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Examining heart and blood vessel health in women with high blood pressure during pregnancy using ultrasound and eye scans

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Registration date 09/06/2025	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 02/06/2026	**Condition category** Circulatory System	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims
High blood pressure during pregnancy, affects about 12% of pregnancies. This can lead to serious problems during pregnancy, e.g. restriction of the baby's growth or life-threatening complications for the mother. At the most serious extent, it can lead to pre-term birth or loss of mum and/or baby. Women who have high blood pressure during pregnancy are likely to develop heart and blood vessel problems later in life. It is important to know who might get heart and blood vessel problems later in life.
Small blood vessels play an important role in blood pressure disorders. Retinal imaging is currently used to identify changes in the tiny blood vessels of people who have had a stroke or diabetes and can be used for early detection.
This study will investigate if imaging of small blood vessels can help measure the health of blood vessels during pregnancy can identify those who are at risk of gestational hypertension.
The research goal is to explore the use of retinal imaging, ophthalmic ultrasound and blood tests to evaluate small blood vessels' function and structure during pregnancy. This will help better understand if women with gestational hypertension have dysfunction in their small blood vessels.
The researchers intend to study women during pregnancy to see if there are signs of blood vessel dysfunction before the development of gestational high blood pressure. They will use new monitoring methods which are quick and easy which could in the future improve the identification of women who are likely to have complications during pregnancy.

Who can participate?
Women aged 18 years and over who are currently pregnant and have normal blood pressure or high blood pressure

What does the study involve?
1. Retinal imaging: retinal imaging takes a digital photograph of the back of the eye. It shows the retina and blood vessels. This helps to look at the health of the tiny blood vessels.
2. Ultrasound: the ultrasound is a painless and safe test that uses sound waves to make images of the region of interest.

3. Eye ultrasound (ophthalmic ultrasound): done on the closed eye it looks at the blood vessel (ophthalmic artery) that goes to the eye.
4. Neck ultrasound (carotid ultrasound): ultrasound of the neck will measure blood flow through the carotid blood vessel, creating a picture of the blood flow using sound waves.
5. The elasticity of the blood vessels will also be measured.A small pen-like device will be placed gently on the neck and at the same time a cuff is placed on the thigh.
6. Blood sample: the procedure involves collecting blood, labelling the tubes, and sending them to the laboratory for analysis.

What are the possible benefits and risks of participating?
There will be no direct benefits from participating in the study. However, the information gathered will be helpful for future pregnant women, as it will aid in better identifying women at risk of high blood pressure and allow for the early detection of complications later in life.
All blood vessel assessments are non-invasive, and there are no significant risks in taking part in the study. However:
1. Ultrasound: pressure may be felt, but no pain, during the ultrasound examinations.
2. Retinal photograph: this will not cause any pain. A photograph is quickly taken when the eye is open, similar to a visit to the optician.
3. Blood sampling: blood sampling is invasive, but the risk is low. A brief prick may be felt when the needle is inserted into the skin, but any discomfort should quickly subside.

Where is the study run from?
Ninewells Hospital, Dundee, Scotland (UK)

When is the study starting and how long is it expected to run for?
October 2023 to June 2026

Who is funding the study?
University of Dundee (UK)

Who is the main contact?
1. Dr Colin Murdoch, c.z.murdoch@dundee.ac.uk
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Contact information

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Additional identifiers

Integrated Research Application System (IRAS)
347685

Sponsor ID
2.021.25

Study information

Scientific Title
Investigating cardiovascular function in pregnancies with gestational hypertension using ultrasound imaging: Studying Pregnancy's VAscular and Retinal Changes (SPARC)

Acronym
SPARC

Study objectives
Hypothesis 1: Retinal imaging in pregnant women with gestational hypertension will show persistent endothelial dysfunction (e.g., altered vessel diameter, tortuosity).

Hypothesis 2: During pregnancy, retinal metrics will correlate with Doppler indices and blood biomarkers, indicating prolonged cardiovascular risk.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 10/05/2025, North of Scotland Research Ethics Committee (Summerfield House, 2 Eday Road, Aberdeen, AB15 6RE, United Kingdom; +44 1224558458; gram.nosres@nhs.scot), ref: 25/NS/0033

Primary study design
Observational

Study design
Single-center prospective cohort observational study

Study type(s)
Screening

Health condition(s) or problem(s) studied
Cardiovascular diseases in women with gestational hypertension

Interventions
This is a prospective study in women in mid to late gestation. The researchers propose to examine:
1. Changes in vascular and placental markers with gestation in normal and hypertensive pregnancy.
2. The correlation between markers of placental function and cardiovascular changes.

In this study, the researchers want to find out if retinal imaging can help identify underlying vascular (endothelial) dysfunction in women who go onto or have gestational hypertension.

They will take measurements at mid and later gestation and then follow participants over the pregnancy to see who develops gestational hypertension. They will compare women with gestational hypertension with women who have normal pregnancies (~n = 20).

The goal is to see if there are any differences in the health of their blood vessels, particularly how well the blood vessels are working and the stiffness of the vessel, between those who develop gestational hypertension and those who do not. This will provide measurements during pregnancy which may precede the gestational hypertension to see if there are continued changes in the microvasculature.

This is a single-centre study that will take place at the School of Medicine & Ninewells Hospital, Dundee. Women will be recruited from the ultrasound department, antenatal clinics, day assessment unit, hypertensive and diabetic clinics, labour ward and postnatal ward. The researchers chose the following sites since this is where pregnant women obtain their routine care.

Retinal imaging and ultrasound (including carotid and ophthalmic artery Doppler) will be conducted in the Tayside Clinical Research Centre/Clinical room at the Division of Cardiovascular Research (Blood Flow Lab), Ninewells Hospital, on the same day of investigation. All participants (control and patient groups) will have the same procedures.
The potential participants will be approached by the care team. There are no site-specific requirements for this study.

Participants will need only one or two visits for all examinations, which will be coordinated with the routine maternity examinations (dating and screening scans). Women recruited for the study will undergo the following investigations: All participants will have baseline assessments, including height and weight. A questionnaire will be administered to assess modifiable risk factors.
Non-invasive imaging will be conducted to evaluate vascular and endothelial function, including

assessments of blood pressure, ultrasound Doppler measurements, and retinal imaging.
1. Doppler Ultrasound for Neck (Carotid) and Eye (Ophthalmic):
The ultrasound is a painless, safe test that uses sound waves to create images of the area of interest. The ophthalmic artery will be examined in both (closed) eyes, and the carotid artery will be examined on the right side only.
Carotid Artery Doppler:
This non-invasive evaluation assesses the thickness and elasticity of the blood vessel walls. For this test, ultrasound images will be taken by scanning the neck. The participant will lie down and be at rest while the images are taken. Three measurements from the images will be made (carotid intima-media thickness, pulse wave velocity, and strain of the vessel). These ultrasound images will help predict any potential risk of cardiovascular disease.
Ophthalmic Ultrasound:
Eye ultrasound is performed through a closed eyelid to visualize the space around and behind the eye that cannot be directly imaged. This test helps to measure the ophthalmic artery. Reflected sound waves create a picture of the eye structure and ophthalmic artery.
The test is conducted while the participant lies back with their eyes closed. A gel will be placed on the skin of the eyelids, and a small device will be gently placed against the front of the eye to perform the test. Participants will not feel any discomfort or pain. They may be asked to look in different directions to improve the ultrasound image or to view different areas of the eye.
2. Arterial Stiffness:
SphygmoCor is a non-invasive, CE-marked device used to measure the elasticity of the blood vessels. This test provides information about arterial pressures that represent systemic arterial stiffness, measured through aortic pulse wave velocity and augmentation index. The participant will lie on a bed and acclimatize for 10 minutes, after which blood pressure will be measured in triplicate. The waveforms from the volunteer's arteries will be recorded at the neck (carotid artery) and groin (femoral artery) using a micromanometer with the SphygmoCor PWV system. The augmentation index, heart rate, and carotid-to-femoral pulse wave velocity will be calculated using this software. This test carries no risks for the participant's health.
3. Retinal Imaging:
Retinal imaging takes a digital picture of the back of the eye, showing the retina and blood vessels. The participant's chin and forehead will be placed on a support to keep the head steady. They will need to open their eyes and stare straight ahead at an object while a laser scans the eyes, and then the images are uploaded to a computer.
4. Blood Samples:
A blood sample (approx. 20 ml) will be taken from the participant during the investigation. The samples will include sFlt-1, PLGF, and endothelin-1. Blood samples from both groups will be assessed for biomarkers of endothelial function, including sFlt-1 and PLGF (clinically used to diagnose preeclampsia), endothelin-1 (a marker of endothelial dysfunction), and peroxynitrate (oxidative stress), centrifuge to separate plasma from serum using standard procedures, that will be conducted for the control group of participants. UoD Immunoassay biomarker core facility will conduct biomarker assessment, following manufacturer and UoD SOP and procedure guides.
The above measurements (1-4) will be taken sequentially. This is likely to be in the order listed above but in some cases the order may be changed.
Retinal imaging and ultrasound (including carotid and ophthalmic artery Doppler) will be conducted in the Tayside Clinical Research Centre/Clinical room at the Division of Cardiovascular Research (Blood Flow Lab), Ninewells Hospital, on the same day of investigation. All participants will have the same procedures.

Sample Size Calculation
Comparison of cardiovascular function in women at high and low risk of preeclampsia
Ninewells has approximately 4500 births per year with approximately 450 cases of gestational

hypertension. The goal here is to describe the evolution of maternal microvascular function in women who develop gestational hypertension compared to those who do not develop gestational hypertension.
As part of a collaboration with St Georges London, a previously published study (Giorgione et al 2023; Ultrasound in Obs&Gyn; Angiogenic markers and maternal echocardiographic indices in women with hypertensive disorders of pregnancy. https://doi.org/10.1002/uog.27474 / REC reference: 19/LO/0794, sponsor: EU Horizon2020 iPlacenta), demonstrated changes in microvasculature at 26 weeks in n = 15 women with PE compared to normotensive (n=54). Using this previous data a Power Analysis (G*power)) -A Piori was carried out to compute the required sample size for the Wilcoxon-Mann Whitney test (two groups). With α = 0.05 and pa ower of 95% to detect an effect size of 25%, each group requires a n = 11.
As this is a prospective study to obtain measurements at the onset of gestational hypertension, we predict we need to recruit 110 women to obtain the 10% of women who develop gestational hypertension. The researchers will try to increase the likelihood of recruiting gestational hypertensive women by recruiting from the IVF clinic at Ninewells. Also, women who are high risk or that have been newly diagnosed i.e. attending hypertensive clinics will be recruited.

Researcher Bias
The risk of researcher bias is minimal, for the following reasons:
1. Non-invasive assessment of vascular changes in pregnancy is by means of objective tests, and most are automated.
2. The diagnosis of pregnancy complications, such as gestational hypertension, will be made by the woman's own attending clinicians according to the criteria laid down by the hospital.

Intervention Type
Other

Primary outcome(s)
1. Retinal vascular health measured using retinal imaging (Canon camera) (VAMPIRE: Vascular Assessment and Measurement Platform for Images of the REtina)
2. Endothelial function measured using retinal imaging and ultrasound pulse-wave Doppler
3. Cardiovascular function biomarkers measured using blood biomarker analysis (sFlt-1 & PLGF, endothelin-1)

Measured at mild-late pregnancy for women with gestational hypertension and normal pregnancies

Key secondary outcome(s)
Long-term cardiovascular risk indicators measured using cardiovascular risk assessment tools (e. g., blood pressure, etc) at mild-late pregnancy for women with gestational hypertension and normal pregnancies

Completion date
10/06/2026

Eligibility

Key inclusion criteria
Case group:
Women who:
1. Are aged 18 years or above

2. Are able to give written informed consent (ICF)
3. Are in mid-to-late gestation
4. Were diagnosed with gestational hypertension (systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg) in their pregnancy
5. Do not have cardiac or ophthalmic disorders

Control group:
Pregnant women who are:
1. Aged 18 years or above
2. Able to give written informed consent (ICF)
3. Have no gestational hypertension (normal pregnancy/non-hypertension)
4. Do not have cardiac or ophthalmic disorders

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
18 Years

Upper age limit
60 Years

Sex
Female

Total final enrolment
16

Key exclusion criteria
Exclusion criteria are the same for both case and control groups:

Case group:
1. Women with ophthalmic disorders
2. Women who have hypertension during pregnancy
3. Maternal age less than 18 years at delivery
4. Women who are not capable of giving informed consent (ICF)
5. Individuals participating in the clinical phase of another interventional study or have done so within the last 30 days (unless they are participating in the follow-up phase of another interventional trial/study, or who are enrolled in an observational study, will be co-enrolled where the CIs of each study agree)

Control group:
1. Women with any history of gestational hypertension (systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg)
2. Women with ophthalmic disorders

3. Women who had hypertension prior to pregnancy
4. Maternal age less than 18 years at delivery
5. Women who are not capable of giving informed consent (ICF)
6. Individuals participating in the clinical phase of another interventional study or have done so within the last 30 days (unless they are participating in the follow-up phase of another interventional trial/study, or who are enrolled in an observational study, will be co-enrolled where the CIs of each study agree)

Date of first enrolment
01/06/2025

Date of final enrolment
31/05/2026

Locations

Countries of recruitment
United Kingdom

Scotland

Study participating centre
Ninewells Hospital
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Sponsor information

Organisation
University of Dundee

ROR
https://ror.org/03h2bxq36

Funder(s)

Funder type
University/education

Funder Name

University of Dundee

Alternative Name(s)
Dundee University, Oilthigh Dhùn Dè

Funding Body Type
Government organisation

Funding Body Subtype
Universities (academic only)

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during this study will be available upon request from Dr Colin Murdoch (c.z.murdoch@dundee.ac.uk). Anonymization will be ensured and access will align with ethical guidelines and consent obtained.

IPD sharing plan summary
Other

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Participant information sheet			19/03/2025	No	Yes
Protocol file			19/03/2025	No	No