**Healthcare professional’s knowledge of pregnancy complications and women's cardiovascular health: an international study utilising social media**

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**Abstract**

*Background*

Despite guidelines recommending the evaluation of adverse pregnancy outcomes (APOs) as a part of the atherosclerotic cardiovascular disease (ASCVD) risk assessment in women, there is limited awareness of this issue in healthcare professionals. We sought to evaluate the extent of this gap in knowledge.

*Methods*

An online study using a standardised questionnaire was advertised through newsletters and websites of professional organisations. Following a low response rate, the link to the survey was announced on Twitter and via personal email invitations. Differences between groups of respondents were evaluated with z-tests of proportion.

*Results*

Out of 446 complete responses, there were 315 cardiologists and 112 obstetricians and gynaecologists. There was an >90% awareness of association of adverse maternal outcomes with gestational hypertension and gestational diabetes with ASCVD, but only <60% awareness of association of adverse maternal outcomes with preterm birth. There were significant differences in ASCVD risk assessment and awareness of the association of APOs with adverse outcomes between cardiologists versus obstetricians and gynaecologists, and between female versus male cardiologists. A greater proportion of female cardiologists thought that the guidelines recommended annual follow-up for high-risk women. Conversely, a greater proportion of male cardiologists were unsure of the frequency of follow-up of such women in the relevant guidelines. A higher proportion of U.K. respondents thought that women with high-risk pregnancies should never be screened for cardiovascular disease postpartum compared with U.S. respondents.

*Conclusions*

In a self-selected group of healthcare professionals interested in women’s cardiovascular health, there remains a large gap in knowledge and awareness of the association of APOs with ASCVD risk, in particular a lack of awareness of the association of ASCVD risk with preterm delivery. Specific target groups for improving knowledge regarding these sex-specific risk enhancers include male cardiologists and healthcare professionals practising in the U.K.

**Introduction**

Atherosclerotic Cardiovascular disease (ASCVD), in particular coronary heart disease, is the leading cause of mortality amongst women in the United States (U.S.).1 Approximately 1 in 5 coronary heart disease events in women occur in the absence of traditional risk factors.2-4 Women receive ASCVD preventative care that is suboptimal compared with men.5-7 Not only are physicians more likely to assign a lower ASCVD risk category to female patients to comparable male patients, they also underestimate chance of ASCVD and are less likely to refer for diagnostic cardiac catheterization in symptomatic women.5,8 There is a trend of increasing prevalence of stroke and myocardial infarction in younger women,9,10 with an increasing rate of obesity amongst young women, compared with men.11-13 Additionally, younger women who present with an acute coronary syndrome have the highest mortality rate14,15 and the highest rates of rehospitalization,14,16 and are less likely to receive guideline directed medical therapies compared with their male peers.17

 It had been difficult to implement ASCVD prevention strategies in young women using simply the ASCVD risk score, since most women would have been estimated to be low risk .18 As of 2018, the risk stratification was further enhanced and included identification of sex-specific cardiovascular risk factors in women which should be utilized for more accurate risk stratification, and are labelled as “risk enhancers” by the American College of Cardiology and the American Heart Association.19,20 Adverse pregnancy outcomes (APOs) may serve to identify at-risk women early in their life course when preventative efforts may alter their trajectory to CVD.9 Current guidelines recommend the evaluation of APOs as part of the ASCVD risk assessment in women.20-23 For example, the AHA/ASA stroke prevention guidelines (2014) recommend for women with a history of preeclampsia/eclampsia, it is reasonable to consider evaluating them starting 6 months to 1 year post-partum and treat for cardiovascular risk factors including hypertension, obesity, smoking, and dyslipidemia.21 The AHA CVD prevention guidelines (2011) consider women with a history of preeclampsia, gestational diabetes, or pregnancy-induced hypertension as at risk and recommends lifestyle modification, blood pressure control and LDL-C lowering therapy if ≥190mg/dL.22 The AHA CVD prevention in adults guidelines (2019) added preeclampsia as a risk enhancing factor.24 The ESC CVD prevention guidelines (2016) suggest that in women with a history of preeclampsia and/or pregnancy-induced hypertension, periodic screening for hypertension and diabetes mellitus should be considered, while in women with a history of preterm birth, periodic screening for hypertension and diabetes mellitus may be considered.23 In the updated version, the ESC guidelines (2021) further added women with a history of stillbirth as a group that may also be considered for periodic screening.25

Despite ample research evidence and guideline recommendations,23,26,27 there is limited public and healthcare professional awareness of the long‐term cardiovascular consequences of APOs.28 A previous study showed that only 5% of internists included preeclampsia during history taking, while 50% of women with preeclampsia did not have any follow-ups in primary care by 3 months after delivery.29,30 Furthermore, only 60% of U.S. primary care physicians were aware of American Heart Association (AHA) guidelines for prevention of CVD in women.5 An understanding of the views of healthcare professionals involved in CVD prevention of women may help to identify factors that could be used to improve quality of care. We sought to evaluate the current level of awareness and knowledge of APOs and their association with future maternal CVD, as well as the relevant guidelines in this area, amongst cardiologists and obstetricians and gynaecologists (OBGyns) practising mainly in the U.S. or the United Kingdom (U.K.).

**Methods**

 An online cross-sectional survey using a standardised questionnaire regarding awareness and knowledge of APOs and future maternal cardiovascular outcomes was administered to healthcare professionals. The survey questions and model answers are shown in Supplemental Table 1. The survey was advertised through newsletters and websites of professional organisations (American College of Obstetricians and Gynecologists (ACOG), Royal College of Obstetricians and Gynaecologists (RCOG), British Maternal and Fetal Medicine Society (BMFMS), American College of Cardiology (ACC), British Cardiovascular Society (BCS)). Following a low response rate through a targeted approach via professional societies in December 2017, we started sending personal email invitations in September 2018. We then posted the URL to the survey on our Twitter profiles on 5 dates in October (PW 3rd, 5th, 16th; MM 3rd, 4th, 13th; MG 3rd, 4th). The survey responses were collected between December 2017 and December 2018.

 Survey responses were anonymous and provided demographic information on the respondents. There were 501 total responses and 446 complete responses, with an 89% completion rate. Out of these there were 315 cardiologists, 112 OBGyns and 19 healthcare professionals in other specialties.

 We used Stata/MP version 14.0 statistical package to perform all analyses. Descriptive statistics were used to characterise the healthcare professionals. Differences between groups of respondents were evaluated with z-tests of proportion. The two sample z-test of proportion determines whether the groups differ significantly on specific characteristics, taking into account the sample sizes of the groups. The “prtesti” command was used to perform the z-tests in Stata. Statistical significance was set at *p*<0.05. No adjustments were made for multiple comparisons. Ethical approval was obtained from Keele Independent Peer Review Committee.

**Results**

 The average time for survey completion was 2 minutes and 55 seconds. The characteristics of the survey respondents are shown in Table 1. Majority of respondents are cardiologists based in the U.S. Following a low response rate, the link to the survey was announced on Twitter and via personal email invitations. Supplemental Figure 1 show that the majority of survey responses in this study were obtained within the month of Twitter and email invitations.

 Supplemental Figure 2 show the survey results for the complete responses. Respondents most commonly enquire about gestational hypertension. There is an >90% awareness of association of adverse maternal outcomes with gestational hypertension and gestational diabetes, but less than 60% awareness of the association of adverse maternal outcomes with preterm birth. Coronary artery disease was most commonly thought to be associated with gestational hypertension and preterm birth, while diabetes was most commonly thought to be associated with gestational diabetes. ACOG, ACC and AHA were most commonly thought to have produced guidelines or recommendations in this field. Most respondents agreed that women with high-risk pregnancies should be screened for CVD postpartum but did not know the optimal timing for this. Of those that provided timing for this, 6 weeks postpartum was the most frequent response. Surprisingly, 5% of respondents thought these women do not need to be screened for CVD following delivery. In terms of knowledge of guidelines for frequency of follow-up of women with APOs, most respondents were unsure of the timing, with the second most common response being annually.

 We compared the responses from those specialising in cardiology to those specialising in obstetrics and gynaecology (Figure 1). There were significant differences in their cardiac risk assessment, their awareness of association with adverse outcomes, risk scores and guidelines in the field, as well as in the recognition of organizations that have produced guidelines or recommendations in the field. Specifically, 34% of cardiologist had awareness of relevant guidelines in the field, compared with 62% of OBGyns.

 Overall U.K. and U.S. respondents conducted similar cardiac risk factor assessments and had similar awareness of association of APOs with future adverse outcomes (Figure 2). A higher proportion of U.K. respondents thought chronic kidney disease were associated with gestational hypertension, preterm delivery and gestational diabetes compared with U.S. respondents. We found significant differences the recognition of organisations that have produced guidelines or recommendations in the field between respondents practising in the U.K. to those practising in the U.S. A higher proportion of U.K. respondents thought that women with high-risk pregnancies should never be screened for CVD postpartum compared with U.S. respondents. This is further compounded by a lower proportion of U.K. respondents thinking that guidelines recommend annual follow-up of these women in comparison with U.S. respondents.

 There was a significant difference in the cardiac risk factor assessments between female and male cardiologists (Figure 3). A greater proportion of female cardiologists were aware of the associations of preterm birth with future APOs as well as being aware of guidelines in this field. Similarly, a greater proportion of female cardiologists thought coronary artery disease was associated with gestational hypertension and preterm delivery, compared with male cardiologists. A greater proportion of male cardiologists thought ESC and RCOG produced guidelines in this field, while a greater proportion of female cardiologists thought ACOG produced the relevant guidelines. A greater proportion of female cardiologists wished to screen women with high-risk pregnancies at 6 weeks postpartum and thought that the guidelines recommended annual follow-up for women with gestational hypertension, preterm birth and gestational diabetes. Conversely, a greater proportion of male cardiologists were unsure of the frequency of follow-up of such women in the relevant guidelines.

 There was no difference in cardiac risk assessment and awareness of association of APOs with future adverse outcomes between cardiologists with ≤10 years’ and >10 years’ of experience (Figure 4). A significantly higher proportion of cardiologists with >10 years’ experience thought that preterm delivery was associated with chronic kidney disease, while a lower proportion of them thought preterm delivery was associated with depression, compared with cardiologists with ≤10 years’ experience. A higher proportion of cardiologist with ≤10 years’ experience thought that ACOG and RCOG had produced guidelines in this field, while a higher proportion of cardiologists >10 years’ experience thought that ACC had produced guidelines in this field or were unsure. A significantly higher proportion of cardiologists with ≤10 years’ experience thought that women with high-risk pregnancies should be screened for CVD at 6 weeks postpartum. In contrast, a higher proportion of cardiologists with >10 years’ experience did not know when the optimal timing is for follow-up of these women. A higher proportion of cardiologists with >10 years’ experience also thought guidelines suggest women with a history of preterm birth do not need to be screened for CVD postpartum.

 We compared the results of cardiologists practising in the U.K. with those practising in the U.S. (Supplemental Figure 3). A lower proportion of cardiologists in the U.K. included preterm birth in their cardiac risk factor assessment and were aware of preterm birth being associated with adverse outcomes, compared with cardiologists in the U.S. A higher proportion of U.K. cardiologists recognised European guidelines in the field. Conversely, a higher proportion of U.S. cardiologists recognised American guidelines. U.K. cardiologists were significantly more likely to recommend no postpartum screening is needed for women with high-risk pregnancies. This is also mirrored by them thinking the guidelines suggest no follow-up screening should occur for women with preterm birth and gestational diabetes.

 We also compared the results of OBGyns practising in the U.K. with those practising in the U.S. (Supplemental Figure 4). A significant lower proportion of OBGyns in the U.K. enquired about any pregnancy complications or gestational diabetes in their cardiac risk factor assessment, compared to those practising in the U.S. Similar to the cardiologists, U.K. OBGyns were more aware of European guidelines than U.S. guidelines. More U.K. OBGyns were unsure of the timing of postnatal follow-up recommended in the guidelines for women with gestational hypertension and gestational diabetes.

**Discussion**

*Current findings*

In this study of 315 cardiologists and 112 OBGyns, we found an >90% awareness of association of adverse maternal outcomes with gestational hypertension and gestational diabetes, but only <60% awareness of association of adverse maternal outcomes with preterm birth. Most respondents agreed that women with high-risk pregnancies should be screened for CVD postpartum, but did not know the optimal timing for this. There was a knowledge gap of frequency of follow-up of women with APOs according to the guidelines. There were significant differences in cardiac risk assessment and awareness of the association of APOs with adverse outcomes between cardiologists versus OBGyns, and between female versus male cardiologists (Figure 5). Therefore, in a cohort of providers interested in this field and self-motivated to complete the survey there are significant knowledge gaps in APOs and ASCVD risk scores.

*Previous literature*

 A study conducted in 2004 showed that 80-95% of cardiologists were aware of ASCVD prevention guidelines (AHA, Joint National Committee, National Cholesterol Education Program) compared with 40-60% of OBGyns.5 However, there was lower awareness in a study conducted 10 years later, whereby only 22% cardiologists fully implemented AHA guidelines for ASCVD risk assessment in women including APO assessment.31 The awareness of guidelines in our study is comparable to this study, confirming that knowledge and awareness of the importance of APOs in ASCVD prevention has reduced over time. The higher level of awareness and knowledge amongst OBGyns compared with cardiologists found in our study is in contrast with previous literature,32,33 this may be due to selection bias of our sample group where survey respondents already have an interest in the area of ASCVD prevention in women. Nonetheless, the societies of OBGyns have been proactively recognizing these risk factors that occur at pregnancy and have been encouraging ASCVD risk screening in women in the so-called “Fourth Trimester” period.34,35

*Education of healthcare professionals*

 Healthcare professionals can educate women and improve awareness of their ASCVD risk. As recommendations from doctors can strongly influence patient decisions,36 following counselling on ASCVD being their leading cause of death, women are more likely to engage in behaviours that are beneficial in reducing their ASCVD risk.37 Most women in the U.S. receive healthcare from primary care providers in the form of OBGyns, family physicians or internal medicine physicians.38 It is important to ensure there is adequate ASCVD prevention training of these healthcare professional groups. Furthermore, many women consider their OBGyns as their main primary care provider, particularly women who are younger, of ethnic minority, have lower income and educational status, and with young children.5,39-41 Although one study has shown that many women do not contact OBGyns until they require obstetric care,42 OBGyns are uniquely placed to provide high-risk women with opportunistic screening and preventative measures or referrals for ASCVD postnatally. The American College of Obstetricians and Gynecologists (ACOG) have also endorsed that OBGyns should offer interventions and referrals for dyslipidaemia, hypertension, diabetes, obesity, exercise, diet and smoking cessation.43,44 There remains a lack of training in sex and gender differences at medical school.45,46 Furthermore, knowledge and training deficits in OBGyns have been identified as a barrier to their ability to provide evidence-based care for ASCVD prevention.47 Strategies, such as continuing professional development, collaborative multidisciplinary care, joint guidelines and training from professional organisations in cardiology and obstetrics and gynaecology, are needed to improve ASCVD prevention care in women. Furthermore, there are age-specific barriers to ASCVD prevention efforts in younger women, such as lack of time, stress, and lower perception of risk.48 Therefore, strategies to improve uptake of ASCVD prevention efforts targeting women of reproductive age are also needed.

*Social media opportunity*

 Our recruitment for survey respondents increased dramatically following the use of social media. This suggest that there is an important role for the use of social media in education and advocacy.49 Previous research has shown that physicians who used email, Facebook, or Twitter were more aware of the ASCVD Risk Assessment Calculator than those who were less digitally engaged.31 Approaches such as Tweetorials or links to online training modules provided by professional organisations may be useful in improving healthcare professional knowledge in APOs and ASCVD preventative care.

*Strengths and limitations*

 The strengths of this study include the novel use of social media to recruit survey respondents in a timely fashion, the comparison of practice between the U.S. and U.K, and the relatively large sample cardiologists surveyed. There are some study limitations. Due to the recruitment strategy and the anonymous nature of this survey study, a major limitation is the inability to validate whether the individuals who answered this survey were who they said they were, e.g. their gender and profession. Although we were not able to verify whether the respondents answered multiple times, we did not find consecutive responses from the same IP address. Our study was online-based and in English, therefore it is possible that the result may not be generalizable to all cardiologists and OBGyns. Our results may be affected by selection bias, as the survey respondents may have ultimately targeted healthcare professionals interested in women’s cardiovascular health, who may have more knowledge and awareness of pertinent issues in this area and possible exposure of education of APOs through social media. We lacked power to conduct additional comparisons due to the small number of respondents in the subgroups. We could not fully assess gender as although we had an “other (please specify)” category for the gender question in the survey, there were no responses in this category. Finally, the majority of our survey period preceded the release of the ACC/AHA cholesterol guidelines in November 2018,20 which introduced the concept of risk enhancers including APOs. Only 7 responses were collected after this guideline was published. It would be a good opportunity to resample in future research to determine the impact of the inclusion of APOs with the update of the ASCVD risk calculator and cholesterol guidelines to see whether there is an improve in risk assessment awareness.

**Conclusions**

In a self-selected group of healthcare professionals interested in women’s cardiovascular health, there remains a large gap in knowledge and awareness of the association of APOs, in particularly preterm delivery, with poor long-term cardiovascular health. Strategies to raise awareness and improve knowledge of ASCVD prevention guidelines in healthcare professionals are needed. Specific target groups for improving knowledge include male cardiologists and healthcare professionals practising in the U.K. Future research into effective interventions to increase adaptation of ASCVD prevention guidelines would help to reduce inequalities in preventative care for women.

**Authors’ disclosure statement**

All authors have no conflicts of interest.

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