognitive-behavioural therapy. *Archives of Disease in Childhood*, **107**, 109-113 (2022).
112. Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., Sarris, J. The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. *World Psychiatry*, **16**, 287-298 (2017).
113. Koutsouleris, N., Hauser, T. U., Skvortsova, V., De Choudhury, M. From promise to practice: towards the realisation of AI-informed mental health care. *The Lancet Digital Health*, **4**, 829-840 (2022).
114. Firth, J., Torous, J., Nicholas, J., Carney, R., Rosenbaum, S., & Sarris, J. (2017). Can smartphone mental health interventions reduce symptoms of anxiety? A meta-analysis of randomized controlled trials. *Journal of affective disorders*, 218, 15-22.
115. Prochaska, J. J., Vogel, E. A., Chieng, A., Kendra, M., Baiocchi, M., Pajarito, S., & Robinson, A. A therapeutic relational agent for reducing problematic substance use (Woebot): development and usability study. *Journal of medical Internet research*, **23**, e24850 (2021).
116. Moffitt, T. E. Genetic and environmental influences on antisocial behaviors: evidence from behavioral-genetic research. *Advances in genetics*, **55**, 41-104 (2005).
117. Lewinsohn, P. M., Clarke, G. N., Seeley, J. R., Rohde, P. Major depression in community adolescents: age at onset, episode duration, and time to recurrence. *Journal of the American Academy of Child & Adolescent Psychiatry*, **33**, 809-818 (1994).
118. John, A., Saunders, R., Desai, R., Bell, G., Fearn, C., Buckman, J. E., Stott, J. Associations between psychological therapy outcomes for depression and incidence of dementia. *Psychological Medicine*, **53**, 4869-4879 (2023).
119. Rugulies, R. Depression as a predictor for coronary heart disease: a review and meta-analysis. *American journal of preventive medicine*, **23**, 51-61 (2002).
120. Sullivan, P. F., Daly, M. J., O'donovan, M. Genetic architectures of psychiatric disorders: the emerging picture and its implications. *Nature Reviews Genetics*, **13**, 537-551 (2012).

References

121. Schwebel, A. I., Fine, M. A. Cognitive-behavioral family therapy. *Journal of Family Psychotherapy*, 3, 73-91 (1992).
122. Sarris, J., Logan, A. C., Akbaraly, T. N., Amminger, G. P., Balanzá-Martínez, V., Freeman, M. P., Jacka, F. N. Nutritional medicine as mainstream in psychiatry. *The Lancet Psychiatry*, 2, 271-274 (2015).
123. Firth, J., Solmi, M., Wootton, R. E., Vancampfort, D., Schuch, F. B., Hoare, E., Stubbs, B. A meta-review of "lifestyle psychiatry": the role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. *World psychiatry*, 19, 360-380 (2020).
124. Compas, B. E., Forehand, R., Thigpen, J., Hardcastle, E., Garai, E., McKee, L., Sterba, S. Efficacy and moderators of a family group cognitive-behavioral preventive intervention for children of parents with depression. *Journal of consulting and clinical psychology*, 83, 541 (2015).
125. Cheng, W. L., Chang, C. C., Griffiths, M. D., Yen, C. F., Liu, J. H., Su, J. A., Pakpour, A. H. Quality of life and care burden among family caregivers of people with severe mental illness: mediating effects of self-esteem and psychological distress. *BMC psychiatry*, 22, 672 (2022).
126. Donohue, J.M., Pincus, H.A. Reducing the Societal Burden of Depression. *Pharmacoeconomics* 25, 7–24 (2007).
127. European Commission. Science-for-Policy Dialogue: Resilient Health Systems for an Ageing EU population. Workshop (2024).
128. Smith, K. A., Alt, J. A. The relationship of chronic rhinosinusitis and depression. *Current Opinion in Otolaryngology & Head and Neck Surgery*, 28, 1-5 (2020).
129. Opolski, M., Wilson, I. Asthma and depression: a pragmatic review of the literature and recommendations for future research. *Clinical Practice and Epidemiology in Mental Health*, 1, 1-7 (2005).
130. Gau, S. Y., Hung, T. H., Chuang, M. F., Wei, J. C. C. Depressive Symptoms in Patients with Fibromyalgia: Current Evidence and Preventive Approaches. *Journal of Clinical Medicine*, 12(12), 3987 (2023).
131. Holt, R. I., De Groot, M., Golden, S. H. Diabetes and depression. *Current diabetes reports*, 14, 1-9 (2014).
132. Stunkard, A. J., Faith, M. S., & Allison, K. C. Depression and obesity. *Biological psychiatry*, 54, 330-337 (2003).
133. Pistollato, F., Burkhart, G., Deceuninck, P., Bernasconi, C., Di Virgilio, S., Emili, L., and Constantino, H. What public health challenges and unmet medical needs would benefit from interdisciplinary collaboration in the EU? A survey and multi-stakeholder debate. *Frontiers in Public Health*, 12 (2024).
134. Evans, S., Katona, C. Epidemiology of depressive symptoms in elderly primary care attenders. *Dementia and Geriatric Cognitive Disorders*, 4, 327-333, (1993).
135. Kelly, J. The Audit Commission: guiding, steering and regulating local government. *Public Administration*, 81, 459-476 (2003).
136. Harris, D. Forget me not: palliative care for people with dementia. *Postgraduate medical journal*, 83, 362-366 (2007).

References

137. Niedderer, K., Ludden, G., Denning, T., & Holthoff-Detto, V. Design for Dementia, Mental Health and Wellbeing.
138. Saunders, R., Buckman, J. E., Stott, J., Leibowitz, J., Aguirre, E., John, A., Pilling, S. Older adults respond better to psychological therapy than working-age adults: evidence from a large sample of mental health service attendees. *Journal of affective disorders*, **294**, 85-93 (2021).
139. Unützer, J., Katon, W., Callahan, C. M., Williams Jr, J. W., Hunkeler, E., Harpole, L., IMPACT Investigators. Collaborative care management of late-life depression in the primary care setting: a randomized controlled trial. *Jama*, **288**, 2836-2845 (2002).
140. Mansell, W. Universal selection theory: Implications for multidisciplinary approaches to clinical psychology and psychiatry. *New Ideas in Psychology*, **21**, 121-140 (2003).
141. Firth, J., Solmi, M., Wootton, R. E., Vancampfort, D., Schuch, F. B., Hoare, E., Stubbs, B. A meta-review of "lifestyle psychiatry": the role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. *World psychiatry*, **19**, 360-380 (2020).
142. Prescott, S. L. History of medicine: Origin of the term microbiome and why it matters. *Human Microbiome Journal*, **4**, 24-25 (2017).
143. Micah, H., Claire, F. L., Rob, K., Gordon Jeffrey, I. The human microbiome project: exploring the microbial part of ourselves in a changing world. *Nature*, **449**, 804-810 (2007).
144. Erny, D., Hrabě de Angelis, A., Jaitin, D. *et al.* Host microbiota constantly control maturation and function of microglia in the CNS. *Nat Neurosci* **18**, 965–977 (2015).
145. Valles-Colomer, M., Falony, G., Darzi, Y. *et al.* The neuroactive potential of the human gut microbiota in quality of life and depression. *Nat Microbiol* **4**, 623–632 (2019).
146. Doré, J., Simrén, M., Buttle, L., & Guarner, F. Hot topics in gut microbiota. *United European Gastroenterology Journal*, **1**, 311-318 (2013).
147. Jacka, F.N., O'Neil, A., Opie, R. *et al.* A randomised controlled trial of dietary improvement for adults with major depression (the 'SMILES' trial). *BMC Med* **15**, 23 (2017).
148. Foster, J. A., Rinaman, L., Cryan, J. F. Stress & the gut-brain axis: regulation by the microbiome. *Neurobiology of stress*, **7**, 124-136 (2017).
149. Monroe, S. M., Anderson, S. F., Harkness, K. L. Life stress and major depression: The mysteries of recurrences. *Psychological review*, **126**, 791. (2019).
150. Buckman, J. E., Saunders, R., Arundell, L. L., Oshinowo, I. D., Cohen, Z. D., O'Driscoll, C., Pilling, S. Life events and treatment prognosis for depression: A systematic review and individual patient data meta-analysis. *Journal of affective disorders*, **299**, 298-308 (2022).
151. Ramirez-Figueroa C, Beckett R. Living with buildings, living with microbes: probiosis and architecture. *Architectural Research Quarterly*, **24**, 155-168 (2020).
152. Watkins, H., Robinson, J. M., Breed, M. F., Parker, B., Weinstein, P. Microbiome-inspired green infrastructure: a toolkit for multidisciplinary landscape design. *Trends in Biotechnology*, **38**, 1305-1308 (2020).

References

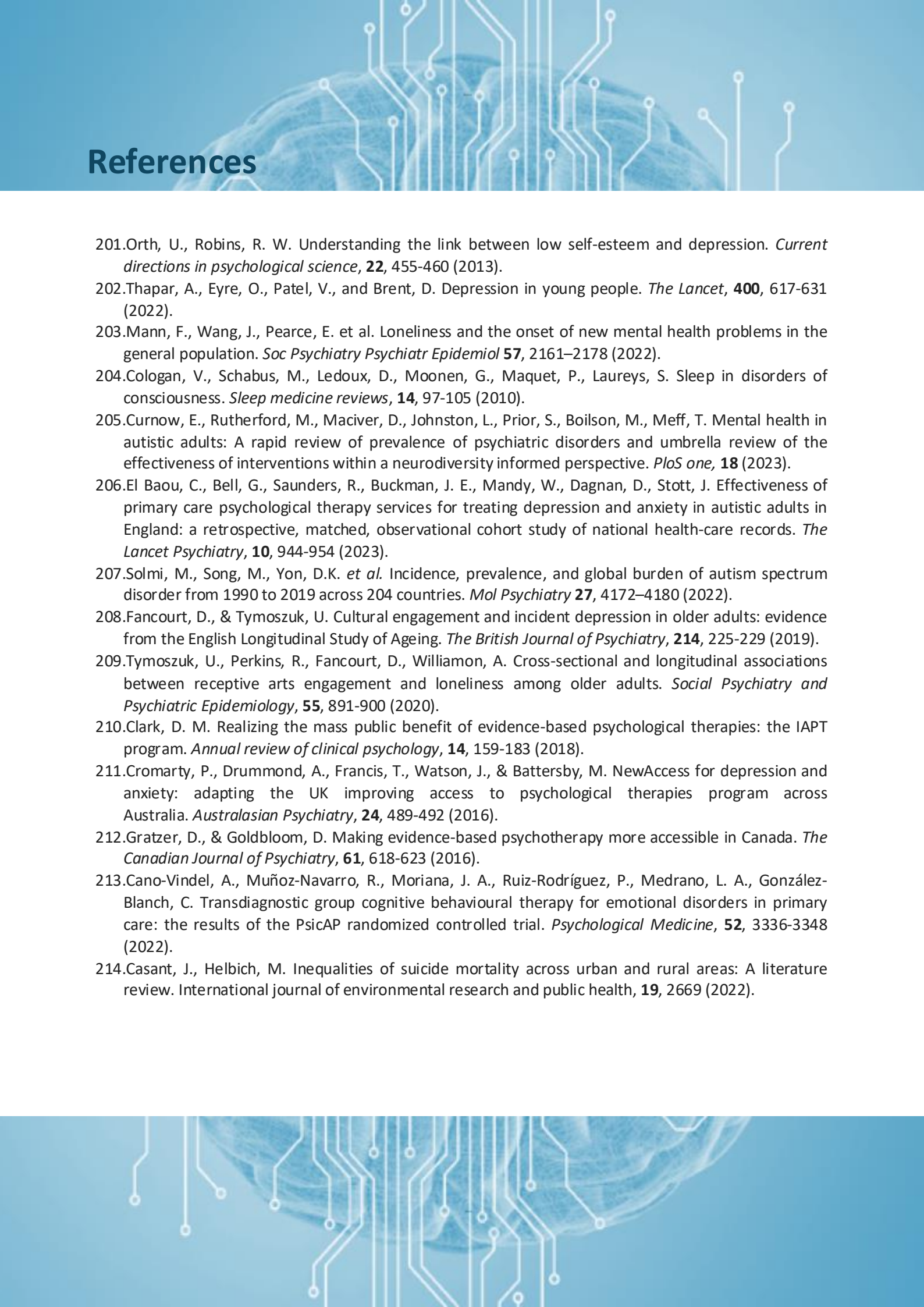
153. Erny, D., Hrabě de Angelis, A. L., Jaitin, D., Wieghofer, P., Staszewski, O., David, E., Prinz, M. Host microbiota constantly control maturation and function of microglia in the CNS. *Nature neuroscience*, **18**, 965-977 (2015).
154. Pretty, J., Griffin, M., Sellens, M., & Pretty, C.. Green exercise: Complementary roles of nature, exercise and diet in physical and emotional well-being and. *Essex: Centre for Environment and Society University of Essex*. (2003).
155. Bosch, J.A., Nieuwdorp, M., Zwinderman, A.H. *et al*. The gut microbiota and depressive symptoms across ethnic groups. *Nat Commun* **13**, 7129 (2022).
156. Lai, J. S., Hiles, S., Bisquera, A., Hure, A. J., McEvoy, M., & Attia, J. A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *The American journal of clinical nutrition*, **99**, 181-197 (2014).
157. Molendijk, M., Molero, P., Sánchez-Pedreño, F. O., Van der Does, W., & Martínez-González, M. A. Diet quality and depression risk: a systematic review and dose-response meta-analysis of prospective studies. *Journal of affective disorders*, **226**, 346-354 (2018).
158. Firth, J., Teasdale, S. B., Allott, K., Siskind, D., Marx, W., Cotter, J., Sarris, J. The efficacy and safety of nutrient supplements in the treatment of mental disorders: a meta-review of meta-analyses of randomized controlled trials. *World Psychiatry*, **18**, 308-324 (2019).
159. Firth J, Marx W, Dash S, Carney R, Teasdale SB, Solmi M, Stubbs B, Schuch FB, Carvalho AF, Jacka F, et al. The effects of dietary improvement on symptoms of depression and anxiety: a meta-analysis of randomized controlled trials. *Psychosom Med*. **81**, 265–280 (2019).
160. Opie, R. S., Itsiopoulos, C., Parletta, Sanchez-Villegas, A., Akbaraly, T. N., Ruusunen, A., Jacka, F. N. Dietary recommendations for the prevention of depression. *Nutritional neuroscience*, **20**, 161-171 (2017).
161. Sarris, J., Mischoulon, D., Schweitzer, I. Omega-3 for bipolar disorder: meta-analyses of use in mania and bipolar depression. *The Journal of clinical psychiatry*, **72**, 13263 (2011).
162. Francis, H. M., Stevenson, R. J., Chambers, J. R., Gupta, D., Newey, B., & Lim, C. K. A brief diet intervention can reduce symptoms of depression in young adults—A randomised controlled trial. *PloS one*, **14**, (2019).
163. NICE, U. Depression in adults: treatment and management. NICE guideline. (2022).
164. Vargiu, N., Belfanti, A., Roberti, M., Trentin, S., Ferrara, C., Tosti, M., Conca, A. Empowerment of Italian general practitioners in depression and suicide prevention: the iFightDepression tool, a game changer of the EAAD-Best project. *Annals of general psychiatry*, **23**, 24 (2024).
165. World Health Organization. WHO recommends considering cultural factors to develop more inclusive health systems (2020).
166. Castanheira, L., Silva, C., Cheniaux, E., Telles-Correia, D. Neuroimaging correlates of depression—implications to clinical practice. *Frontiers in Psychiatry*, **10**, 703 (2019).
167. Idlett-Ali, S. L., Salazar, C. A., Bell, M. S., Short, E. B., Rowland, N. C. Neuromodulation for treatment-resistant depression: Functional network targets contributing to antidepressive outcomes. *Frontiers in human neuroscience*, **17**, (2023).

References

- 168.Yao, Y., Guo, D., Lu, T. S., Liu, F. L., Huang, S. H., Diao, M. Q., Han, Y.. Efficacy and safety of psychedelics for the treatment of mental disorders: A systematic review and meta-analysis. *Psychiatry Research* (2024).
- 169.Marwaha, S., Palmer, E., Suppes, T., Cons, E., Young, A. H., Upthegrove, R. Novel and emerging treatments for major depression. *The Lancet*, **401**, 141-153 (2023).
- 170.Collette, F., Van der Linden, M., Laureys, S., Delfiore, G., Degueldre, C., Luxen, A., Salmon, E. Exploring the unity and diversity of the neural substrates of executive functioning. *Human brain mapping*, **25**, 409-423 (2005).
- 171.Laureys, S. The No-Nonsense Meditation Book: A scientist's guide to the power of meditation. Bloomsbury Publishing (2021).
- 172.Marx, W., Manger, S. H., Blencowe, M., Murray, G., Ho, F. Y. Y., Lawn, S., O'Neil, A. Clinical guidelines for the use of lifestyle-based mental health care in major depressive disorder: World Federation of Societies for Biological Psychiatry (WFSBP) and Australasian Society of Lifestyle Medicine (ASLM) taskforce. *The World Journal of Biological Psychiatry*, **24**, 333–386 (2022).
- 173.Jaylet, T., Coustillet, T., Smith, N. M., Viviani, B., Lindeman, B., Vergauwen, L., Audouze, K. Comprehensive mapping of the AOP-Wiki database: identifying biological and disease gaps. *Frontiers in toxicology*, **6**, (2024).
- 174.Chauhan, V., Hamada, N., Wilkins, R., Garnier-Laplace, J., Laurier, D., Beaton, D., & Tollefsen, K. E. A high-level overview of the OECD AOP Development Programme. *International Journal of Radiation Biology*, **98**, 1704-1713 (2022).
- 175.Clerbaux, L. A., Albertini, M. C., Amigo, N., Beronius, A., Bezemer, G. F., Coecke, S., Landesmann, B. Factors modulating COVID-19: A mechanistic understanding based on the adverse outcome pathway framework. *Journal of Clinical Medicine*, **11**, 4464, (2022).
- 176.Pohl, C., Hadorn, G. H. Principles for designing transdisciplinary research (2007).
- 177.OECD, OECD Science, Technology and Innovation Outlook 2016, *OECD Publishing*.
- 178.OECD, Addressing societal challenges using transdisciplinary research, *OECD Science, Technology and Industry Policy Papers*, **88**, (2022).
- 179.Lawrence, R. J. Advances in transdisciplinarity: Epistemologies, methodologies and processes. *Futures*, **65**, 1-9 (2015).
- 180.Heath-Carpentier, A. The challenge of complexity: Essays by Edgar Morin. Liverpool University Press (2022).
- 181.Morin, E. *La Voie: Pour l'avenir de l'humanité*. Fayard. (2011).
- 182.Heidegger, M. Basic writings: from Being and time (1927) to The task of thinking (1964).
- 183.Robert A. Cook, William B. Karesh, and Steven A. Osofsky, The Manhattan principles (2004).
- 184.World Health Organization. Mental health atlas 2017: resources for mental health in the Eastern Mediterranean Region (2019).
- 185.Chisholm, D., Sweeny, K., Sheehan, P., Rasmussen, B., Smit, F., Cuijpers, P., & Saxena, S. Scaling-up treatment of depression and anxiety: a global return on investment analysis. *The Lancet Psychiatry*, **3**, 415-424 (2016).

References

186. Barican, J. L., Yung, D., Schwartz, C., Zheng, Y., Georgiades, K., & Waddell, C. Prevalence of childhood mental disorders in high-income countries: a systematic review and meta-analysis to inform policymaking. *BMJ Ment Health*, **25**, 36-44 (2022).
187. Marquez, P. V., & Saxena, S. Making mental health a global priority. In *Cerebrum: the Dana forum on brain science*. Dana Foundation (2016).
188. Wilcox, B. A., Aguirre, A. A., Daszak, P., Horwitz, P., Martens, P., Parkes, M., Waltner-Toews, D. EcoHealth: a transdisciplinary imperative for a sustainable future. *EcoHealth*, **1**, 3-5 (2004).
189. Lerner, H., & Berg, C. A comparison of three holistic approaches to health: one health, ecohealth, and planetary health. *Frontiers in veterinary science*, **4**, 163 (2017).
190. Bexell, M., & Jönsson, K. Responsibility and the United Nations' sustainable development goals. *Forum for development studies*, **44**, 13-29 (2017).
191. Demaio, A. R., & Rockström, J. Human and planetary health: towards a common language. *The Lancet*, **386**, 36-37 (2015).
192. Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., Yach, D. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The lancet*, **386**, 1973-2028 (2015).
193. De Zeeuw, J., Rupppa, F., Klymchuk, V., Königstein, H. F., Shields-Zeeman, L., Bolinski, F., Zuljevic-Salamon, T. Needs assessment to design a multidisciplinary training programme within the EU-PROMENS project. *European Journal of Public Health*, **34**, 144-2223 (2024).
194. Palmer, V. J., Bibb, J., Lewis, M., Densley, K., Kritharidis, R., Dettmann, E., McDonald, G. A co-design living labs philosophy of practice for end-to-end research design to translation with people with lived-experience of mental ill-health and carer/family and kinship groups. *Frontiers in Public Health*, **11**, 1206620 (2023).
195. Sher, L. The impact of the COVID-19 pandemic on suicide rates. *QJM: An International Journal of Medicine*, **113**(10), 707-712 (2020).
196. Toczyski, P. The Local Awareness-Raising of Public Mental Health in the Capital City of Poland through Launch of Local Alliance against Depression. *International Journal of Environmental Research and Public Health*, **20**, 3892 (2023).
197. Mendelson, T., Eaton, W.W. Recent advances in the prevention of mental disorders. *Soc Psychiatry Psychiatr Epidemiol*, **53**, 325–339 (2018).
198. Cuijpers, P., Pineda, B. S., Quero, S., Karyotaki, E., Struijs, S. Y., Figueroa, C. A., Muñoz, R. F. Psychological interventions to prevent the onset of depressive disorders: A meta-analysis of randomized controlled trials. *Clinical Psychology Review*, **83**, 101955 (2021).
199. Clark, D. M., Canvin, L., Green, J., Layard, R., Pilling, S., & Janecka, M. Transparency about the outcomes of mental health services (IAPT approach): an analysis of public data. *The Lancet*, **391**, 679-686 (2018).
200. Saunders, R., Cape, J., Leibowitz, J., et al. Improvement in IAPT outcomes over time: are they driven by changes in clinical practice? *The Cognitive Behaviour Therapist*. (2020).



References

- 201.Orth, U., Robins, R. W. Understanding the link between low self-esteem and depression. *Current directions in psychological science*, **22**, 455-460 (2013).
- 202.Thapar, A., Eyre, O., Patel, V., and Brent, D. Depression in young people. *The Lancet*, **400**, 617-631 (2022).
- 203.Mann, F., Wang, J., Pearce, E. et al. Loneliness and the onset of new mental health problems in the general population. *Soc Psychiatry Psychiatr Epidemiol* **57**, 2161–2178 (2022).
- 204.Cologan, V., Schabus, M., Ledoux, D., Moonen, G., Maquet, P., Laureys, S. Sleep in disorders of consciousness. *Sleep medicine reviews*, **14**, 97-105 (2010).
- 205.Curnow, E., Rutherford, M., Maciver, D., Johnston, L., Prior, S., Boilson, M., Meff, T. Mental health in autistic adults: A rapid review of prevalence of psychiatric disorders and umbrella review of the effectiveness of interventions within a neurodiversity informed perspective. *PloS one*, **18** (2023).
- 206.El Baou, C., Bell, G., Saunders, R., Buckman, J. E., Mandy, W., Dagnan, D., Stott, J. Effectiveness of primary care psychological therapy services for treating depression and anxiety in autistic adults in England: a retrospective, matched, observational cohort study of national health-care records. *The Lancet Psychiatry*, **10**, 944-954 (2023).
- 207.Solmi, M., Song, M., Yon, D.K. et al. Incidence, prevalence, and global burden of autism spectrum disorder from 1990 to 2019 across 204 countries. *Mol Psychiatry* **27**, 4172–4180 (2022).
- 208.Fancourt, D., & Tymoszuk, U. Cultural engagement and incident depression in older adults: evidence from the English Longitudinal Study of Ageing. *The British Journal of Psychiatry*, **214**, 225-229 (2019).
- 209.Tymoszuk, U., Perkins, R., Fancourt, D., Williamon, A. Cross-sectional and longitudinal associations between receptive arts engagement and loneliness among older adults. *Social Psychiatry and Psychiatric Epidemiology*, **55**, 891-900 (2020).
- 210.Clark, D. M. Realizing the mass public benefit of evidence-based psychological therapies: the IAPT program. *Annual review of clinical psychology*, **14**, 159-183 (2018).
- 211.Cromarty, P., Drummond, A., Francis, T., Watson, J., & Battersby, M. NewAccess for depression and anxiety: adapting the UK improving access to psychological therapies program across Australia. *Australasian Psychiatry*, **24**, 489-492 (2016).
- 212.Gratzer, D., & Goldbloom, D. Making evidence-based psychotherapy more accessible in Canada. *The Canadian Journal of Psychiatry*, **61**, 618-623 (2016).
- 213.Cano-Vindel, A., Muñoz-Navarro, R., Moriana, J. A., Ruiz-Rodríguez, P., Medrano, L. A., González-Blanch, C. Transdiagnostic group cognitive behavioural therapy for emotional disorders in primary care: the results of the PsicAP randomized controlled trial. *Psychological Medicine*, **52**, 3336-3348 (2022).
- 214.Casant, J., Helbich, M. Inequalities of suicide mortality across urban and rural areas: A literature review. *International journal of environmental research and public health*, **19**, 2669 (2022).

References

215. Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., Yach, D. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The lancet*, **386**, 1973-2028 (2015).
216. EU research project-policy link explorer (2024).
217. Van den Berg, M., Van Poppel, M., Van Kamp, I., Andrusaityte, S., Balseviciene, B., Cirach, M., Maas, J. Visiting green space is associated with mental health and vitality: A cross-sectional study in four european cities. *Health & place*, **38**, 8-15 (2016).
218. Van den Berg, M. M., van Poppel, M., van Kamp, I., Ruijsbroek, A., Triguero-Mas, M., Gidlow, C., Maas, J. Do physical activity, social cohesion, and loneliness mediate the association between time spent visiting green space and mental health?. *Environment and behavior*, **51**, 144-166 (2019).
219. EU projects on Biodiversity and Health (2024).
220. Shukla, A., Choudhari, S. G., Gaidhane, A. M., Syed, Z. Q. Role of art therapy in the promotion of mental health: a critical review. *Cureus*, **14** (2022).
221. Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., Van Susteren, L. Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet Planetary Health*, **5**, 863-873 (2021).
222. Stanley, S. K., Hogg, T. L., Leviston, Z., Walker, I. From anger to action: Differential impacts of eco-anxiety, eco-depression, and eco-anger on climate action and wellbeing. *The Journal of Climate Change and Health*, **1** (2021).
223. Santini, M., Armas, F., Carioli, A., Ceccato, P., Coecke, S., De Girolamo, L., Panzarella, G., Voukouvalas, E. Hurricane Beryl: JRC emergency report: situation as at 09 July 2024 and comparison with past hurricanes. (2024).
224. Kumar, P., Brander, L., Kumar, M., & Cuijpers, P. Planetary Health and Mental Health Nexus: Benefit of Environmental Management. *Annals of Global Health*, **89**, (2023).
225. Rose, S., Bisson, J., & Wessely, S. A systematic review of single-session psychological interventions ('debriefing') following trauma. *Psychotherapy and psychosomatics*, **72**, 176-184 (2003).
226. Cole, C. L., Barry, C., Saunders, R., Billings, J., Stott, J., Buckman, J. E., Wheatley, J. A service evaluation of phased-and stepped-care psychological support for health and social care workers during the COVID-19 pandemic. *BJPsych Open*, **9**, 95 (2023).
227. Waterman, S., Hunter, E. C. M., Cole, C. L., Evans, L. J., Greenberg, N., Rubin, G. J., Beck, A. Training peers to treat Ebola centre workers with anxiety and depression in Sierra Leone. *International Journal of Social Psychiatry*, **64**, 156-165 (2018).
228. Loos, R., Carvalho, R., António, D. C., Comero, S., Locoro, G., Tavazzi, S., Gawlik, B. M. EU-wide monitoring survey on emerging polar organic contaminants in wastewater treatment plant effluents. *Water research*, **47**, 6475-6487 (2013).
229. Melchor-Martínez, E. M., Jiménez-Rodríguez, M. G., Martínez-Ruiz, M., Peña-Benavides, S. A., Iqbal, H. M., Parra-Saldívar, R., Sosa-Hernández, J. E. Antidepressants surveillance in wastewater: overview extraction and detection. *Case Studies in Chemical and Environmental Engineering*, **3**, (2021).

References

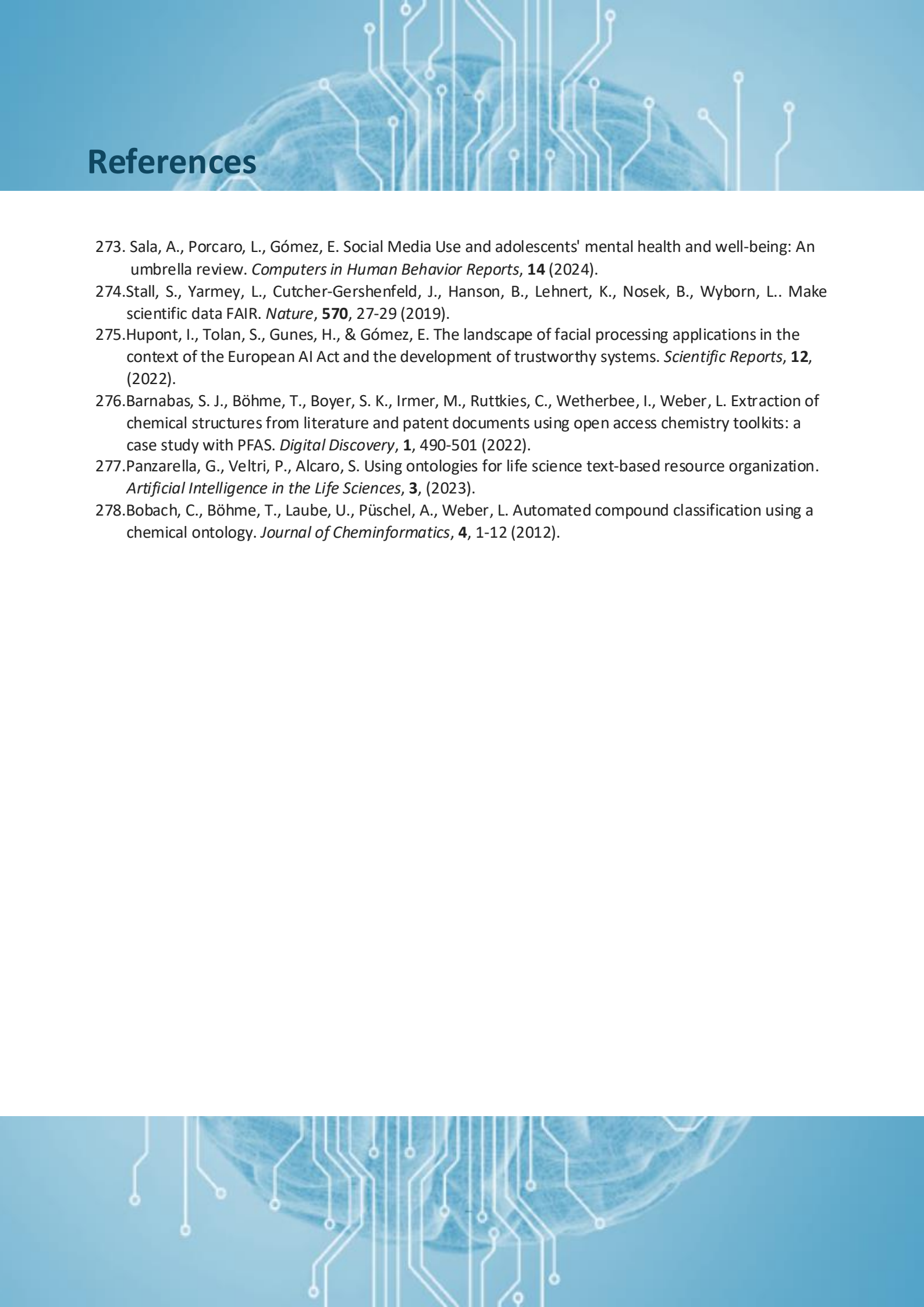
230. Clarke, K., Mayo-Wilson, E., Kenny, J., & Pilling, S. Can non-pharmacological interventions prevent relapse in adults who have recovered from depression? A systematic review and meta-analysis of randomised controlled trials. *Clinical psychology review*, **39**, 58-70, (2015).
231. Geddes, J. R., Carney, S. M., Davies, C., Furukawa, T. A., Kupfer, D. J., Frank, E., Goodwin, G. M. (2003). Relapse prevention with antidepressant drug treatment in depressive disorders: a systematic review. *The Lancet*, **361**, 653-661.
232. Bockting, C. L., Hollon, S. D., Jarrett, R. B., Kuyken, W., Dobson, K. A lifetime approach to major depressive disorder: the contributions of psychological interventions in preventing relapse and recurrence. *Clinical psychology review*, **41**, 16-26 (2015).
233. Hermoso, V., Carvalho, S. B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Yates, K. L. The EU Biodiversity Strategy for 2030: Opportunities and challenges on the path towards biodiversity recovery. *Environmental Science & Policy*, **127**, 263-271 (2022).
234. Giusto, A., Jack, H. E., Magidson, J. F., Ayuku, D., Johnson, S. L., Lovero, K. L., Wainberg, M. L. Global Is local: leveraging global mental-health methods to promote equity and address disparities in the United States. *Clinical Psychological Science*, **12**, 270-289 (2024).
235. Purnell, T. S., Calhoun, E. A., Golden, S. H., Halladay, J. R., Krok-Schoen, J. L., Appelhans, B. M., Cooper, L. A. Achieving health equity: closing the gaps in health care disparities, interventions, and research. *Health Affairs*, **35**, 1410-1415 (2016).
236. Kumar, P., Brander, L., Kumar, M., Cuijpers, P. Planetary Health and Mental Health Nexus: Benefit of Environmental Management. *Annals of Global Health*, **89** (2023).
237. Barnes, N., Torao-Angosto, M., Slater, M., Sanchez-Vives, M. V. Virtual reality for mental health and in the rehabilitation of violent behaviours. Fonseca, *Journal of Communication*, **28**, 10-46 (2024).
238. Webb, C. A., Hirshberg, M. J., Davidson, R. J., & Goldberg, S. B. Personalized prediction of response to smartphone-delivered meditation training: Randomized controlled trial. *Journal of Medical Internet Research*, **24**, 41566 (2022).
239. Williams, L. M., Hack, L. M. (Eds.). Precision psychiatry: Using neuroscience insights to inform personally tailored, measurement-based care. *American Psychiatric Pub.* (2021).
240. Firth, J., Torous, J., López-Gil, J. F., Linardon, J., Milton, A., Lambert, J., Firth, J. A. From “online brains” to “online lives”: understanding the individualized impacts of Internet use across psychological, cognitive and social dimensions. *World Psychiatry*, **23**, 176-190 (2024).
241. States of Fragility 2022, OECD pub.
242. Butler, L. D., Critelli, F. M., Rinfrette, E. S. Trauma-informed care and mental health. *Directions in Psychiatry*, **31**, 197-212 (2011).
243. Marmot, M., Bell, R. Fair society, healthy lives. (2015).
244. Buckman, J. E., Saunders, R., Stott, J., Cohen, Z. D., Arundell, L. L., Eley, T. C., Pilling, S. Socioeconomic indicators of treatment prognosis for adults with depression: a systematic review and individual patient data meta-analysis. *JAMA psychiatry*, **79**, 406-416 (2022).

References

245. Buckman, J. E., Stott, J., Main, N., Antonie, D. M., Singh, S., Naqvi, S. A., Saunders, R. Understanding the psychological therapy treatment outcomes for young adults who are not in education, employment, or training (NEET), moderators of outcomes, and what might be done to improve them. *Psychological medicine*, **53**, 2808-2819 (2023).
246. Saunders, R., Cohen, Z. D., Ambler, G., DeRubeis, R. J., Wiles, N., Kessler, D., Buckman, J. E. A patient stratification approach to identifying the likelihood of continued chronic depression and relapse following treatment for depression. *Journal of Personalized Medicine*, **11**, 1295 (2021).
247. Agarwal, B., Brooks, S. K., Greenberg, N. The role of peer support in managing occupational stress: a qualitative study of the sustaining resilience at work intervention. *Workplace Health & Safety*, **68**, 57-64 (2020).
248. Pinheiro, M., Ivandic, I., Razzouk, D. The Economic Impact of Mental Disorders and Mental Health Problems in the Workplace. In: Razzouk, D. (eds) *Mental Health Economics*. Springer (2017).
249. Kirby, A., Smith, T. Neurodiversity at work: Drive innovation, performance and productivity with a neurodiverse workforce. *Kogan Page Publishers* (2021).
250. Van Kamp, I., Van der Velden, P. G., Stellato, R. K., Roorda, J., Van Loon, J., Kleber, R. J., Lebet, E. Physical and mental health shortly after a disaster: first results from the Enschede firework disaster study. *The European Journal of Public Health*, **16**, 252-258 (2006).
251. Sandifer, P. A., Sutton-Grier, A. E., & Ward, B. P. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosystem services*, **12**, 1-15 (2015).
252. Act, S. M. Communication from the commission to the european parliament, the council, the economic and social committee and the committee of the regions (2011).
253. Maes, J., Quaglia, A., Pereira, Â., Tokarski, M., Zulian, G., Marando, F., & Schade, S. BiodiverCities: A roadmap to enhance the biodiversity and green infrastructure of European cities by 2030 BiodiverCities: A roadmap to enhance the. Publications Office of the European Union, Luxembourg (2021).
254. Clark, J. S., Dyer, K. A., Davis, C. R., Shivappa, N., Hébert, J. R., Woodman, R., Murphy, K. J. Adherence to a mediterranean diet for 6 months improves the dietary inflammatory index in a western population: Results from the medley study. *Nutrients*, **15**, 366 (2023).
255. Sarris, J., Murphy, J., Mischoulon, D., Papakostas, G. I., Fava, M., Berk, M., & Ng, C. H. Adjunctive nutraceuticals for depression: a systematic review and meta-analyses. *American Journal of Psychiatry*, **173**, 575-587 (2016).
256. Firth, J., Teasdale, S. B., Allott, K., Siskind, D., Marx, W., Cotter, J., Sarris, J. The efficacy and safety of nutrient supplements in the treatment of mental disorders: a meta-review of meta-analyses of randomized controlled trials. *World Psychiatry*, **18**, 308-324 (2019).
257. Sarris, J., Panossian, A., Schweitzer, I., Stough, C., & Scholey, A. Herbal medicine for depression, anxiety and insomnia: a review of psychopharmacology and clinical evidence. *European neuropsychopharmacology*, **21**, 841-860 (2011).

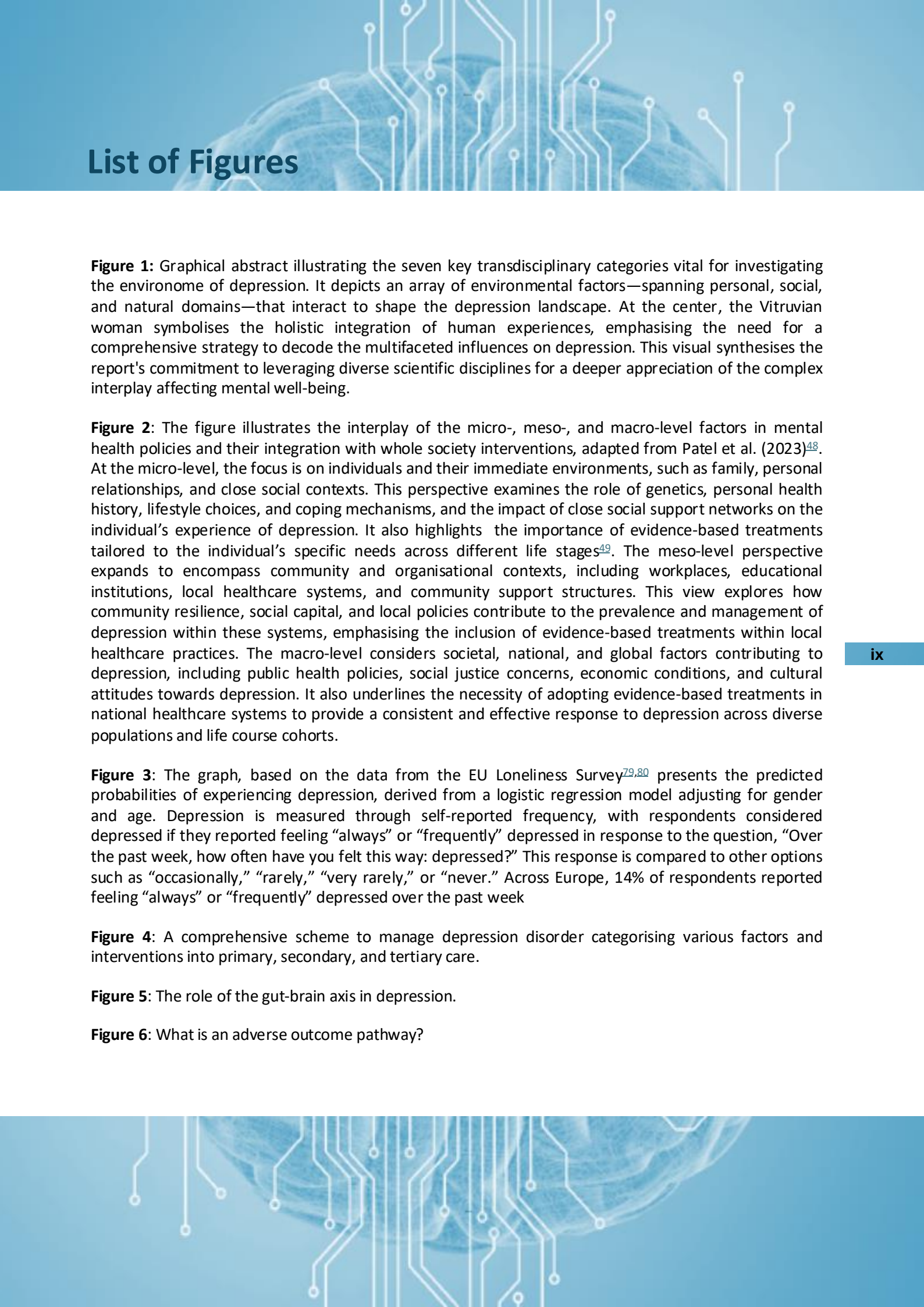
References

- 258.Firth, J., Marx, W., Dash, S., Carney, R., Teasdale, S. B., Solmi, M., Sarris, J. The effects of dietary improvement on symptoms of depression and anxiety: a meta-analysis of randomized controlled trials. *Psychosomatic medicine*, **81**, 265-280 (2019).
- 259.Freeman, D., Sheaves, B., Goodwin, G. M., Yu, L. M., Nickless, A., Harrison, P. J., Espie, C. A. The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. *The Lancet Psychiatry*, **4**, 749-758 (2017).
- 260.Sarris, J., & Byrne, G. J. A systematic review of insomnia and complementary medicine. *Sleep medicine reviews*, **15**, 99-106 (2011).
- 261.Sarris, J., O'Neil, A., Coulson, C. E., Schweitzer, I., & Berk, M. Lifestyle medicine for depression. *BMC psychiatry*, **14**, 1-13 (2014).
- 262.Firth, J., Siddiqi, N., Koyanagi, A. I., Siskind, D., Rosenbaum, S., Galletly, C., Stubbs, B. The Lancet Psychiatry Commission: a blueprint for protecting physical health in people with mental illness. *The Lancet Psychiatry*, **6**, 675-712 (2019).
- 263.Nail-Beatty, O., Ibanez, A., Ayadi, R., Swieboda, P., Njamnshi, A. K., Occhipinti, J. A., Eyre, H. A. Brain health is essential for smooth economic transitions: towards socio-economic sustainability, productivity and well-being. *Brain Communications*, **6** (2024).
- 264.Ridley, M., Rao, G., Schilbach, F., & Patel, V. Poverty, depression, and anxiety: Causal evidence and mechanisms. *Science*, **370** (2020).
- 265.Directorate-General for Education, Youth, Sport and Culture (European Commission), Wellbeing and mental health at school. Guidelines for education policymakers, school leaders, teachers and educators (2024).
- 266.Directorate-General for Education, Youth, Sport and Culture (European Commission), Pathways to school success (2024).
- 267.Kundu, S., Sair, H., Sherr, E. H., Mukherjee, P., & Rohde, G. K. Discovering the gene-brain-behavior link in autism via generative machine learning. *Science Advances*, **10** (2024).
- 268.Firth, Joseph, et al. The Lancet Psychiatry Commission: a blueprint for protecting physical health in people with mental illness. *The Lancet Psychiatry*, **6**, 675-712 (2019)
- 269.Saunders, R., Buckman, J. E., Stott, J., Leibowitz, J., Aguirre, E., John, A., Pilling, S. Older adults respond better to psychological therapy than working-age adults: evidence from a large sample of mental health service attendees. *Journal of affective disorders*, **294**, 85-93 (2021).
- 270.Adler, D.A., Stamatis, C.A., Meyerhoff, J. et al. Measuring algorithmic bias to analyze the reliability of AI tools that predict depression risk using smartphone sensed-behavioral data. *npj Mental Health Res* **3**, 17 (2024).
- 271.Koutsouleris, N., Hauser, T. U., Skvortsova, V., & De Choudhury, M. From promise to practice: towards the realisation of AI-informed mental health care. *The Lancet Digital Health*, **4**, 829-840 (2022).
- 272.Deisenhofer, A. K., Barkham, M., Beierl, E. T., Schwartz, B., Aafjes-van Doorn, K., Beevers, C. G., Cohen, Z. D. (2024). Implementing precision methods in personalizing psychological therapies: Barriers and possible ways forward. *Behaviour research and therapy*, **172** (2024).



References

273. Sala, A., Porcaro, L., Gómez, E. Social Media Use and adolescents' mental health and well-being: An umbrella review. *Computers in Human Behavior Reports*, **14** (2024).
274. Stall, S., Yarmey, L., Cutcher-Gershenfeld, J., Hanson, B., Lehnert, K., Nosek, B., Wyborn, L.. Make scientific data FAIR. *Nature*, **570**, 27-29 (2019).
275. Hupont, I., Tolan, S., Gunes, H., & Gómez, E. The landscape of facial processing applications in the context of the European AI Act and the development of trustworthy systems. *Scientific Reports*, **12**, (2022).
276. Barnabas, S. J., Böhme, T., Boyer, S. K., Irmer, M., Ruttkies, C., Wetherbee, I., Weber, L. Extraction of chemical structures from literature and patent documents using open access chemistry toolkits: a case study with PFAS. *Digital Discovery*, **1**, 490-501 (2022).
277. Panzarella, G., Veltri, P., Alcaro, S. Using ontologies for life science text-based resource organization. *Artificial Intelligence in the Life Sciences*, **3**, (2023).
278. Bobach, C., Böhme, T., Laube, U., Püschel, A., Weber, L. Automated compound classification using a chemical ontology. *Journal of Cheminformatics*, **4**, 1-12 (2012).



List of Figures

Figure 1: Graphical abstract illustrating the seven key transdisciplinary categories vital for investigating the environome of depression. It depicts an array of environmental factors—spanning personal, social, and natural domains—that interact to shape the depression landscape. At the center, the Vitruvian woman symbolises the holistic integration of human experiences, emphasising the need for a comprehensive strategy to decode the multifaceted influences on depression. This visual synthesises the report's commitment to leveraging diverse scientific disciplines for a deeper appreciation of the complex interplay affecting mental well-being.

Figure 2: The figure illustrates the interplay of the micro-, meso-, and macro-level factors in mental health policies and their integration with whole society interventions, adapted from Patel et al. (2023)⁴⁸. At the micro-level, the focus is on individuals and their immediate environments, such as family, personal relationships, and close social contexts. This perspective examines the role of genetics, personal health history, lifestyle choices, and coping mechanisms, and the impact of close social support networks on the individual's experience of depression. It also highlights the importance of evidence-based treatments tailored to the individual's specific needs across different life stages⁴⁹. The meso-level perspective expands to encompass community and organisational contexts, including workplaces, educational institutions, local healthcare systems, and community support structures. This view explores how community resilience, social capital, and local policies contribute to the prevalence and management of depression within these systems, emphasising the inclusion of evidence-based treatments within local healthcare practices. The macro-level considers societal, national, and global factors contributing to depression, including public health policies, social justice concerns, economic conditions, and cultural attitudes towards depression. It also underlines the necessity of adopting evidence-based treatments in national healthcare systems to provide a consistent and effective response to depression across diverse populations and life course cohorts.

Figure 3: The graph, based on the data from the EU Loneliness Survey^{79,80} presents the predicted probabilities of experiencing depression, derived from a logistic regression model adjusting for gender and age. Depression is measured through self-reported frequency, with respondents considered depressed if they reported feeling “always” or “frequently” depressed in response to the question, “Over the past week, how often have you felt this way: depressed?” This response is compared to other options such as “occasionally,” “rarely,” “very rarely,” or “never.” Across Europe, 14% of respondents reported feeling “always” or “frequently” depressed over the past week

Figure 4: A comprehensive scheme to manage depression disorder categorising various factors and interventions into primary, secondary, and tertiary care.

Figure 5: The role of the gut-brain axis in depression.

Figure 6: What is an adverse outcome pathway?



List of Figures

Figure 7: Global, interpersonal, and intrapersonal factors contributing to adverse outcomes associated with depression.

Figure 8: One Mental Health (OMH) framework grouping the sustainable development goals (SDGs). It reflects a global perspective on mental well-being that originates from individual mental health - One Mental Health - to become global - Global Mental Health, encompassing key intervention areas such as healthcare, social inclusion, education, art, public health, environmental health, and technology.

Figure 9: The InDepDash - Interactive Depression Dashboard - is designed to synthesise the vast and continuously evolving evidence-based knowledge and scientific literature, mapping the environome of depression.

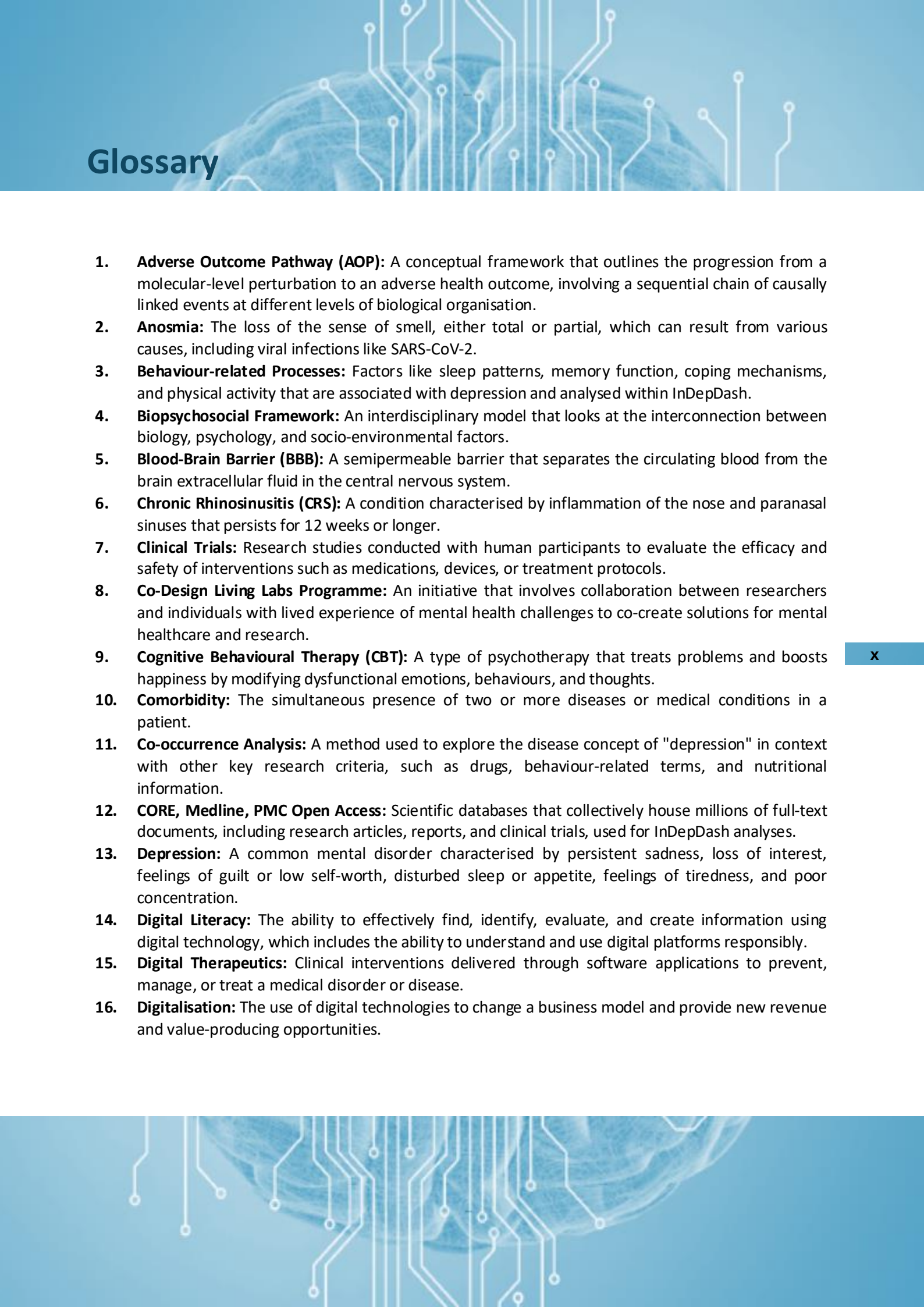
Figure A1. Overview of the semantic architecture underlying InDepDash.

Figure A2: Some levels of the Disease hierarchical taxonomy within *Sodiad* platform^{[278](#)}.

Figure A3: The trend line over the last 20 years encompasses PMC Open Access repository. The trend line reveals a substantial growth trajectory in depression research, especially between 2016 and 2022.

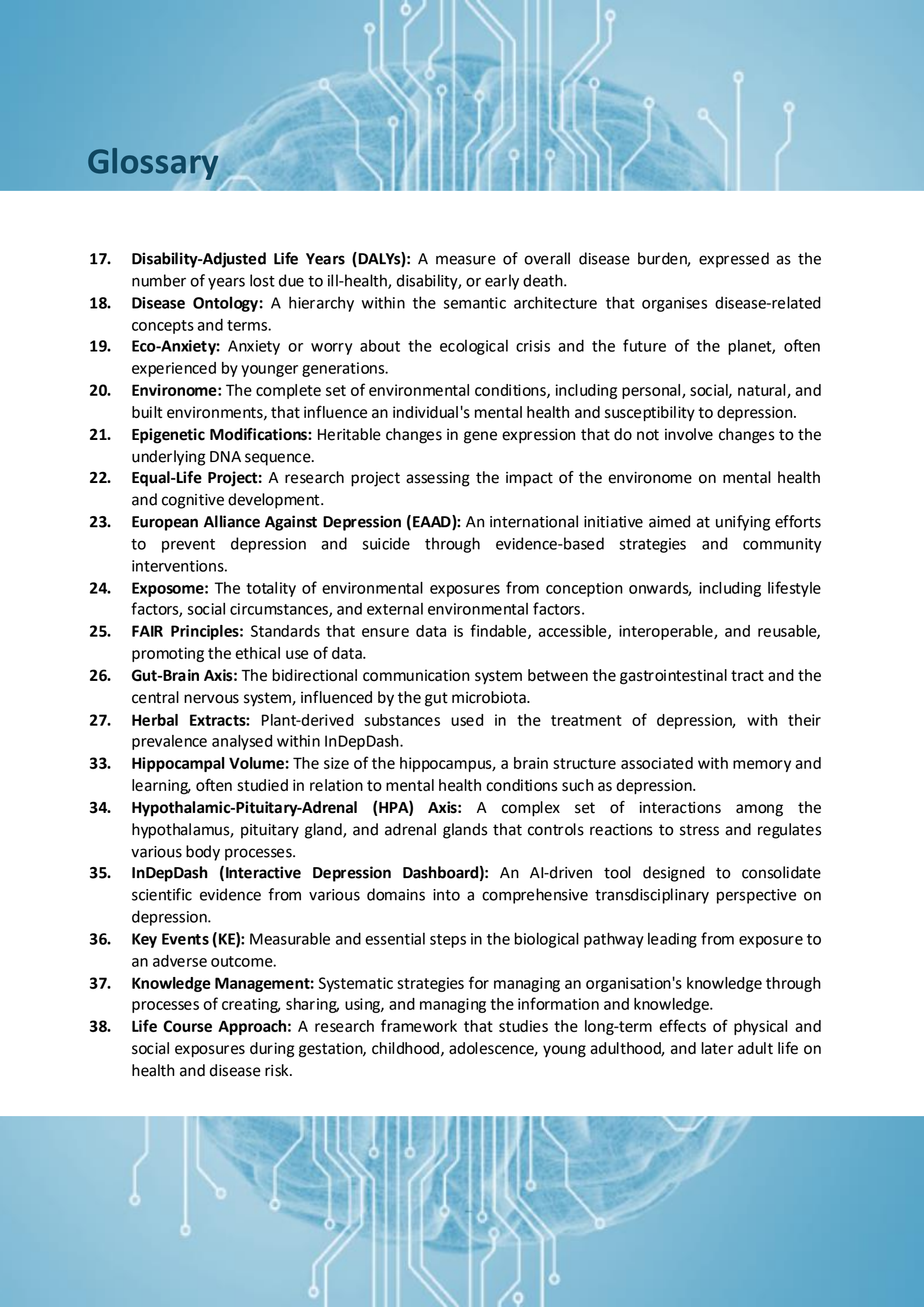
Figure A4: Quarterly analysis over the last 5 years.





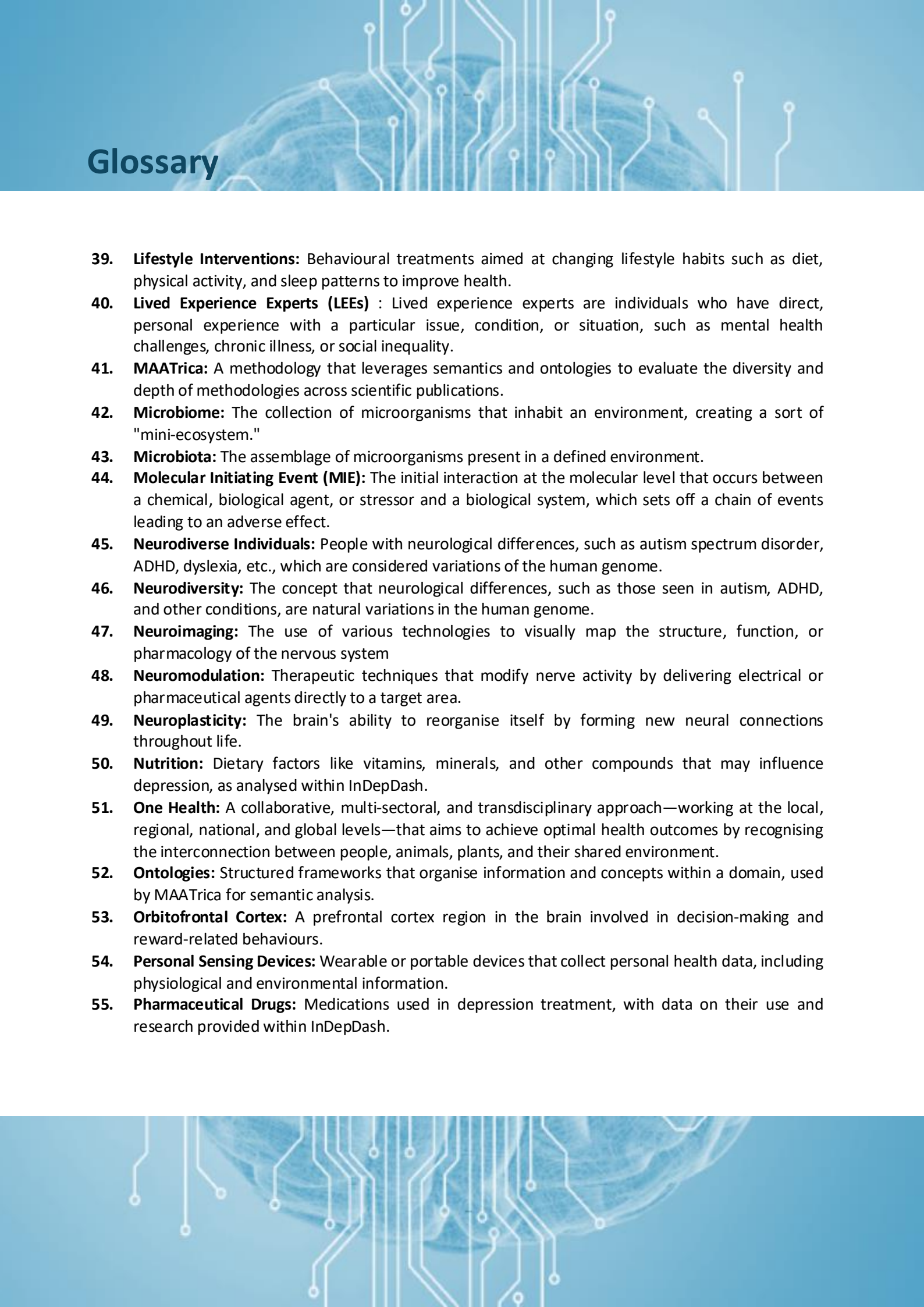
Glossary

1. **Adverse Outcome Pathway (AOP):** A conceptual framework that outlines the progression from a molecular-level perturbation to an adverse health outcome, involving a sequential chain of causally linked events at different levels of biological organisation.
2. **Anosmia:** The loss of the sense of smell, either total or partial, which can result from various causes, including viral infections like SARS-CoV-2.
3. **Behaviour-related Processes:** Factors like sleep patterns, memory function, coping mechanisms, and physical activity that are associated with depression and analysed within InDepDash.
4. **Biopsychosocial Framework:** An interdisciplinary model that looks at the interconnection between biology, psychology, and socio-environmental factors.
5. **Blood-Brain Barrier (BBB):** A semipermeable barrier that separates the circulating blood from the brain extracellular fluid in the central nervous system.
6. **Chronic Rhinosinusitis (CRS):** A condition characterised by inflammation of the nose and paranasal sinuses that persists for 12 weeks or longer.
7. **Clinical Trials:** Research studies conducted with human participants to evaluate the efficacy and safety of interventions such as medications, devices, or treatment protocols.
8. **Co-Design Living Labs Programme:** An initiative that involves collaboration between researchers and individuals with lived experience of mental health challenges to co-create solutions for mental healthcare and research.
9. **Cognitive Behavioural Therapy (CBT):** A type of psychotherapy that treats problems and boosts happiness by modifying dysfunctional emotions, behaviours, and thoughts.
10. **Comorbidity:** The simultaneous presence of two or more diseases or medical conditions in a patient.
11. **Co-occurrence Analysis:** A method used to explore the disease concept of "depression" in context with other key research criteria, such as drugs, behaviour-related terms, and nutritional information.
12. **CORE, Medline, PMC Open Access:** Scientific databases that collectively house millions of full-text documents, including research articles, reports, and clinical trials, used for InDepDash analyses.
13. **Depression:** A common mental disorder characterised by persistent sadness, loss of interest, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness, and poor concentration.
14. **Digital Literacy:** The ability to effectively find, identify, evaluate, and create information using digital technology, which includes the ability to understand and use digital platforms responsibly.
15. **Digital Therapeutics:** Clinical interventions delivered through software applications to prevent, manage, or treat a medical disorder or disease.
16. **Digitalisation:** The use of digital technologies to change a business model and provide new revenue and value-producing opportunities.



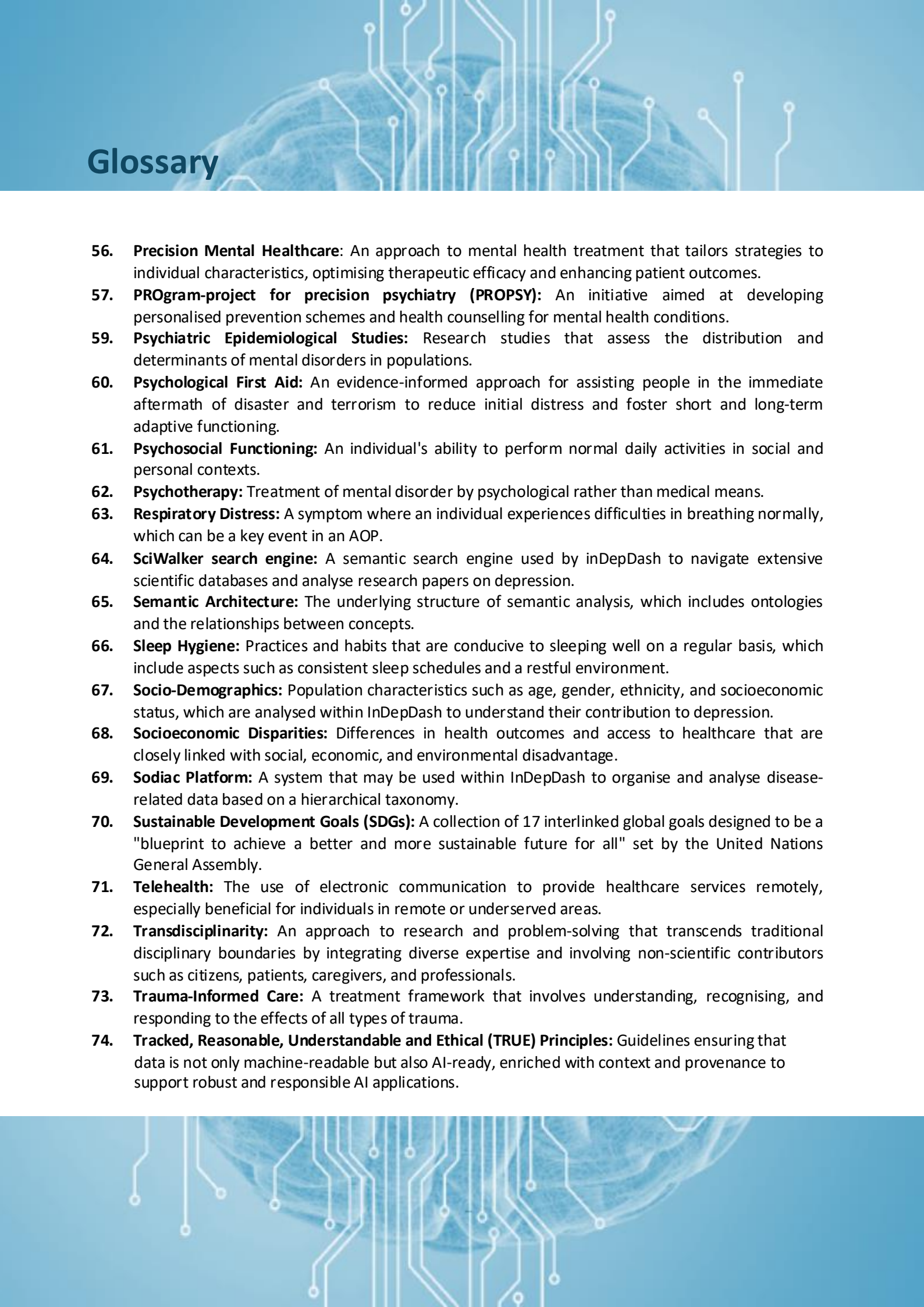
Glossary

17. **Disability-Adjusted Life Years (DALYs):** A measure of overall disease burden, expressed as the number of years lost due to ill-health, disability, or early death.
18. **Disease Ontology:** A hierarchy within the semantic architecture that organises disease-related concepts and terms.
19. **Eco-Anxiety:** Anxiety or worry about the ecological crisis and the future of the planet, often experienced by younger generations.
20. **Environome:** The complete set of environmental conditions, including personal, social, natural, and built environments, that influence an individual's mental health and susceptibility to depression.
21. **Epigenetic Modifications:** Heritable changes in gene expression that do not involve changes to the underlying DNA sequence.
22. **Equal-Life Project:** A research project assessing the impact of the environome on mental health and cognitive development.
23. **European Alliance Against Depression (EAAD):** An international initiative aimed at unifying efforts to prevent depression and suicide through evidence-based strategies and community interventions.
24. **Exposome:** The totality of environmental exposures from conception onwards, including lifestyle factors, social circumstances, and external environmental factors.
25. **FAIR Principles:** Standards that ensure data is findable, accessible, interoperable, and reusable, promoting the ethical use of data.
26. **Gut-Brain Axis:** The bidirectional communication system between the gastrointestinal tract and the central nervous system, influenced by the gut microbiota.
27. **Herbal Extracts:** Plant-derived substances used in the treatment of depression, with their prevalence analysed within InDepDash.
33. **Hippocampal Volume:** The size of the hippocampus, a brain structure associated with memory and learning, often studied in relation to mental health conditions such as depression.
34. **Hypothalamic-Pituitary-Adrenal (HPA) Axis:** A complex set of interactions among the hypothalamus, pituitary gland, and adrenal glands that controls reactions to stress and regulates various body processes.
35. **InDepDash (Interactive Depression Dashboard):** An AI-driven tool designed to consolidate scientific evidence from various domains into a comprehensive transdisciplinary perspective on depression.
36. **Key Events (KE):** Measurable and essential steps in the biological pathway leading from exposure to an adverse outcome.
37. **Knowledge Management:** Systematic strategies for managing an organisation's knowledge through processes of creating, sharing, using, and managing the information and knowledge.
38. **Life Course Approach:** A research framework that studies the long-term effects of physical and social exposures during gestation, childhood, adolescence, young adulthood, and later adult life on health and disease risk.



Glossary

39. **Lifestyle Interventions:** Behavioural treatments aimed at changing lifestyle habits such as diet, physical activity, and sleep patterns to improve health.
40. **Lived Experience Experts (LEEs) :** Lived experience experts are individuals who have direct, personal experience with a particular issue, condition, or situation, such as mental health challenges, chronic illness, or social inequality.
41. **MAATrica:** A methodology that leverages semantics and ontologies to evaluate the diversity and depth of methodologies across scientific publications.
42. **Microbiome:** The collection of microorganisms that inhabit an environment, creating a sort of "mini-ecosystem."
43. **Microbiota:** The assemblage of microorganisms present in a defined environment.
44. **Molecular Initiating Event (MIE):** The initial interaction at the molecular level that occurs between a chemical, biological agent, or stressor and a biological system, which sets off a chain of events leading to an adverse effect.
45. **Neurodiverse Individuals:** People with neurological differences, such as autism spectrum disorder, ADHD, dyslexia, etc., which are considered variations of the human genome.
46. **Neurodiversity:** The concept that neurological differences, such as those seen in autism, ADHD, and other conditions, are natural variations in the human genome.
47. **Neuroimaging:** The use of various technologies to visually map the structure, function, or pharmacology of the nervous system
48. **Neuromodulation:** Therapeutic techniques that modify nerve activity by delivering electrical or pharmaceutical agents directly to a target area.
49. **Neuroplasticity:** The brain's ability to reorganise itself by forming new neural connections throughout life.
50. **Nutrition:** Dietary factors like vitamins, minerals, and other compounds that may influence depression, as analysed within InDepDash.
51. **One Health:** A collaborative, multi-sectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—that aims to achieve optimal health outcomes by recognising the interconnection between people, animals, plants, and their shared environment.
52. **Ontologies:** Structured frameworks that organise information and concepts within a domain, used by MAATrica for semantic analysis.
53. **Orbitofrontal Cortex:** A prefrontal cortex region in the brain involved in decision-making and reward-related behaviours.
54. **Personal Sensing Devices:** Wearable or portable devices that collect personal health data, including physiological and environmental information.
55. **Pharmaceutical Drugs:** Medications used in depression treatment, with data on their use and research provided within InDepDash.



Glossary

- 56. **Precision Mental Healthcare:** An approach to mental health treatment that tailors strategies to individual characteristics, optimising therapeutic efficacy and enhancing patient outcomes.
- 57. **PROgram-project for precision psychiatry (PROPSY):** An initiative aimed at developing personalised prevention schemes and health counselling for mental health conditions.
- 59. **Psychiatric Epidemiological Studies:** Research studies that assess the distribution and determinants of mental disorders in populations.
- 60. **Psychological First Aid:** An evidence-informed approach for assisting people in the immediate aftermath of disaster and terrorism to reduce initial distress and foster short and long-term adaptive functioning.
- 61. **Psychosocial Functioning:** An individual's ability to perform normal daily activities in social and personal contexts.
- 62. **Psychotherapy:** Treatment of mental disorder by psychological rather than medical means.
- 63. **Respiratory Distress:** A symptom where an individual experiences difficulties in breathing normally, which can be a key event in an AOP.
- 64. **SciWalker search engine:** A semantic search engine used by inDepDash to navigate extensive scientific databases and analyse research papers on depression.
- 65. **Semantic Architecture:** The underlying structure of semantic analysis, which includes ontologies and the relationships between concepts.
- 66. **Sleep Hygiene:** Practices and habits that are conducive to sleeping well on a regular basis, which include aspects such as consistent sleep schedules and a restful environment.
- 67. **Socio-Demographics:** Population characteristics such as age, gender, ethnicity, and socioeconomic status, which are analysed within InDepDash to understand their contribution to depression.
- 68. **Socioeconomic Disparities:** Differences in health outcomes and access to healthcare that are closely linked with social, economic, and environmental disadvantage.
- 69. **Sodiac Platform:** A system that may be used within InDepDash to organise and analyse disease-related data based on a hierarchical taxonomy.
- 70. **Sustainable Development Goals (SDGs):** A collection of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all" set by the United Nations General Assembly.
- 71. **Telehealth:** The use of electronic communication to provide healthcare services remotely, especially beneficial for individuals in remote or underserved areas.
- 72. **Transdisciplinarity:** An approach to research and problem-solving that transcends traditional disciplinary boundaries by integrating diverse expertise and involving non-scientific contributors such as citizens, patients, caregivers, and professionals.
- 73. **Trauma-Informed Care:** A treatment framework that involves understanding, recognising, and responding to the effects of all types of trauma.
- 74. **Tracked, Reasonable, Understandable and Ethical (TRUE) Principles:** Guidelines ensuring that data is not only machine-readable but also AI-ready, enriched with context and provenance to support robust and responsible AI applications.



Glossary

- 75. **Virtual Reality-Based Exposure Therapy:** A type of therapy that uses virtual reality technology to expose patients to stimuli related to their psychological conditions in a controlled environment to help them overcome their disorders.
 - 76. **Wastewater Surveillance:** The monitoring of wastewater to detect the presence of specific substances, providing insights into the health of a population.
- 

Annexes

Annex 1. Description of the Interactive Depression Dashboard (InDepDash)

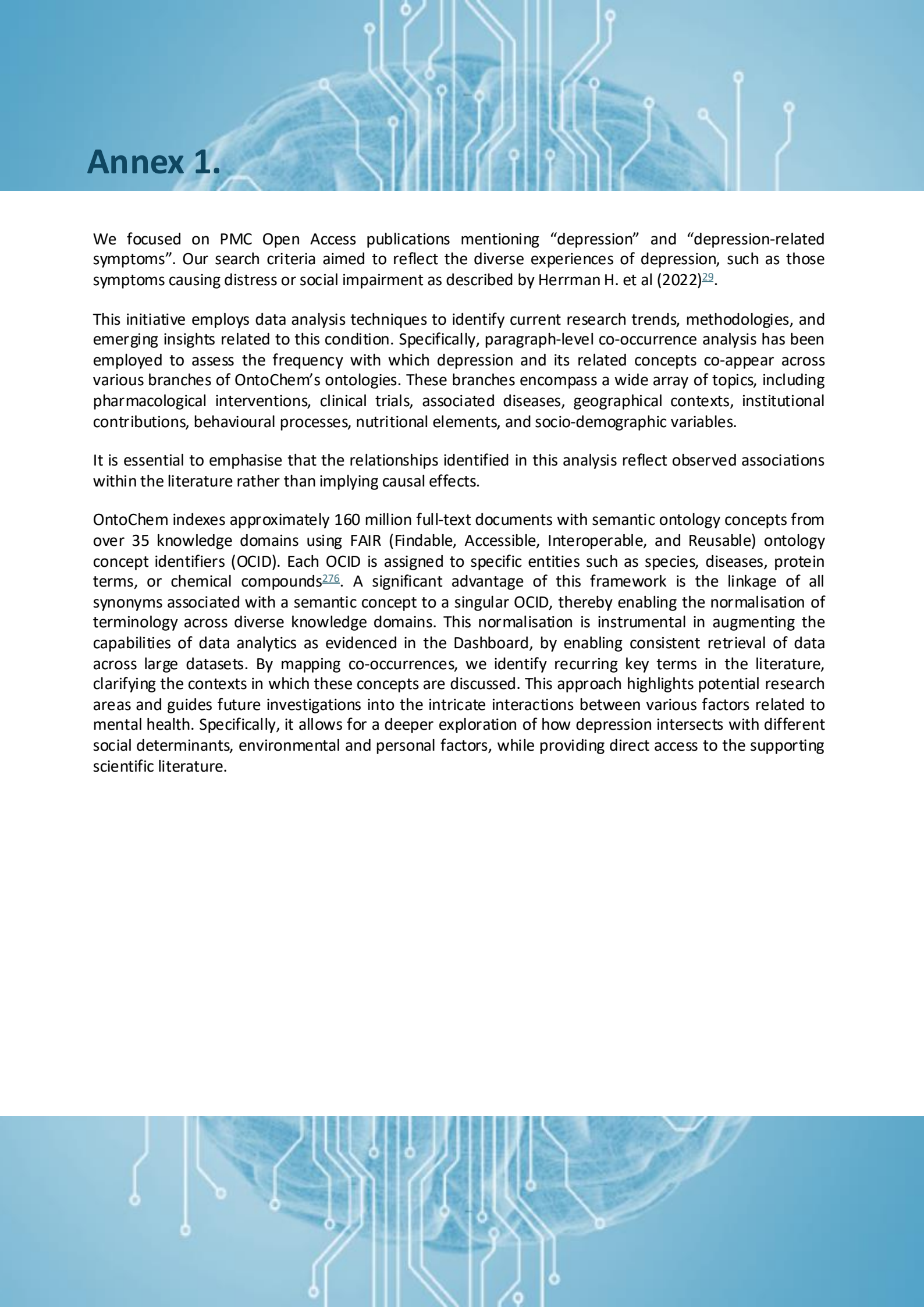


This science for policy report is complemented by the interactive depression dashboard, *InDepDash*. Two supporting videos are provided: the [first](#) (1.) demonstrates the platform's main functionality, while the [second](#) (2.) presents an overview of its purpose and context. As *InDepDash* undergoes further refinement before its public release, these videos offer an initial perspective on its potential contributions to science for policy initiatives.

In our research, we utilised comprehensive databases such as PubMed, Scopus, Web of Science, and PMC Open Access. These databases collectively serve as a repository for a vast and continuously expanding trove of peer reviewed articles, clinical trial reports, review papers, and other critical full-text documents that are essential for the advancement of scientific knowledge across a multitude of disciplines. *InDepDash* currently accesses only PMC Open Access articles, with each dashboard section linking directly to the supporting literature for detailed exploration. The quantitative insights formed the foundation for evidence-based policy recommendations, which were refined in structured expert meetings through discussions with healthcare professionals, individuals with lived experience, and other stakeholders. This integrated approach ensures that the policy recommendations are both methodologically sound and enriched by diverse, transdisciplinary perspectives.

By consolidating diverse data sources into a single, accessible, and open platform, *InDepDash* serves as a centralised information hub, offering a comprehensive navigation and synthesis of the extensive and evolving scientific research on the field, enhancing access to and utilisation of comprehensive depression-related data. Policymakers and health authorities can benefit from having the most current information at their fingertips, enabling them to understand and explore the current transdisciplinary landscape of depression research, addressing emerging mental health trends and crises.

Given the heterogeneous nature of depression, which manifests through various combinations of signs and symptoms, severity levels, and longitudinal trajectories, our search strategy was designed to encompass a wide array of related terminologies.



Annex 1.

We focused on PMC Open Access publications mentioning “depression” and “depression-related symptoms”. Our search criteria aimed to reflect the diverse experiences of depression, such as those symptoms causing distress or social impairment as described by Herrman H. et al (2022)²⁹.

This initiative employs data analysis techniques to identify current research trends, methodologies, and emerging insights related to this condition. Specifically, paragraph-level co-occurrence analysis has been employed to assess the frequency with which depression and its related concepts co-appear across various branches of OntoChem’s ontologies. These branches encompass a wide array of topics, including pharmacological interventions, clinical trials, associated diseases, geographical contexts, institutional contributions, behavioural processes, nutritional elements, and socio-demographic variables.

It is essential to emphasise that the relationships identified in this analysis reflect observed associations within the literature rather than implying causal effects.

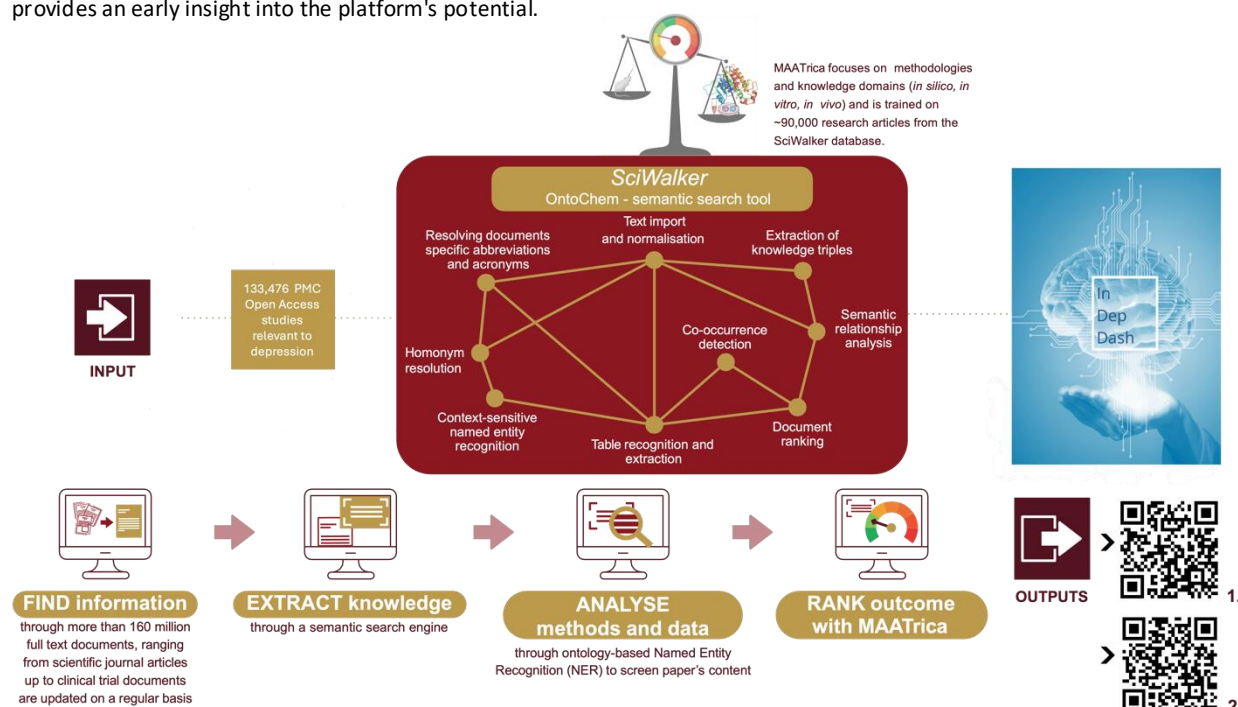
OntoChem indexes approximately 160 million full-text documents with semantic ontology concepts from over 35 knowledge domains using FAIR (Findable, Accessible, Interoperable, and Reusable) ontology concept identifiers (OCID). Each OCID is assigned to specific entities such as species, diseases, protein terms, or chemical compounds²⁷⁶. A significant advantage of this framework is the linkage of all synonyms associated with a semantic concept to a singular OCID, thereby enabling the normalisation of terminology across diverse knowledge domains. This normalisation is instrumental in augmenting the capabilities of data analytics as evidenced in the Dashboard, by enabling consistent retrieval of data across large datasets. By mapping co-occurrences, we identify recurring key terms in the literature, clarifying the contexts in which these concepts are discussed. This approach highlights potential research areas and guides future investigations into the intricate interactions between various factors related to mental health. Specifically, it allows for a deeper exploration of how depression intersects with different social determinants, environmental and personal factors, while providing direct access to the supporting scientific literature.

Annex 1.

InDepDash seeks to build bridges among islands of knowledge, increasing transdisciplinary information sharing. Such a tool facilitates navigation through vast literature collections, enables rapid identification of relevant studies to deepen understanding of evidence-based knowledge, and supports a proactive approach to formulating policy advice. InDepDash ensures that the data is not only machine-readable but also enriched with context and provenance to support responsible AI practices.

The data analysis of the research papers collection was conducted using the SciWalker semantic search engine, as part of the InDepDash project. SciWalker enables complete document mapping, scanning documents, text, images, chemical compounds and structures, applying ontology-driven annotation for easier analysis. Additionally, the MAATrica³⁹ metric has been incorporated (Figure A1). MAATrica is an innovative methodology that uses semantics and ontologies to evaluate research papers²⁷⁷. Designed to enhance the review process, it assesses methodological diversity across experimental approaches by systematically identifying the range of interventions reported in the literature. Each paper receives a completeness score, ranging from 0 to 100%, which is colour-coded: red indicates gaps or limitations, while green signifies a more methodologically comprehensive approach. The metric utilises three ontologies encompassing *in silico*, *in vitro*, and *in vivo* methods, helping researchers identify methodological diversity across studies.

Figure A1. Overview of the semantic architecture underlying InDepDash. The provided QR code (1.) directs to a video presentation highlighting the context and purpose of the InDepDash science-for-policy platform, as it is still being further defined prior to its public release. A second QR code (2.) provides access to a video serving as a preview of the ongoing work and provides an early insight into the platform's potential.



Source: own production.

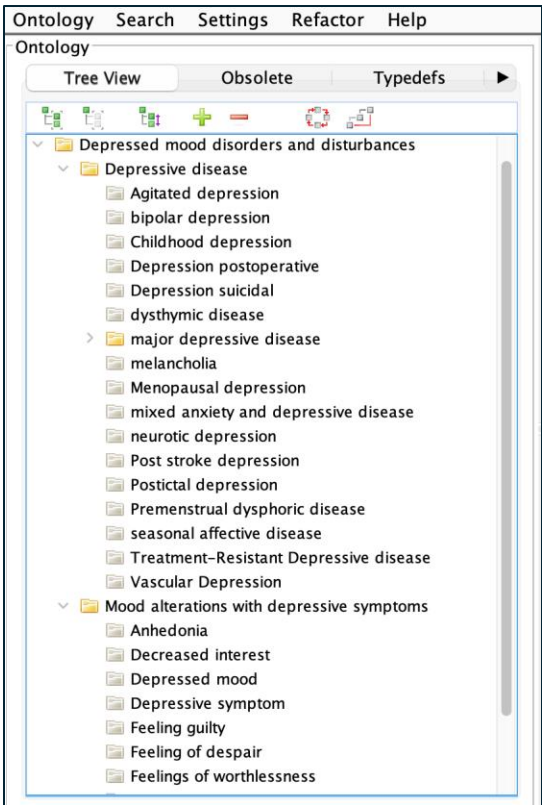
Annex 1.

We generated the paper collection results using the following link: <https://sciwalker.com/docfinder/advancedsearch>. As of January 15th, 2025, our refined and periodically updated dataset includes 139.761 PMC Open Access studies relevant to depression, for which the following query has been performed to retrieve the relevant large document set restricted to title/abstract (termloc: "ta"):

query	termloc: "ta" +(t:"depression" ocid:"206010012375")
-------	---

Users can access the provided link to replicate the query; however, it is important to note that the system continuously updates its ontologies and document collections, which may result in variations in the data over time. Figure A2 illustrates the ontology and subtree utilised for the query, representing the underlying vocabulary, specifically a segment of OntoChem's Disease Ontology.

Figure A2: Some levels of the Disease hierarchical taxonomy within SODIAC platform²⁷⁸.



Source: own production.

Annex 2. Additional InDepDash Content Information

InDepDash Description page illustrates the frequency and impact of various "environome" factors influencing depression, as evidenced by extensive literature data compiled through InDepDash.

By integrating a large volume of research findings with insights from a broad network of experts, we gain a deeper understanding of the wide-ranging influences of depression across multiple domains. Among environmental factors, natural disasters emerge as the most significant, followed by climate change and green space access. Within the personal environment, physical health, sleep disturbances, emotional regulation, memory, and substance use (e.g. smoking) are key contributors. In the social domain, influential factors include socio-economic status, education level, peer influences, social isolation, secure employment, and experiences of racism.

The quantitative findings provided the basis to develop the following evidence-based policy recommendations, which were elaborated and discussed in structured expert meetings with input from healthcare professionals, individuals with lived experience, and diverse stakeholders. This integrated approach ensures that the policy recommendations are both methodologically robust and enriched by transdisciplinary perspectives.

InDepDash advocates for ethical research practices, equitable knowledge sharing, and scientific understanding. It calls for collective action to tackle depression as a One Health and Open Science challenge, benefiting people, animals, the environment, and planetary ecosystems.

Our aim is to deepen the understanding of the complexities and transdisciplinary aspects of depression, by illustrating the integration of diverse research areas and methodologies.

This includes major clinical trials, population demographics, significant pharmacological and nutraceutical compounds, research methodologies, and critical environmental factors influencing the onset and treatment of depression. Final goal is to orchestrate coordinated, science-based policy responses.

Annex 2.

2.1 InDepDash Overview

Our initial analysis examined global trends in depression-related publications over the past two decades (Figure A3), with a particular emphasis on the past five years, analysed on a quarterly basis (Figure A4).

Figure A3: The trend line over the last 20 years encompasses PMC Open Access repository. The trend line reveals a substantial growth trajectory in depression research, especially between 2016 and 2022.

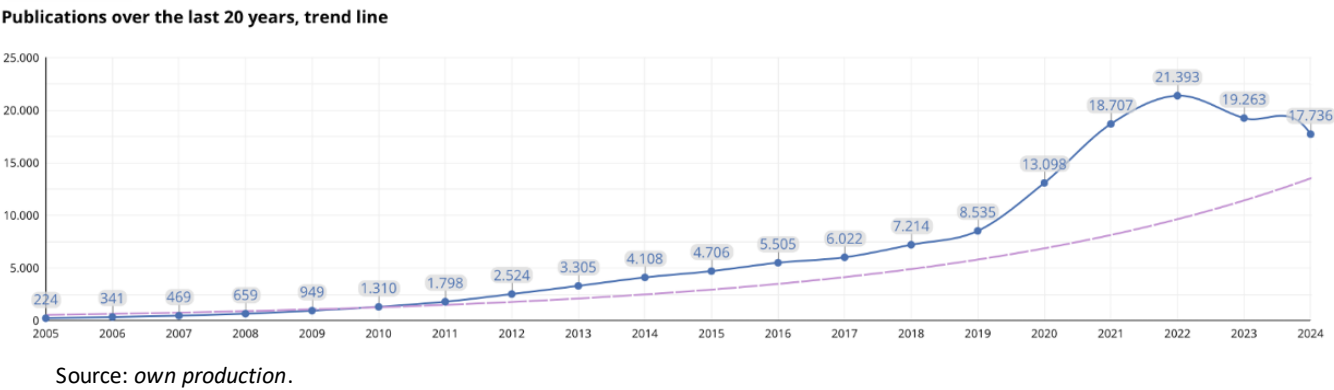
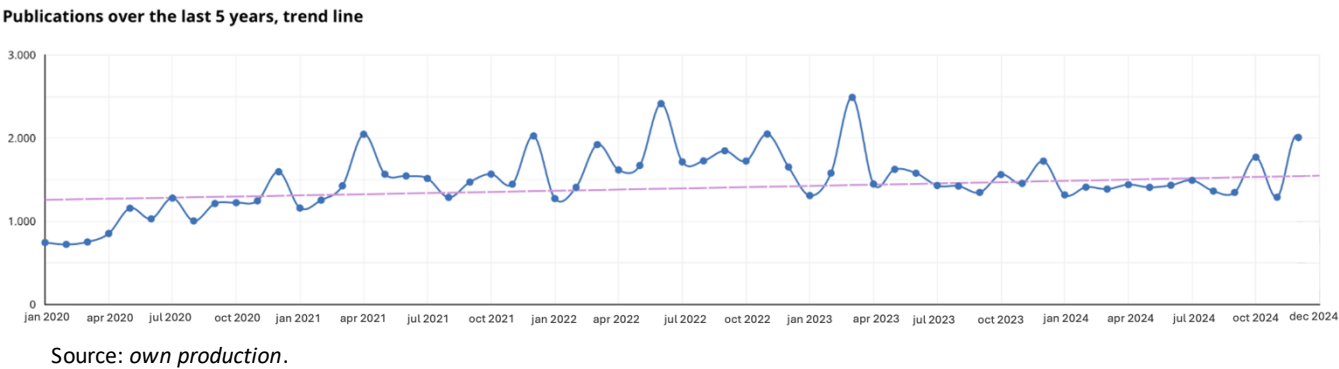


Figure A4: Quarterly analysis over the last 5 years.



This extensive exploration aims to trace global depression-related publications trend and identify, within InDepDash, the key journals contributing to the field.



Annex 2.

2.2 InDepDash *Natural Environment*

The co-occurrence analysis investigates how frequently concepts related to depression align with those linked to the natural environment. This method uncovers significant associations that highlight the crucial influence of environmental determinants on mental health. By exploring these relationships, we gain literature insights into how factors such as natural disasters and climate change affect depression and overall well-being, particularly regarding the potential for climate-related disruptions to exacerbate mental health challenges. This context allows for a comprehensive understanding of the interplay between mental health and environmental elements, opening pathways for further research and intervention strategies that incorporate these critical connections. The positive effects of green spaces on mental health have also gained considerable attention in scientific literature, contrasting sharply with the detrimental impacts of urbanisation and environmental degradation. Other factors, such as air pollution, housing quality, and environmental toxins, have also been shown to significantly influence mental health outcomes. Moreover, exposure to natural light is essential for regulating circadian rhythms, which are vital for mood stability and overall mental health. The implications of water pollution are similarly critical, as contamination disproportionately impacts vulnerable populations, exacerbating socioeconomic disparities and increasing levels of psychological distress. The findings of the InDepDash are supported by scientific literature, accessible on each dashboard page for reference.

2.3 InDepDash *Personal Environment*

The co-occurrence analysis in this section investigates how frequently concepts related to depression align with those linked to the personal environment, specifically the behavioural processes most frequently associated with depression, including factors like physical health, sleep patterns, memory function, and coping mechanisms such as avoidance and substance misuse. The findings emphasise physical health as the most significant factor, emphasising the strong link between physical and mental health. Good physical health encompasses regular exercise, a balanced diet, avoiding harmful habits, and routine medical check-ups. Physical activity, in particular, shows a strong association with depression, where decreased activity levels may contribute to its onset, while regular exercise can alleviate symptoms. The relationship between depression and sleep patterns also emerges as critical. Sleep disturbances not only exacerbate depressive symptoms but can also impede recovery, making sleep a central focus for both prevention and treatment efforts. These factors—like sleep disturbances and memory impairments—are not only symptoms of depression but also bi-directionally linked to its onset and worsening. The analysis further highlights the role of behavioural factors such as smoking and diet. Smoking can contribute to long-term mental health challenges, and poor dietary habits have been linked to a higher risk of depression. Ethnicity also appears as a key factor, indicating how socio-cultural backgrounds influence mental health outcomes. This finding aligns with research that highlights disparities in mental health among different ethnic groups due to factors like unequal access to care, cultural perceptions of mental illness, and experiences of discrimination.





Annex 2.

2.4 InDepDash *Social Environment*

The Social Environment section investigates how frequently concepts related to depression align with those linked to the social environment, showing the most prevalent sociological factors contributing to depressive conditions. This section identifies key determinants such as socioeconomic status, education, peer influence, family history and sociodemographic data as primary contributors to depression. These factors are crucial to understanding the broader context in which depressive symptoms arise, offering insights into how social determinants shape mental health outcomes. Among these, socioeconomic status is recognised as a significant factor, with evidence supporting a bidirectional causal relationship between poverty and mental health. This highlights the importance of coordinated policy action to address both issues simultaneously. Education emerges as another crucial factor in this analysis. Access to quality education not only enhances individuals' knowledge and skills but also fosters resilience against mental health challenges. Moreover, peer influence plays a vital role in shaping behaviour and attitudes towards mental health. Supportive social networks can provide crucial emotional backing, while negative peer dynamics can contribute to feelings of isolation and distress. Family history also significantly impacts mental health, as well as sociodemographic factors, including race and ethnicity.

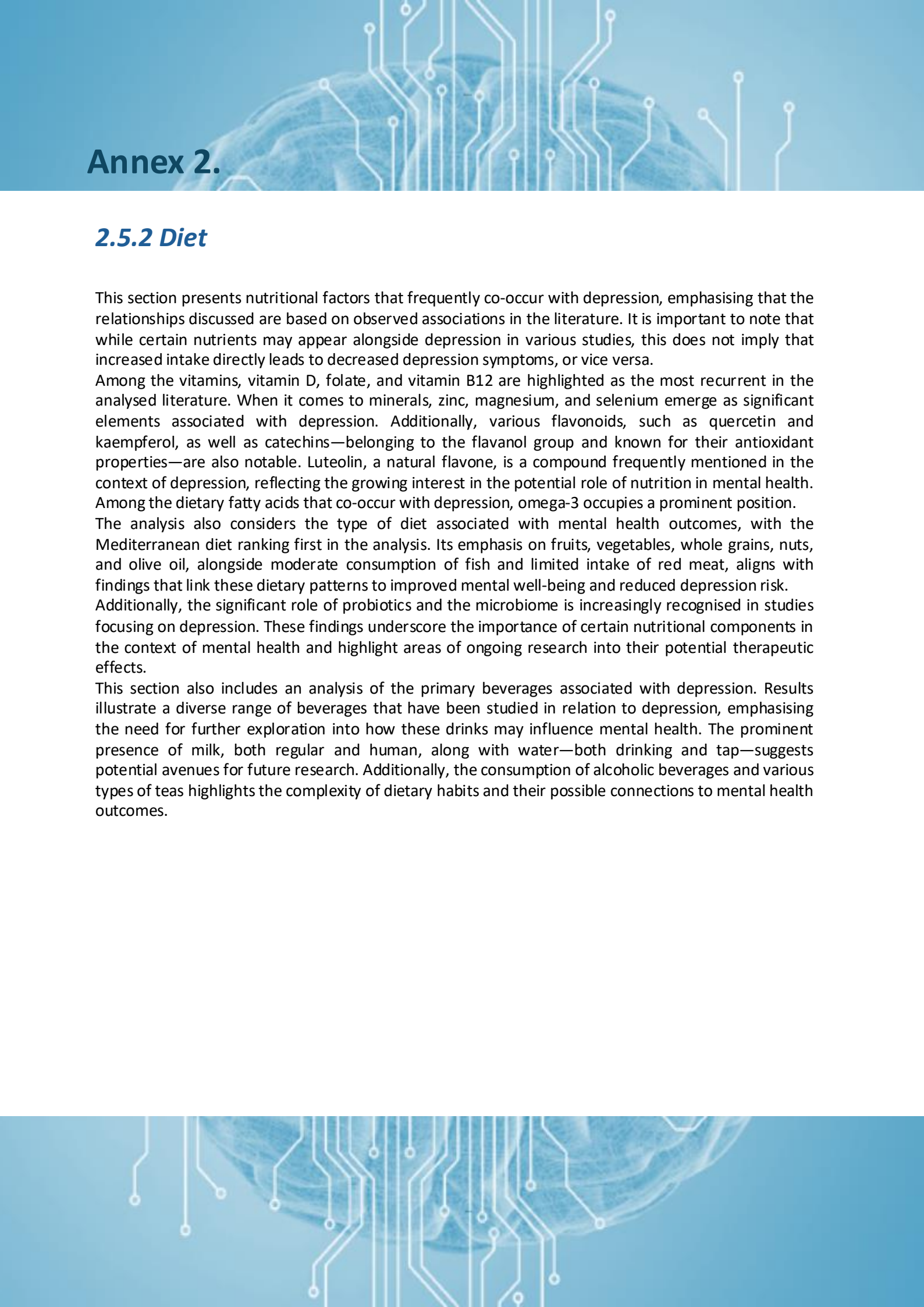
2.5 InDepDash *Additional Analysis*

2.5.1 *Drugs*

The pharmaceutical drugs section of the Dashboard highlights the 100 most studied drug classes and specific drugs used.

It offers an overview of key drugs used in treatment, along with detailed publication information. Furthermore, this section includes an analysis of herbal remedies that co-occur with depression, underscoring the increasing interest in alternative and complementary approaches to mental health care. Collectively, these analyses highlight the necessity for further research into the efficacy and mechanisms of herbal treatments, as well as their possible interactions with conventional treatments for depression.





Annex 2.

2.5.2 Diet

This section presents nutritional factors that frequently co-occur with depression, emphasising that the relationships discussed are based on observed associations in the literature. It is important to note that while certain nutrients may appear alongside depression in various studies, this does not imply that increased intake directly leads to decreased depression symptoms, or vice versa.

Among the vitamins, vitamin D, folate, and vitamin B12 are highlighted as the most recurrent in the analysed literature. When it comes to minerals, zinc, magnesium, and selenium emerge as significant elements associated with depression. Additionally, various flavonoids, such as quercetin and kaempferol, as well as catechins—belonging to the flavanol group and known for their antioxidant properties—are also notable. Luteolin, a natural flavone, is a compound frequently mentioned in the context of depression, reflecting the growing interest in the potential role of nutrition in mental health. Among the dietary fatty acids that co-occur with depression, omega-3 occupies a prominent position.

The analysis also considers the type of diet associated with mental health outcomes, with the Mediterranean diet ranking first in the analysis. Its emphasis on fruits, vegetables, whole grains, nuts, and olive oil, alongside moderate consumption of fish and limited intake of red meat, aligns with findings that link these dietary patterns to improved mental well-being and reduced depression risk.

Additionally, the significant role of probiotics and the microbiome is increasingly recognised in studies focusing on depression. These findings underscore the importance of certain nutritional components in the context of mental health and highlight areas of ongoing research into their potential therapeutic effects.

This section also includes an analysis of the primary beverages associated with depression. Results illustrate a diverse range of beverages that have been studied in relation to depression, emphasising the need for further exploration into how these drinks may influence mental health. The prominent presence of milk, both regular and human, along with water—both drinking and tap—suggests potential avenues for future research. Additionally, the consumption of alcoholic beverages and various types of teas highlights the complexity of dietary habits and their possible connections to mental health outcomes.

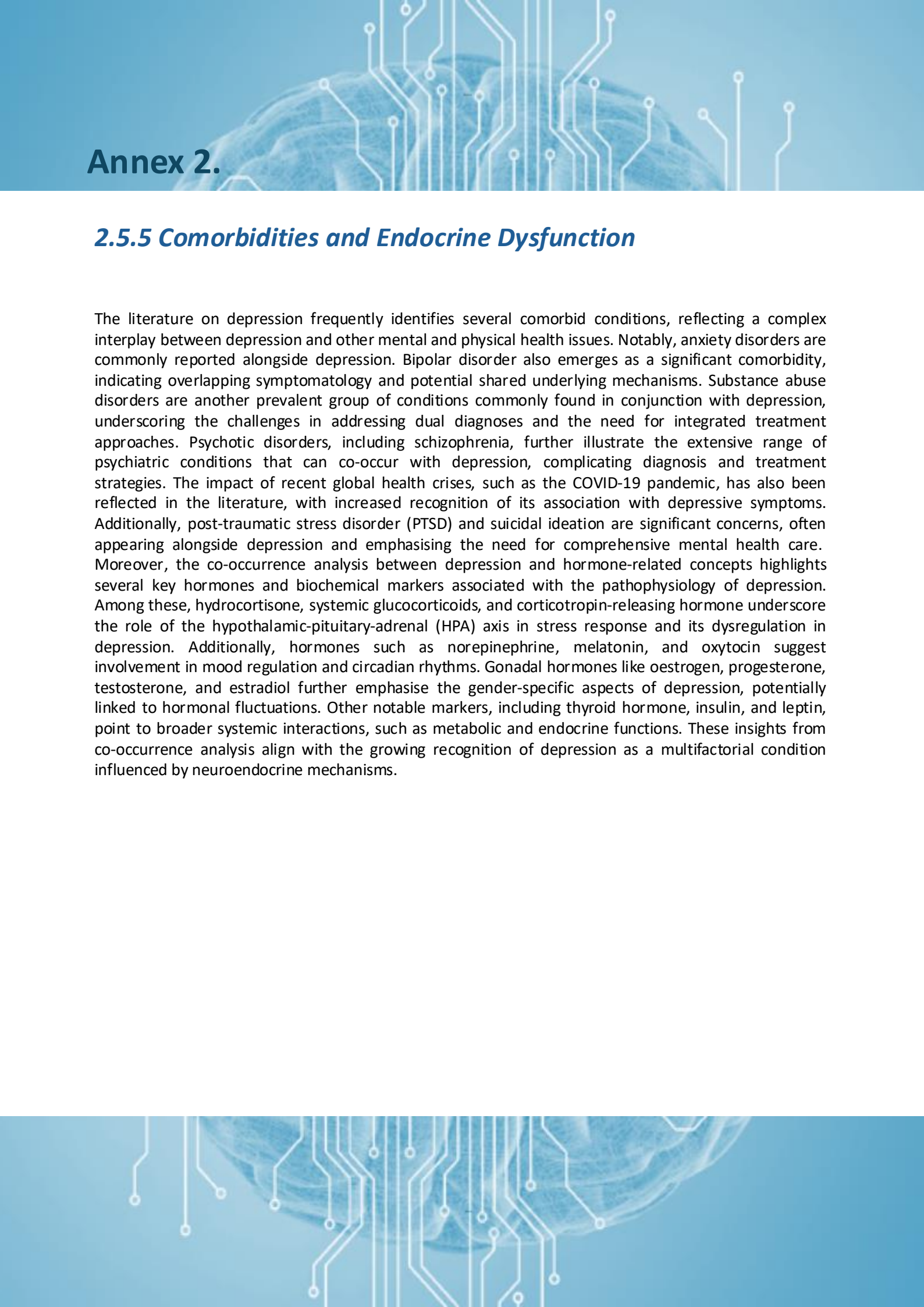
Annex 2.

2.5.3 Experimental and Observational studies

This co-occurrence investigation focuses on three ontological branches: “depression”, “experimental trials” and “observational trials”. By examining the intersections and frequency of these terms, we could gain insights into the prevalent approaches used in experimental and observational research on depression. The findings include the following types of studies for experimental trials and/or observational trials: randomised controlled trial, cohort study, cross-sectional study, longitudinal study, epidemiological study, prospective study, pilot study, observational trial, prospective cohort study, and population-based study. Following this, a subsequent co-occurrence analysis focuses on clinical trial phases, with a strong emphasis on Phase 2 and Phase 3 studies, which exhibit the highest co-occurrence rates. For instance, by clicking on “Phase 2,” users can access all documents specifically related to Phase 2 trials in the context of depression. The dashboard is designed to assist users in navigating the vast literature and rapidly identifying related relevant articles. Additional co-occurrence analyses in this section present findings related to study populations, with data categorised by age, gender, and ethnicity. Women and older adults emerge as the most frequently studied groups in the analysed depression literature. The co-occurrence analysis between depression and ethnicity reveals that African, American, and European populations are the most frequently studied groups.

2.5.4 MAATrica

MAATrica³⁹ is an innovative methodology that utilises semantics and ontologies to evaluate research papers, employing SciWalker³⁸ as its semantic search engine. This tool is designed to improve the review process by helping to uncover methodological diversity and potential lack of consistencies in research documentation. MAATrica systematically identifies the range of methodologies discussed in the literature and assigns a completeness score to the scientific paper. In the context of depression research, MAATrica reveals insights into in silico concepts, in vitro methods (with a focus on key assays), and in vivo approaches (addressing therapeutic and diagnostic procedures). This analysis highlights research domains that have been thoroughly explored while also pinpointing areas that have received less attention. It is essential to clarify that MAATrica does not assess the quality of individual papers. Instead, it evaluates them based on the methodologies and studies employed, assessing their “quantitative completeness” for the specific research topic. This methodology is particularly beneficial for scientists, researchers, and policymakers who must navigate extensive literature to identify credible and pertinent research findings. By providing a clearer understanding of the research landscape, MAATrica supports strategic policy planning. The methodology assigns a completeness score to scientific papers, ranging from 0 to 100%. These scores are colour-coded for easy interpretation: lower scores (indicated in red) signal gaps or limitations, while higher scores (shown in green) reflect a more comprehensive research approach.

A decorative background image featuring a human brain in a light blue, semi-transparent style. Overlaid on the brain are white, stylized circuit lines and nodes, resembling a neural network or a computer circuit board. The lines are thin and connect various points across the brain's surface.

Annex 2.

2.5.5 Comorbidities and Endocrine Dysfunction

The literature on depression frequently identifies several comorbid conditions, reflecting a complex interplay between depression and other mental and physical health issues. Notably, anxiety disorders are commonly reported alongside depression. Bipolar disorder also emerges as a significant comorbidity, indicating overlapping symptomatology and potential shared underlying mechanisms. Substance abuse disorders are another prevalent group of conditions commonly found in conjunction with depression, underscoring the challenges in addressing dual diagnoses and the need for integrated treatment approaches. Psychotic disorders, including schizophrenia, further illustrate the extensive range of psychiatric conditions that can co-occur with depression, complicating diagnosis and treatment strategies. The impact of recent global health crises, such as the COVID-19 pandemic, has also been reflected in the literature, with increased recognition of its association with depressive symptoms. Additionally, post-traumatic stress disorder (PTSD) and suicidal ideation are significant concerns, often appearing alongside depression and emphasising the need for comprehensive mental health care. Moreover, the co-occurrence analysis between depression and hormone-related concepts highlights several key hormones and biochemical markers associated with the pathophysiology of depression. Among these, hydrocortisone, systemic glucocorticoids, and corticotropin-releasing hormone underscore the role of the hypothalamic-pituitary-adrenal (HPA) axis in stress response and its dysregulation in depression. Additionally, hormones such as norepinephrine, melatonin, and oxytocin suggest involvement in mood regulation and circadian rhythms. Gonadal hormones like oestrogen, progesterone, testosterone, and estradiol further emphasise the gender-specific aspects of depression, potentially linked to hormonal fluctuations. Other notable markers, including thyroid hormone, insulin, and leptin, point to broader systemic interactions, such as metabolic and endocrine functions. These insights from co-occurrence analysis align with the growing recognition of depression as a multifactorial condition influenced by neuroendocrine mechanisms.



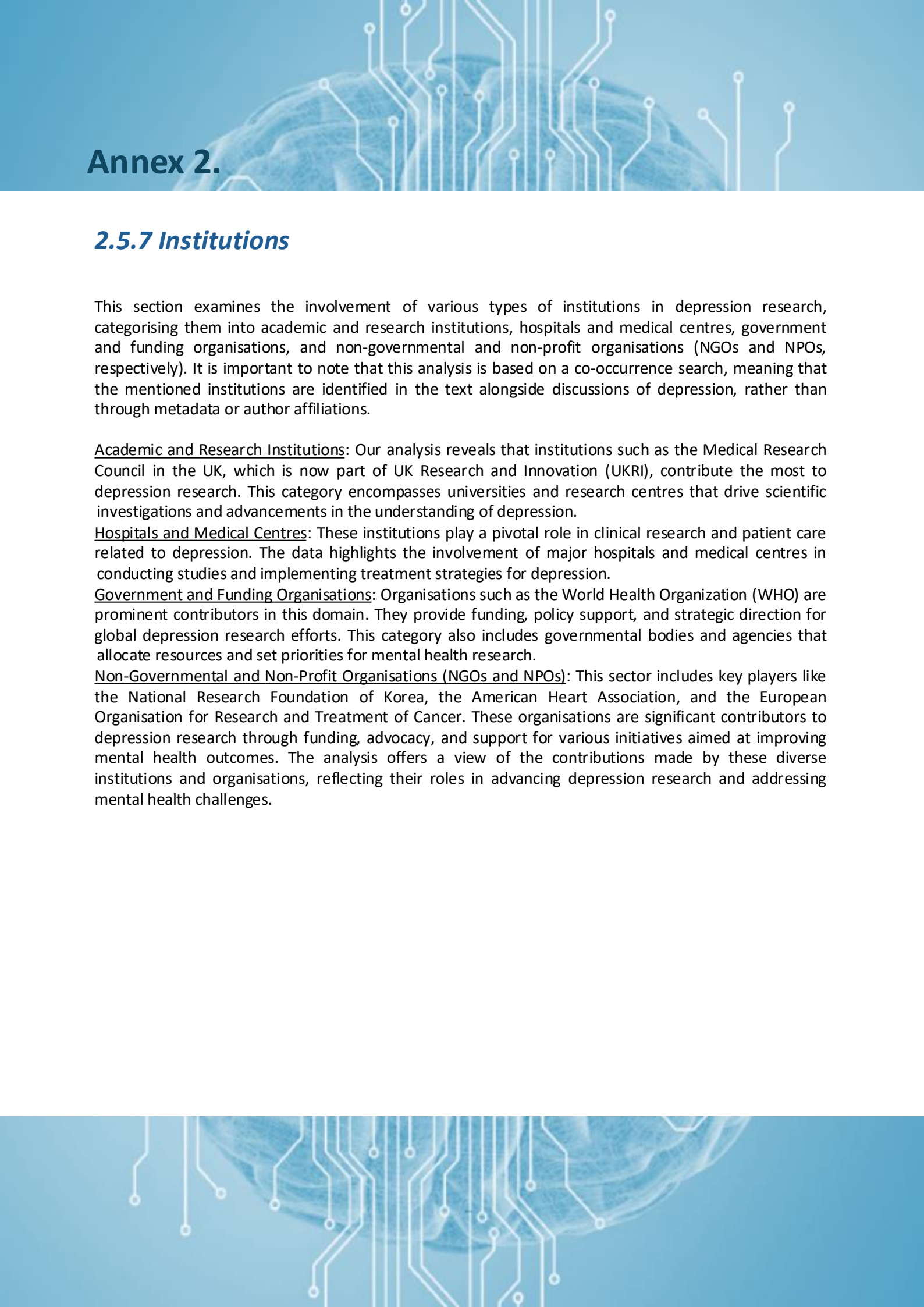
Annex 2.

2.5.6 Regions

The Regions section in InDepDash offers an analysis of the continents associated with depression studies, followed by a detailed examination of country-level data presented through an interactive map. It is important to clarify that this is not a metadata search of publications, nor is it related to the affiliations of the authors. Instead, this co-occurrence analysis focuses on how various regions are mentioned together in the text body alongside discussions of depression. In this context, Europe and America are the continents most prominently represented in the literature. At the country level, China, Germany, and the United States emerge as leading contributors to research on depression.

The interactive map allows for a detailed exploration of how different countries are engaged in this field, facilitating a deeper understanding of regional research trends and priorities. By examining these co-occurrences, we can interpret the significance of regional involvement in the broader context of depression research.





Annex 2.

2.5.7 Institutions

This section examines the involvement of various types of institutions in depression research, categorising them into academic and research institutions, hospitals and medical centres, government and funding organisations, and non-governmental and non-profit organisations (NGOs and NPOs, respectively). It is important to note that this analysis is based on a co-occurrence search, meaning that the mentioned institutions are identified in the text alongside discussions of depression, rather than through metadata or author affiliations.

Academic and Research Institutions: Our analysis reveals that institutions such as the Medical Research Council in the UK, which is now part of UK Research and Innovation (UKRI), contribute the most to depression research. This category encompasses universities and research centres that drive scientific investigations and advancements in the understanding of depression.

Hospitals and Medical Centres: These institutions play a pivotal role in clinical research and patient care related to depression. The data highlights the involvement of major hospitals and medical centres in conducting studies and implementing treatment strategies for depression.

Government and Funding Organisations: Organisations such as the World Health Organization (WHO) are prominent contributors in this domain. They provide funding, policy support, and strategic direction for global depression research efforts. This category also includes governmental bodies and agencies that allocate resources and set priorities for mental health research.

Non-Governmental and Non-Profit Organisations (NGOs and NPOs): This sector includes key players like the National Research Foundation of Korea, the American Heart Association, and the European Organisation for Research and Treatment of Cancer. These organisations are significant contributors to depression research through funding, advocacy, and support for various initiatives aimed at improving mental health outcomes. The analysis offers a view of the contributions made by these diverse institutions and organisations, reflecting their roles in advancing depression research and addressing mental health challenges.

2.6 Final Considerations

We acknowledge that the ontologies supporting InDepDash are currently undergoing refinement and enhancement. These ontologies necessitate continual updates to align with the latest advancements in scientific research. This iterative process involves the active engagement of field experts, a practice we have established and continue to pursue, to facilitate the continuous improvement of this informational hub—InDepDash — which will be updated periodically. As scientific research evolves, so too does InDepDash, ensuring that it remains a dynamic and up-to-date resource reflective of current developments and insights in the field. To this end we invite all users to explore the interactive dashboard and actively contribute to its continuous improvement, expansion, and implementation, and expansion into other relevant areas. The field of informed decision-making, whether for academic research, clinical studies, or policy development, depression research is broad and complex, therefore we encourage collaboration to further enhance and refine this tool. We believe it can play a critical role in supporting the understanding of and exploring the scientific evidence necessary.



Getting in touch with the EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

Finding information about the EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

Open data from the EU

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society



EU Science Hub

[Joint-research-centre.ec.europa.eu](https://joint-research-centre.ec.europa.eu)



Publications Office
of the European Union