



Sex as a Biological Variable: Current Successes and Future Needs

Jill B. Becker, Ph.D.

Editor-in-Chief, Biology of Sex Differences

Biopsychology Area Chair,

Patricia Y. Gurin Collegiate Professor of

Psychology, and Senior Research

Professor, Michigan Neuroscience

Institute, University of Michigan



Why should *you* care about Sex as a Biological Variable?

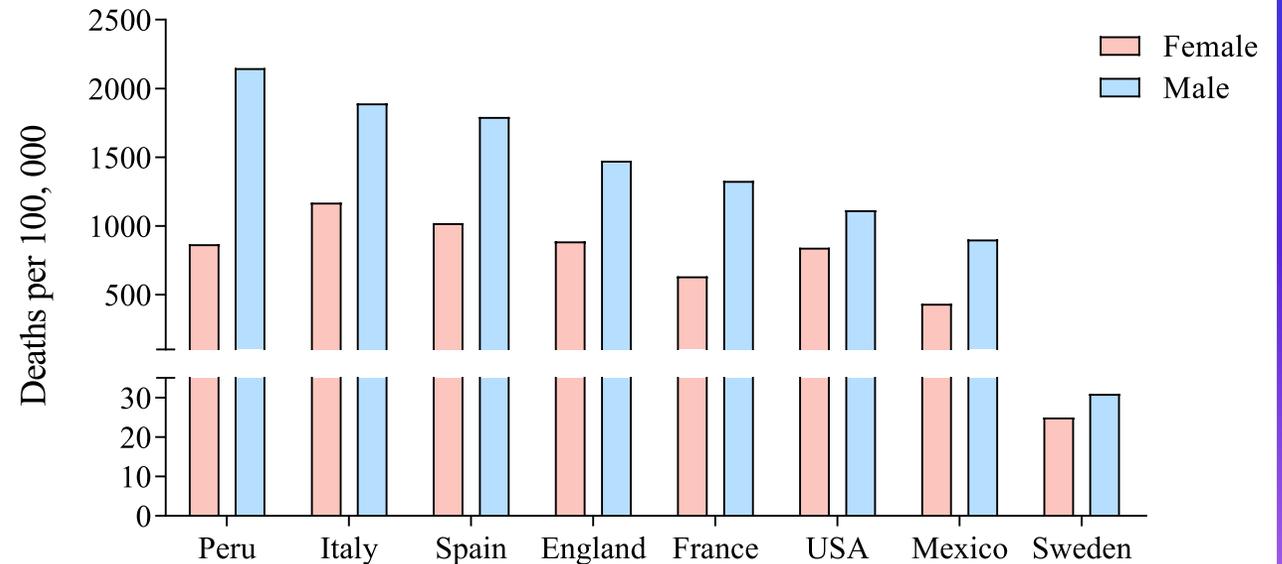
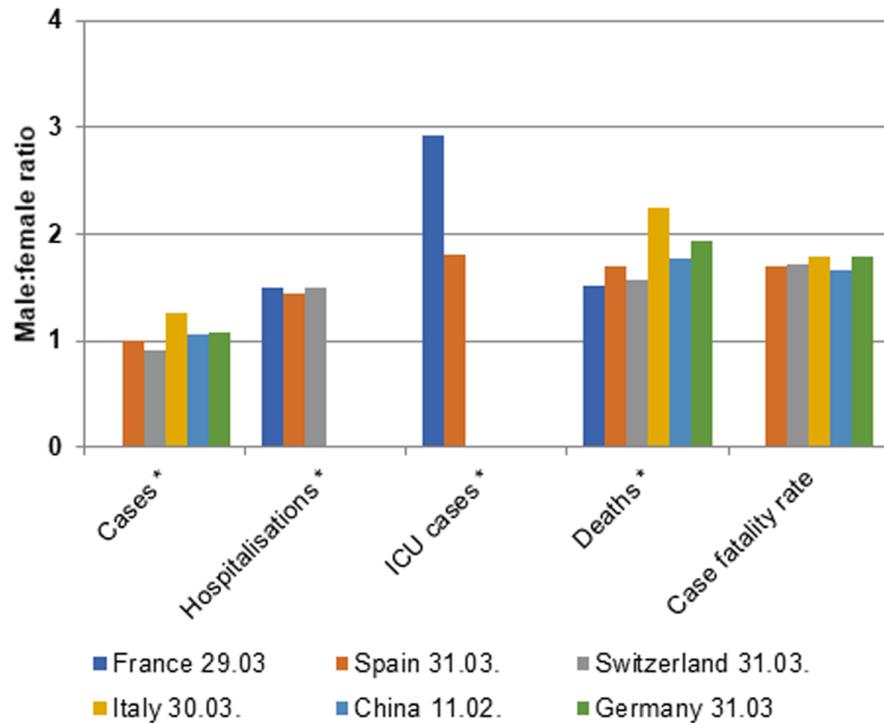
- + Infectious Diseases: COVID-19 and other infectious diseases vary by biological sex.
- + Biological sex affects gene expression and its genetic regulation throughout the body.
- + Neural mechanisms for pain and mental health disorders vary by biological sex.

COVID-19

+ Sex-specific Risk Factors.

+ Sex Differences in Disease Presentation and Disease Progression

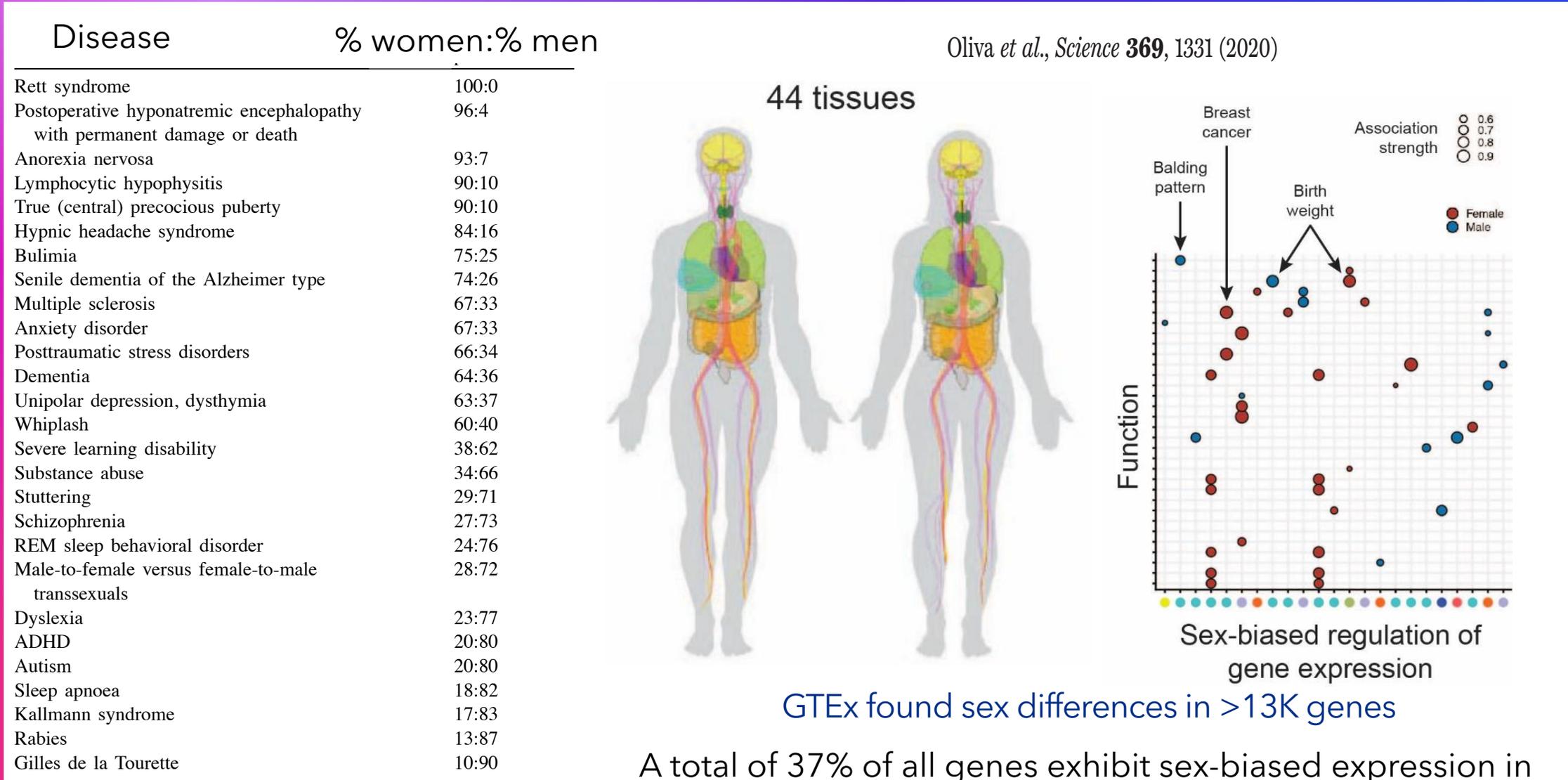
Male:female ratios Covid-19



Pradhan and Olsson *Biology of Sex Differences* (2020) 11:53
<https://doi.org/10.1186/s13293-020-00330-7>

Gebhard *et al. Biology of Sex Differences* (2020) 11:29

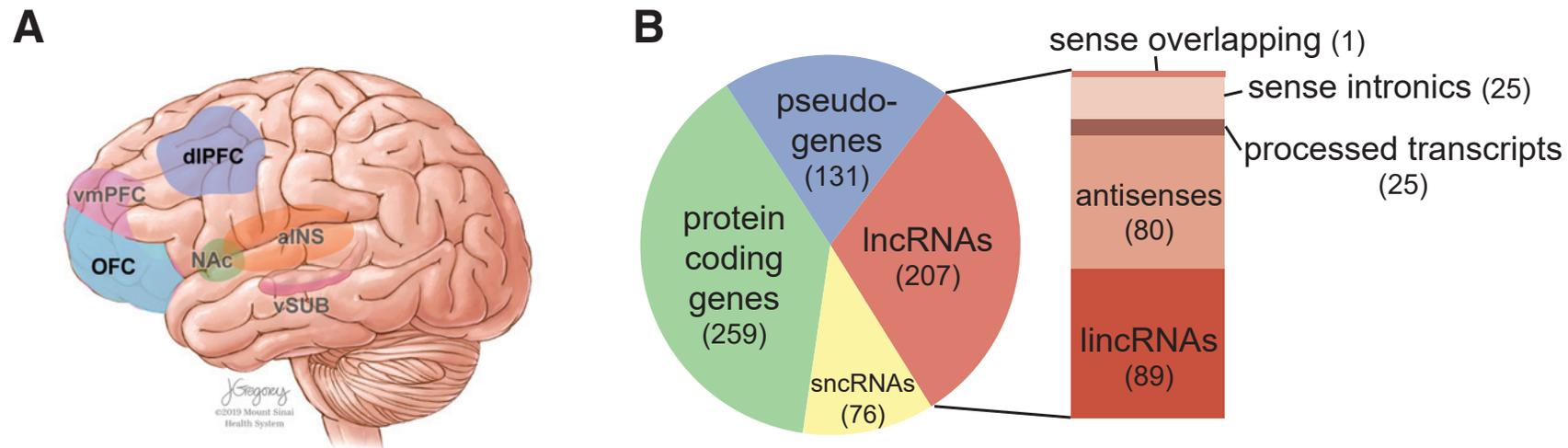
Sex affects gene expression and its genetic regulation throughout the body



D.F. Swaab et al./Neurobiology of Aging 24 (2003) S1–S16

A total of 37% of all genes exhibit sex-biased expression in at least one tissue. 58 gene-trait associations are driven by genetic regulation of gene expression in a single sex.

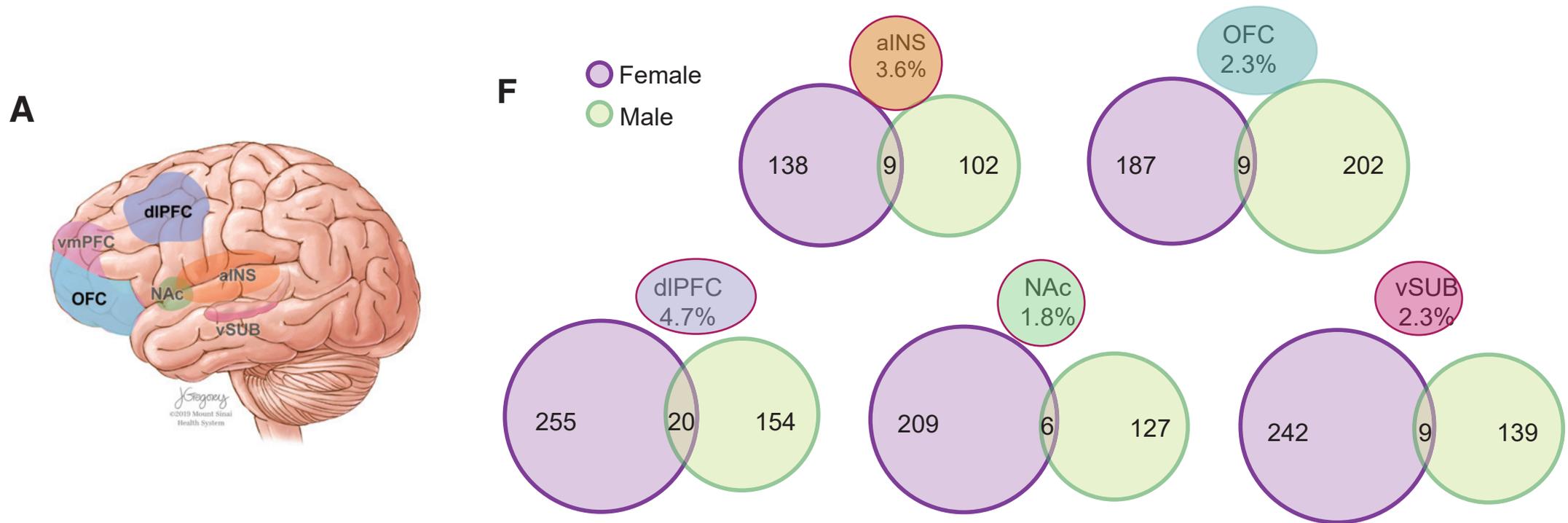
Depression affects women at twice the rate of men



Pie chart illustrates the proportion of RNA biotypes that are differentially expressed in depression across brain regions and sexes. Issler et al., 2020, Neuron 106, 912-926

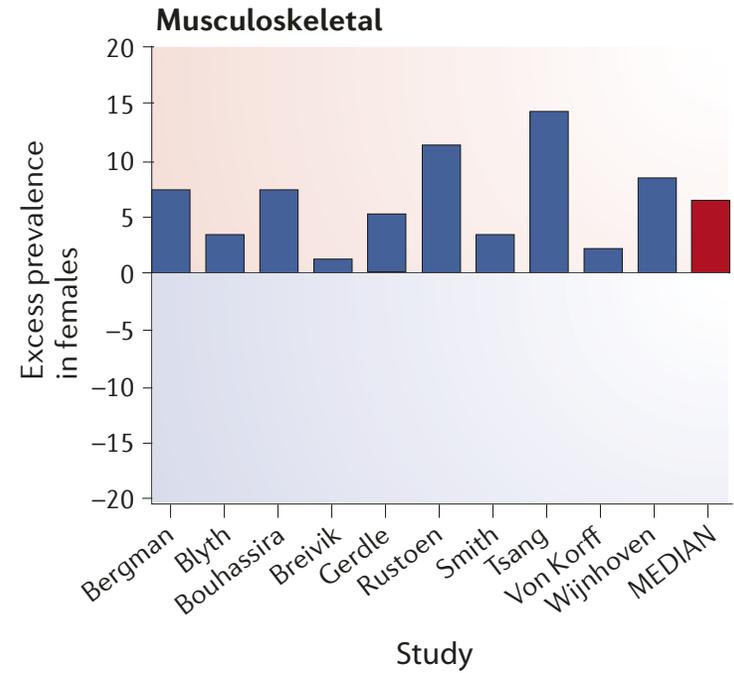
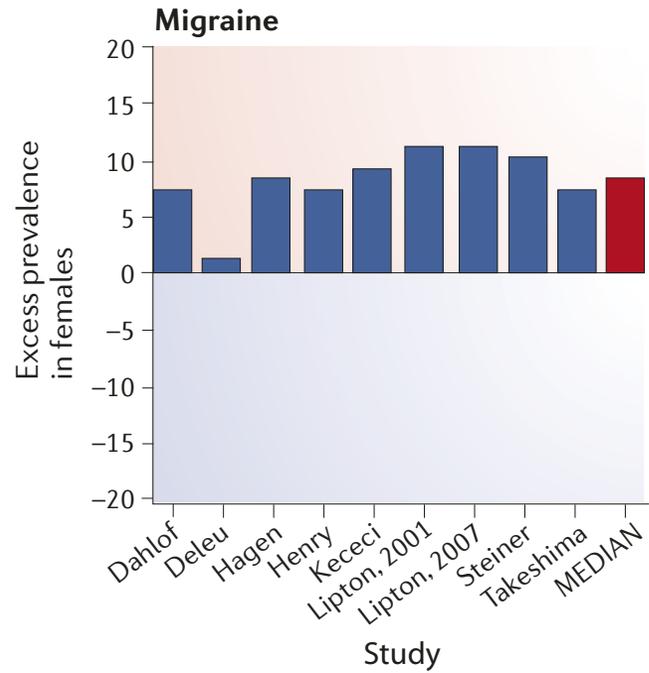
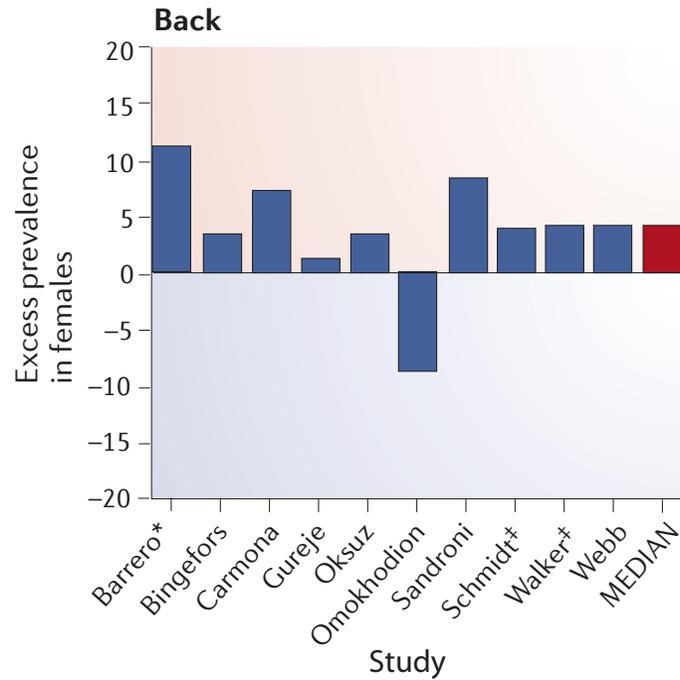
Depression looks the same in men and women

Male and female depressed brains use different genes



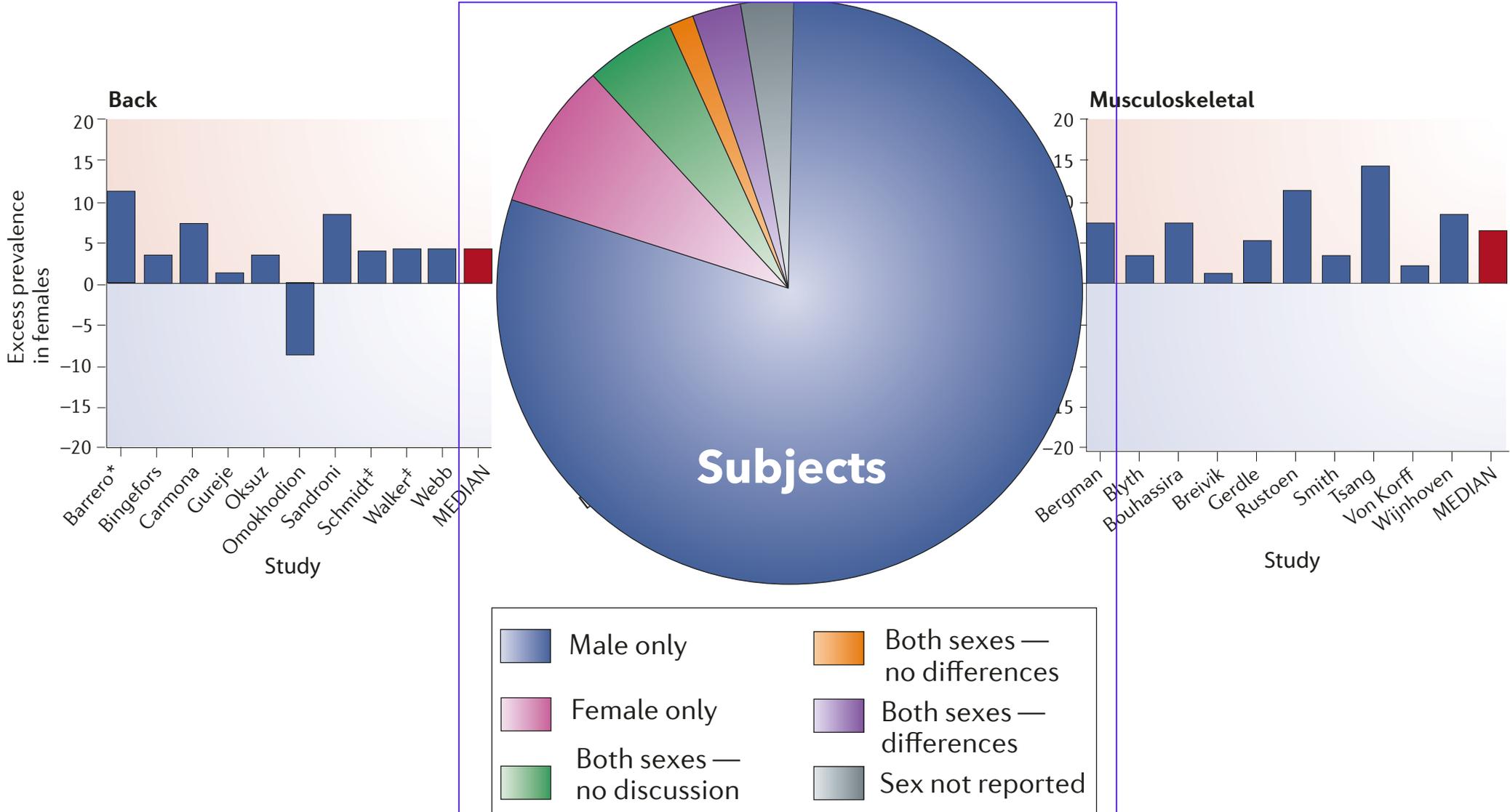
Studies identify a female-specific driver of stress resilience that is aberrant in female depression.

Sex Differences in Chronic Pain



Mogil (2012) Nature Reviews Neuroscience

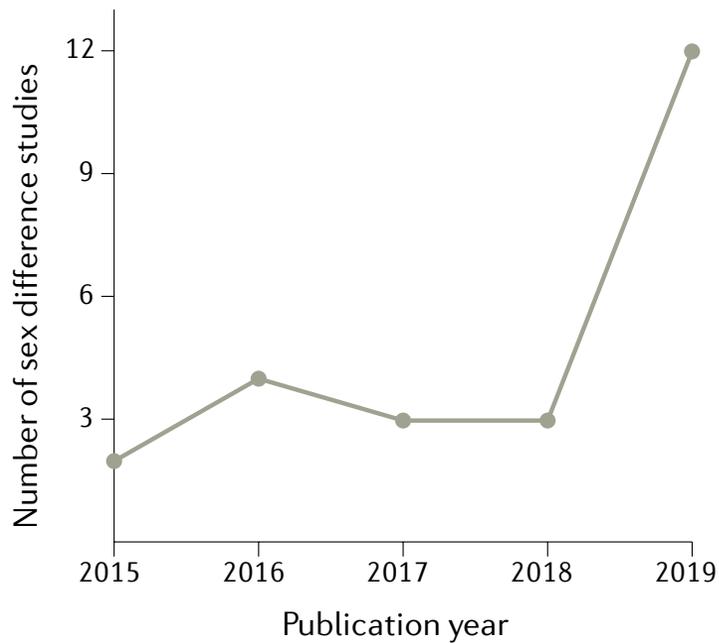
Sex Differences in Chronic Pain



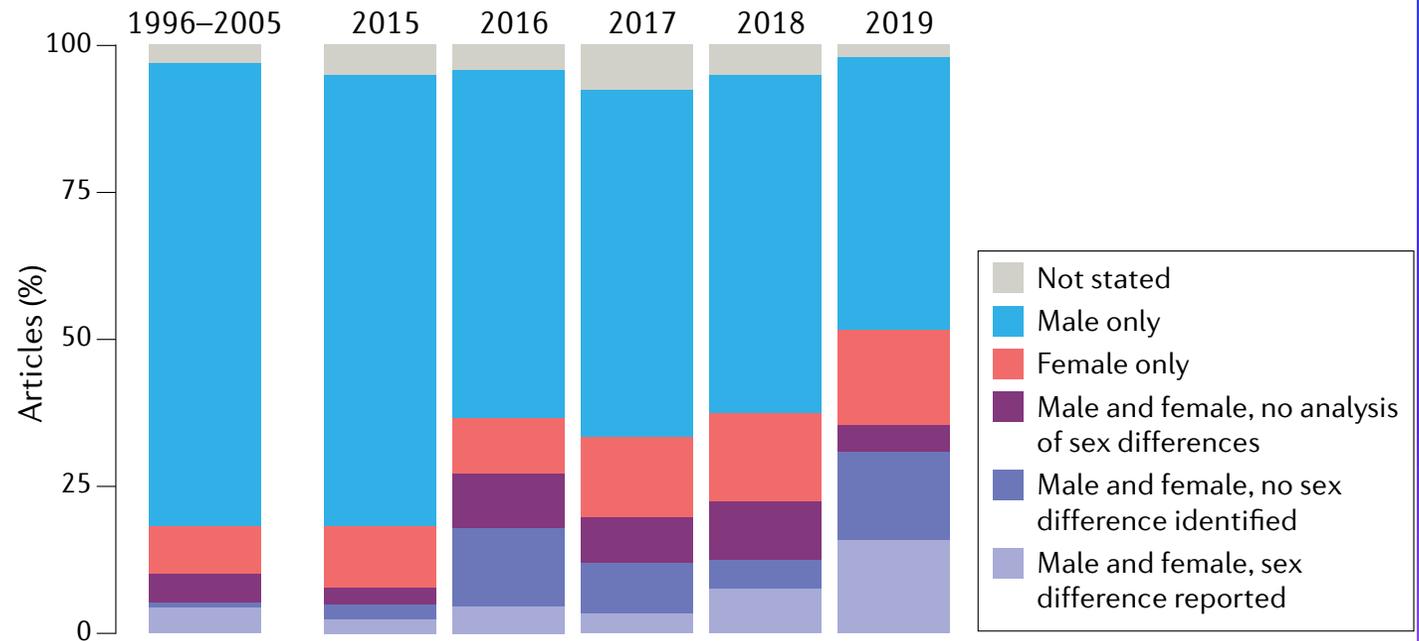
Mogil (2012) Nature Reviews Neuroscience

SABV is having an effect

a Sex difference studies published in the journal *Pain*



b Choice and reporting of animal subjects in the journal *Pain*

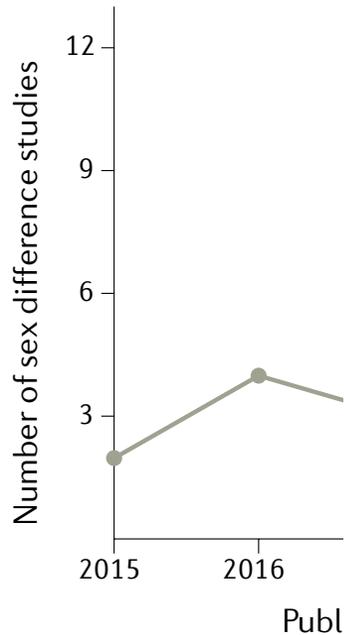


Mogil (2020) Nature Reviews Neuroscience

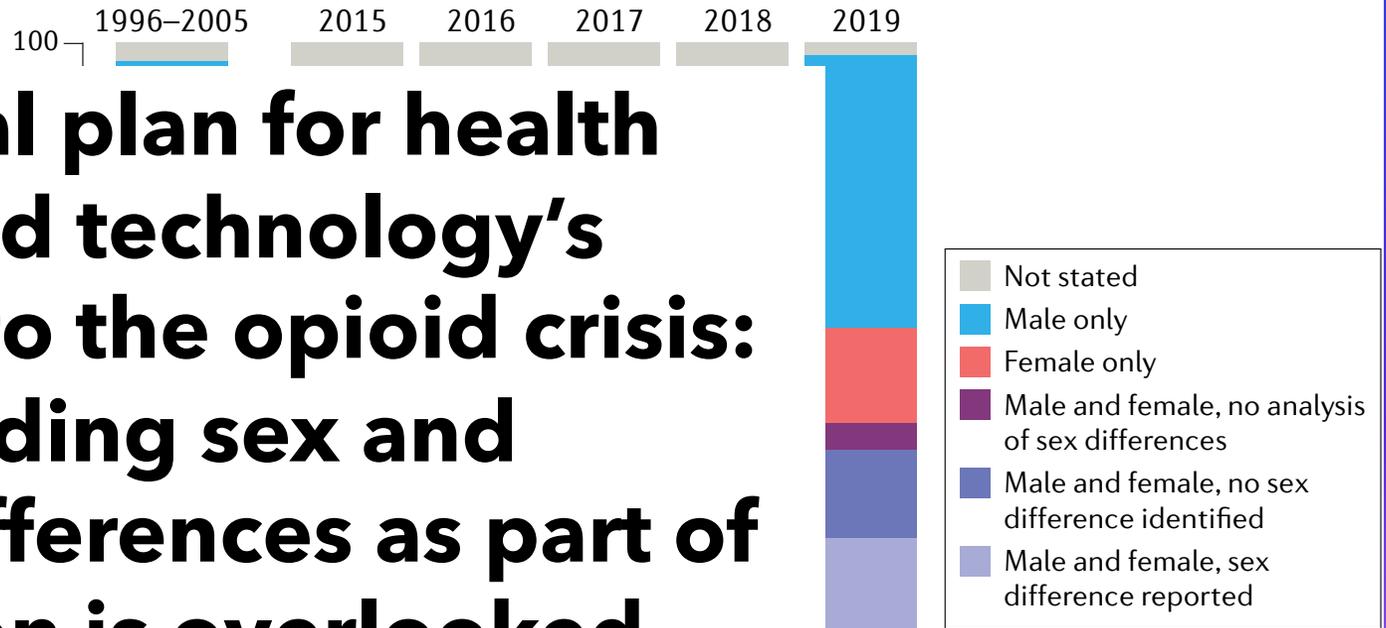
Studies published in the journal 'Pain'
Since 2016 more sex differences studies published and
more studies include female subjects.

SABV is having an effect but policy needs to follow the science

a Sex difference studies published in the journal *Pain*



b Choice and reporting of animal subjects in the journal *Pain*



The federal plan for health science and technology's response to the opioid crisis: understanding sex and gender differences as part of the solution is overlooked

Becker and Mazure *Biology of Sex Differences* (2019) 10:3
<https://doi.org/10.1186/s13293-018-0215-5>

studies published in the journal *Pain*

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Future Research Needs for SABV

- + Computational approaches for Sex X gene X trait analyses
- + Systems level analysis and analyses across systems
- + Interdisciplinary and transdisciplinary teams
- + Prioritize translational studies that test mechanistic hypotheses
- + Gender-centered treatments