

openheart Patients' understanding of long-term cardiovascular risks and associated health-seeking behaviours after pre-eclampsia

Jessica Atkinson ^{1,2}, William Wei,³ Stephanie Potenza,² Grace Simpson,¹ Anna Middleton,^{1,2} Susan Walker,^{1,2} Stephen Tong,^{1,2} Roxanne Hastie,^{1,2} Anthea Lindquist^{1,2}

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¹Department of Obstetrics & Gynaecology, The University of Melbourne, Heidelberg, Victoria, Australia

²Mercy Perinatal, Mercy Hospital for Women, Heidelberg, Victoria, Australia

³School of Medicine, Deakin University, Burwood, Victoria, Australia

Correspondence to
Dr Anthea Lindquist; anthea.lindquist@unimelb.edu.au

ABSTRACT

Objective The lifelong risks of cardiovascular disease following hypertensive disorders of pregnancy are well described. Awareness of these risks and associated health-seeking behaviours among affected individuals remains unclear. We aimed to assess participants' knowledge of their cardiovascular disease risk and relevant health-seeking behaviours following a pregnancy affected by preeclampsia or gestational hypertension.

Methods We undertook a single-site, cross-sectional cohort study. The target population included individuals who birthed at a large tertiary referral centre in Melbourne, Australia, between 2016 and 2020, and were diagnosed with gestational hypertension or pre-eclampsia. Participants completed a survey assessing pregnancy details, medical comorbidities, knowledge of future risks and health-seeking behaviours post-pregnancy.

Results 1526 individuals met inclusion criteria and 438 (28.6%) completed the survey. Of these, 62.6% (n=237) were unaware of their increased risk of cardiovascular disease following a hypertensive disorder of pregnancy. Participants who reported awareness of their increased risk were more likely to have annual blood pressure monitoring (54.6% vs 38.1%, $p<0.01$), and at least one assessment of blood cholesterol ($p<0.01$), blood glucose ($p=0.03$) and renal function ($p=0.01$). Participants who were aware were more likely to be taking antihypertensive medication (24.5% vs 6.6%, $p<0.01$) since pregnancy, compared with those who were unaware. There were no differences between groups in diet, exercise or smoking habits.

Conclusion Among our study cohort, risk awareness was associated with increased health-seeking behaviours. Participants who were aware of their increased risk of cardiovascular disease were more likely to have regular cardiovascular risk factor assessments. They were also more likely to be taking antihypertensive medication.

INTRODUCTION

The aftermath of pre-eclampsia and gestational hypertension extends decades after pregnancy. In particular, the postpartum cardiovascular sequelae for individuals

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Individuals who experience hypertensive disorders of pregnancy are more likely to develop cardiovascular disease following pregnancy. This study was conducted to determine the effect of risk awareness on health-seeking behaviours among this cohort of patients.

WHAT THIS STUDY ADDS

⇒ We have demonstrated a lack of awareness among this cohort about their long-term risk of cardiovascular disease. We have shown that individuals who are made aware of their increased risk of cardiovascular disease following hypertensive disorders of pregnancy may be more likely to engage in health-seeking behaviours to reduce their risk.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study may provide impetus for a change in practice. It is important that clinicians communicate the risk of cardiovascular disease to their patients with hypertensive disorders of pregnancy, in order to motivate sustained lifestyle changes and health-seeking behaviour. In doing so, significant disease burden may be eliminated.

affected by hypertensive disorders of pregnancy have been well characterised: pre-eclampsia and gestational hypertension are both associated with the subsequent development of essential hypertension, coronary heart disease and heart failure.¹⁻⁷ Having had pre-eclampsia confers a twofold increased risk of death due to coronary heart disease.²

Cardiovascular disease risk is often considered a disease of advanced age.⁸ However, among individuals with a history of hypertensive disorders of pregnancy, the onset of cardiovascular disease can occur surprisingly soon. A 2015 Norwegian study demonstrated a fivefold increased risk of hypertension just

5 years after a pre-eclamptic pregnancy.⁹ Similarly, a study of over 1 million patients in Denmark found that the risk of hypertension among those with a hypertensive disorder of pregnancy was threefold to 10-fold higher within 10 years postpartum, and that this risk persisted for up to 20 years.¹⁰

Given these risks, it is critical that early preventative measures are applied to this population. Lifestyle interventions to mitigate cardiovascular risk are well understood, and trials are underway to validate these interventions in the postpartum setting.^{11 12} The Heart Foundation Australia recommends that affected individuals monitor their blood pressure annually and have their serum lipids and blood glucose monitored every 5 years.¹³ However, lifestyle intervention strategies and appropriate cardiovascular screening are not universally part of routine care for affected individuals in the postpartum context.^{13–15}

We conducted a cross-sectional survey of participants diagnosed with pre-eclampsia or gestational hypertension during pregnancy in a tertiary maternity hospital. The survey evaluated (a) participants' knowledge about their future cardiovascular risks, (b) postpartum health-seeking behaviours and engagement with primary care and (c) adoption of relevant lifestyle interventions.

METHODS

Study design and setting

We performed a cross-sectional study of women who attended for pregnancy care at a large tertiary referral centre in Melbourne, Australia (the Mercy Hospital for Women). Eligible women were identified through medical records on the hospital Birthing Outcomes System, a system which is widely used across the state of Victoria to collect routine antenatal and birth data.

Eligible participants were asked to complete a survey consisting of 51 questions, with invitations sent via text message between 31 January 2022 and 7 March 2022. Survey responses were collected via Research Electronic Data Capture hosted at University of Melbourne.¹⁶ Participants were informed of the rationale behind their recruitment and provided with a personalised survey link. Informed consent was obtained for all survey respondents. The survey was closed on 21 March 2022, after which time no further responses were accepted.

The survey assessed baseline characteristics, risk factors for cardiovascular disease, lifestyle mitigation strategies before and after pregnancy, and perceived risk of cardiovascular disease following a diagnosis of pre-eclampsia or gestational hypertension (online supplemental document S2). Survey questions were developed by the research team, and based on the Australian Heart Foundation recommendations for women after a diagnosis of pre-eclampsia or gestational hypertension (online supplemental document S3).¹³ Survey answers were validated using hospital data where possible, and individual responses were reviewed by researchers for plausibility.

Study population

The target population included participants who gave birth at or beyond 20 weeks' gestation between 1 January 2016 and 31 December 2020. Eligible participants were diagnosed with pre-eclampsia and/or gestational hypertension during the relevant pregnancy or within 42 days of the end of pregnancy. Gestational hypertension and pre-eclampsia were diagnosed according to the Society of Obstetric Medicine of Australia and New Zealand guidelines.¹⁷

Data extraction from Birthing Outcomes System occurred between 6 January and 25 January 2022, and 1794 pregnancy episodes were initially identified. Women were excluded from the survey invitation if they were under 18 at the time of survey distribution; were non-English speaking (determined by the use of interpreter services at the hospital during their most recent antenatal care episode; or if their pregnancy had resulted in a still-birth, neonatal death, transfer of their infant to foster care combined (n=268), out of respect to these individuals and the likely sensitivity regarding their traumatic pregnancy outcome. Multiple pregnancies were included.

Patient and public involvement

Patients were involved in the survey aspect of this study, and their responses make up our results. Given the authors' clinical backgrounds and newly emerging literature, a lack of awareness about future cardiovascular disease risk among women with a history of hypertensive disorders of pregnancy was identified as a point of concern. We surveyed patients from our research centre in order to test this assumption.

The results of this survey will be used to design patient and clinician information pamphlets. The authors intend to use a co-design approach, and will seek feedback from study participants in the design and dissemination of these materials. All participants who expressed interest in receiving this information will have it sent to them via email.

Statistical analysis

Two subgroups were established: 'responders', who consented to and completed the survey; and 'non-responders', who were eligible but did not complete the survey. The demographic characteristics of the two groups were compared to ensure that the survey sample ('responders') was representative of the total population.

The responders were then divided into two groups based on their reported knowledge of the risk of cardiovascular disease associated with hypertensive disorders of pregnancy. Reported lifestyle choices, including healthcare visits, diet, exercise, medication and smoking status, in the year(s) since the affected pregnancy were compared between participants who were aware of the risks and those who were not. For participants who reported being aware of cardiovascular risks, the source and extent of their knowledge were also examined.

For all continuous variables, mean and SD were reported. For all categorical variables, frequency and percentage were reported. Statistical significance was

determined using Student's t-test for numerical variables, Fisher's exact test for nominal variables, and logistic regression for ordinal variables. The significance level was two-sided and set at 0.05. All statistical data analysis was undertaken using STATA V.17 software (StataCorp. 2021, Stata Statistical Software: Release 17).

RESULTS

Characteristics of survey respondents

One thousand five hundred and twenty-six patients met the inclusion criteria and of these, 438 (28.7%) completed the survey Figure 1. Generally, survey responders did not differ significantly from non-responders (online supplemental table S1). However, responders were significantly less likely to smoke during pregnancy and were primarily

born within Australia, compared with non-responders (online supplemental table S1).

Among the 438 survey respondents, 69.2% were diagnosed with pre-eclampsia, and 30.8% were diagnosed with gestational hypertension (table 1). Overall, 62.6% of participants reported being unaware of the cardiovascular risks associated with a diagnosis of pre-eclampsia or gestational hypertension. There was no difference in awareness based on the type of hypertensive diagnosis.

Awareness of cardiovascular risk and associated behaviours

Participants who reported being aware of the increased risk of cardiovascular disease following hypertension in pregnancy were significantly more likely to have had annual blood pressure assessments since their affected pregnancy (54.6% vs 38.1%, $p<0.01$). They were also

Table 1 Survey-reported medical history and pregnancy outcomes

Characteristic	Aware of increased cardiovascular risk (n=163)	Unaware of increased cardiovascular risk (n=273)	P value
Family medical history, n (%)			
Any family medical history of cardiovascular disease	132 (81.0)	192 (70.3)	0.02
Stroke	28 (17.2)	43 (15.8)	0.69
Heart disease	35 (21.5)	50 (18.3)	0.45
'Heart attack'	32 (19.6)	56 (20.5)	0.90
High blood pressure	114 (69.9)	147 (53.9)	<0.01
Postpartum diagnoses, n (%)			
Any postpartum medical condition	71 (43.6)	61 (22.3)	<0.01
Heart failure	0 (0.0)	1 (0.4)	1.00
High blood pressure ('Hypertension')	59 (36.2)	44 (16.1)	<0.01
Heart disease	0 (0.0)	1 (0.4)	1.00
Stroke	1 (0.6)	1 (0.4)	1.00
High cholesterol	17 (10.4)	15 (5.5)	0.06
Type 2 diabetes	5 (3.1)	5 (1.8)	0.51
Chronic kidney disease	1 (0.6)	4 (1.4)	0.66
Blood clot in the leg (deep vein thrombosis)	3 (1.8)	3 (1.1)	0.68
Unsure	3 (4.8)	13 (1.8)	0.19
Hypertensive condition in pregnancy, n (%)			
Pre-eclampsia	116 (71.2)	185 (67.8)	0.52
Gestational hypertension	47 (28.8)	88 (32.2)	
Special care nursery/neonatal intensive care unit admission			
Singletons			
Yes	87 (54.7)	98 (38.1)	<0.01
No	72 (45.3)	159 (61.8)	
Twins and singletons			
Yes	91 (55.8)	114 (41.8)	<0.01
No	72 (44.2)	159 (58.2)	
Preterm birth			
Preterm (<37 weeks)	61 (37.4)	84 (30.8)	0.172
Term (≥37 weeks)	102 (62.6)	189 (69.2)	
Characteristics as stated in participant survey.			

Table 2 Survey-reported health-related behaviours since affected pregnancy

Characteristic	Aware of risk (n=163)	Unaware of risk (n=273)	P value
Annual blood pressure assessment since affected pregnancy, n (%)			
Yes (≥1 check per year since pregnancy)	89 (54.6)	104 (38.1)	<0.01
Other cardiovascular risk assessments since affected pregnancy, n (%)			
Blood glucose	95 (58.3)	129 (47.3)	0.03
Blood cholesterol	97 (59.5)	122 (44.7)	<0.01
Kidney function	102 (62.6)	135 (49.5)	0.01
Daily serves of fruit and vegetables since most recent pregnancy, n (%)			
<5 serves	143 (87.7)	238 (87.2)	0.37
≥5 serves	19 (11.7)	34 (12.5)	
Missing	1 (0.6)	1 (0.4)	
Amount of weekly exercise (number of times exercised for ≥30 min), n (%)			
<5 times	128 (78.5)	225 (82.4)	0.24
≥5 times	34 (20.9)	47 (17.2)	
Missing	1 (0.6)	1 (0.4)	
Type of exercise, n (%)			
Running	26 (16.0)	30 (11.0)	0.14
Walking	135 (82.8)	221 (81.0)	0.70
Strength training	30 (18.4)	61 (22.3)	0.39
Yoga/pilates	33 (20.3)	51 (18.7)	0.71
Other	31 (19.0)	43 (15.8)	0.43
Body mass index (BMI) at time of survey completion			
Mean (SD)	28.75 (6.05)	28.50 (6.87)	0.72
Current medications, n (%)			
Anti-hypertensive medication	40 (24.5)	18 (6.6)	<0.01
Diabetes management	8 (4.9)	8 (2.9)	0.30
Cholesterol management	7 (4.3)	4 (1.5)	0.11
Any medication	97 (59.5)	95 (34.8)	<0.01
Medication for essential hypertension diagnosis only (n=103), n (%)			
Medicated	38 (64.4)	16 (36.4)	<0.01
Unmedicated	21 (35.6)	28 (63.6)	
Smoking status, n (%)			
Ever smoked	56 (34.4)	90 (33.1)	0.83
Never smoked	107 (65.6)	182 (66.9)	
Wanting to receive more information about pre-eclampsia and gestational hypertension from research team			
Yes	128 (80.0)	226 (83.1)	0.44
No	32 (20.0)	46 (16.9)	
Characteristics as stated in participant survey.			

more likely to have had at least one blood glucose, cholesterol or renal function assessment, compared with their unaware peers (table 2).

Participants who reported awareness of cardiovascular risks were also more likely to have been prescribed and report taking antihypertensive medications (25.5% vs 6.6%, $p<0.01$). This was irrespective of a reported post-partum diagnosis of essential hypertension (table 2).

There was no significant association between reported knowledge of cardiovascular risk and lifestyle modification, including daily servings of fruit and vegetables, amount of weekly exercise, types of exercise, or smoking habits. Overall, 82% of participants requested more information about their risk of cardiovascular disease and risk modification strategies from the researchers (table 2).

Reported sources of information regarding cardiovascular risk

Among the participants who reported being aware of cardiovascular risks following an affected pregnancy (n=163), 43.6% reported receiving this information from their general practitioner, 53.4% from a clinical staff member at their birthing hospital (doctor and/or midwife), 9.2% from another healthcare worker (eg, specialist, staff from other hospitals) and 38.7% reported finding this information for themselves. Participants were able to specify more than one source of information.

Participants who reported awareness of the associated cardiovascular risk were asked to describe their knowledge of specific risks associated with pre-eclampsia and gestational hypertension. The most frequently identified risk was heart disease (44.8%), followed by hypertension (42.9%) and stroke (31.9%).

DISCUSSION

Principal findings

Our study examined a high-risk population of individuals diagnosed with gestational hypertension or pre-eclampsia. We found that participants' knowledge regarding their future cardiovascular risk was concerningly low: 62.6% of respondents were unaware of their risk. Notably, those who were aware of their cardiovascular disease risk were significantly more likely to have had regular review of cardiovascular risk factors, such as blood pressure, blood glucose, and cholesterol. And importantly, they were more likely to have been prescribed antihypertensive medications.

Results in context

Annual blood pressure assessment and 5-yearly assessment of other risk factors (such as cholesterol, glucose and renal function) are recommended for individuals with a history of hypertensive disorders of pregnancy by the Heart Foundation Australia.¹³ Previous studies have highlighted the importance of regular cardiovascular monitoring in general for reducing burden of disease.^{2,10} Ensuring individuals understand their long-term risks may thus confer improved health outcomes through improved engagement with the health system and more regular risk factor assessment.

Among individuals at high risk of cardiovascular disease, the benefits of antihypertensive treatment to attain optimal blood pressure have been shown, even in circumstances where blood pressure is below the diagnostic threshold for hypertension.^{18,19} Our findings have demonstrated that participants who were aware of their increased risk of cardiovascular disease were more likely to be taking antihypertensive medications. This association was present among all respondents, including those with and without postpartum chronic hypertension. Our findings suggest that by informing individuals of their increased risk of cardiovascular disease, an important opportunity is created to initiate antihypertensive

treatment prior to the development of severe cardiovascular disease.

Despite the increase in healthcare engagement, we did not observe any significant lifestyle changes pertaining to diet, exercise or smoking associated with knowledge of cardiovascular risk. Small lifestyle changes such as increased intake of fruits and vegetables, more frequent exercise, and smoking cessation are well understood to reduce the risk of cardiovascular disease development.²⁰⁻²² Among survey respondents, only 34% reported reaching the Heart Foundation Australia's recommended exercise goals, and 29% the recommended daily serves of fruit and vegetables.^{23,24} The lack of lifestyle modification despite awareness of risk likely indicates that the benefits of lifestyle modification are not adequately conveyed to this at-risk group.

In the absence of a relevant hospital-based protocol for practitioners, only 53.4% of aware participants reported receiving information from their pregnancy care team (ie, hospital-based doctor and/or midwife); while 38.7% of participants sourced the information themselves. A focus group-based study in Norway found that this cohort want personalised information about their future risk of cardiovascular disease during their affected pregnancy in order to motivate them to engage in sustained lifestyle modification.²⁵ This finding has also been observed in an Australian context.²⁶ It is thus unsurprising that we observed minimal lifestyle change among a cohort of participants who do not routinely receive early or personalised information about risk-modification strategies from their treating healthcare teams.

Clinical and research implications

Among individuals with a history of hypertensive disorders of pregnancy, we have shown a significant association between patient understanding of future cardiovascular risk and increased health-seeking behaviours and engagement with the healthcare system. Our data provide evidence of potential tangible benefits in such individuals simply being aware of the future risks to their health. Our data potentially create a greater urgency for women with hypertensive disorders of pregnancy to be adequately informed of their risk of future cardiovascular disease by their pregnancy care team, followed by their primary health providers.

Improved education resources are needed for postpartum patients and their care providers, and consumer input will be essential for the development of appropriate resources. There are many benefits to patient-led co-design in the healthcare setting, and evidence suggests that adopting a co-design approach leads to more rapid and sustained adoption of novel practices.²⁷

Strengths and limitations

To our knowledge, our study is the largest survey to investigate patient knowledge of cardiovascular risk following hypertension in pregnancy, including over 400 participants with a confirmed history of pre-eclampsia

or gestational hypertension. Our comprehensive survey allowed us to examine participants' awareness of risk, in addition to postpartum lifestyle and health-seeking behaviours, family and medical history, and diagnoses following an affected pregnancy. In Australia, healthcare is universal. As such, all participants in our study population had access to postpartum review and ongoing health management in the primary care setting.

The reliability of participant responses is a universal limitation of survey data. We addressed this by using hospital data for validation where possible. Our survey questions were written in clear, simple language (Flesch-Kincaid Grade Level 6.2),²⁸ with appropriate explanations provided where necessary, ensuring the collected data were as accurate as possible.

Given the observational nature of this study, it is difficult to establish causation. Our study was cross-sectional, as such, we need to consider the possibility of reverse causality.²⁹ Women who were aware of their risk were also more likely to have been diagnosed with a chronic health condition since their affected pregnancy. It is therefore possible they may be aware of the association between hypertensive disorders of pregnancy and future disease because of their diagnosis. Similarly, women who were aware of their risk were also more likely to have family history of cardiovascular disease, and it is therefore possible they became aware through their concern about this family history. More research is required to further elucidate the direction of this observed association.

We hope to see our findings expanded on with the results of a randomised trial currently underway in New South Wales, Australia, aiming to assess postpartum follow-up and lifestyle changes within the first twelve months of an affected pregnancy.³⁰ A preliminary qualitative analysis from this study has highlighted the importance of targeted, structured and routine support to assist postpartum women with adopting healthy lifestyle changes post-birth, given the unique challenges faced by this cohort of new parents.³¹ The results of this trial, in addition to our own study findings, will collectively help inform risk-mitigation strategies which may be adopted by health professionals and affected patients.

CONCLUSIONS

Our study has demonstrated a significant lack of awareness regarding long-term cardiovascular impacts of hypertensive disorders of pregnancy among affected individuals. Critically, our findings demonstrate that increased awareness may be associated with increased engagement with the health system. Communication with women about risk and the provision of appropriate support and resources are key in ensuring that affected young people do not continue to suffer a disproportionate burden of disease in the years following pregnancy.

Twitter Jessica Atkinson @jess_aatkinson

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Competing interests None declared.

Patient consent for publication Not applicable.

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ORCID iD

Jessica Atkinson <http://orcid.org/0000-0002-6604-7456>

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Table S1. Maternal demographic and perinatal characteristics for responders and non-responders

Characteristic	Non-responders (N = 1088)	Responders (N = 438)	p
Maternal age at delivery (years)			
Mean (standard deviation)	32.85 (5.34)	33.18 (5.39)	0.29
≥ 35, n (%)	415 (38.1%)	173 (39.5%)	0.64
Body mass index at first antenatal visit (kg/m²)			
Mean (standard deviation)	28.81 (6.88)	28.30 (6.70)	0.20
< 18.5 (<i>underweight</i>)	12 (1.1%)	1 (0.2%)	0.12
18.5 – 24.9 (<i>healthy weight</i>)	315 (29.0%)	155 (35.4%)	
25.0 – 29.9 (<i>overweight</i>)	344 (31.6%)	126 (28.8%)	
30.0 – 34.9 (<i>obese class I</i>)	186 (17.1%)	70 (16.0%)	
35.0 – 39.9 (<i>obese class II</i>)	94 (8.6%)	32 (7.3%)	
> 40.0 (<i>obese class III</i>)	137 (12.6%)	54 (12.3%)	
Missing	64 (5.9%)	27 (6.2%)	
Parity at start of affected pregnancy, n (%)			
Nulliparous	667 (61.3%)	283 (64.6%)	0.26
Multiparous	421 (38.7%)	155 (35.4%)	
Gravidity at start of affected pregnancy, n (%)			
Gravida 1	453 (41.6%)	208 (47.5%)	0.27
Gravida 2+	635 (58.4%)	230 (52.5%)	
Plurality of affected pregnancy, n (%)			
Singleton	1014 (93.2%)	418 (95.4%)	0.06
Twins	74 (6.8%)	20 (4.6%)	
Country of birth, n (%)			
Australia	731 (67.2%)	322 (73.5%)	0.02
Overseas	357 (32.8%)	116 (25.5%)	
Primary spoken language, n (%)			
English	969 (89.1%)	410 (93.6%)	< 0.01
Language other than English	119 (11.0%)	28 (6.4%)	

Indigenous status, n (%)			
<i>Aboriginal and/or Torres Strait Islander</i>	24 (2.2%)	7 (1.6%)	0.55
<i>Neither Aboriginal nor Torres Strait Islander</i>	1064 (97.8%)	431 (98.4%)	
Diabetes status during affected pregnancy, n (%)			
<i>No diabetes</i>	868 (79.8%)	374 (85.4%)	0.07
<i>Gestational diabetes</i>	186 (17.1%)	56 (12.8%)	
<i>Pre-existing type 1 diabetes</i>	17 (1.6%)	5 (1.1%)	
<i>Pre-existing type 2 diabetes</i>	17 (1.6%)	3 (0.7%)	
Smoking status during affected pregnancy, n (%)			
<i>Non-smoker</i>	1023 (94.0%)	430 (98.2%)	< 0.01
<i>Smoker</i>	60 (5.5%)	7 (1.6%)	
<i>Unknown</i>	5 (0.5%)	1 (0.2%)	
Mode of birth (affected pregnancy)			
<i>Unassisted vaginal birth</i>	322 (29.6%)	126 (28.8%)	0.37
<i>Ventouse vaginal birth</i>	55 (5.1%)	22 (5.0%)	
<i>Forceps vaginal birth</i>	82 (7.5%)	24 (5.5%)	
<i>Elective caesarean</i>	194 (17.8%)	69 (15.8%)	
<i>Emergency caesarean</i>	435 (39.4%)	187 (45.0%)	
Gestation (weeks), n (%)			
Singletons (n=1,432)			
<i>< 37 weeks (preterm)</i>	263 (25.9)	129 (30.9)	0.06
<i>≥ 37 weeks (term)</i>	751 (74.1)	289 (69.1)	
Twins (n=93)			
<i>< 37 weeks (preterm)</i>	60 (82.2)	17 (85.0)	1.00
<i>≥ 37 weeks (term)</i>	13 (17.8)	3 (15.0)	

SCN/NICU admission status (following affected pregnancy), n (%)			
Singletons (n=1,432)			0.35
	<i>Yes</i> 425 (41.9)	187 (44.7)	
	<i>No</i> 589 (58.1)	231 (55.3)	
Twins (n=93)			1.00
	<i>Yes – one twin</i> 8 (10.8)	2 (10.0)	
	<i>Yes – both twins</i> 66 (89.2)	18 (90.0)	
	<i>No</i> 0 (0.0)	0 (0.0)	
Infant discharge destination (affected pregnancy), n (%)			
Singletons (n=1,432)			0.43
	<i>Home</i> 894 (88.2)	362 (86.6)	
	<i>Transfer</i> 120 (11.8)	56 (13.4)	
Twins (n=93)			0.91
	<i>Home – both twins</i> 53 (72.6)	14 (70.0)	
	<i>Transfer – both twins</i> 15 (20.6)	5 (25.0)	
	<i>Home – one twin & transfer – one twin</i> 5 (6.9)	1 (5.0)	

Document S2: Complete participant survey questions and possible responses

Participant Survey

Important Information:

The researchers are using REDCap for the collection, aggregation, and analysis of survey data. The information collected in this survey is transmitted and stored securely within Australia and is accessed by the University of Melbourne and Mercy Perinatal researchers in accordance with this privacy statement. You may decline to provide your information by not responding to the survey. This voluntary survey should take about 10 minutes to complete. The survey is mostly made up of 'tick-the-box' questions. We sometimes ask you to provide some more details, depending on your answers. Please answer as honestly as you can - it is important that we get accurate information from your answers. Your answers to this survey are not linked to your name. If you are unsure about any of the answers, please write 'unsure'. If any of these questions cause concern for you, you may contact the researchers on 03 8458 4381 (business hours, Monday to Friday). We will not be able to provide you with any personalised health advice. Alternatively, you may wish to make an appointment to see your regular doctor to discuss your health if you have any specific concerns. Thank you for taking the time to participate in this important study.

Do you consent to participating in this survey? Yes
 No

Today's Date _____

Section 1 - About you, your health and your family's medical history:

What is your date of birth? _____

What is your height? (cm) _____

(cm)

How much do you weigh? (kg) _____

(kg)

Have you ever had any type of diabetes?

- No - No diabetes
 Yes - Gestational diabetes (diabetes during pregnancy)
 Yes - Type 1 diabetes
 Yes - Type 2 diabetes
 Unsure

Year of diagnosis _____

Year of diagnosis _____

Year of diagnosis _____

Have you ever had a close relative* who has had (tick any that apply):

- Heart disease
 A heart attack
 High blood pressure
 A stroke (a bleed or clot in the brain)
 None of the above
 I'm unsure of my family medical history

*A "close relative" is a parent, full sibling, or child who is related to you by blood (i.e. not related to you by marriage or adoption).

Section 2 - About your pregnancy/pregnancies

How many times have you been pregnant?

How many of your pregnancies have been complicated by high blood pressure?

How many children do you have?

- 0
 1
 2
 3
 4
 5
 6
 7
 8
 9
 10

Date of birth of first child:

Date of birth of second child:

Date of birth of third child:

Date of birth of fourth child:

Date of birth of fifth child:

Date of birth of sixth child:

Date of birth of seventh child:

Date of birth of eighth child:

Date of birth of ninth child:

Date of birth of tenth child:

Were any of your children considered small at birth ("small for gestational age")?

- Yes
 No

Were you diagnosed with any of the following during a pregnancy?

(Tick at least one answer)

- Gestational hypertension (high blood pressure during pregnancy, without other problems)
- Pre-eclampsia (high blood pressure, plus other problems, like protein in your urine)
- Other high blood pressure problem (please provide detail)
- None of the above
- Unsure

Please provide detail of other blood pressure problem diagnosed during pregnancy _____

Section 3 - Doctor visits since your most recent child's birth

Since your most recent birth, how many times have you visited a doctor or health clinic to check your blood pressure?

- 0
- 1
- 2
- 3
- 4
- 5+

Since your most recent birth, how many times have you had blood tests to check your blood sugar?

(Names of blood tests might include: fasting glucose, random glucose, oral glucose tolerance test [GTT], HbA1c)

- 0
- 1
- 2
- 3
- 4
- 5+

Since your most recent birth, how many times have you had blood tests to check your cholesterol?

(Names of blood tests might include: lipid profile, lipid panel, LDL, HDL, total cholesterol, triglycerides)

- 0
- 1
- 2
- 3
- 4
- 5+

Since your most recent birth, how many times have you had blood tests to check your kidney function?

(Names of blood tests might include: UEC, or U&EC)

- 0
- 1
- 2
- 3
- 4
- 5+

Section 4 - Your smoking history

Have you ever smoked?

- No
- Yes

Over the last month, how many cigarettes did you smoke each day (on average)?

- 0 - I have quit smoking
- 1-5
- 6-10
- 11-15
- 16-20
- 21-25
- 25+

Did you smoke during your most recent pregnancy?

- Yes
- No

Did you quit (or try to quit) during your most recent pregnancy?

- No
 Yes
 N/A - I had quit prior to pregnancy

Have you quit (or tried to quit) smoking since your youngest child was born?

- No
 Yes
 N/A - I had already quit

Section 5 - Your health after pregnancy

Since your most recent birth, have you had any of the following conditions?

(select one or more)

- Type 2 Diabetes
 Heart failure
 High blood pressure (or "hypertension")
 Heart disease
 Stroke
 Chronic kidney disease
 High cholesterol
 Blood clot in the leg (or a "DVT")
 None of the above

Are you currently taking medications to manage any of the following conditions?

- High blood pressure (or "hypertension")
 Diabetes (any type)
 High cholesterol
 Not taking medication for any of the above reasons

Are you currently taking any medications?

- No current medications
 Yes (please list names of medications below)

Please list names of any current medications:

Are you currently pregnant?

- Yes
 No

What is your due date?

Over the last month, how many times each week did you do 30 minutes or more of exercise (on average)?

- 0 times
 1-2 times
 2-3 times
 3-4 times
 5 or more times

What types of exercise have you done in the last month (for at least 30 minutes at a time)?

(select all that apply)

- Running
 Walking
 Strength training (i.e. weights)
 Yoga/Pilates
 Other (please specify)

Please specify any other types of exercise you have done in the last month (for at least 30 minutes at a time)

Over the last month, how many portions of fruit or vegetables did you eat on a typical day?

- 0 serves
 1-2 serves
 2-3 serves
 3-4 serves
 5 or more serves

Having high blood pressure during a pregnancy can impact on a woman's future health and her risk of certain illnesses later on in her life.

- No, I did not know
 Yes, I am aware of this

Were you aware of this?

If yes, please list the related risks that you know about:

Who has given you information about your future health risks that are linked to having high blood pressure during a pregnancy?

- A Mercy Hospital doctor
 A Mercy Hospital midwife
 My local doctor (GP)
 Another healthcare worker (please specify)
 I found out this information for myself
 I was not already aware of this information

Please specify any other healthcare workers who have given you information about your future health risks that are linked to having high blood pressure during a pregnancy

Would you find it helpful to receive an information sheet/pamphlet about the things that you can do to improve your lifelong health following your experience of high blood pressure during pregnancy?

- No, I would not like to receive this information/I will get this information elsewhere
 Yes, please forward an information sheet on to the following email address

Please note, we are in the process of developing this information sheet. It will be sent out to those who are interested upon its completion during 2021-2022.

Please enter the email address you would like to receive the information sheet/pamphlet:

Document S3: Pregnancy and heart disease – Information and resources for health professionals (Heart Foundation of Australia)¹³



heartfoundation.org.au | Helpline 13 11 12

Pregnancy and heart disease

Information and resources for health professionals.

Cardiovascular disease risk associated with pregnancy has until recent times been poorly acknowledged, researched and understood. However, we now know:

Women who have been diagnosed with either pre-eclampsia or gestational hypertension are at increased risk of subsequent hypertension and cardiovascular disease. The relative risk of chronic hypertension is four times and ischaemic heart disease twice that of women who did not experience these conditions in pregnancy.¹

Hypertensive disorders of pregnancy affect five to ten percent of pregnancies worldwide. In Australia, 30,000 women each year will develop high blood pressure in pregnancy and 10,000 of these will lead to preeclampsia.^{2,3}

Between five and ten percent of pregnant women will develop gestational diabetes, also associated with increased risk of Type 2 Diabetes and cardiovascular disease later in life. AIHW data collected in 2015 suggests that as many as 10.5 percent of Australian women may experience gestational diabetes.⁴

There is currently limited information available for women to understand these vascular conditions, their implications for long-term cardiovascular health and actions they can take to reduce their risk.

Resources for health professionals

CLINICAL MANAGEMENT ADVICE ^

Guidelines and recommendations have been developed for pregnancy care and long-term management of cardiovascular risk in the United States, Europe and Australia.

The following is based on current best practice.

Hypertension in pregnancy and preeclampsia

Clinical follow-up:

1. An annual blood pressure check
2. Regular (five-yearly or more frequently if indicated) assessment of other CV risk factors including serum lipids and blood glucose.¹

Advice for women who have experienced hypertensive disorders of pregnancy:

- Maintain a healthy weight
- Eat a healthy diet
- Engage in regular physical activity
- Don't smoke
- Plan subsequent pregnancies with your obstetrician

Gestational diabetes

Clinical follow-up:

Oral Glucose Tolerance Test six weeks after the birth, then every two to three years (annually if planning subsequent pregnancies).²

Advice for women who have experienced gestational diabetes:

- Maintain weight within a normal range by following a healthy diet.
- Take regular exercise – aim for 30 minutes of brisk walking five times a week.

(1) Lowe et al. *Society of Obstetric Medicine of Australian and New Zealand 2014. Guideline for the Management of Hypertensive Disorders of Pregnancy 2014*. Sydney: SOMANZ.

(2) *Australian Diabetes in Pregnancy Society Consensus Guidelines for the Testing and Diagnosis of Hyperglycaemia in Pregnancy in Australia and New Zealand (modified November 2014)*.

GUIDELINES AND TOOLS

- Lowe et al. *The SOMANZ Guideline for the Management of Hypertensive Disorders of Pregnancy*. Society of Obstetric Medicine of Australian and New Zealand 2014. Sydney: SOMANZ 2014
- NSW Health Policy Directive: PD2011_064. *Maternity - Management of Hypertensive Disorders of Pregnancy*. NSW Health: 2011
- Regitz-Zagrosek et al. *ESC Guidelines on the management of cardiovascular disease in pregnancy*. The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology. *European Heart Journal*. 2011; 32:3147-3197
- Royal Australian College of General Practitioners. *General Practice Management of Type 2 Diabetes*. 2016-2018
- *Australian Diabetes in Pregnancy Society Consensus Guidelines for the Testing and Diagnosis of Hyperglycaemia in Pregnancy in Australia and New Zealand (modified November 2014)*

INFORMATION FOR PATIENTS



- [Video: Preeclampsia explained by experts and women who lived it](#)
- [Video: Sabine shares her experience of preeclampsia during her second pregnancy](#)
- [Video: Learn more about Jo's experience of preeclampsia during both her pregnancies](#)
- [Fact sheet: Gestational diabetes & CVD \(PDF\)](#)
- [Fact sheet: High blood pressure in pregnancy & CVD \(PDF\)](#)