


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

Jessica Atkinson <sup>1,2</sup>, William Wei,<sup>3</sup> Stephanie Potenza,<sup>2</sup> Grace Simpson,<sup>1</sup> Anna Middleton,<sup>1,2</sup> Susan Walker,<sup>1,2</sup> Stephen Tong,<sup>1,2</sup> Roxanne Hastie,<sup>1,2</sup> Anthea Lindquist<sup>1,2</sup>

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/openhrt-2022-002230>).

**To cite:** Atkinson J, Wei W, Potenza S, *et al.* Patients' understanding of long-term cardiovascular risks and associated health-seeking behaviours after pre-eclampsia. *Open Heart* 2023;**10**:e002230. doi:10.1136/openhrt-2022-002230

Received 1 December 2022  
Accepted 27 February 2023



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Department of Obstetrics & Gynaecology, The University of Melbourne, Heidelberg, Victoria, Australia

<sup>2</sup>Mercy Perinatal, Mercy Hospital for Women, Heidelberg, Victoria, Australia

<sup>3</sup>School of Medicine, Deakin University, Burwood, Victoria, Australia

**Correspondence to**  
Dr Anthea Lindquist; [anthea.lindquist@unimelb.edu.au](mailto: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.<sup>1-7</sup> Having had pre-eclampsia confers a twofold increased risk of death due to coronary heart disease.<sup>2</sup>

Cardiovascular disease risk is often considered a disease of advanced age.<sup>8</sup> 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.<sup>9</sup> 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.<sup>10</sup>

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.<sup>11–12</sup> 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.<sup>13</sup> However, lifestyle intervention strategies and appropriate cardiovascular screening are not universally part of routine care for affected individuals in the postpartum context.<sup>13–15</sup>

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.<sup>16</sup> 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).<sup>13</sup> 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.<sup>17</sup>

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			<0.01
Yes	87 (54.7)	98 (38.1)	
No	72 (45.3)	159 (61.8)	
Twins and singletons			<0.01
Yes	91 (55.8)	114 (41.8)	
No	72 (44.2)	159 (58.2)	
Preterm birth			0.172
Preterm (<37 weeks)	61 (37.4)	84 (30.8)	
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.<sup>13</sup> Previous studies have highlighted the importance of regular cardiovascular monitoring in general for reducing burden of disease.<sup>2,10</sup> 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.<sup>18,19</sup> 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.<sup>20-22</sup> 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.<sup>23,24</sup> 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.<sup>25</sup> This finding has also been observed in an Australian context.<sup>26</sup> 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.<sup>27</sup>

### 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),<sup>28</sup> 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.<sup>29</sup> 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.<sup>30</sup> 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.<sup>31</sup> 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

**Acknowledgements** We are grateful to Joshua Samuel and the Quality, Systems and Extracts team at Mercy Health for facilitating and providing data extracts for this research.

**Contributors** AL and RH conceived of the study. AM provided technical support and created the patient survey. JA collected results and performed primary analysis. AL, RH, ST and SW served as scientific advisors. JA and WW drafted the manuscript. AL, RH, ST, SW, AM and GS critically reviewed the manuscript. AL acted as the guarantor of this manuscript.

**Funding** AL (No. 1185467), RH (No. 1176922) and ST (No. 1136418) receive salary support from the National Health and Medical Research Council of Australia.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by the Mercy Health Human Research Ethics Committee (HREC approval number 2021-018). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iD

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

## REFERENCES

- 1 Townsend R, O'Brien P, Khalil A. Current best practice in the management of hypertensive disorders in pregnancy. *Integr Blood Press Control* 2016;9:79–94.
- 2 Wu P, Haththotuwa R, Kwok CS, *et al*. Preeclampsia and future cardiovascular health: a systematic review and meta-analysis. *Circ Cardiovasc Qual Outcomes* 2017;10:e003497.
- 3 Brouwers L, van der Meiden-van Roest AJ, Savelkoul C, *et al*. Recurrence of pre-eclampsia and the risk of future hypertension and cardiovascular disease: a systematic review and meta-analysis. *BJOG* 2018;125:1642–54.
- 4 Benschop L, Brouwers L, Zoet GA, *et al*. Early onset of coronary artery calcification in women with previous preeclampsia. *Circ Cardiovasc Imaging* 2020;13:11.
- 5 Lo CCW, Lo ACQ, Leow SH, *et al*. Future cardiovascular disease risk for women with gestational hypertension: a systematic review and meta-analysis. *J Am Heart Assoc* 2020;9:e013991.
- 6 Melchiorre K, Thilaganathan B, Giorgione V, *et al*. Hypertensive disorders of pregnancy and future cardiovascular health. *Front Cardiovasc Med* 2020;7:59.
- 7 Arnott C, Nelson M, Alfaro Ramirez M, *et al*. Maternal cardiovascular risk after hypertensive disorder of pregnancy. *Heart* 2020;106:1927–33.
- 8 North BJ, Sinclair DA. The intersection between aging and cardiovascular disease. *Circ Res* 2012;110:1097–108.
- 9 Engeland A, Borge T, Klungsoyr K, *et al*. Preeclampsia in pregnancy and later use of antihypertensive drugs. *Eur J Epidemiol* 2015;30:501–8.
- 10 Behrens I, Basit S, Melbye M, *et al*. Risk of post-pregnancy hypertension in women with a history of hypertensive disorders of pregnancy: nationwide cohort study. *BMJ* 2017;358:j3078.
- 11 Berks D, Hoedjes M, Raat H, *et al*. Risk of cardiovascular disease after pre-eclampsia and the effect of lifestyle interventions: a literature-based study. *BJOG* 2013;120:924–31.

- 12 Lui NA, Jeyaram G, Henry A. Postpartum interventions to reduce long-term cardiovascular disease risk in women after hypertensive disorders of pregnancy: a systematic review. *Front Cardiovasc Med* 2019;6:160.
- 13 National Heart Foundation of Australia. Pregnancy and heart disease: information and resources for health professionals canberra. Available: [www.heartfoundation.org.au/conditions/fp-pregnancy-and-heart-disease](http://www.heartfoundation.org.au/conditions/fp-pregnancy-and-heart-disease) [Accessed 13 Apr 2022].
- 14 Hutchesson M, Shrewsbury V, Park F, *et al.* Are women with a recent diagnosis of pre-eclampsia aware of their cardiovascular disease risk? A cross-sectional survey. *Aust N Z J Obstet Gynaecol* 2018;58:E27–8.
- 15 Roth H, Homer CSE, Arnott C, *et al.* Assessing knowledge of healthcare providers concerning cardiovascular risk after hypertensive disorders of pregnancy: an Australian national survey. *BMC Pregnancy Childbirth* 2020;20:717.
- 16 Harris PA, Taylor R, Thielke R, *et al.* Research electronic data capture (redcap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81.
- 17 Lowe SA, Bowyer L, Lust K, *et al.* SOMANZ guidelines for the management of hypertensive disorders of pregnancy 2014. *Aust N Z J Obstet Gynaecol* 2015;55:e1–29.
- 18 Ettehad D, Emdin CA, Kiran A, *et al.* Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. *The Lancet* 2016;387:957–67.
- 19 Rahimi K, Bidel Z, Nazarzadeh M, *et al.* Pharmacological blood pressure lowering for primary and secondary prevention of cardiovascular disease across different levels of blood pressure: an individual participant-level data meta-analysis. *The Lancet* 2021;397:1625–36.
- 20 Pinckard K, Baskin KK, Stanford KI. Effects of exercise to improve cardiovascular health. *Front Cardiovasc Med* 2019;6:69.
- 21 Yu E, Malik VS, Hu FB. Cardiovascular disease prevention by diet modification: JACC health promotion series. *J Am Coll Cardiol* 2018;72:914–26.
- 22 Banks E, Joshy G, Korda RJ, *et al.* Tobacco smoking and risk of 36 cardiovascular disease subtypes: fatal and non-fatal outcomes in a large prospective Australian study. *BMC Med* 2019;17:128.
- 23 National Heart Foundation of Australia. Physical activity and your heart health canberra. Available: [www.heartfoundation.org.au/heart-health-education/physical-activity-and-exercise](http://www.heartfoundation.org.au/heart-health-education/physical-activity-and-exercise) [Accessed 29 Apr 2022].
- 24 National Heart Foundation of Australia. Fruit, vegetables and heart health canberra. Available: [www.heartfoundation.org.au/heart-health-education/fruit-vegetables-and-heart-health](http://www.heartfoundation.org.au/heart-health-education/fruit-vegetables-and-heart-health) [Accessed 29 Apr 2022].
- 25 Sandsæter HL, Horn J, Rich-Edwards JW, *et al.* Preeclampsia, gestational diabetes and later risk of cardiovascular disease: women's experiences and motivation for lifestyle changes explored in focus group interviews. *BMC Pregnancy Childbirth* 2019;19:448.
- 26 Roth H, Henry A, Roberts L, *et al.* Exploring education preferences of Australian women regarding long-term health after hypertensive disorders of pregnancy: a qualitative perspective. *BMC Womens Health* 2021;21:384.
- 27 Robert G, Cornwell J, Locock L, *et al.* Patients and staff as codesigners of healthcare services. *BMJ* 2015;350:g7714.
- 28 FLESCH R. A new readability yardstick. *J Appl Psychol* 1948;32:221–33.
- 29 Sattar N, Preiss D. Reverse causality in cardiovascular epidemiological research: more common than imagined? *Circulation* 2017;135:2369–72.
- 30 Henry A, Arnott C, Makris A, *et al.* Blood pressure postpartum (bp2) RCT protocol: follow-up and lifestyle behaviour change strategies in the first 12 months after hypertensive pregnancy. *Pregnancy Hypertens* 2020;22:1–6.
- 31 Rossiter C, Henry A, Roberts L, *et al.* Optimising mothers' health behaviour after hypertensive disorders of pregnancy: a qualitative study of a postnatal intervention. *BMC Public Health* 2022;22:1259.