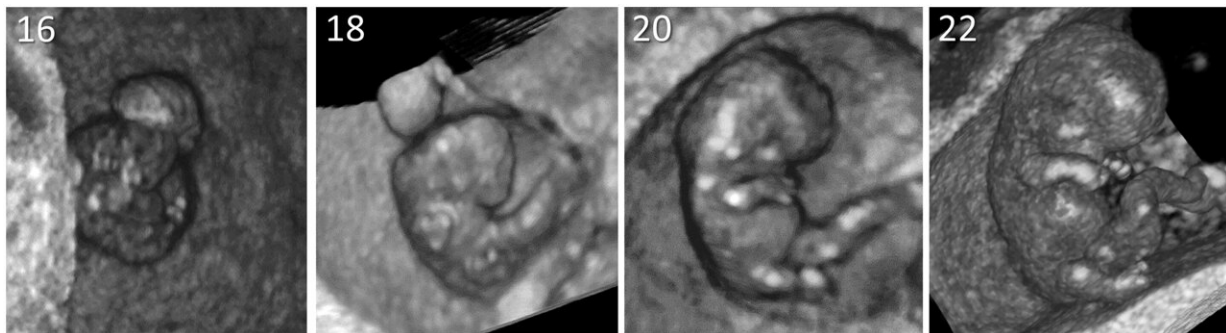


Smoking before and after conception is linked to delayed embryonic development

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Three-dimensional virtual reality images of four embryos reflecting four different Carnegie stages. The 23 Carnegie developmental stages are based on examination of internal and external morphological features of the embryo, such as the development and position of the limbs and curvature of the embryo.
Credit: DOI: [10.1093/humrep/deac018](https://doi.org/10.1093/humrep/deac018)

Smoking by mothers during the period immediately before and after conception is linked to a delay in embryonic development, smaller fetuses at the time of the 20-week ultrasound scan, and lower birth weight.

The study, which is published today in *Human Reproduction*, followed 689 women with singleton pregnancies between 2010 and 2018. The researchers found that by the tenth week of [pregnancy](#), embryo development was delayed by nearly a day in women who smoked 10 or

more cigarettes a day compared to non-smokers, and by 1.6 days in smokers who had conceived by means of in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI).

They also found that embryos were not able to "catch up" their development over the course of the pregnancy and were more likely to be born small for gestational age and with a median (average) birth weight 93 grams lower than babies born to non-smoking women.

This is the first study to investigate the association between smoking by mothers from 14 weeks before conception up to 10 weeks after conception (the periconceptual period) and the development of embryos as assessed by looking at the external and internal shape of the embryo (the morphology) during ongoing pregnancies. The researchers used [virtual reality](#) to look at the [embryos'](#) development and they compared the morphology against established stages of embryo development, known as the Carnegie Stages.

Dr. Melek Rousian, a gynecologist at Erasmus MC, University Medical Center, Rotterdam, The Netherlands, who led the study, said: "One of the key messages of this study is that the delay in [embryonic development](#) due to mothers smoking in the periconceptual period is also associated with smaller fetal measurements at the 20-week ultrasound scan and a lower birth weight. Part of fetal and neonatal outcomes can be explained by smoking during the periconceptual period and the delay in embryonic development."

The Carnegie Stages only cover embryonic development for the first 10 weeks of gestation, so the researchers could not compare the embryo shapes against an agreed standard beyond this stage, but the ultrasound scans and birth weights provided developmental information instead, including head and abdominal circumferences and thigh bone length.

"The impact of periconceptional maternal smoking on delaying embryonic development appears to have a greater effect in the second trimester of pregnancy than at birth," said Dr. Rousian. "We think that perhaps there is some catch-up growth during the second and third trimesters, but the delay in morphological development cannot be fully recuperated during the course of the pregnancy, as is shown by the 20-week ultrasound scans and birth weights."

The mothers were taking part in the ongoing Rotterdam periconceptional cohort, a large prospective study embedded in [patient care](#) in the department of obstetrics and gynecology at Erasmus MC, University Medical Center, Rotterdam, which is a tertiary care hospital for preconception and prenatal care. Consequently, they do not represent the general population. However, Dr. Rousian said the results are important for all women planning to become pregnant.

"The results of this study emphasize the importance of smoking cessation prior to conception and that efforts to help women stop smoking should focus on this time window. If possible, women should stop smoking from the very moment they plan to become pregnant, but it's always a good thing to stop smoking anyway, particularly at any stage of pregnancy. Smoking not only impacts an embryo's growth during pregnancy and birth weight, but also [embryo development](#) right from the very early stages of pregnancy," she said.

"We were able to show a dose-response effect of maternal smoking on embryonic morphology and fetal growth; the more cigarettes a woman smoked the greater the developmental delay. This stresses the importance of public health initiatives to promote preconception education and care, including effective programs to assist couples to stop smoking."

Dr. Rousian and her colleagues are studying how best to help future

parents stop smoking with the help of face-to-face consultations, follow-up visits and digital lifestyle interventions. They believe this is important as numerous studies have shown how factors that affect fetal development can have an impact not only during pregnancy but also on health in later life.

"This is why the periconceptional period is an important area of research because many future parents are not aware of the presence of a developing embryo in the early days when a pregnancy has not yet been confirmed," said Dr. Rousian.

New developments, such as better imaging techniques, including virtual reality, have made it possible to study how an embryo develops in much greater detail, rather than depending on information gained from laboratory research.

First author of the study, Dr. Carsten Pietersma, a Ph.D. candidate and ultrasonographer at Erasmus MC, said: "Since it is known that smoking negatively affects fetal growth during pregnancy, we wanted to study how this may also impact the development of the embryo. This developmental morphological study using the Carnegie stages takes multiple dimensions of the embryo into account, instead of just one growth parameter."

Strengths of the study include the large number of pregnancies studied, with certainty about the dates of conception, particularly for the IVF/ICSI couples, and the availability of ultrasound data from the first trimester. Limitations include the fact that women reported their smoking habits using a questionnaire and so might not report accurately, leading to an underestimation of the true effects of smoking. The association between [smoking](#) one to nine cigarettes a day and delayed development was not significant, probably because of the small number of women in this group.

More information: The impact of maternal smoking on embryonic morphological development: the Rotterdam Periconception Cohort, *Human Reproduction* (2022). [DOI: 10.1093/humrep/deac018](https://doi.org/10.1093/humrep/deac018)

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