

DECEMBER 2021

MONASH HEALTHCARE INNOVATION SUMMER SCHOLARSHIPS

Project Gravitar



Monash Partners
Academic Health Science Centre



**MONASH
YOUNG
MEDTECH
INNOVATORS**



Current Team: Maitri Justitian, Rishikha Thangavelu
Clinical Champion: Lisa Moran, Siew Lim, Joanne Enticott
Affiliations: MCHRI

Executive Summary

Project Gravitator aims to develop a risk prediction tool using AI for cardiometabolic risks such as gestational diabetes and hypertensive disorders during pregnancy.

Gestational diabetes mellitus refers to high blood sugar (diabetes) that is diagnosed for the first time during pregnancy (gestation). There are three types of hypertension disorder in pregnancy that are focused in this project. They are gestational hypertension, preeclampsia and eclampsia. Gestational hypertension is a disorder where high blood pressure is first diagnosed during pregnancy. Preeclampsia is hypertension with a potential of organ failure, while eclampsia is the most severe type of hypertension disorder where pregnant women have a potential for organ failure, coma or even seizure.

These conditions can further lead to pregnancy complications like excessive birth weight, preterm birth, macrosomia (baby being born over the average weight), etc.

They also lead to long term risk for the women. Women with a history of hypertensive disorders, including pre-eclampsia, during pregnancy have a two- to-five-fold increased risk of cardiovascular disease (CVD). It also leads to long term risks like cardiovascular disease and type 2 diabetes. About 50% of women with gestational diabetes go on to develop type 2 diabetes. Currently the doctors diagnose gestational diabetes after 24 weeks using a glucose tolerance test.

However, all these pregnancy risk complications, long term risks can be prevented if the doctors were able to identify and intervene before the first semester by advising lifestyle changes to the pregnant women. Therefore, the project Gravitator aims to develop a web app to help with the prediction of gestational diabetes and hypertensive disorder. This app will be used for free by the clinicians in the hospitals with the pregnant women before the first trimester. Therefore, the clinicians can intervene and provide appropriate lifestyle management advice such that the gestational diabetes and hypertensive disorders can be controlled or prevented.

Objectives

- Personalised risk prediction based on broad range of factors
- Selection of appropriate factors for the machine learning model.
- Dynamic prediction model
- Develop a model with accuracy of at least 80% for prediction that is made within the first trimester.
- The web app should be easy to use and understand especially for clinicians and pregnant women.
- Appropriate risk communication to pregnant women.

Gaps Analysis

The current approach for GDM and HDP is to check for the symptoms of the disorder. This means that the disorders had developed and the pregnant women already have an increased risk of future diabetes or future cardiovascular problem by 7 to 10 fold.

Furthermore, there are cases where the woman might not show any symptoms until it's too late (ex: blood pressure suddenly shot up and now the women shows symptoms of preeclampsia (insert ref), some women have normal protein level in their urine test)

There do not exist any solution for prediction of hypertensive disorders during the pregnancy. However, there are two apps to predict gestational diabetes. However, they have some gaps which will be improved by our project.



The first solution is the lifestyle prediction tool by the personal GDM. The personal GDM app is a rough guide to identify women with risk of developing GDM. The app uses a linear equation based on a classical statistical method to predict if the pregnant women might have gestational diabetes or not. However, this information is not enough. A risk percentage is required to understand the severity of the risk. Also the personal GDM app only uses a few factors for calculation.

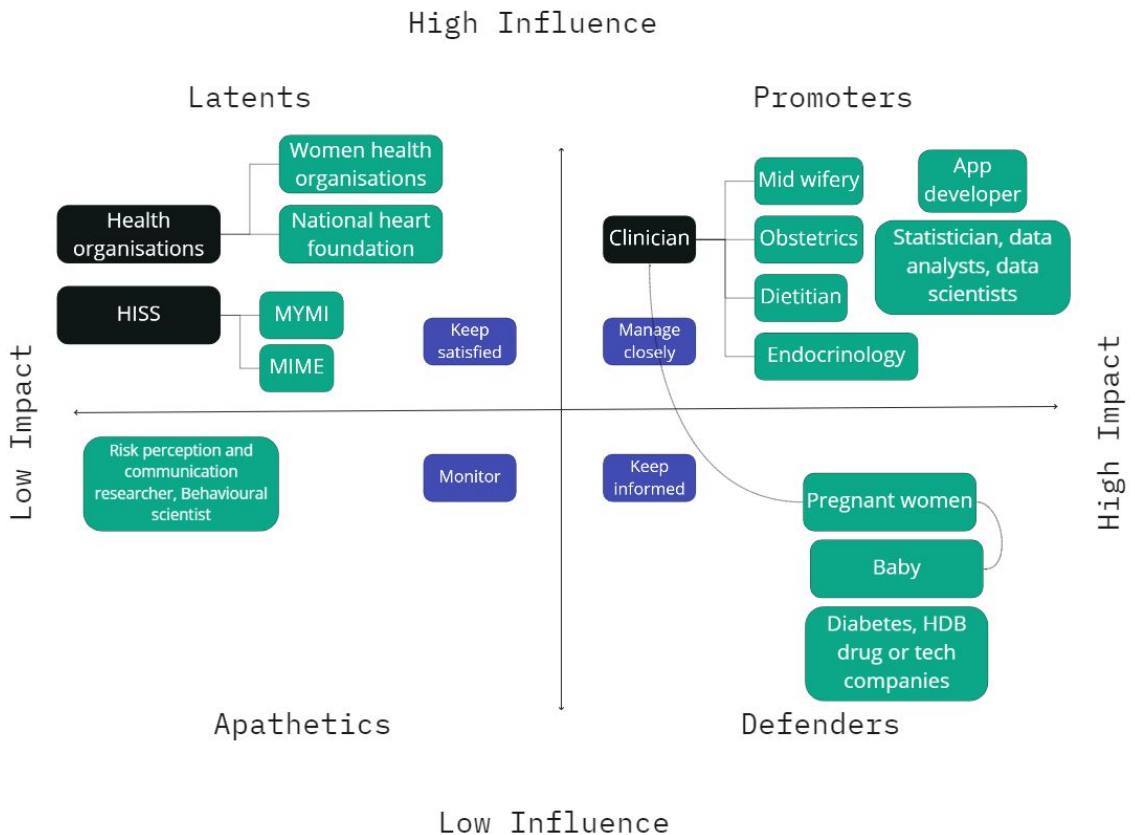
The second solution is the monash GDM prediction app which can be accessed in the link below:

<https://www.evidencio.com/models/show/2102>.

This app predicts gestational diabetes based on demographic data. However, the app only uses classical statistical methods, it has only few factors and it has minimal interpretability. Also the app is not dynamic.

However, our app would most likely use machine learning or deep learning models instead of classical statistical methods. We are aiming for a dynamic app where the machine learning model will be continuously updated with the latest data available. This will also help with improvement in the accuracy of the model. The app will also focus on more understanding of the risk. The dataset has 160 factors which will be used for our modelling and therefore, we have more factors which would give more accuracy. In these 160 factors the data will be analysed appropriately to choose the best factors.

Stakeholder Map



The stakeholder map shows the relevant stakeholder for project Gravitar. The black block on the graph shows the main group and the green box shows the segments within the group. The map also shows the connection between the individual stakeholders.

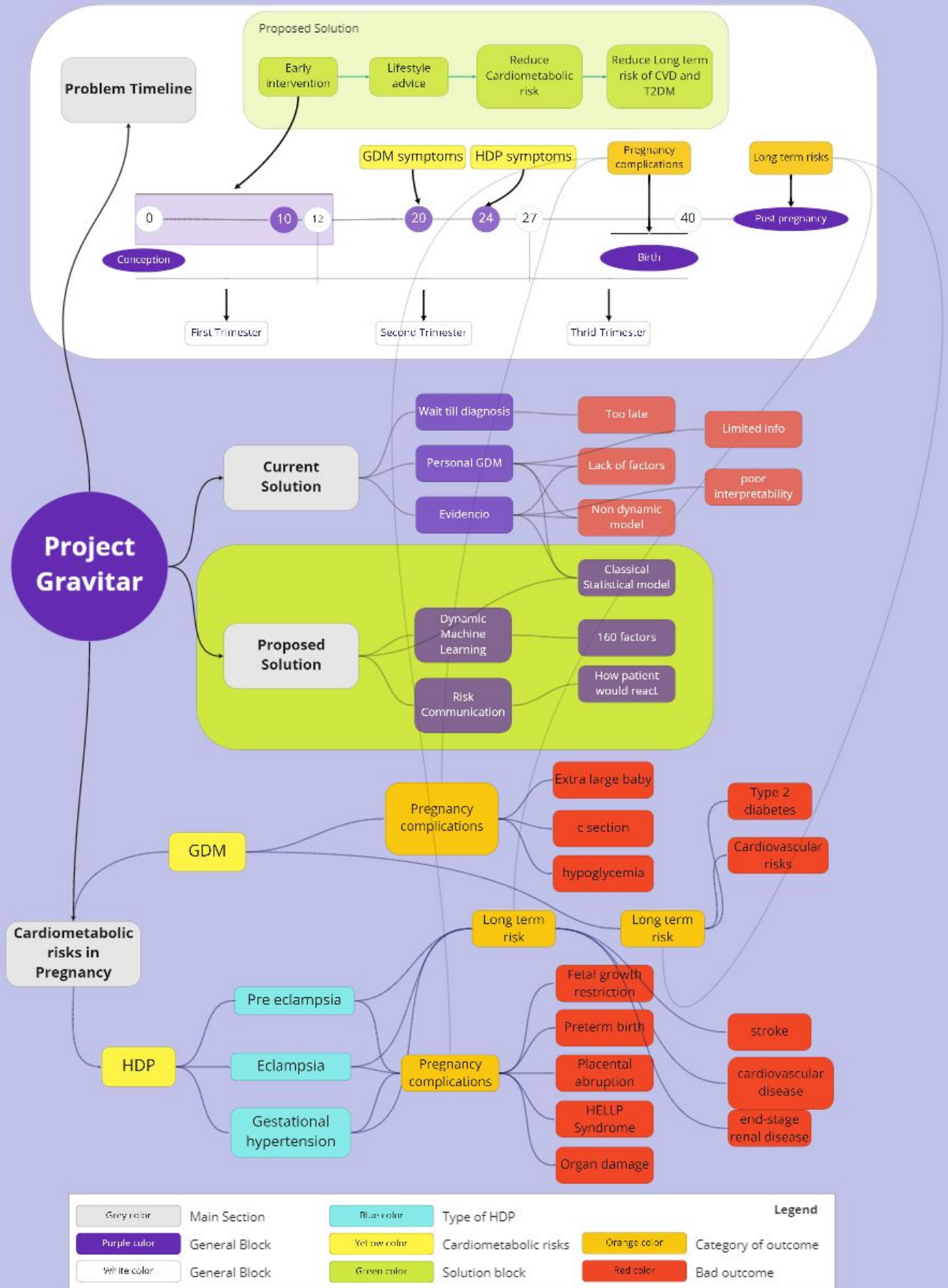
The clinicians and the app developers, statistician/data analyst/data scientist are the stakeholders who need to be managed closely since they have high impact on the project and high influence.

The health organisations provide the funding for further research and development and thus they have high influence on the project.

The risk perception and communication researcher, behaviour scientist have minimal influence on the project since we use their inputs through user interviews or research papers to understand the way to communicate the risk effectively to pregnant women.

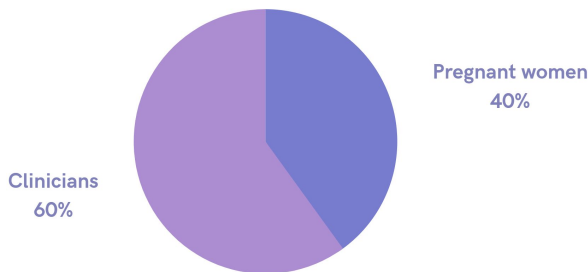
Pregnant women and babies have high impact along with the diabetes/hypertensive disorders drug or technology companies. This is because if the lifestyle of the pregnant women is managed and the long term risks are prevented then these companies might lose many consumers and endure less profit.

Systems Map



Outcomes of

Qualitative Research



Our user interviewee consists of 40% pregnant women and 60% clinicians (pediatrician and midwives) who are crucial stakeholders of our project as they will be the end user of our app.

All of the pregnant women interviewed expressed their interest in the prediction app with one person stating that she “... *wasn't aware of the increased heart risk in the future, (and) it would be nice to have a tool that could predict such common risks*”. However, the interviewees also stated that the app might make them feel anxious if the predicted risk result calculated is above 20%.

One clinician expressed their concern on the integration of the app to the current medical routine as they think it might add extra burden on the pregnant women.

All Clinician agrees on the importance of prediction method which would allow early prevention, they all mention that most of pregnancy related complications can somehow be traced to their risk of developing cardiometabolic risk such as GDM and HDP

A clinician also points out that because the amount of pregnancy care personnel is limited, they would like the app to have easy and quick result communication such as color coding the outcome of the prediction, red of patients with very high risk and green for patient of low risk.

Quantitative Research

In 2016–17, gestational diabetes affected 15% of all women aged 15–49.[1]

In Queensland, between 2014–2019 there were 364,194 pregnancies where

- Gestational hypertension affected 9,692 women (2.7% of total pregnancies),
- Preeclampsia affected 8,463 women (2.3% of total pregnancies),
- Eclampsia affected 139 women.

Therefore, **1 in 5** pregnant women face either gestational diabetes mellitus or hypertensive disorders. [2]

Meta analyses has shown that women who developed GDM have higher chance of getting type 2 diabetes mellitus as well as cardiovascular diseases. From a pool of 9 studies found on PubMed and EMBASE database, a total of 101,424 cardiovascular events were noted from 5,390,591 women. Those who did have GDM, has higher risk of cardiovascular event by twofold compared to women with no GDM had[ref].

Evaluation of Potential Impact

The start of a greater project towards Women's Health

- The development of this app will be supported by the grant received from the Medical Research Future Funds (MRFF) as well as the Heart Foundation Vanguard for a broader project that aims to improve women's health in Australia. The grant covers for the development of risk prediction tools using dynamic machine learning models as well as personalized lifestyle advice with appropriate risk communication.
- The grant will cover the project for 4 years and Monash Centre for Health Research and Implementation (MCHRI) is actively developing a procedure that would allow further funding to sustain the web app in the long run.
- Project Gravitar will be an important start and base of this broad project.
- In accordance with the final aim of the broader project of improving women's health, the revenue stream and the margin structure of this project will purely be from the grant as the app is to be made available online for free where anyone with a mobile device and internet can access them easily.
- Sales investment will begin in women's hospital and pregnancy care institution where women's health, especially pregnant women's health is the priority of the organizations

Intellectual Property

- There are other fundings currently that supports the development of this project.
- This project expands on previous project supported by MIME, by comparing a new to-be developed AI/machine learning model with the previous web, a web-based risk prediction app for gestational diabetes using classical statistical methods.

Barrier to Entry

- Based on our clinician interview, it was mentioned that midwives have the tendency to follow closely by the guideline for midwives.
- This means that further work may be needed, to ensure that the targeted end users to use the app.

Burden of cost related to GDM and HDP towards the Healthcare System(US)

- GDM and HDP affects 700k women annually in US [m1]
- 1.3 billion USD for GDM associated maternal health care cost (2014)
- While with pre eclampsia - 1.03 billion USD for mother's healthcare and , 1.15 billion USD for infants (2017)
- This totals in a 3.58 billion USD spent annually for healthcare related to GDM and HDP (only preeclampsia)

Increasing percentage of women with GDM and HDP

- A study in 2000-2010 shows that the percentage of women developing GDM increases by 56%.
- And similarly to preeclampsia where a study from 2000-2020 shows a 25% increase of patient

Our Team



Maitri Justitian, a final year Electrical and Computer System Engineering student with a minor in Computer Science and AI in Engineering. Part of Monash Deep Neuron Deep Learning member and External member in Monash Brew Lab. Interested in AI and human-related technologies.



Rishikha Thangavelu. A 2nd year student of Applied data science Advanced(Honours) with a minor in Anatomy and Developmental biology.



Dr Lisa Moran leads the Healthy Lifestyle Research Program within the Monash Centre for Health Research and Implementation, Monash University. She is a research dietitian and Accredited Practicing Dietitian and an Affiliate staff member of the Robinson Research Institute at the University of Adelaide. I work in clinical and epidemiological nutrition research and clinical dietetics.



Dr Joanne Enticott is a 2019 Data-Driven Fellow with a mandate to develop health data research incubator hubs, and funded by Monash Partners AHRTC and Medical Research Future Fund. She is also a Senior Research Fellow and Biostatistician at the Department of General Practice and Health Services Research Coordinator at Southern Synergy Department of Psychiatry, Monash University.



Dr Siew Lim is an early career researcher and an Accredited Practising Dietitian with a highly competitive biomedical, clinical and public health research track record. She is recognised nationally and internationally as an emerging leader in the field of lifestyle management in women of reproductive age.

Resources

1. Incidence of gestational diabetes in Australia, Gestational diabetes incidence - Australian Institute of Health and Welfare [Internet]. Australian Institute of Health and Welfare. 2021 [cited 16 December 2021]. Available from:
<https://www.aihw.gov.au/reports/diabetes/incidence-of-gestational-diabetes-in-australia/contents/gestational-diabetes-incidence>
2. [Internet]. Health.qld.gov.au. 2021 [cited 16 December 2021]. Available from:
https://www.health.qld.gov.au/_data/assets/pdf_file/0034/139948/g-hdp.pdf
3. Bailey C, Skouteris H, Harrison CL, Boyle J, Bartlett R, Hill B, Thangaratinam S, Teede H, Ademi Z. Cost Effectiveness of Antenatal Lifestyle Interventions for Preventing Gestational Diabetes and Hypertensive Disease in Pregnancy. *Pharmacoecon Open*. 2020 Sep;4(3):499-510. doi: 10.1007/s41669-020-00197-9. PMID: 32026397; PMCID: PMC7426355.
4. Diabetes During Pregnancy | Maternal Infant Health | Reproductive Health | CDC [Internet]. Cdc.gov. 2021 [cited 16 December 2021]. Available from:
<https://www.cdc.gov/reproductivehealth/maternalinfanthealth/diabetes-during-pregnancy.htm>
5. Gestational diabetes - Symptoms and causes [Internet]. Mayo Clinic. 2021 [cited 16 December 2021]. Available from:
<https://www.mayoclinic.org/diseases-conditions/gestational-diabetes/symptoms-causes/syc-20355339#:~:text=Gestational%20diabetes%20is%20diabetes%20diagnosed,pregnancy%20and%20your%20baby's%20health.>
6. 5. SA L. Guideline for the Management of Hypertensive Disorders of Pregnancy [Internet]. Ranzcog.edu.au. 2014 [cited 16 December 2021]. Available from:
https://ranzcog.edu.au/RANZCOG_SITE/media/RANZCOG-MEDIA/Women%27s%20Health/SOMANZ-Hypertension-Pregnancy-Guideline-April-2014.pdf?ext=.pdf