

Bias in Health Data. Aspects to Consider in our Models.

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Bias in Health Data

Aspects to Consider in our Models



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Avoiding Bias in AI

7 March 2023, 13.00-17.00h

Auditorium Felix Frey, sitem-insel, Freiburgstrasse 3

Advancing technology + Expanding data availability



Window of possibilities

Decision-aid tools

Risk prediction

Natural language processing

etc



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Advancing technology + Expanding data availability



Window of possibilities



Greater impact



Greater responsibility



Trustworthy and responsible AI
Fairness of AI/ML system/model/algorithm

Absence of bias and discrimination.
Equal outcome or benefit; equal performance.



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- Representative sample - Diversity and inclusion
- Absence of biases
 - Statistical / computational biases
 - Societal / human biases

Risk of perpetuating / increasing systemic, historical, societal biases



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agenda

Health data overview

Diversity domains and associated biases

To watch out in health data

What can be done?



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Health data

Demographics

Medication

Diagnosis

Clinical endpoints

Images (e.g., X-ray)

Patient-reported outcomes

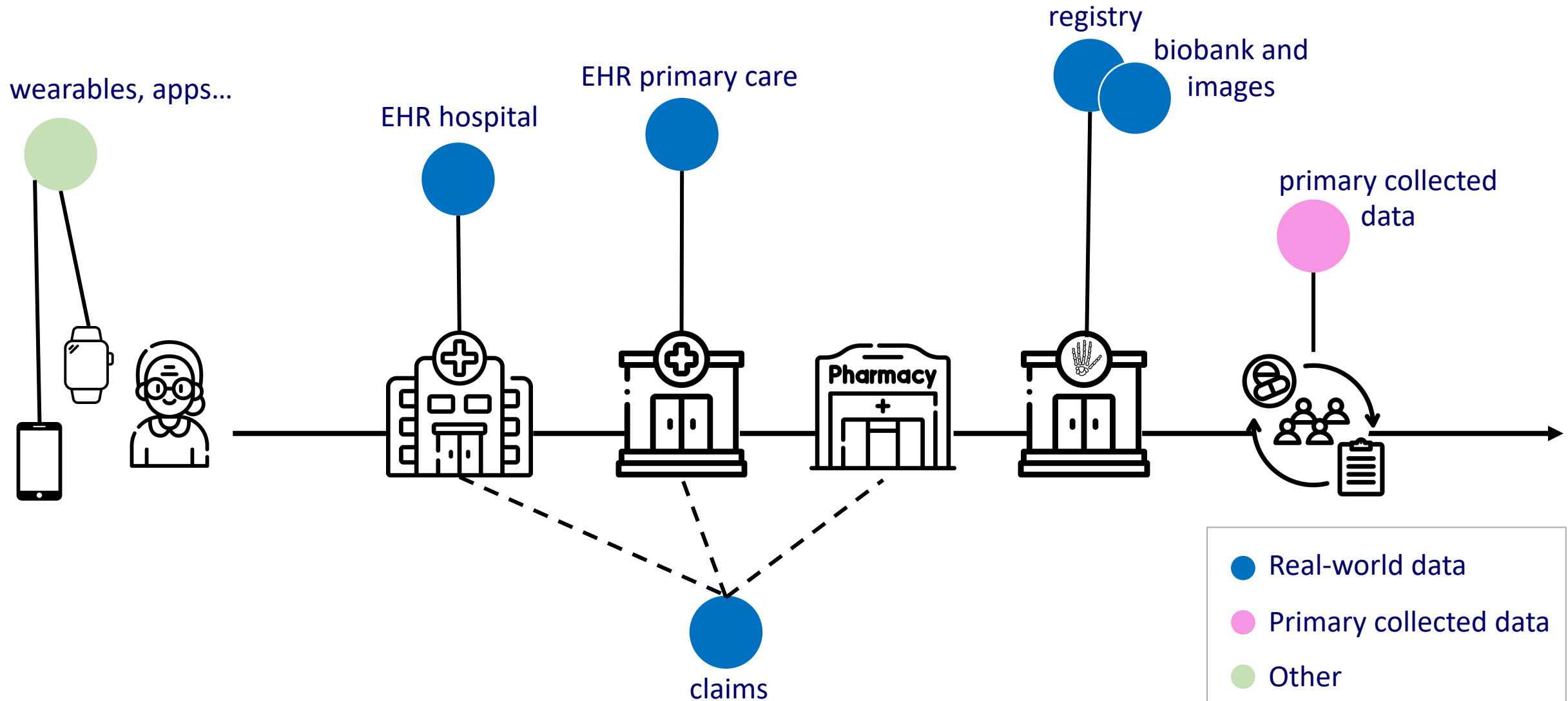
Biomarkers

Genetics

SDoH

Lifestyle

Health data

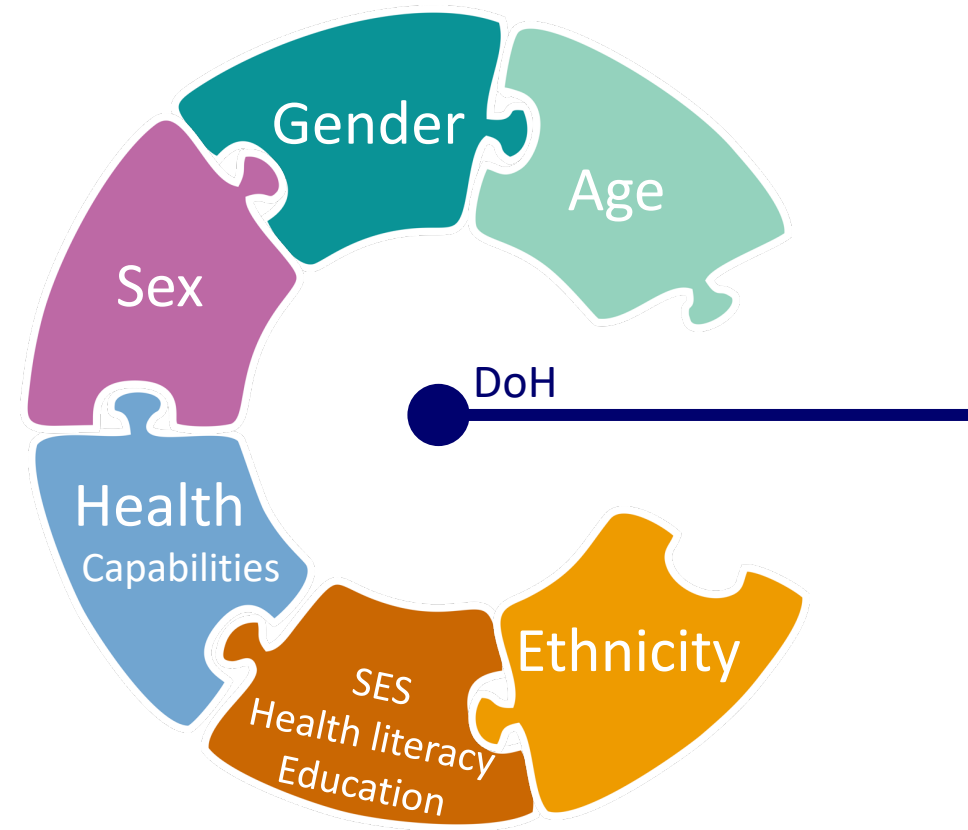


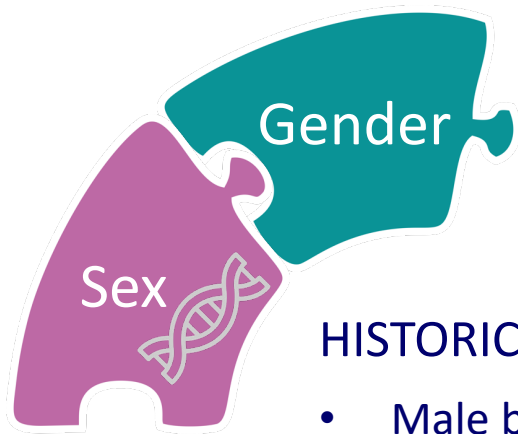
Systemic / societal / human biases

- Diversity and inclusion
- Determinants of health, potentially subject of discrimination



Photo by Jr Korpa on Unsplash

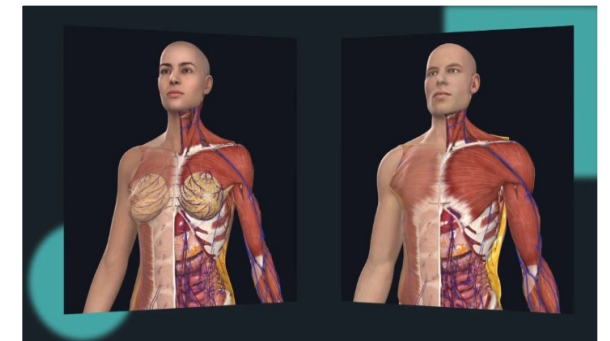




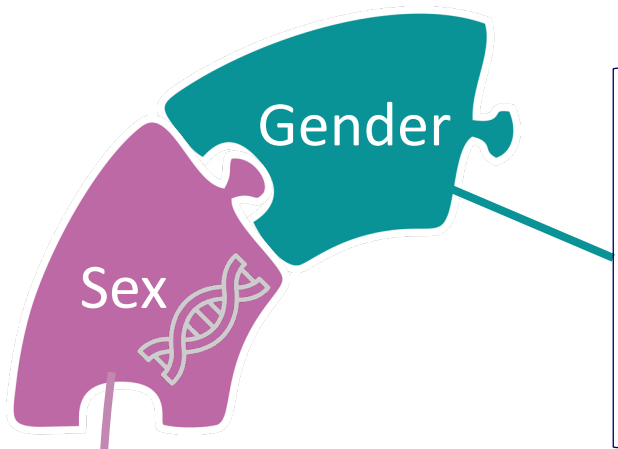
HISTORICAL LACK OF SEX AND GENDER DIMENSIONS IN HEATH RESEARCH AND PRACTICE

- Male body stablished as the norm
- Females underrepresented in preclinical research
- Women underrepresented in clinical trials
- Undervalue of female-specific conditions

- Data gap (and evidence gap) from the female body
 - Misdiagnosis
 - Worse treatment response / More safety events



Bottom image from elsevier.com

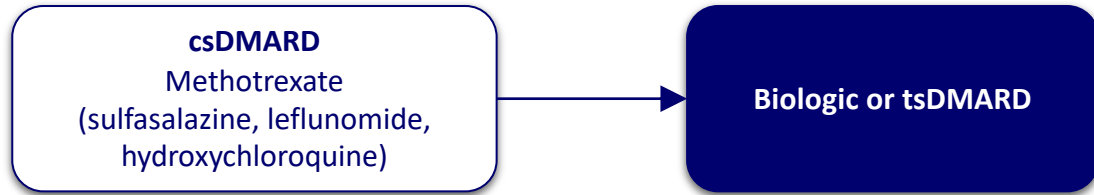


- Self-assessed health status
- Health behavior
- Clinical communication
- Diagnosis and treatment

- Immune system
- Body composition
- Disease clinical phenotype
- Treatment response (safety, half-life...)

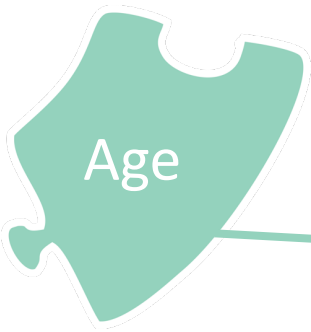
Examples:

- Women's pain is often dismissed, and pain medication given later than in men.
- LGBTQAI+ community faces discrimination in health
- Are we underdiagnosing depression in men?



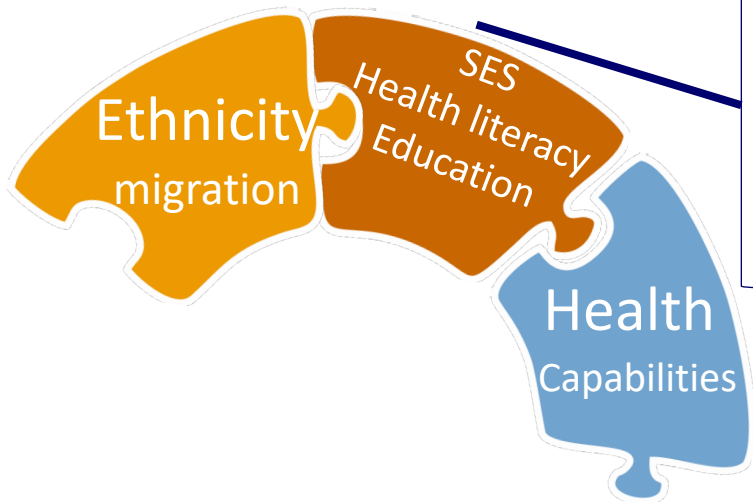
Rheumatoid arthritis (RA) in Switzerland

- **Males presented 21% higher odds** of achieving DAS28-remission within the year after starting their first b/tsDMARD.
- This may be explained by their **shorter RA-duration** and **lower DAS28** at the start of their 1st b/tsDMARD.
- **Relevance:** While other unmeasured factors could also affect the disparity, earlier step-up to b/tsDMARD treatment in female patients could benefit patients and reduce the observed disparity.



Historical exclusion from clinical trials.

- Biological aging
 - Decline in immune system – higher vulnerability for infections, cancer, etc.
- Social determinant of health
 - Risk behaviours
 - Income, resources
 - Access



Historical exclusion from clinical trials.

- Discrimination
- Access / resources

RESEARCH ARTICLE

ECONOMICS

Dissecting racial bias in an algorithm used to manage the health of populations

Ziad Obermeyer^{1,2*}, Brian Powers³, Christine Vogeli⁴, Sendhil Mullainathan^{5*†}

Health risk score – Bias attributable to label choice.

Wrong label choice, use of healthcare expenditures as proxy of endpoint health.

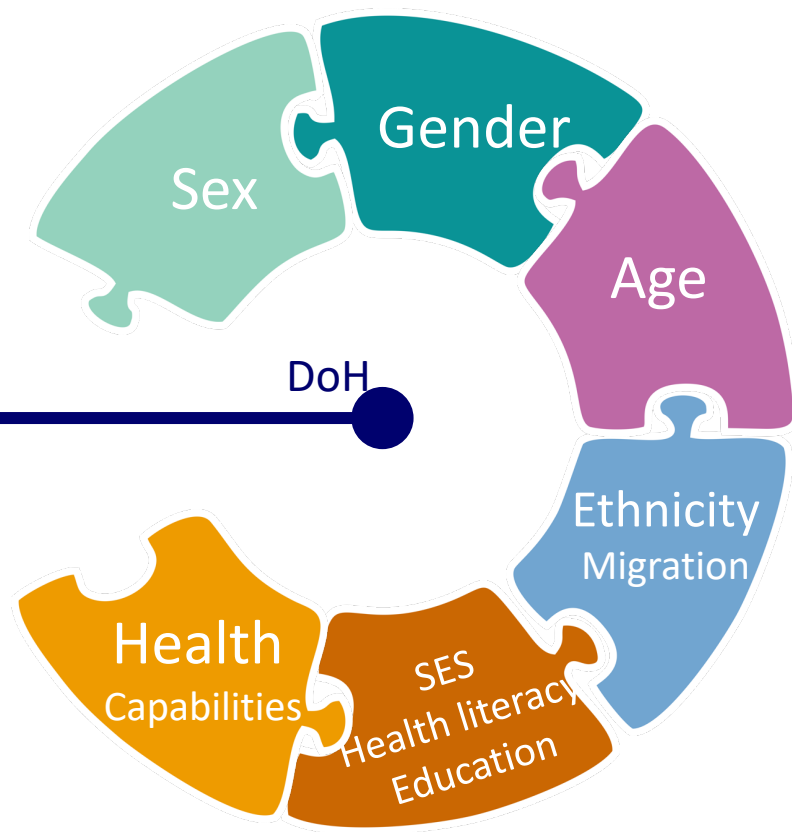
At same level of health (number of chronic illnesses), they observed that different race/ethnicity generated differ costs and types of costs. Here race/ethnicity was correlated to socioeconomic status, but other factors can also play a role, like trust in healthcare, racism from healthcare providers... (Note that race was excluded from the model for training, but included for fairness assessment)

Thus, although accurate prediction of cost, it led to wrong predictions of health, resulting in biases output, discriminating based on race/ethnicity.

The authors tested alternative labels. Similar prediction metrics but different race distribution among those categorized at high risk.

Authors and manufacturer looked for solutions. Better label: combination of health prediction with cost prediction.

To watch out in health data



Real-world data (RWD):

- Societal bias can lead to bias in label (e.g., differential exposure/outcome due to bias). Think in advance the role that this plays in the study objective and the model.

Primary collected data:

- Societal bias can (and should not) affect participation in studies. Efforts in recruitment are essential to ensure representative, diverse, and inclusive input data.

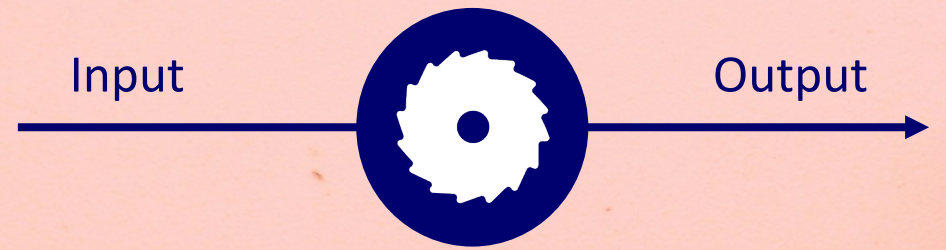
Wearables, digital apps...:

- Who uses them?

What can be done?



What can be done?



- Promote **diversity and inclusion** in your data.
- **Think in advanced** the role that these determinants of health can play in your data, your objective, and your model.
- Define and apply metrics to **evaluate** AI biases, and techniques for mitigating biases in datasets and models.
- **Multidisciplinary teams**, including end-user / patient-research partner.
- Education and training.
- **Opportunity:**
 - AI to help address disparities.
 - Contribute to bridge the sex/gender data gap and highlight health inequalities.

References

- Rajkomar A, Hardt M, Howell MD, Corrado G, Chin MH. Ensuring Fairness in Machine Learning to Advance Health Equity. *Ann Intern Med* 2018; **169**: 866–72.
- Nazer LH, Zatarah R, Waldrip S, *et al.* Bias in artificial intelligence algorithms and recommendations for mitigation. *PLOS Digit Health* 2023; **2**: e0000278.
- Liu M, Ning Y, Teixayavong S, *et al.* A translational perspective towards clinical AI fairness. *NPJ Digit Med* 2023; **6**: 172.
- Islam R, Keya KN, Pan S, Sarwate AD, Foulds JR. Differential Fairness: An Intersectional Framework for Fair AI. *Entropy Basel Switz* 2023; **25**: 660.
- Cirillo D, Catuara Solarz S, Morey C, *et al.* Sex and gender differences and biases in artificial intelligence for biomedicine and healthcare. *Npj Digit Med* 2020; **3**. DOI:10.1038/s41746-020-0288-5.
- Pasin C, Consiglio CR, Huisman JS, *et al.* Sex and gender in infection and immunity: addressing the bottlenecks from basic science to public health and clinical applications. *R Soc Open Sci* 2023; **10**: 221628.
- Together we created the most advanced 3D female anatomy. [www.elsevier.com. https://www.elsevier.com/connect/together-we-created-the-most-advanced-3d-female-anatomy-model](https://www.elsevier.com/connect/together-we-created-the-most-advanced-3d-female-anatomy-model) (accessed March 6, 2024).
- European Institute for Gender Equality (EU body or agency), Barbieri D, García Cazorla A, *et al.* Gender equality index 2021: health. LU: Publications Office of the European Union, 2021 <https://data.europa.eu/doi/10.2839/834132> (accessed March 7, 2023)
- Whitley R. *Risk Factors and Rates of Depression in Men: Do Males Have Greater Resilience, or Is Male Depression Underrecognized and Underdiagnosed? In: Whitley R, ed. Men's Issues and Men's Mental Health: An Introductory Primer. Cham: Springer International Publishing, 2021: 105–25*
- Samulowitz A, Greymr I, Eriksson E, Hensing G. 'Brave Men' and 'Emotional Women': A Theory-Guided Literature Review on Gender Bias in Health Care and Gendered Norms towards Patients with Chronic Pain. *Pain Res Manag* 2018; 2018: 6358624.
- Hoffmann DE, Tarzian AJ. The girl who cried pain: a bias against women in the treatment of pain. *J Law Med Ethics J Am Soc Law Med Ethics* 2001; **29**: 13–27.
- van Marum RJ. Underrepresentation of the elderly in clinical trials, time for action. *British Journal of Clinical Pharmacology* 2020; **86**: 2014–6.
- European Union Agency For Fundamental Rights. Survey on Minorities and Discrimination in EU (2016). European Union Agency for Fundamental Rights. 2017; published online Dec 4. <http://fra.europa.eu/en/publications-and-resources/data-and-maps/survey-data-explorer-second-eu-minorities-discrimination-survey> (accessed Aug 22, 2023).
- ICF Consulting Services Ltd. Thematic session 4: Addressing the social determinants of health - Concept Paper. 2017. https://health.ec.europa.eu/system/files/2018-02/ev_20171107_co04_en_0.pdf (accessed Jan 12, 2024).
- Obermeyer Z, Powers B, Vogeli C, Mullainathan S. Dissecting racial bias in an algorithm used to manage the health of populations. *Science* 2019; **366**: 447–53.

Note: Images from Unsplash have been cropped to fit.

THANK YOU

Merci / Danke / Gracias

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