Risk Factors for Cardiovascular Disease among Pregnant Women in San Juan, Puerto Rico

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Objective: Cardiovascular disease (CVD) is the leading cause of death among women in Puerto Rico (PR). Cardiovascular disease risk factors (CVDRF) during pregnancy, such as obesity, type 2 diabetes (T2D), hypertension, and hypertensive disorders of pregnancy, increase risks for maternal and neonatal health. Limited data exist on CVDRF prevalence among pregnant women in PR.

Methods: This cross-sectional study analyzed medical records of 264 pregnant women aged 21-35 years with no prior pregnancies from an outpatient clinic in San Juan, PR, during 2018-2019. Key CVDRFs included pre-pregnancy obesity, T2D, gestational diabetes, hypertension, and hypertensive disorders of pregnancy. Age groups (21-25, 26-30, 31-35 years) were assessed for CVDRF prevalence. Logistic and multinomial regressions adjusted for sociodemographic variables were used to evaluate associations.

Results: Pre-pregnancy obesity was the most prevalent CVDRF (23.5%). Women aged 31-35 years had significantly higher odds of T2D/ gestational diabetes (OR=4.66; 95% CI=1.18, 18.4) and were more likely to experience two or more CVDRFs (RRR=2.73; 95% CI=1.10, 6.80).

Discussion: Findings align with global data showing increased CVDRF prevalence with age among pregnant women. Comparisons with Latino and non-Latino populations reveal shared risks, such as higher rates of gestational diabetes and obesity in older age groups, emphasizing the universal relevance of addressing maternal CVDRFs. Significance: This study highlights the importance of identifying and managing CVDRF among pregnant women in PR, particularly those aged 31-35 years. The findings provide critical data to inform targeted interventions, optimize prenatal care, and reduce long-term maternal and neonatal complications, contributing to improved health outcomes for Puerto Rican women.

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ardiovascular disease (CVD) poses a significant challenge to women's health, accounting for one-fifth of women's deaths in the United States (US). CVD has also emerged as the leading cause of death among women in Puerto Rico (PR), an unincorporated territory of the US largely comprised of Latinx persons (1). The main drivers of CVD, CVD risk factors (CVDRF), include high blood pressure, hyperlipidemia, type 2 diabetes (T2D), and obesity, which are largely preventable (2-4). In PR, the prevalence of these CVDRF is high among women: 34% for obesity, 39% for hypertension, 37% for hyperlipidemia, and 16% for T2D (5). Despite these alarming rates, little is known about CVDRF among pregnant women in PR.

Experiencing CVDRF is of great clinical and public health relevance for pregnant women and those trying to conceive. CVDRF may exacerbate pre-existing health conditions and influence adverse pregnancy outcomes and complications (6, 7). CVDRF can also lead to the development of maternal CVD and cardio-metabolic disorders and negatively affect the newborn's health (8-10). These complications are further exacerbated with age as the prevalence of CVDRF and pregnancy and birth-related complications increase (11, 12). In contemporary industrialized societies, women are increasingly choosing to conceive at later stages of life (13). In PR, this is compounded by the high outmigration rate of young persons, which is accelerating the aging of the island's population (14). These trends may lead to notable pregnancy and birth complications in PR, particularly for women with pre-existing CVDRF (15). Because

of this, it is imperative to document the CVDRF among pregnant women in PR and evaluate potential differences by age. Such knowledge is needed for early intervention and to preserve women's and children's health on the island. This study aimed to document the proportion of CVDRF (i.e., pre-pregnancy obesity, T2D, hypertension, gestational diabetes, and pre-eclampsia) in a sample of pregnant women in PR and evaluate their associations with age.

Methods _

Study design and Participants

This cross-sectional study utilized medical records from December 2018 to November 2019 at an outpatient clinic in San Juan, PR. The data were originally collected for a broader investigation of CVDRF and preeclampsia among women with no prior pregnancies. The current analysis specifically focuses on women aged 21-35 years during their pregnancy.

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Inclusion criteria included women aged 21-35 years with no prior pregnancies. Exclusion criteria were age below 21 or above 35 years and a history of prior pregnancies. These age groups were selected due to the clinical significance of reproductive health in women within their primary reproductive years (21-35), where a balance of fertility and health risks is observed (15, 16). Women above 35 years were excluded because the scope of this study was to explore risk factors in the typical reproductive age range, avoiding the confounding risks associated with advanced maternal age, which is better studied as a distinct category. A total of 302 medical records were available for review, of which 38 were excluded due to incomplete data regarding prior pregnancies, leaving a final sample of 264 women. The study was approved by the Institutional Review Board of San Juan Bautista School of Medicine (Approval num. EMSJB IRB-24-2018).

Definitions of CVDRF

The study investigated five key CVDRF: pre-pregnancy obesity, T2D, hypertension, gestational diabetes, and hypertensive disorders of pregnancy (including gestational hypertension and preeclampsia).

Obesity pre-pregnancy was defined as a body mass index (BMI) \geq 30.0 kg/m², calculated from pre-pregnancy weight and height documented in medical records. When pre-pregnancy weight was unavailable, weight from the early stages of the current pregnancy was used (n=17).

T2D, characterized by insulin resistance and impaired glucose metabolism leading to elevated blood sugar levels, was determined based on documented diagnoses in the medical records using the codes E08, E09, E10, E11, and E13.

Gestational Diabetes is a form of diabetes diagnosed during pregnancy that was not clearly present before gestation. Gestational diabetes was determined based on documented diagnoses in the medical records using the code O24.

Hypertension is marked by persistently high blood pressure, typically \geq 140/90 mmHg. Hypertension was determined based on documented diagnoses in the medical records using the code I10.

Hypertensive disorders during pregnancy are a group of conditions characterized by high blood pressure during pregnancy, including gestational hypertension (high blood pressure that develops after 20 weeks of pregnancy without proteinuria or other systemic signs of preeclampsia) and preeclampsia (a more severe condition occurring after 20 weeks of pregnancy, characterized by high blood pressure along with proteinuria or signs of organ dysfunction). Hypertensive disorders during pregnancy were determined based on documented diagnoses in the medical records using the codes O13, O14, O15, and O16.

Due to the small number of T2D (n=8) and gestational diabetes (n=9), we collapsed these two CVDRFs into one group (i.e., T2D or gestational diabetes).

Total number of CVDRF. The total number of CVDRF was calculated by adding up the number of the diseases mentioned above experienced by each subject. The range of the total number of CVDRF was 0-5, which was further categorized into: 0 risk factors, 1 risk factor, and 2 or more risk factors.

Socio-Demographic characteristics

Sociodemographic variables available in the medical records and considered in this analysis included age, race, ethnicity, current smoking, and area of residency. Age groups were categorized into 21-25 years, 26-30 years, and 31-35 years to examine the relationship between increasing age and CVDRF. This categorization aligns with trends in obstetrics, where women aged 21-35 represent the primary reproductive age range (15), while age stratification allows for nuanced insights into risk factor variation. For race, participants self-identified as either White, Black, Asian, or other. For ethnicity, participants self-identified between Hispanic or Non-Hispanic. The area of residency was categorized into San Juan metropolitan area (including San Juan, Guaynabo, Bayamón, Cataño, Carolina, and Trujillo Alto) and outside of the San Juan metropolitan area (all other municipalities).

Statistical analysis

Characteristics and proportion of each CVDRF and number of CVDRF were contrasted by age group using Chi-square tests or Fisher's exact tests, when appropriate. Adjusted logistic regression (for each CVDRF) and multinomial (for the total number of CVDRF) models were used to explore the association between age and each CVDRF, using the 21-35y group as the reference. Models were adjusted for race and area of residency. Ethnicity was not considered a confounder due to the high proportion of persons identifying as Hispanic. A low proportion of subjects reported smoking and thus were not included in regression models. Significance was set at p<0.05. STATA version 14 was used.

Results

Sample characteristics are shown in Table 1. Slightly over 40% of women were 26-30y, the majority (85.6%) self-identified as White, and all participants self-identified as Hispanic. Women of younger age were more likely to report residing in non-metropolitan areas than women of older age (p=0.026). The most common CVDRF experienced was obesity, with almost a quarter of women having obesity pre-pregnancy. Overall, 36% experienced at least one CVDRF (Table 1).

There was an apparent higher proportion of persons with each CVDRF evaluated with increasing age group, but only significant for T2D or gestational diabetes (Table 1). For instance, 19% of women between the ages of 21-25y experienced obesity before their current pregnancy, whereas this proportion was 24% and 30% for participants in the 26-30y and 31-35y, respectively. This difference was not statistically significant (p=0.28). The proportion of women with hypertension was approximately 6% in the 21-25y and 26-30y groups but almost doubled in women of 31-35y, albeit not statistically significant (p=0.17). The proportion of women diagnosed with T2D or having gestational diabetes was only 3% in the 21-25y and 26-30y groups, whereas this was significantly higher, 14%, for women of 31-35y (p=0.017). The presence of at least one CVDRF was marginally significantly higher among women of older age (p=0.076).

 Table 1. Sample characteristics and proportion of CVDRF among women seeking care at an outpatient clinic in San Juan, PR (n=264).

| | Age group | | | | | |
|---|--------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---------|--|
| Characteristic | Total Sample n=264 (100%) | 21-25y n=91 (34.5%) | 26-30y n=109 (41.3%) | 31-35y n=64 (24.2%) | p value | |
| Race White Black | 226 (85.6) 38 (14.4) | 76 (83.5) 15 (16.5) | 96 (88.1) 13 (11.9) | 54 (84.4) 10 (15.6) | 0.63 | |
| Hispanic ethnicity | 264 (100.0) | 91 (100.0) | 91 (100.0) | 64 (100.0) | 1.00 | |
| Area of residency San Juan area Non-San Juan area | 80 (30.3) 184 (69.7) | 18 (19.8) 73 (80.2) | 39 (35.8) 70 (64.2) | 23 (35.9) 41 (64.1) | 0.026 | |
| Smoking* Never or former smoker Current smoker | 247 (98.8) 3 (1.2) | 83 (33.6) 0 (0.0) | 104 (98.1) 2 (1.9) | 60 (98.4) 1 (1.6) | 0.47 | |
| Obesity | 62 (23.5) | 17 (18.9) | 26 (23.9) | 19 (29.7) | 0.28 | |
| T2D or gestational diabetes | 16 (6.1) | 3 (3.3) | 4 (3.7) | 9 (14.1) | 0.017 | |
| Hypertension | 22 (8.4) | 6 (6.7) | 7 (6.4) | 9 (14.1) | 0.17 | |
| Preeclampsia | 37 (14.0) | 11 (12.1) | 17 (15.6) | 9 (14.1) | 0.78 | |
| Number of CVD risk factors 0 1 2+ | 169 (64.0) 59 (22.4) 36 (13.6) | 65 (71.4) 15 (16.5) 11 (12.1) | 70 (64.2) 28 (25.7) 11 (10.1) | 34 (53.2) 16 (25.0) 14 (21.9) | 0.076 | |

T2D : type 2 diabetes. *Data missing for 14 participants. p values are from Chi-square tests or Fisher's exact test, when appropriate. Column percentages are shown.

In adjusted models, women in the 31-35y group (vs. 21-25y) had marginally significantly higher odds of obesity (OR=1.95; 95% CI=0.91, 4.18) and hypertension (OR=2.84; 95% CI=0.93, 8.69) (Table 2). Additionally, women in the 31-35y group (vs. 21-25y) had significantly higher odds of T2D or gestational diabetes (OR=4.66; 95% CI=1.18, 18.4) and of experiencing 2 or more CVDRF (RRR=2.73; 95% CI=1.10, 6.80); however, caution needs to be taken when evaluating these estimates due to small cell size and wide confidence intervals.

Discussion

To our knowledge, this is the first study evaluating the association between age and CVDRF among pregnant women with no prior pregnancies in PR. Our findings show that pre-pregnancy obesity was the most prevalent CVDRF and that women in the 31-35y age group were more likely to experience T2D/ gestational diabetes and have two or more CVDRF compared to women of younger age.

Pre-pregnancy obesity in our sample was observed in 23.5% of women, which is consistent with prior studies in PR, reporting obesity rates of 19-23% in pregnant women depending on the region and study period (17, 18). Comparable studies in Latino populations outside PR reveal similar or higher obesity rates. For example, research conducted in California identified Hispanic women's pre-pregnancy obesity rates of approximately 33% (19). This highlights the shared burden of obesity in Latino populations. In addition, in non-Latino populations outside of PR, prepregnancy obesity is also alarming. A study in the United States that used data from the National Vital Statistics System reported a 26% rate for 2016 and a 29% rate for 2019 among pregnant women nationwide (20). This rate increase was observed for all race

and age groups (20), suggesting that pre-pregnancy obesity is a nationwide problem that needs to be addressed.

The significant association between age and T2D or gestational diabetes observed in our study aligns with findings in other studies among Latino populations. Our study found that 14% of women in the 31-35y group experienced T2D/gestational diabetes. Research in Brazil, for instance, has shown that older pregnant women (\geq 30 years) are at a higher risk of developing gestational diabetes compared to younger women, with prevalence rates nearing

Table 2. Association between age and CVD risk factors among women seeking care at an outpatient clinic in San Juan, PR (n=264).

| Age | Obesity | T2D or gestational diabetes OR (95% CI) | Hypertension OR (95% CI) | Preeclampsia OR (95% Cl) | Number of CVD risk factors | | |
|----------------------------|--|---|--|---|-------------------------------------|---|---|
| | OR (95% CI) OF | | | | 0 RRR (95% CI) | 1 RRR (95% CI) | 2+ RRR (95% CI) |
| 21-25y 26-30y 31-35y | Reference 1.43 (0.72, 2.88) 1.95 (0.91, 4.18)* | Reference 1.11 (0.24, 5.23) 4.66 (1.18, 18.4)** | Reference 1.19 (0.38, 3.76) 2.84 (0.93, 8.69)* | Reference 1.34 (0.59, 3.07) 1.20 (0.46, 3.13) | Reference Reference Reference | Reference 1.71 (0.93, 3.50) 2.00 (0.87, 4.56) | Reference 1.05 (0.42, 2.62) 2.73(1.10,6.80)** |

T2D: type 2 diabetes. All estimates are from logistic regression models except for number of CVD risk factors, in which case are from multinomial regressions. All estimates are adjusted for race and area of residency. *Marginally significant: 0.05>p value<0.01.**Statistically significant: p value<0.05.

12% (21). Similar findings have been observed in non-Latino populations, such as in Canada and Australia, where gestational diabetes prevalence exceeds 10% among women aged 30 and older (22, 23). These parallels underscore the need for targeted screening and management for T2D and gestational diabetes for childbearing women, particularly those in older age groups.

The prevalence of hypertensive disorders, including gestational hypertension and preeclampsia, was marginally significantly higher among older women in our study. Other studies have found significant associations between hypertensive disorders and age. In Ethiopia, for example, a hospital-based study reported that hypertensive disorders were significantly more common in women aged 30 and above, with rates reaching 16% (24). In non-Latino populations, such as in Finland and Indonesia countries, studies have similarly shown increased rates of preeclampsia among older pregnant women (25).

Our study highlights the compounded risks associated with multiple CVDRF in older pregnant women, a phenomenon supported by international literature. In India, research has documented that women with two or more CVDRFs experience higher rates of adverse pregnancy outcomes, such as preterm delivery and low birth weight (26). These findings reinforce the importance of integrated approaches to maternal health, focusing on early detection and comprehensive management of CVDRF.

Given PR's unique socio-political context, its rapidly aging population, and the substantial burden of CVDRF experienced by women on the island (5), larger studies are needed to deeply understand the health risks of women with no prior pregnancies giving birth after 30y age. Future studies should evaluate continued health care during the postpartum period in this population subgroup to prevent CVD and early intervention of offspring promoting cardiometabolic health.

This study has limitations that need to be considered when interpreting our results. Firstly, the study had a small cell size for some of the CVDRF evaluated, especially when evaluating by age group, as evidenced by wide confidence intervals in regression models. Secondly, the study had limited data on covariates made available by the clinic and was not able to account for important covariates such as the age of onset of CVDRF, gestational weight gain, and behavioral factors; these need to be considered in future studies. Nonetheless, the valuable knowledge generated for pregnant women in PR offset these limitations.

In conclusion, our study provides valuable insights into the prevalence and age-related patterns of CVDRF among pregnant women in PR, with comparisons to similar groups in Latino and non-Latino populations. These findings emphasize the need for culturally tailored public health interventions and prenatal care strategies to mitigate the burden of CVDRF globally. Larger studies are needed to confirm our findings and to continue monitoring the health of women at high risk of CVD throughout the postpartum period.

Resumen

Objetivo: La enfermedad cardiovascular (CVD) es la principal causa de muerte entre las mujeres en Puerto Rico (PR). Los factores de riesgo de enfermedad cardiovascular (CVDRF) durante el embarazo, como la obesidad, diabetes tipo 2 (T2D), hipertensión y los trastornos hipertensivos del embarazo, aumentan los riesgos para la salud materna y neonatal. Existe información limitada sobre la prevalencia de los CVDRF en mujeres embarazadas en PR. Métodos: Este estudio transversal analizó los expedientes médicos de 264 mujeres embarazadas de 21 a 35 años sin embarazos previos de una clínica ambulatoria en San Juan, PR, durante 2018-2019. Los principales CVDRF incluyeron obesidad pregestacional, T2D, diabetes gestacional, hipertensión y trastornos hipertensivos del embarazo. Se evaluó la prevalencia de los CVDRF en grupos de edad (21-25, 26-30, 31-35 años). Se utilizaron regresiones logísticas y multinomiales ajustadas por variables sociodemográficas para evaluar las asociaciones. Resultados: La obesidad pregestacional fue el CVDRF más prevalente (23.5%). Las mujeres de 31 a 35 años tuvieron significativamente mayores probabilidades de presentar T2D/diabetes gestacional (OR=4.66; IC 95%=1.18, 18.4) y más probabilidades de experimentar dos o más CVDRF (RRR=2.73; IC 95%=1.10, 6.80). Discusión: Los hallazgos coinciden con datos globales que muestran un aumento de los CVDRF con la edad en mujeres embarazadas. Comparaciones con poblaciones latinas y no latinas revelan riesgos compartidos, como tasas más altas de diabetes gestacional y obesidad en grupos de mayor edad, destacando la relevancia universal de abordar los CVDRF maternos. Significancia: Este estudio subraya la importancia de identificar y manejar los CVDRF en mujeres embarazadas en PR, particularmente en aquellas de 31-35 años. Los hallazgos aportan datos críticos para informar intervenciones dirigidas, optimizar el cuidado prenatal y reducir complicaciones maternas y neonatales a largo plazo, contribuyendo a mejorar los resultados de salud de las mujeres puertorriqueñas.

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