Sex-specific changes in cerebral blood flow begin at puberty, study finds

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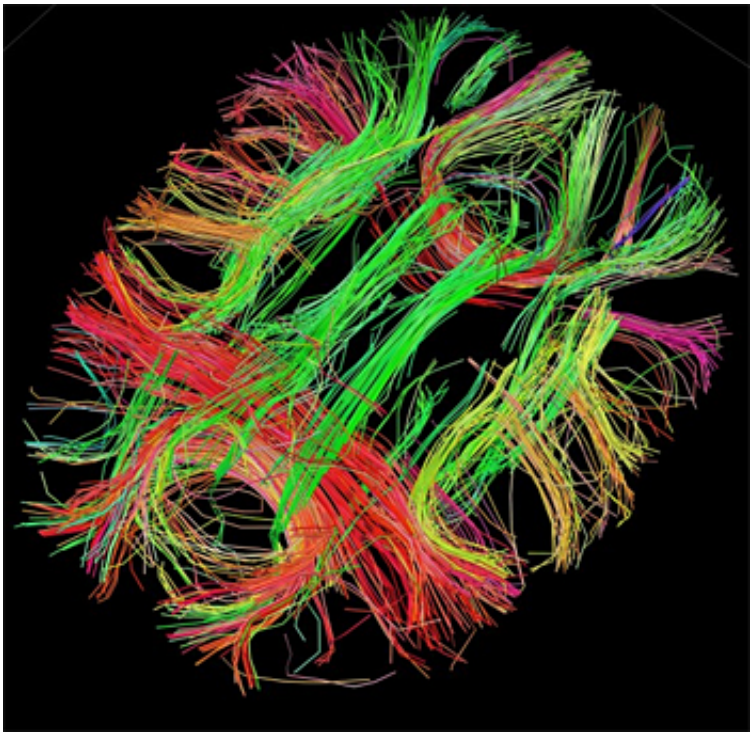

White matter fiber architecture of the brain. Credit: Human Connectome Project.

Puberty is the defining process of adolescent development, beginning a cascade of changes throughout the body, including the brain. Penn Medicine researchers have discovered that cerebral blood flow (CBF) levels decreased similarly in males and females before puberty, but saw them diverge sharply in puberty, with levels increasing in females while

decreasing further in males, which could give hints as to developing differences in behavior in men and women and sex-specific predispositions to certain psychiatric disorders. Their findings are available in *Proceedings of the National Academy of Science* (*PNAS*).

"These findings help us understand normal neurodevelopment and could be a step towards creating normal 'growth charts' for brain development in kids. These results also show what every parent knows: boys and girls grow differently. This applies to the brain as well," says Theodore D. Satterthwaite, MD, MA, assistant professor in the Department of Psychiatry in the Perelman School of Medicine at the University of Pennsylvania. "Hopefully, one day such growth charts might allow us to identify abnormal brain development much earlier before it leads to major mental illness."

Studies on structural brain development have shown that puberty is an important source of sex differences. Previous work has shown that CBF declines throughout childhood, but the effects of puberty on properties of brain physiology such as CBF, also known as cerebral perfusion, are not well known. "We know that adult women have higher blood flow than men, but it was not clear when that difference began, so we hypothesized that the gap between women and men would begin in adolescence and coincide with puberty," Satterthwaite says.

The Penn team imaged the brains of 922 youth ages 8 through 22 using arterial spin labeled (ASL) MRI. The youth were all members of the Philadelphia Neurodevelopmental Cohort, a National Institute of Mental Health-funded collaboration between the University of Pennsylvania Brain Behavior Laboratory and the Center for Applied Genomics at the Children's Hospital of Philadelphia.

They found support for their hypothesis.

Age related differences were observed in the amount and location of blood flow in males versus females, with blood flow declining at a similar rate before puberty and diverging markedly in mid-puberty. At around age 16, while male CBF values continue to decline with advanced age, females CBF values actually increased. This resulted in females having notably higher CBF than males by the end of adolescence. The difference between males and females was most notable in parts of the brain that are critical for social behaviors and emotion regulation such as the orbitofrontal cortex. The researchers speculate that such differences could be related to females' well-established superior performance on social cognition tasks. Potentially, these effects could also be related to the higher risk in women for depression and anxiety disorders, and higher risk of flat affect and schizophrenia in men.

More information: Impact of puberty on the evolution of cerebral perfusion during adolescence, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1400178111

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